FINAL DRAFT

RI/FS Work Plan
LEHR Environmental Restoration
University of California at Davis

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Volume II

U.S. Department of Energy

Oakland Operations Office
Environmental Restoration

APPENDIX A
FINAL DRAFT
FIELD SAMPLING PLAN
RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

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DAVIS, CALIFORNIA

TABLE OF CONTENTS

SECTION **PAGE**

1.0 INTRODUCTION 1.1
1.1 PURPOSE AND OBJECTIVES 1.2
1.2 APPROACH AND FORMAT 1.3

2.0 BACKGROUND 2.1
2.1 LEHR SITE HISTORY 2.1
2.2 PHYSICAL SETTING 2.2
2.3 CHEMICAL IMPACTS 2.4

3.0 MAPS 3.1
3.1 LEHR SITE LOCATION 3.1
3.2 SOIL INVESTIGATION LOCATIONS 3.1
3.3 WATER AND AIR MONITORING LOCATIONS 3.2

4.0 RATIONALE AND APPROACH 4.1
4.1 SOIL INVESTIGATION 4.1
4.1.1 Background Study 4.2
4.1.2 DOE Burial Trenches, and DOE Disposal Box (OU-1) 4.2
4.1.3 UC Davis Disposal Trenches (OU-1) 4.3
4.1.4 Radium-226 Treatment Tank and Leach System (OU-2) 4.4
4.1.5 Strontium-90 Treatment (Imhoff) System (OU-2) 4.6
4.1.6 Western Dog Pen and North Chemical Dispensing Areas (OU-3) . 4.8

4.1.7 Domestic Septic Tanks (OU-4) 4.9
4.1.8 UC Davis Landfill Units (OU-5) 4.10
4.2 WATER MONITORING 4.11
4.2.1 Groundwater 4.11
4.2.2 Surface Water 4.12
4.2.3 Storm Water 4.12
4.3 HYDROLOGIC INVESTIGATION (OU-6) 4.13
4.3.1 CPT/Hydropunch™ 4.13
4.3.2 Monitoring Well Installation 4.14
4.3.3 Saturated Zone Modelling Parameters 4.15
4.4 AIR QUALITY INVESTIGATION 4.15

5.0 SAMPLE ANALYSIS 5.1
5.1 SUMMARY OF ANALYSES 5.1
5.2 ANALYTICAL AND LABORATORY QUALITY CONTROL PROCEDURES . 5.42

6.0 FIELD METHODS AND PROCEDURES 6.1
6.1 GEOPHYSICAL INVESTIGATIONS 6.1
6.1.1 Background Soils Investigation 6.4
6.1.2 DOE Burial Areas, Trenches and DOE Disposal Box (OU-1) 6.4
6.1.3 UC Davis Burial Trenches (OU-1) 6.4
6.1.4 Radium-226 Treatment System (OU-2) 6.4
6.1.5 Strontium-90 Treatment System (OU-2) 6.5
6.1.6 Western Dog Pens and North Chemical Dispensing Areas (OU-3) 6.5
6.1.7 Domestic Septic Systems (OU-4) 6.5
6.1.8 UC Davis Landfill Units (OU-5) 6.6
6.1.9 Regional Stratigraphic Evaluation 6.6
6.2 SOIL VAPOR SURVEY 6.6
6.2.1 Background Soils Investigation 6.7
6.2.2 DOE Burial Areas, Trenches and DOE Disposal Box (OU-1) 6.8
6.2.3 UC Davis Burial Trenches (OU-1) 6.8
6.2.4 Radium-226 Treatment System (OU-2) 6.8
6.2.5 Strontium-90 Treatment (Imhoff) System (OU-2) 6.8

6.2.6 Western Dog Pens and North Chemical Dispensing Areas (OU-3) 6.8
6.2.7 Domestic Septic Systems (OU-4) 6.9
6.2.8 UC Davis Landfill Units (OU-5) 6.9
6.3 EXPLORATORY TRENCH INVESTIGATION 6.9
6.3.1 Background Soils Investigation 6.14
6.3.2 DOE Burial Areas, Trenches and DOE Disposal Box (OU-1) . . . 6.14
6.3.3 UC Davis Burial Trenches (OU-1) 6.15
6.3.4 Radium-226 Treatment System (OU-2) 6.15
6.3.5 Strontium-90 Treatment (Imhoff) System (OU-2) 6.16
6.3.6 Western Dog Pens and North Chemical Dispensing Areas 6.17
6.3.7 Domestic Septic Systems (OU-4) 6.17
6.3.8 UC Davis Landfill Units (OU-5) 6.17
6.4 SOIL BORINGS 6.17
6.4.1 Background Soils Investigation 6.19
6.4.2 DOE Burial Areas, Trenches and DOE Disposal Box (OU-1) . . . 6.19
6.4.3 UC Davis Burial Trenches (OU-2) 6.20
6.4.4 Radium-226 Treatment System 6.20
6.4.5 Strontium-90 Treatment System (OU-2) 6.21
6.4.6 Western Dog Pen Area and North Chemical Dispensing Area (OU-6) 6.21
6.4.7 Domestic Septic Systems 6.22
6.4.8 UC Davis Landfill Units 6.22
6.5 SOIL PERMEABILITY TESTING 6.23
6.6 WELL INSTALLATION AND ABANDONMENT 6.23
6.6.1 Well Borings 6.23
6.6.2 Soil Logging and Sample Collection 6.24
6.6.3 Monitoring Well Installation 6.26
6.6.4 Well Construction Materials 6.26
6.6.5 Piezometer Installation 6.27
6.6.6 Monitoring Well Abandonment 6.28
6.7 WELL DEVELOPMENT 6.28
6.8 CPT/HYDROPUNCH™ INVESTIGATION AND IN SITU WATER SAMPLING 6.29

6.9 WATER SAMPLING 6.30
6.9.1 Preparation and Mobilization 6.30
6.9.2 Groundwater Monitoring 6.32
6.9.3 Piezometer Sampling 6.35
6.9.4 Surface Water Monitoring Procedures 6.35
6.9.5 Storm Water Sampling Procedures 6.35
6.9.6 Field Quality Assurance Sampling - Water 6.37
6.9.7 Water Sample Packaging and Shipping 6.40
6.10 SATURATED ZONE PERMEABILITY TESTING 6.40
6.11 BASELINE AIR MONITORING INVESTIGATION 6.41
6.12 BIOTA INVESTIGATION 6.41

7.0 REFERENCES1 . . . . . 7.1

FINAL DRAFT
FIELD SAMPLING PLAN
RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

LIST OF TABLES, FIGURES AND ATTACHMENTS

LIST OF TABLES

TABLE A-5.1 SAMPLE ANALYSES - SOIL 5.2
TABLE A-5.2 SAMPLE ANALYSES - WATER 5.21
TABLE A-5.2a WATER SAMPLE ANALYSES — TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES 5.30
TABLE A-5.3 SAMPLE ANALYSES - AIR 5.38
TABLE A-6.1 SUMMARY OF SOIL INVESTIGATION ACTIVITIES 6.2
TABLE A-6.2 PROPOSED WATER MONITORING SCHEDULE FOR ONE MONITORING YEAR 6.3
TABLE A-6.3 SOIL ANALYTICAL PARAMETERS 6.12
TABLE A-6.4 SOIL ANALYTICAL PARAMETERS - MONITORING WELL SOIL BORINGS 6.25
TABLE A-6.5 MONITORING PARAMETERS GROUNDWATER SAMPLES 6.31
TABLE A-6.6 MONITORING POINTS FOR THE WATER MONITORING PROGRAM . . 6.34
TABLE A-6.7 MONITORING PARAMETERS - SURFACE WATER 6.36
TABLE A-6.8 MONITORING PARAMETERS - STORM WATER RUNOFF 6.38
TABLE A-6.9 PROPOSED WATER MONITORING SCHEDULE FOR ONE MONITORING YEAR 6.39
TABLE A-6.10 ANALYTICAL PARAMETERS - AIR MONITORING 6.42

LIST OF FIGURES

FIGURE A1 SITE LOCATION MAP

FIGURE A2 SITE VICINITY MAP

FIGURE A3 SITE STRUCTURES AND FEATURES

FIGURE A4 INVESTIGATION AREAS

FIGURE A5 LOCATION MAP BACKGROUND SOIL BORINGS

FIGURE A6 APPROXIMATE LOCATION MAP DOE DISPOSAL TRENCHES SAMPLING POINTS

FIGURE A7 LOCATION MAP DOE DISPOSAL BOX

FIGURE A8 LOCATION MAP UC DAVIS DISPOSAL TRENCH SAMPLING POINTS

FIGURE A9 LOCATION MAP RADIUM-226 TREATMENT SYSTEM SAMPLING POINTS

FIGURE A10 LOCATION MAP STRONTIUM-90 (IMHOFF) TREATMENT SYSTEM SAMPLING POINTS

FIGURE A11 LOCATION MAP WESTERN DOG PEN AREA SAMPLES

FIGURE A12 APPROXIMATE LOCATION OF DOMESTIC SEPTIC TANKS AT LEHR

FIGURE A13 LOCATION MAP LANDFILL UNIT NO. 1 SAMPLING POINTS

FIGURE A14 LOCATION MAP UC DAVIS LANDFILL UNIT NO. 2 SAMPLING POINTS

FIGURE A15 LOCATION MAP UC DAVIS LANDFILL UNIT NO. 3 SAMPLING POINTS

FIGURE A16 SCHEMATIC DRAWING DISPOSAL TRENCHES AND LANDFILL SAMPLING POINTS

FIGURE A17 CONCEPTUAL DIAGRAM OF DOMESTIC SEPTIC TANK SAMPLING LOCATIONS

FIGURE A18 LOCATION OF DOUBLE RING/DOWNHOLE PERMEABILITY TESTS

FIGURE A19 FIRST HSU GROUNDWATER CONTOUR ELEVATION AUGUST 27, 1993

FIGURE A20 SECOND HSU GROUNDWATER CONTOUR ELEVATIONS AUGUST 27, 1993

FIGURE A21 LOCATION MAP PROPOSED GROUNDWATER MONITORING WELLS

FIGURE A22 LOCATION MAP PROPOSED CPT/HYDROPUNCH™ LOCATIONS

FIGURE A23 LOCATION MAP SURFACE WATER MONITORING POINTS

FIGURE A24 LOCATION MAP STORM WATER RUNOFF MONITORING POINTS

FIGURE A25 LOCATION MAP AIR PERIMETER MONITORING STATIONS

LIST OF ATTACHMENTS

ATTACHMENT 1 STANDARD OPERATING PROCEDURES

ATTACHMENT 2 FIELD DOCUMENTATION FORMS

FINAL DRAFT
FIELD SAMPLING PLAN
RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

1.0 INTRODUCTION

This Final Draft Field Sampling Plan (FSP) has been prepared to conduct a Remedial Investigation (RI) at the former Laboratory for Energy-Related Health Research facility (LEHR site) located at the University of California, Davis (Figures A1 and A2). This FSP, combined with the Quality Assurance Project Plan (QAPjP) presented in Appendix B of this document, represents the Sampling and Analysis Plan (SAP) for the RI. This FSP has been developed in accordance with the following documents: ~~This FSP has been developed as part of the Sampling and Analysis Plan (SAP) and in accordance with the following documents:~~

- Draft Remedial Investigation/Feasibility Study (RI/FS) Work Plan, LEHR Environmental Restoration; Davis, California: prepared by Dames & Moore; and

- Preparation of a U.S. EPA Region 9 Sampling and Analysis Plan for Private and State-Lead Superfund Projects: Document Control No. 9QA-06-89, USEPA Region 9 (April 1990).

The RI to be conducted at the LEHR site is presented in the RI/FS Work Plan, and was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). For the purposes of the RI, the LEHR site has been divided into ten investigation areas as follows:

- The U.S. Department of Energy (DOE) burial areas and trenches in the southwest corner of LEHR and the disposal unit known as the "DOE Disposal Box";

- The radium-226 treatment system, a septic treatment system;

- The strontium-90 treatment (Imhoff) system, which also treated septage;
- The seven domestic septic tanks and associated leach systems;
- The western dog pen area, including the area currently occupied by the Cellular Biology Laboratory, and the north chemical dispensing area;
- The UC Davis trenches between Landfill Unit Nos. 1 and 2, and along the south side of the dog pens;
- The UC Davis Landfill Unit (Nos. 1, 2, and 3);
- Groundwater;
- Surface water; and
- Air.

The RI of these investigation areas has been divided into a number of tasks addressing soil, water, and air. These investigations are described in detail in the RI/FS Work Plan, and summarized in appropriate sections of this document.

1.1 PURPOSE AND OBJECTIVES

The purpose of this FSP is to document the sample locations, numbers, and analytical procedures and field methods that will be used during the RI. Specific objectives of sampling and analysis during the RI include:

- Provide data for use in assessing the nature and extent of LEHR site impacts noted during previous investigations;
- Provide data for use in developing the Risk Assessment and Feasibility Study (FS) portions of this investigation;
- Provide information to support the Environmental Assessment (EA) required by the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) for remediation;
- Monitor seasonal variations of impacts at the LEHR site; and

- Provide additional data during construction of monitoring systems to guide in the final design and selection of appropriate materials. For example, information obtained during the drilling of soil borings will be used to finalize the design of monitoring wells (screen length and filter pack).

This FSP is part of the overall quality assurance program for the LEHR site and has been developed to be consistent with the QAPjP. A final draft copy of the QAPjP is submitted concurrently with this document as Appendix B to this RI/FS Work Plan. A Health and Safety Plan (HSP) is also submitted concurrently with this document as Appendix C to this RI/FS Work Plan.

1.2 APPROACH AND FORMAT

Currently, there are no regulatory enforcement actions driving the RI for the LEHR site, although the LEHR site has been included on the National Priority List (NPL). The RI/FS is being conducted as part of the overall environmental restoration program sponsored by the DOE. To comply with this program, the RI/FS was developed using the EPA guidance document "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988). As such, to obtain sufficient quality and quantities of data for the RI, the work will be performed under QAMS-005, NQA-1, and DOE 5700.6C Quality Assurance specifications.

This FSP is intended to be a document for use by personnel conducting field investigations for the RI. The format of the FSP was developed based on the EPA Region 9 guidance document (EPA, April 1990). Chapter 2, Background, summarizes the LEHR site history, hydrogeologic characteristics, and environmental conditions in groundwater, soil, surface water, and sediment. Maps outlining each of the areas of investigation, known sources of LEHR site constituents, and other relevant information are discussed in Chapter 3. The rationale for sample locations, numbers of samples, and analytical parameters are presented in Chapter 4. The proposed analytical methods and methodology for sample collection are discussed in Chapters 5 and 6, respectively. References for this document are presented in Chapter 7. Standard operating procedures (SOP) that will be employed during the RI are presented in Attachment 1, and Field Documentation Forms are presented in Attachment 2.

2.0 BACKGROUND

Presented below is a brief description of the LEHR site background. A detailed discussion of the LEHR site background and previous investigations conducted at the LEHR site are presented in Chapters 2 and 3, respectively, of the RI/FS Work Plan.

The LEHR site encompasses approximately 15 acres and consists of one- and two-story laboratory and office buildings, and animal-handling facilities. The LEHR site is located in a rural area in the southeast portion of the UC Davis campus, and is bounded on the west, north and east by UC Davis research facilities. The southern boundary of the LEHR site is the northern levee of the South Fork of Putah Creek (Putah Creek). Private land is adjacent to and surrounds UC Davis property on all sides. Most of the private land is used for agricultural purposes.

2.1 LEHR SITE HISTORY

UC Davis conducted radiological studies on laboratory animals for the DOE beginning in the 1950s until the mid 1980s. The initial studies, conducted for the U.S. Atomic Energy Commission (AEC, now DOE), involved the irradiation of beagles at the UC Davis main campus. Eventually, irradiation experiments were discontinued at the LEHR site which was then used to house the breeding colony that supplied beagles for future studies at LEHR.

Full-scale experimental use of radioactive materials, including strontium-90 and radium-226, began at LEHR in 1960. In the initial stages of operation at the LEHR site, waste was handled through a central handling facility on the main campus. However, due to safety concerns, waste handling for LEHR-generated waste was returned to the LEHR site in the early 1960s.

Portions of the LEHR site had previously been used as the UC Davis campus landfill. At the LEHR site, the landfill consisted of two separate disposal units. Disposal in the oldest unit, Landfill Unit No. 1, began in the 1940s and ceased in the late 1950s to early 1960s. This area is now covered by the Cobalt-60 field. The next oldest disposal area, Landfill Unit No. 2, received wastes from 1956 to 1967. Landfill Unit No. 1 is partially

covered with the easternmost of two sets of dog pens used for animal research at the LEHR site. A third landfill disposal unit located approximately 600 feet east of LEHR, Landfill Unit No. 3, was used from 1963 to 1967. The combined total acreage for the three disposal areas is estimated at approximately six acres (Dames & Moore, 1990).

In the early 1970s, an outdoor Cobalt-60 Field was constructed at the LEHR site to study the effects of chronic exposure to penetrating gamma ray irradiation on bone marrow cells of beagles. Outdoor research was terminated in 1985 and indoor irradiation was terminated in 1988; the cobalt-60 source was removed in January 1993.

In 1975, a program in basic aerosol science was initiated at the LEHR site to link the evaluation of airborne materials and the laboratory study of these materials utilizing cellular and animal models. The DOE (1988) reported that research activities in this program focused on the potential health effects of release to the atmosphere of combustion products from fossil fuel power plants with emphasis on coal flyash.

In 1983, construction of the Toxic Pollutant Health Research Laboratory (TPHRL) was completed at LEHR. This facility was designed for the study of highly toxic and carcinogenic agents, including both radioactive and chemical materials. Research at the TPHRL included studies of the behavior of plutonium-241 and americium-241 in beagles and monkeys; radioactive and toxic gas-particle mechanistic aerosol studies; monodisperse aerosol inhalation deposition; intratracheal applications of carcinogen-coated particles; and an organic vapor uptake utilizing beagles (DOE, 1988).

2.2 PHYSICAL SETTING

The LEHR site is located in the southern portion of the Sacramento Valley, which extends from the Red Bluff area in the north to the Sacramento-San Joaquin Delta region in the south. The LEHR site sits in a flat-lying or gently sloping area of former farmland. The LEHR site and the surrounding area are located on the geomorphic unit termed "low alluvial plains and fans" (DWR, 1978), specifically the Putah Plain. This surface represents distal portions of alluvial fan deposits associated with Putah Creek. Sediments that form these alluvial fan deposits consist primarily of silts and clays with coarse-grained

sediments found locally. The age of these deposits range from late Pleistocene to Recent. The thickness of the alluvial fan deposits is at least 180 feet (DWR, 1978).

Putah Creek is the principal surface water feature of the region. It meanders along the southern border of the UC Davis property, and the levee on its north bank forms the southern border of the LEHR site. Putah Creek flows eastward from Lake Berryessa, and ultimately empties into the Yolo Bypass approximately 8 miles east of the UC Davis campus.

The stratigraphy and hydrogeology in the vicinity of the LEHR site was assessed during the Phase II Investigation (Dames & Moore, 1993). Beneath the LEHR site, sediments approximately 80 feet below ground surface (bgs) are predominantly fine-grained (silt or clay). Below 80 feet bgs coarse sand and gravel are encountered. At approximately 125 to 140 feet bgs, a silty clay unit is present. No investigations have yet been conducted at the LEHR site to assess the thickness of the underlying clay unit.

Groundwater is encountered beneath the LEHR site at depths ranging from approximately 45 to 70 feet bgs. The uppermost aquifer has been divided into two units based upon stratigraphy. These units are identified as the "first hydrostratigraphic unit" (HSU) and the "second HSU." Based on drillers logs of wells in the vicinity, additional hydrostratigraphic units not evaluated under the Phase II investigation are present at greater depths.

The first HSU extends from the water table to approximately 80 feet bgs and consists of relatively fine-grained sediments varying from very fine-grained sandy silt or silty sand to sandy clay. The second HSU extends from approximately 80 to 135 feet bgs and consists of coarse sand and cobble gravel. Based upon review of agricultural well logs, this unit appears to be relatively extensive in this area. The base of the second HSU is defined by the underlying clay unit. The first and second HSUs are not separated by an identified aquitard, and are considered to be in hydraulic communication.

Groundwater in both units typically flows to the northeast. Regional water levels decline from May to September and rise from September to May.

2.3 CHEMICAL IMPACTS

Groundwater quality has been assessed by previous investigations and by a quarterly sampling program that began in November 1990. The quarterly sampling program currently includes 13 monitoring wells screened within the first HSU and 5 monitoring wells screened within the second HSU. Several metals, volatile organic compounds (VOCs), pesticides, nitrate, and tritium have been reported at levels above drinking water standards. The metals and nitrate have been reported above drinking water standards in wells both upgradient and downgradient of LEHR. Pesticides have only been reported in three wells along the upgradient border of the LEHR site. VOCs are typically above drinking water standards in several wells downgradient of the UC Davis landfill units and trenches. Tritium is consistently reported above drinking water standards in one well located downgradient of UC Davis trenches.

LEHR site soil samples had frequent detections of gross alpha, gross beta, and tritium activity with the highest concentrations reported from samples collected from the southwest area of the LEHR site. The highest reported detections of nitrate were reported for soil samples collected from the radium-226 area, and nitrate and chlordane were reported at elevated levels in samples collected from the dog pen areas. Hexavalent chromium was reported at levels higher than the maximum levels reported for samples collected off-site for both the radium-226 and strontium-90 areas. The highest levels of strontium-90 were reported for samples collected from the radium-226 area. Limited VOCs, predominantly methylene chloride, have been detected in soil samples collected from the LEHR site.

Some organic chemicals, metals, nitrate, and pesticides have been reported for surface water samples collected both upstream and downstream of LEHR. Some of these compounds have been reported above state drinking water levels. Tritium, carbon-14 and strontium-90 have been detected sporadically in surface water samples at levels below the drinking water standards.

3.0 MAPS

This chapter contains and explains the maps and figures that are referenced in this FSP. The purpose of these figures is to illustrate:

- The location of the LEHR site and LEHR site boundaries;
- LEHR site physical features and structures;
- Potential source areas for target constituents;
- Directions of surface and groundwater flow; and
- Known and proposed sampling and investigation locations for the RI/FS program.

A full description of the LEHR site, a review of the history of LEHR site operations, and a summary of previous work are presented in Chapters 2 and 3 of the RI/FS Work Plan.

3.1 LEHR SITE LOCATION

Figures A1 through A4 present the LEHR site location and LEHR site structures for the LEHR site and the surrounding area. Figure A1 shows Davis, California which is located 15 miles west of Sacramento, and 50 miles east of the San Francisco Bay area. Figure A2 presents the general LEHR site vicinity. The LEHR site is located south of the City of Davis and Interstate Route 80 and north of Putah Creek. Figure A3 shows locations of the structures and buildings currently present on the LEHR site. Figure A4 presents the LEHR site boundaries and the general locations of the preliminary soil operable units (OU) ~~areas~~ that will be investigated during the RI/FS program.

3.2 SOIL INVESTIGATION LOCATIONS

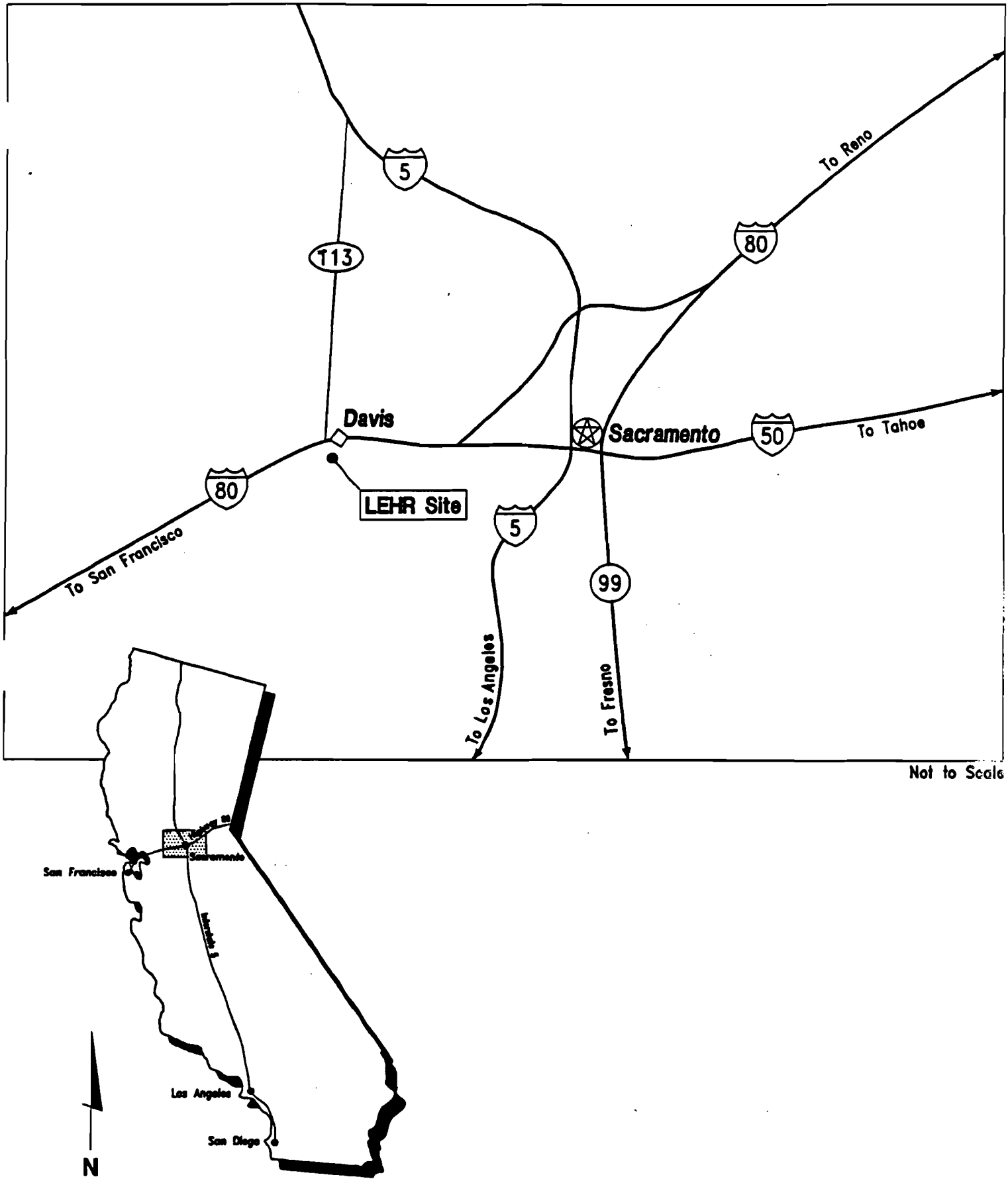
A soil investigation will be conducted for background locations and five preliminary OUs ~~eight areas~~ during the RI/FS program. The five soil OUs are made up of eight individual investigation areas. Figures A5 through A18 present a detail of each individual investigation area along with proposed locations for soil borings, surface soil sample locations, soil vapor survey points, and exploration trenches. The individual investigation areas include:

- Background soil boring locations (Figure A5);
- DOE Disposal Trench Areas - OU-1 (Figure A6);
- DOE Disposal Box - OU-1 (Figure A7);
- UC Davis Disposal Trenches - OU-1 (Figure A8);
- The Radium-226 Treatment Tank and Leach System - OU-2 (Figure A9);
- The Strontium-90 Treatment Tank and Leach System - OU-2 (Figure A10);
- The Western Dog Pen Area and North Chemical Dispensing Area - OU-3 (Figure A11);
- Domestic Septic Tanks - OU-4 (Figure A12);
- Three UC Davis Landfill Units - OU-5 (Figures A13 A14, and A15);

A detailed description of each area is presented in Chapter 5 of the RI/FS Work Plan. Figures A16 and A17 present schematic diagrams of sampling locations in the disposal trenches and domestic septic tank areas. Figure A18 is a map presenting the proposed locations for double-ring infiltrometer tests.

3.3 WATER AND AIR MONITORING LOCATIONS

Figures A19 through A24 present water and air monitoring locations for the RI/FS. Figure A19 presents the locations of the 17 existing groundwater monitoring wells that are screened in the first HSU. Figure A20 presents the locations of the five (5) existing groundwater monitoring wells screened in the second HSU. Groundwater elevation contours are included on both Figures A19 and A20 to indicate the general groundwater horizontal gradient in each HSU. Figure A21 presents the proposed locations for ten monitoring wells that will be installed as part of the RI/FS program. Figure A22 presents the proposed locations for the CPT and Hydropunch™ investigation. Three surface water and two storm water monitoring locations are presented in Figures A23 and A24, respectively. Air monitoring locations are presented in Figure A25.



SITE LOCATION MAP
RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

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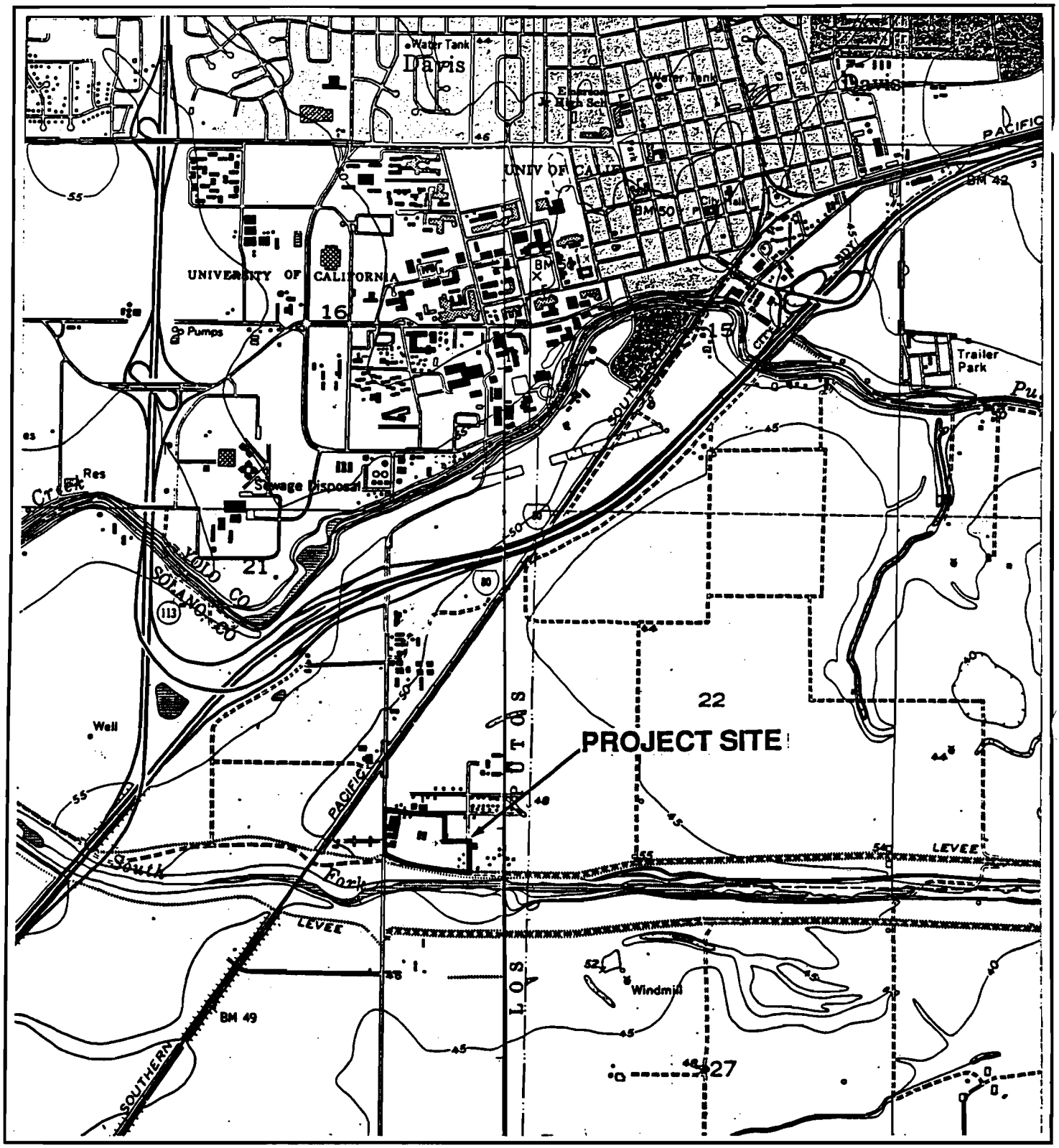
FIGURE A1



REFERENCE: USGS 7.5' Quadrangle Merritt CA, 1981,
Davis CA, 1982

N

0 2000

Scale In Feet

SITE VICINITY MAP

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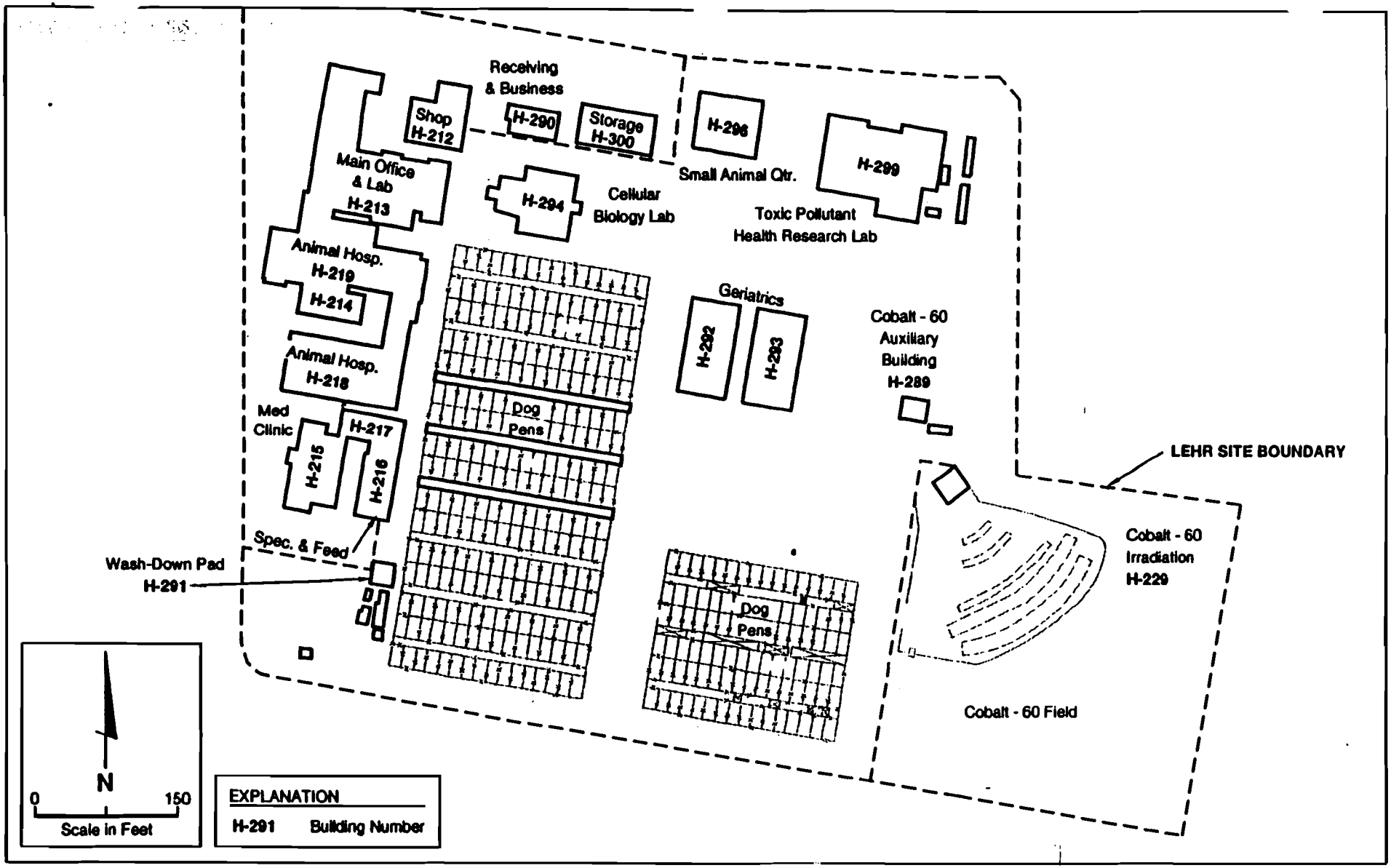
10805-454-044 DOE1

FIGURE A2



SITE STRUCTURES AND FEATURES

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Davis, California

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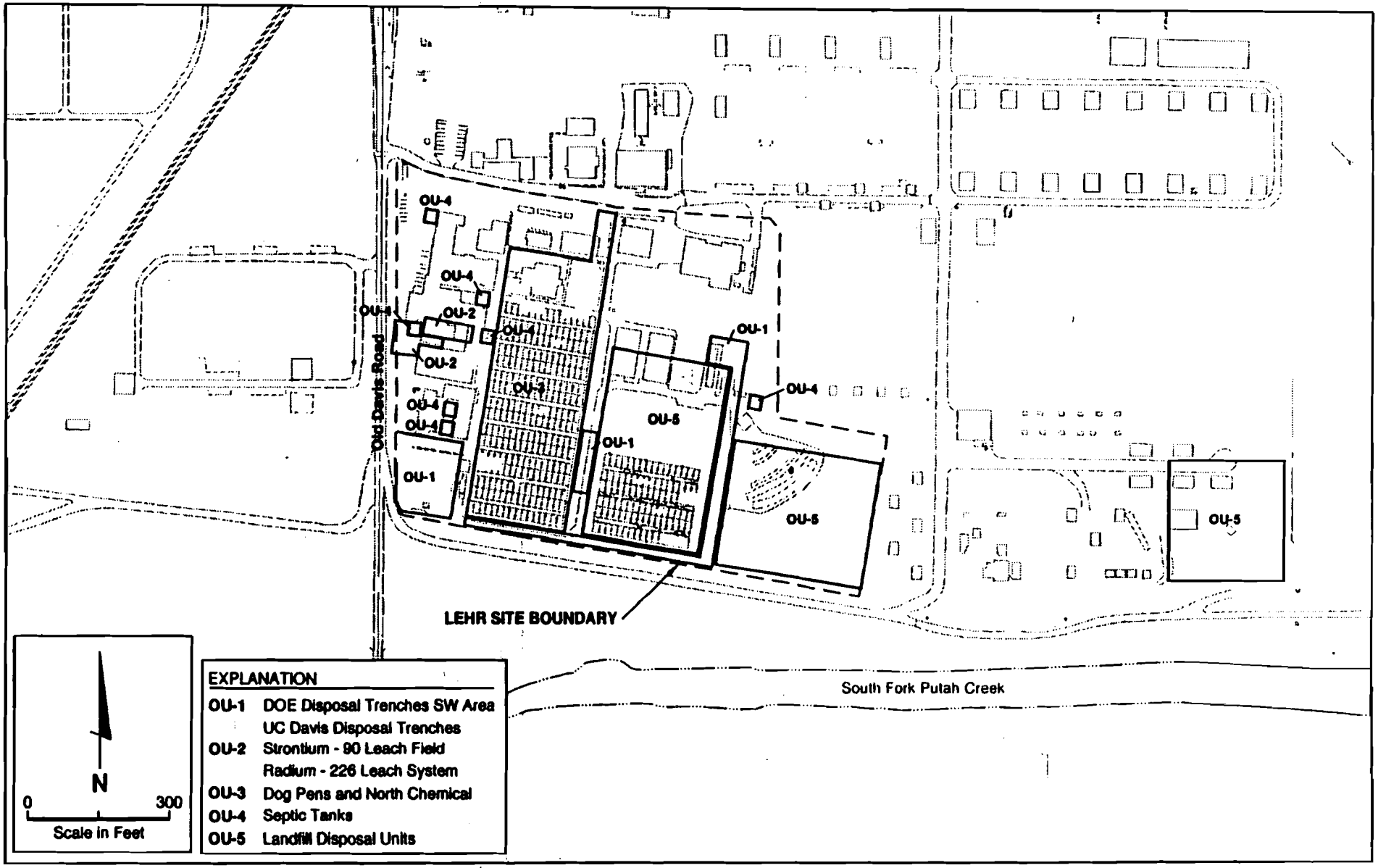
FIGURE A3



INVESTIGATION AREAS

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Davis, California

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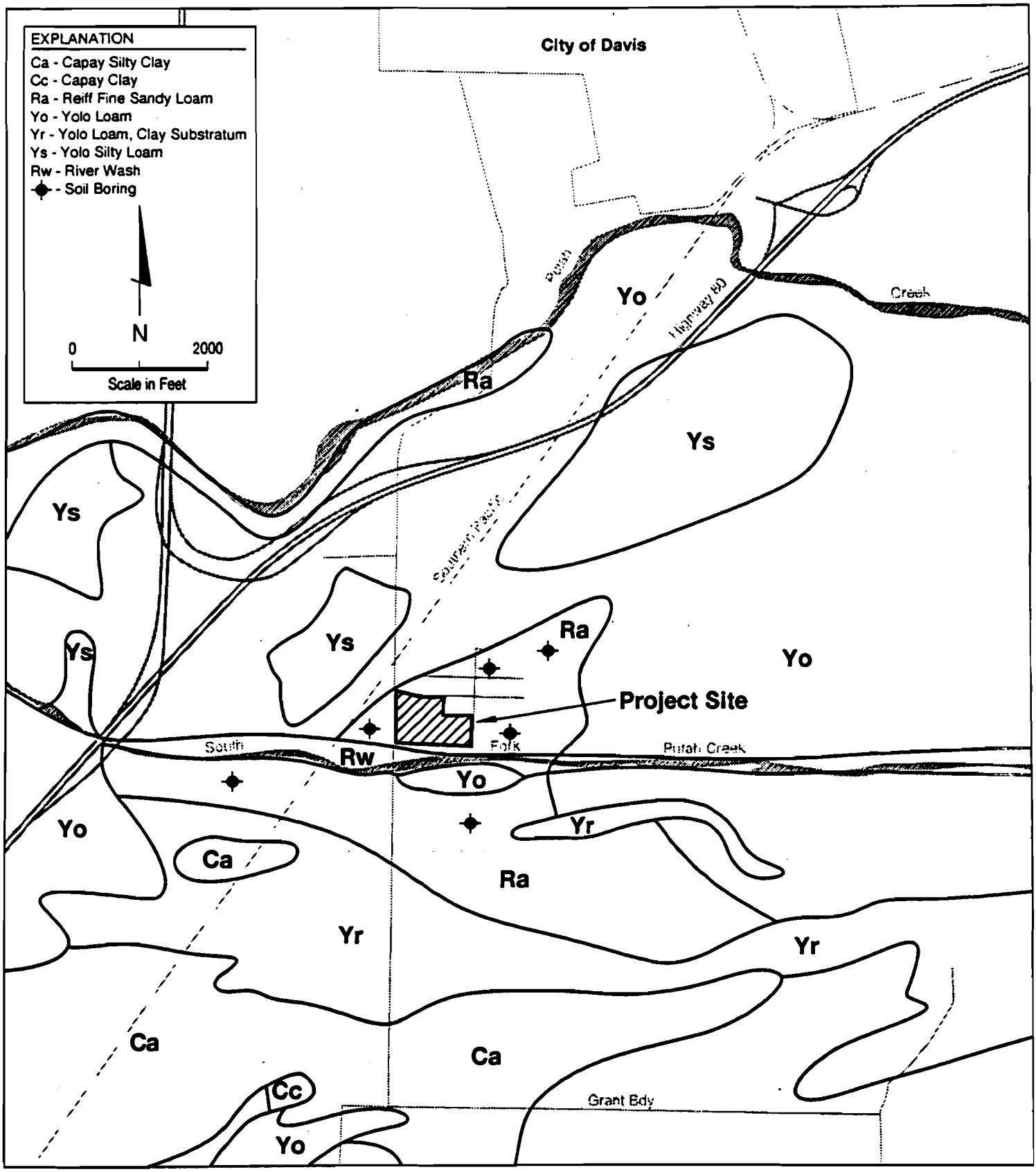
FIGURE A4



Source:
Soil Survey of Solano County, USDA Soil Conservation Service 1977.

LOCATION MAP
BACKGROUND SOIL BORINGS

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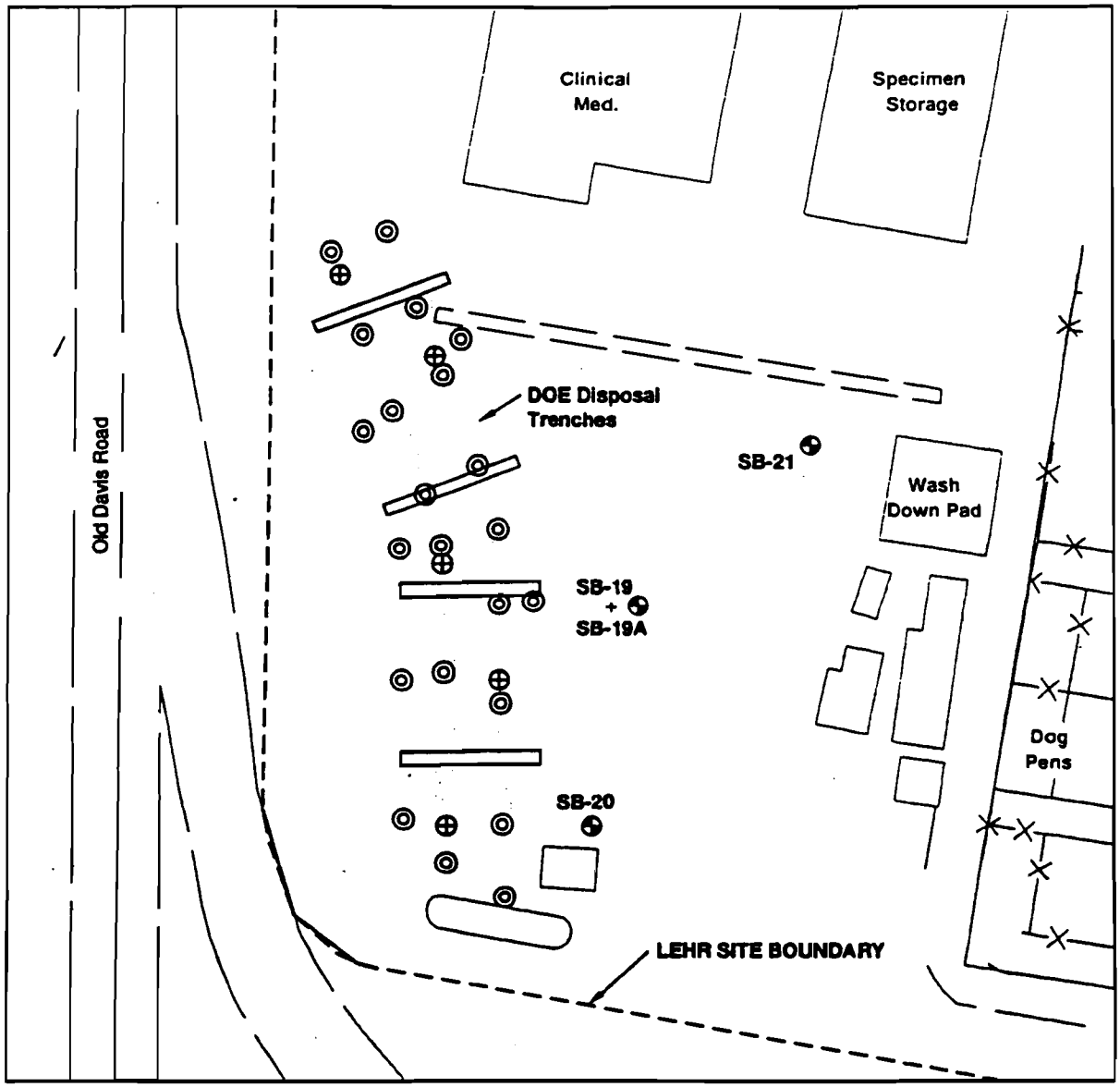
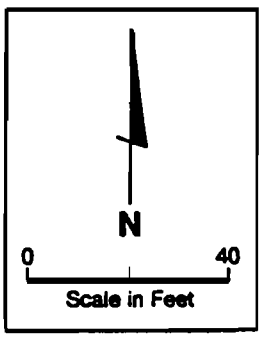
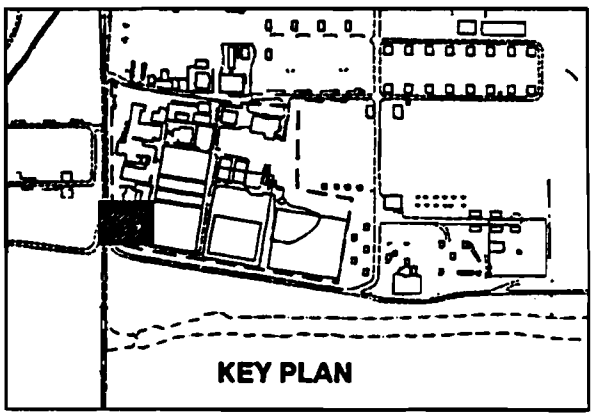
FIGURE A5





EXPLANATION

- Proposed Stage 1 Soil Borings
- Existing Soil Borings
- Proposed Soil Vapor Probes
- Proposed Exploration Trenches

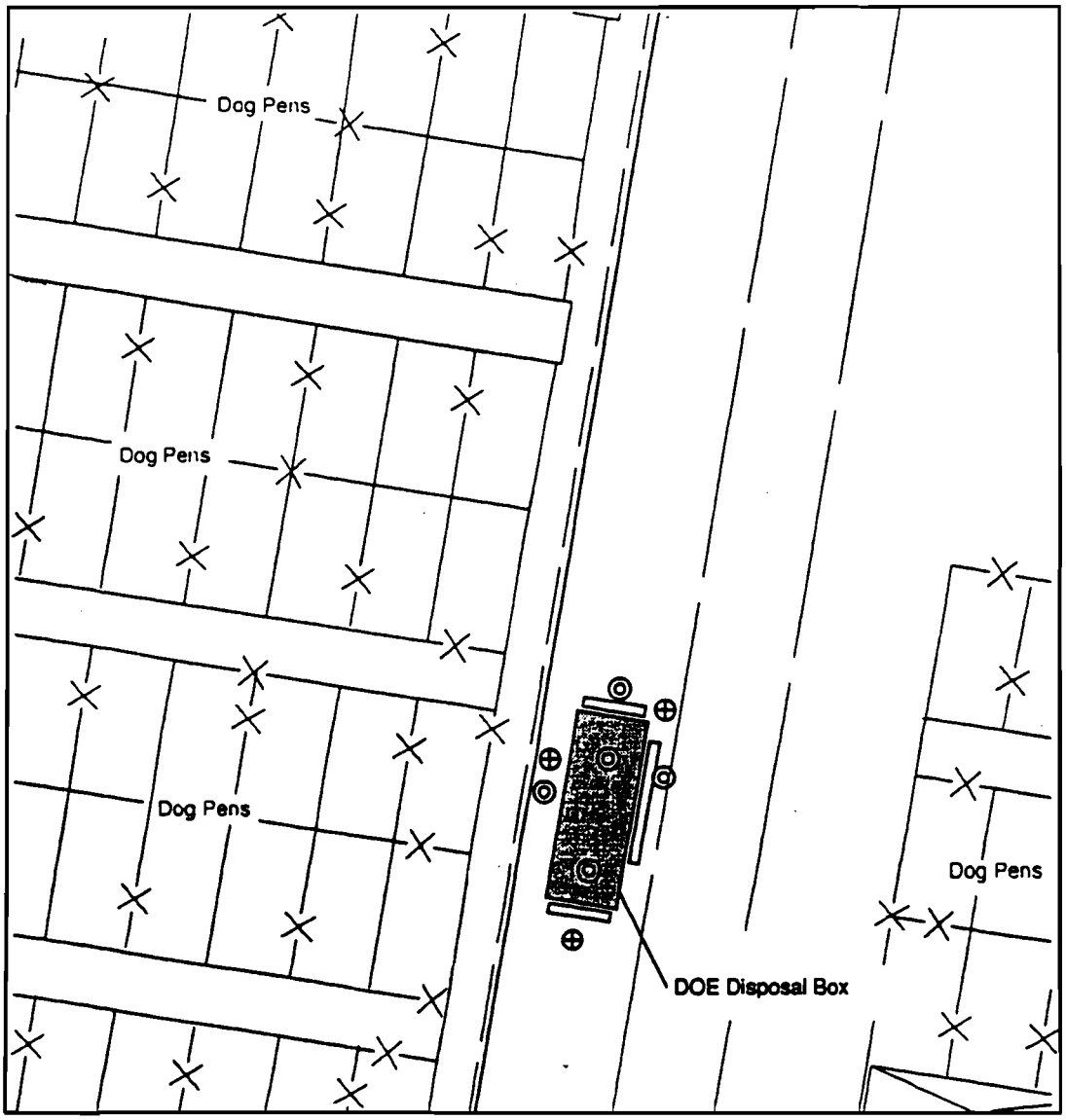


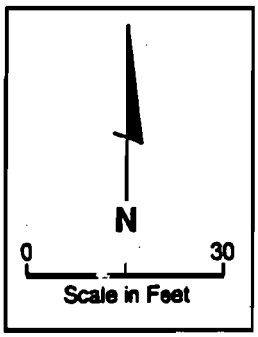
APPROXIMATE LOCATION MAP DOE DISPOSAL TRENCHES SAMPLING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-454-044 SJR 3/24/94 5705AB

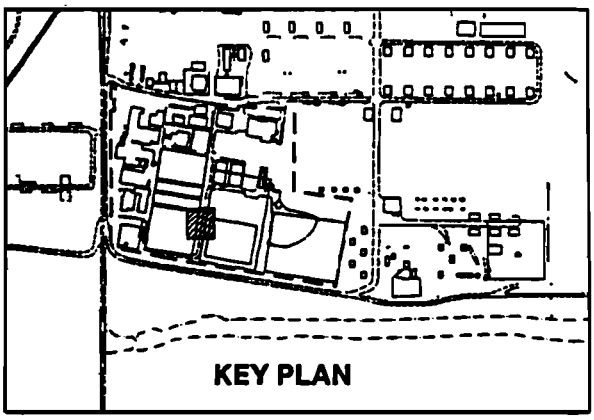
FIGURE A6





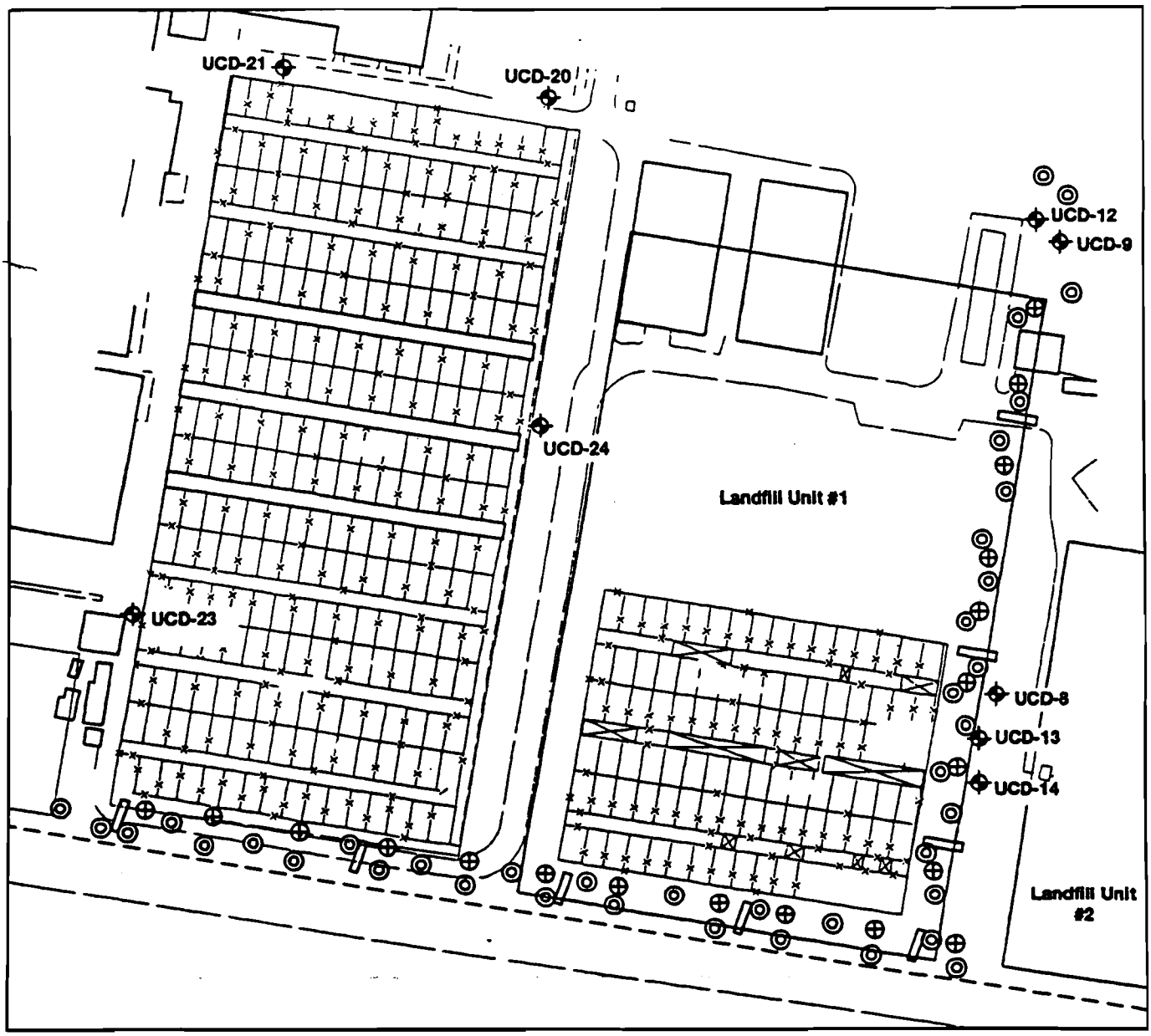
EXPLANATION

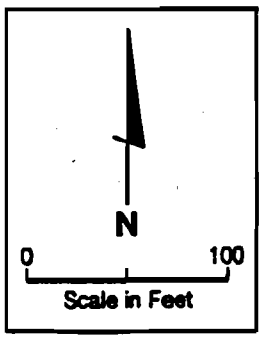
- ⊕ Proposed Soil Borings
- ◎ Proposed Vapor Probes
- ▭ Proposed Exploration Trenches



LOCATION MAP
DOE DISPOSAL BOX

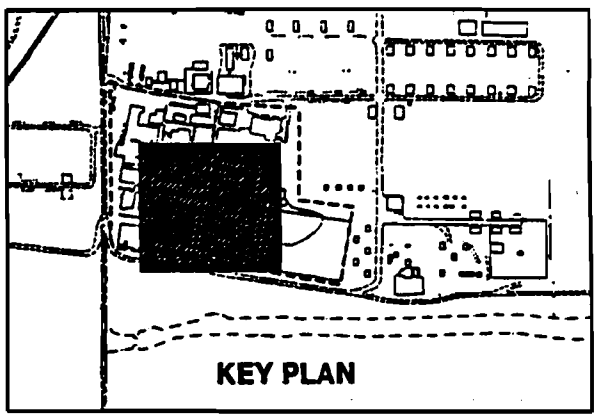
RI/FS Work Plan
LEHR Environmental Restoration
Davis, California





EXPLANATION

- Proposed Soil Borings (First Stage Borings) Based On Results of Soil Vapor Survey
- Existing Monitoring Well
- Proposed Soil Vapor Probes
- Proposed Exploration Trenches

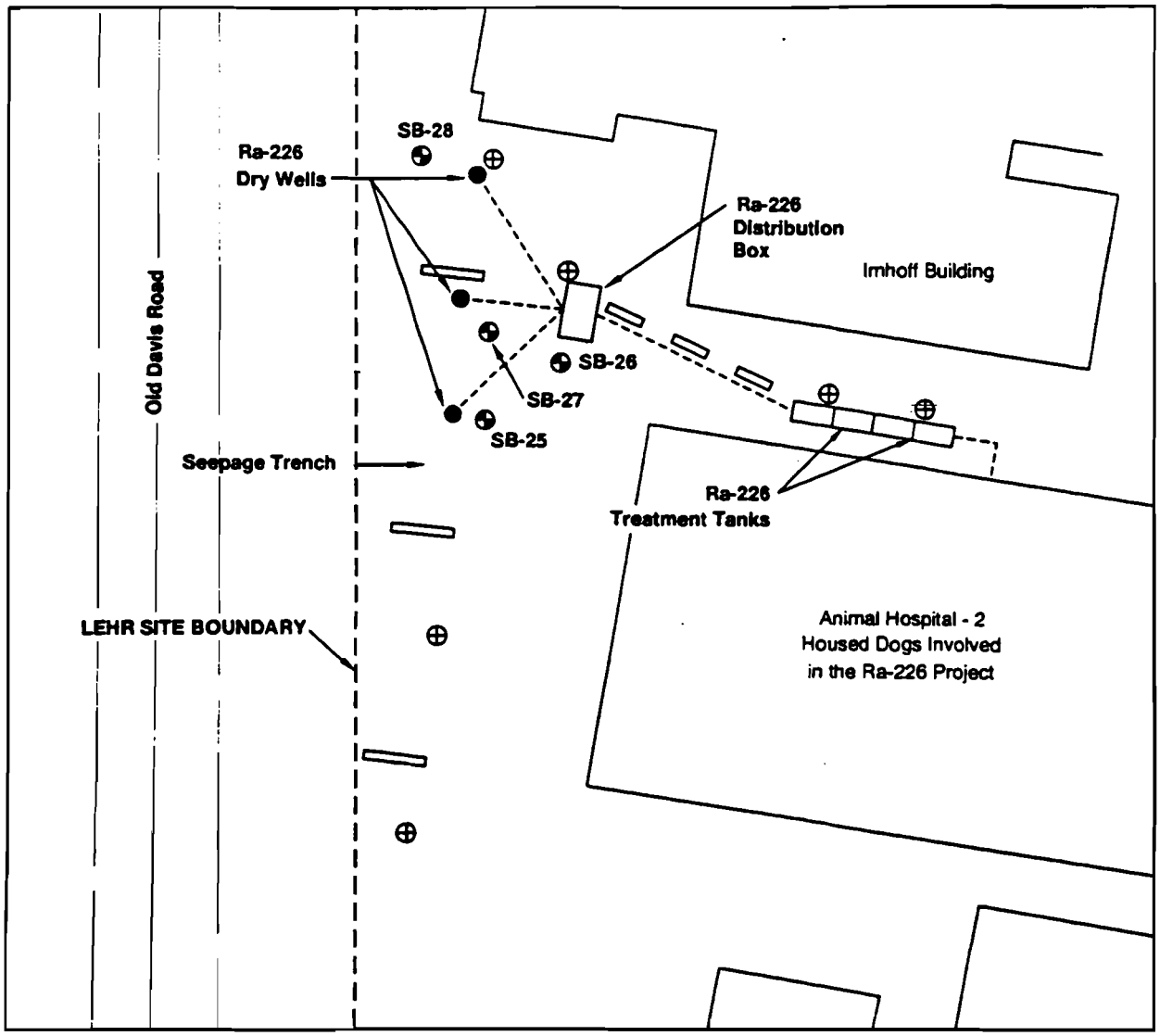


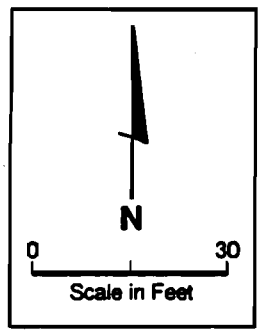
LOCATION MAP UC DAVIS DISPOSA
TRENCH SAMPLING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 sjr 2/23/94 5705AG

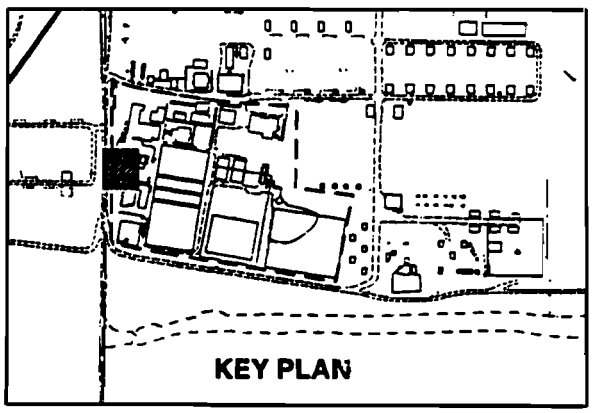
FIGURE A8





EXPLANATION

- ⊕ Proposed Stage 1 Borings
- Existing Borings
- Proposed Exploration Trenches
- ---- Distribution Pipelines

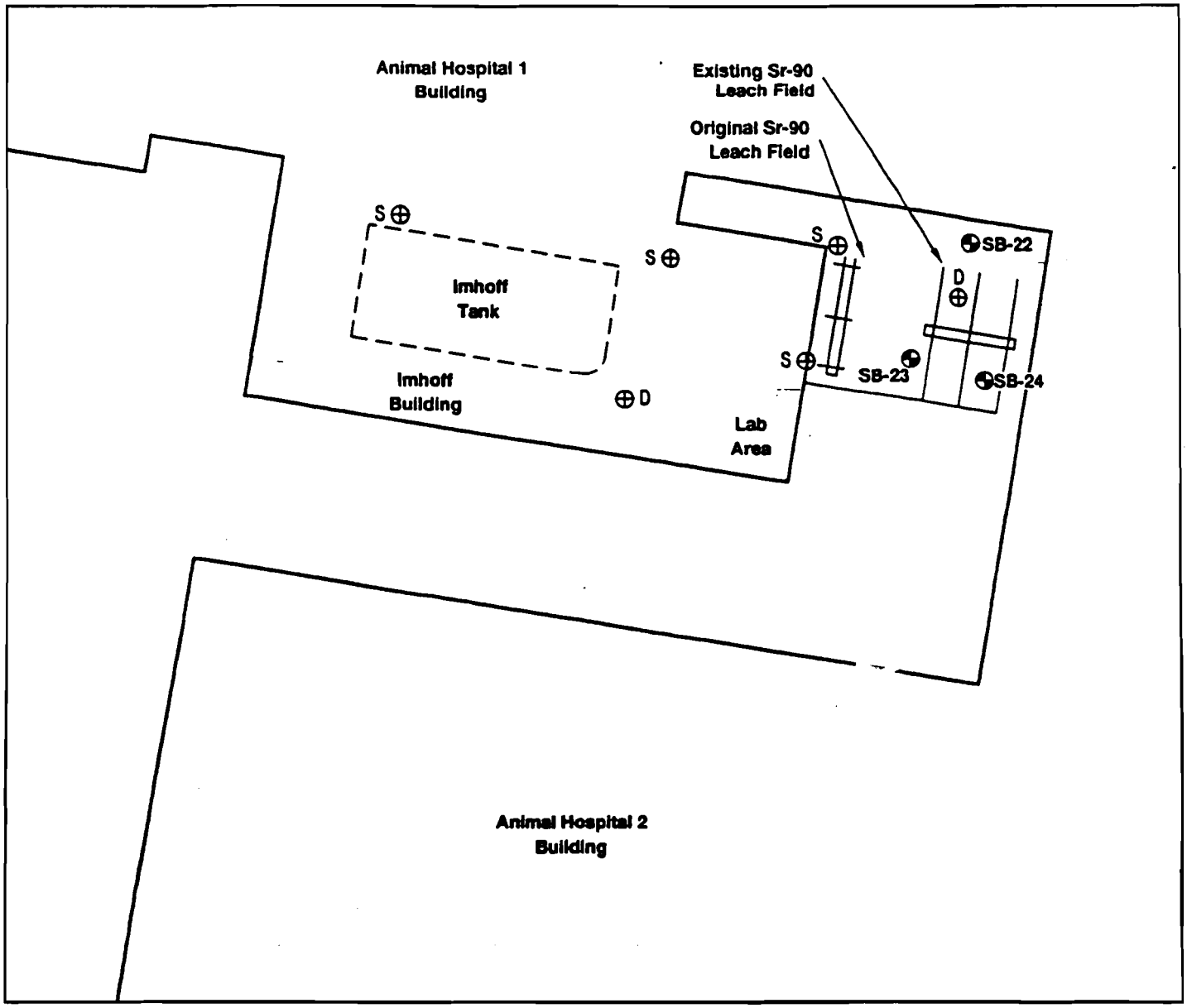


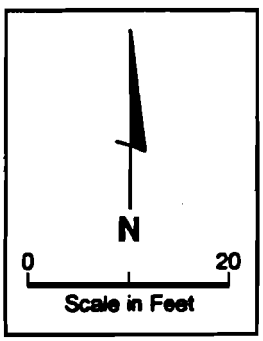
LOCATION MAP RADIUM 226 TREATMENT SYSTEM SAMPLING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 SJR 2/23/94 5705Z

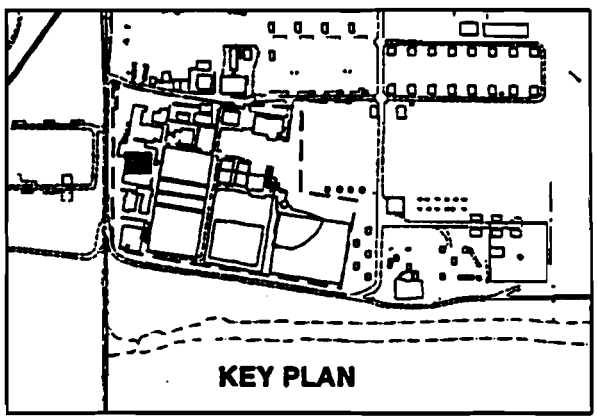
FIGURE A9





EXPLANATION

- ⊕D Proposed Deep Soil Borings
- ⊕S Proposed Shallow Soil Borings
- Existing Soil Borings
- Proposed Exploration Trenches

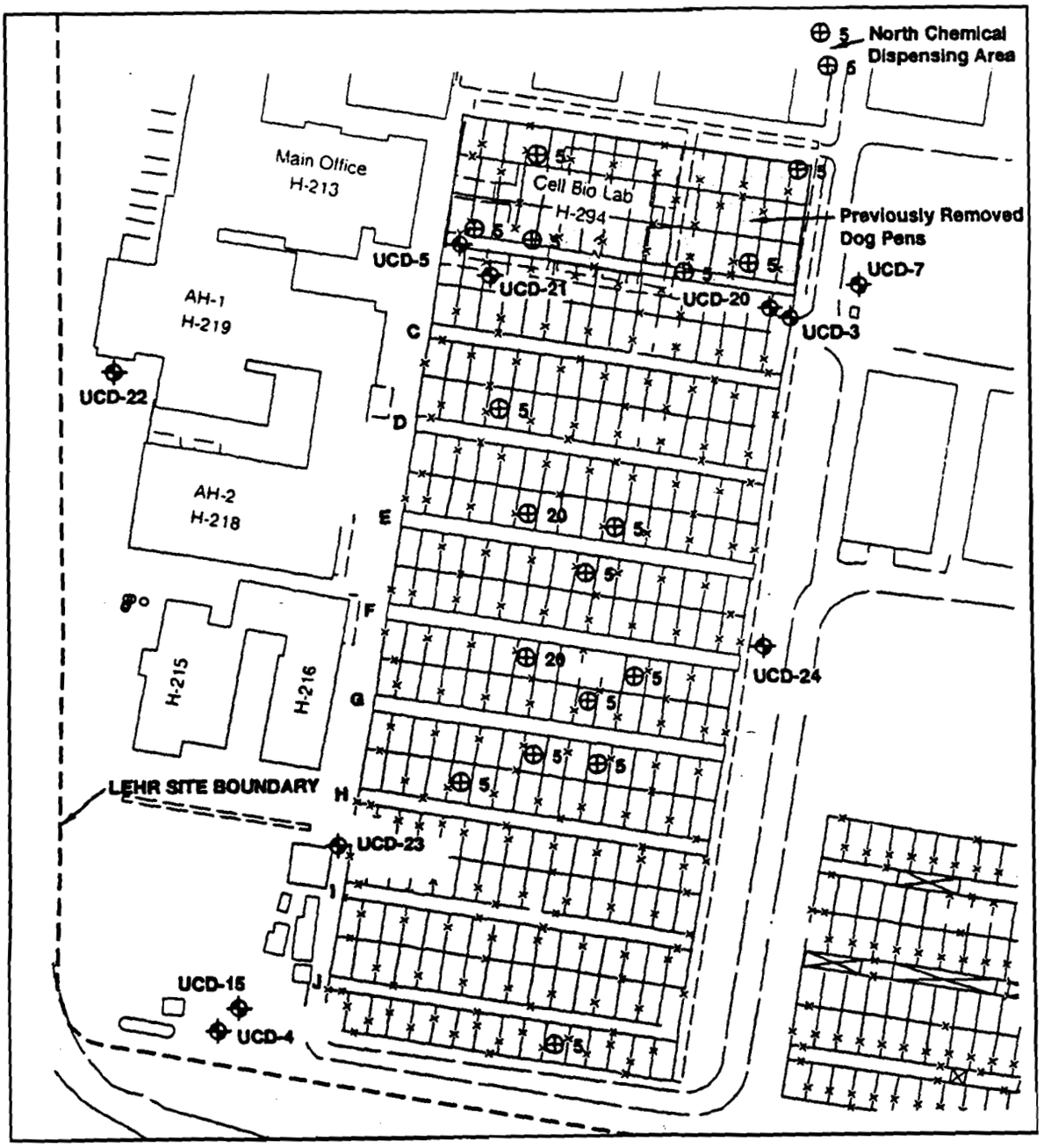


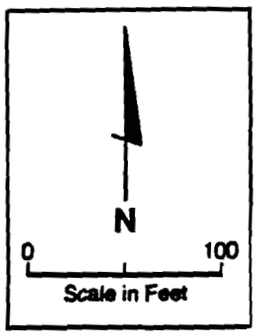
LOCATION MAP STRONTIUM-90 (IMHOFF TREATMENT SYSTEM SAMPLING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-454-044 SJR 2/23/94 5705AA

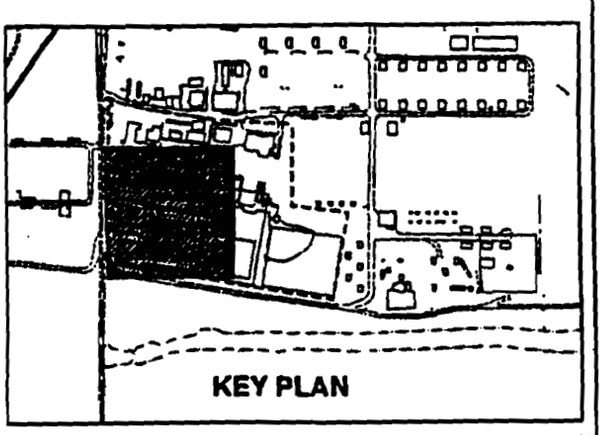
FIGURE A10





EXPLANATION

UCD-4	Existing Monitoring Well Location
5	Proposed 5 Foot Soil Borings
20	Proposed 20 Foot Soil Borings

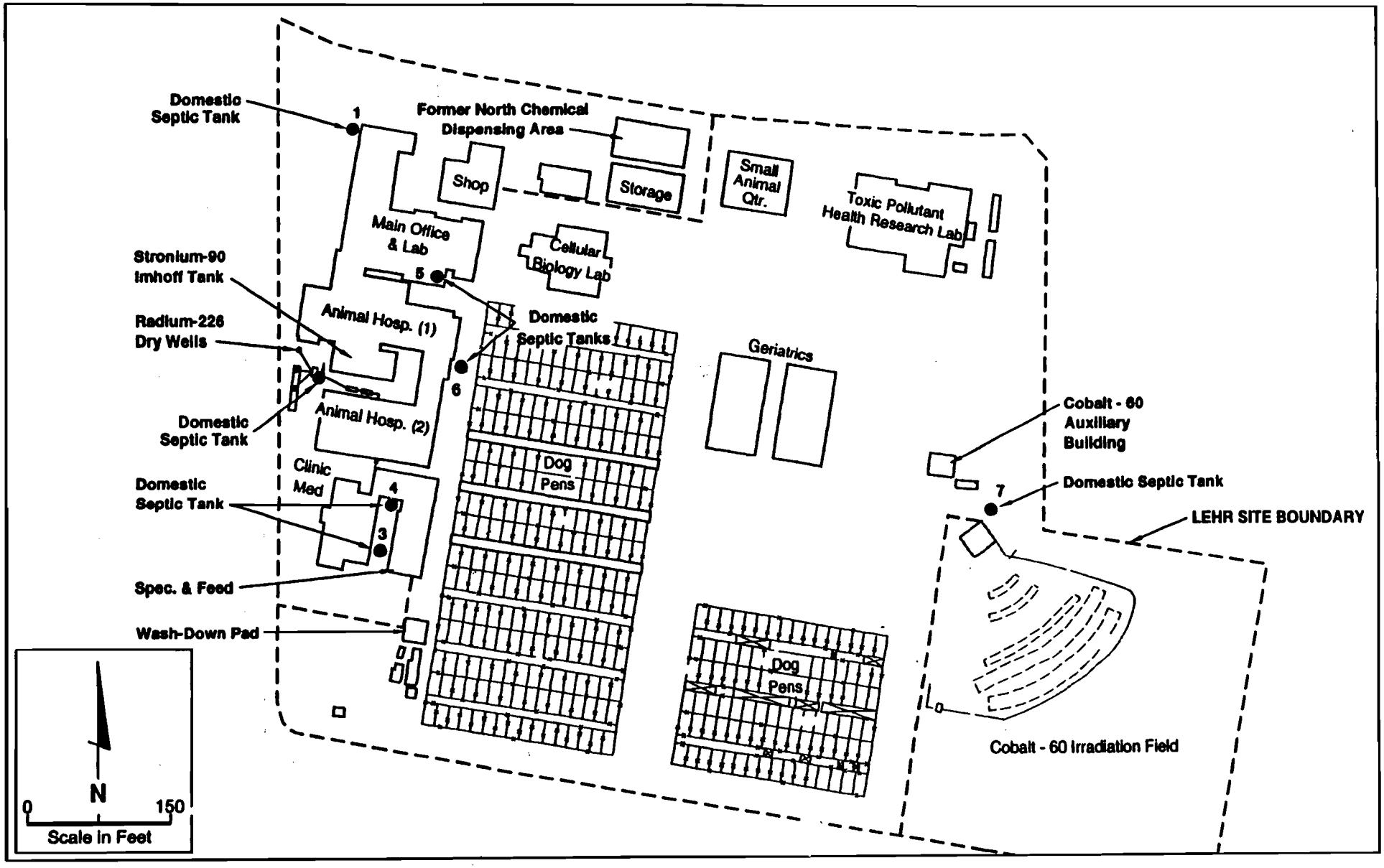


LOCATION MAP
WESTERN DOG PEN AREA SAMPLES

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 sjr 3/24/94 5705AC

FIGURE A11

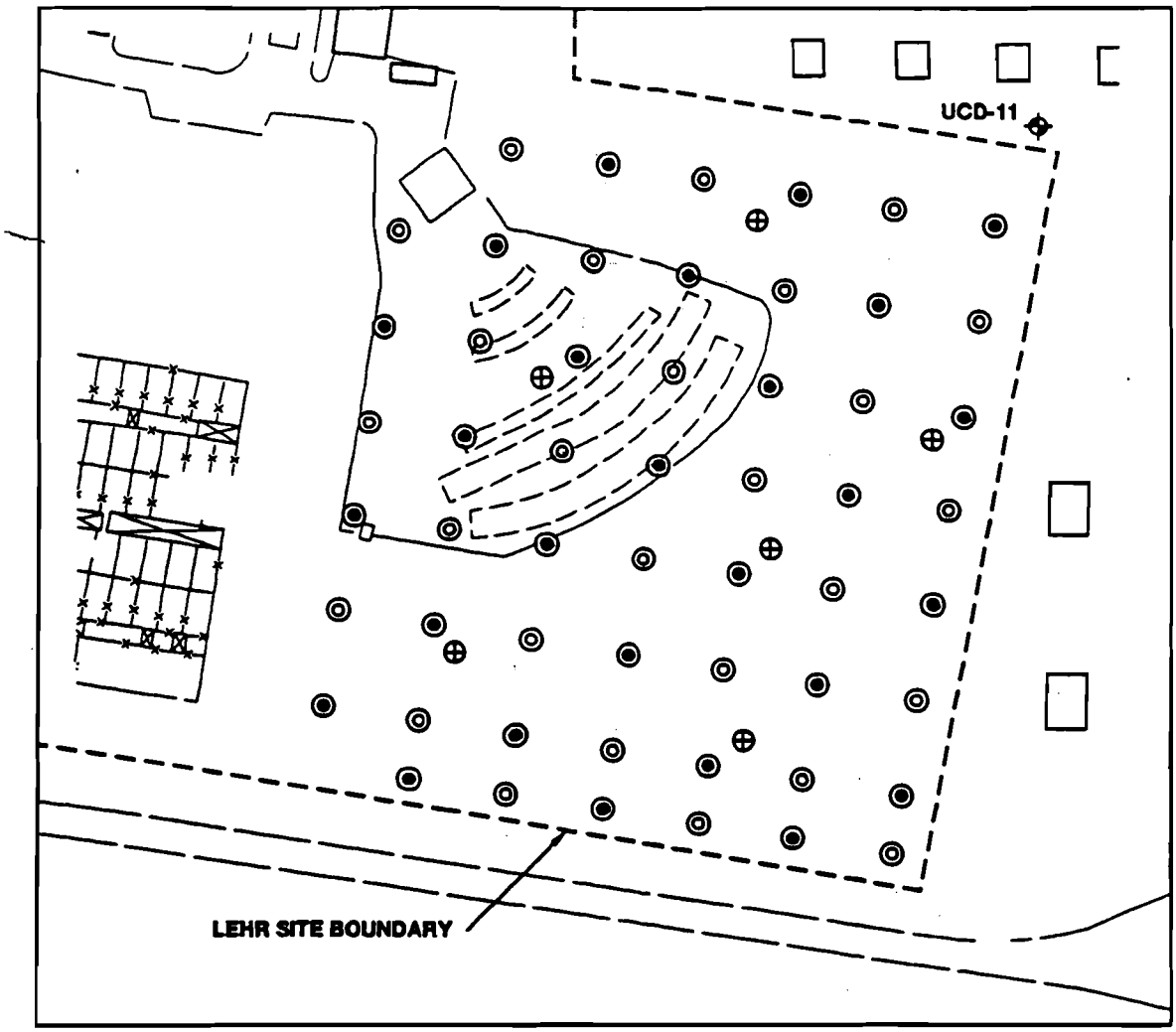


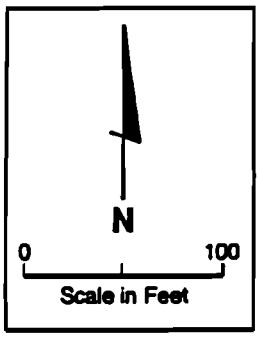
APPROXIMATE LOCATIONS OF DOMESTIC SEPTIC TANKS AT LEHR

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 SJR 2/24/94 5705O

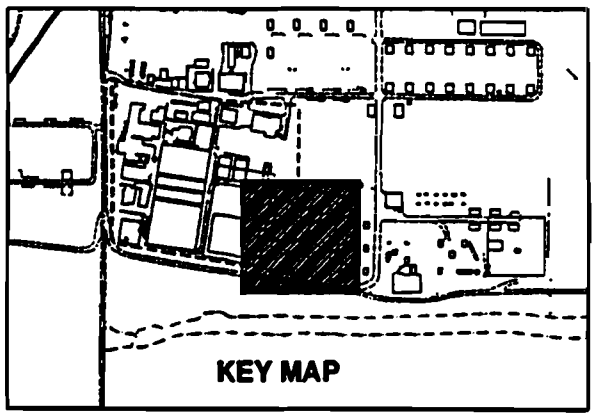
FIGURE A12





EXPLANATION

- Monitoring Well
- Proposed Boring Location (To Be Based On Soil Gas Survey Results)
- Proposed Primary Soil Vapor Points
- Proposed Secondary Soil Vapor Points

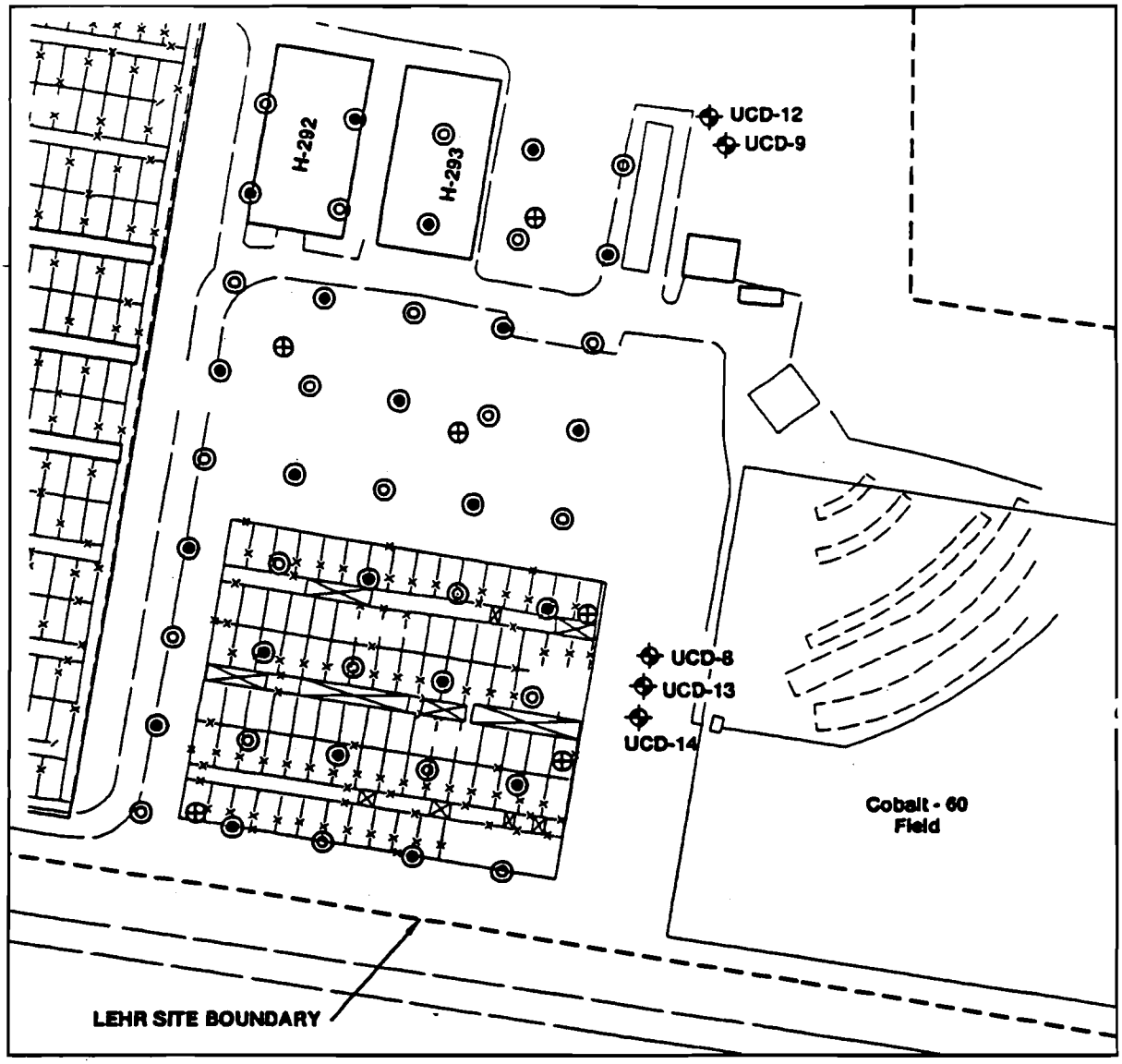


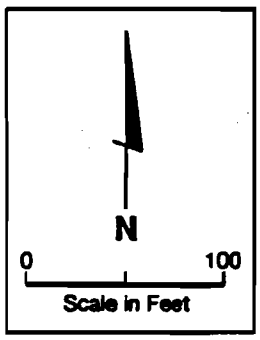
LOCATION MAP LANDFILL UNIT NO. 1 SAMPLING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 sjr 2/23/94 5705AE

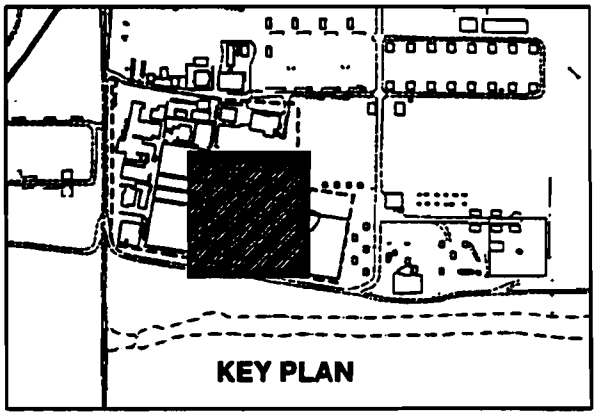
FIGURE A13





EXPLANATION

- Monitoring Well
- Proposed Soil Boring Location (To Be Based On Soil Gas Survey Results)
- Proposed Primary Soil Vapor Points
- Proposed Secondary Soil Vapor Points

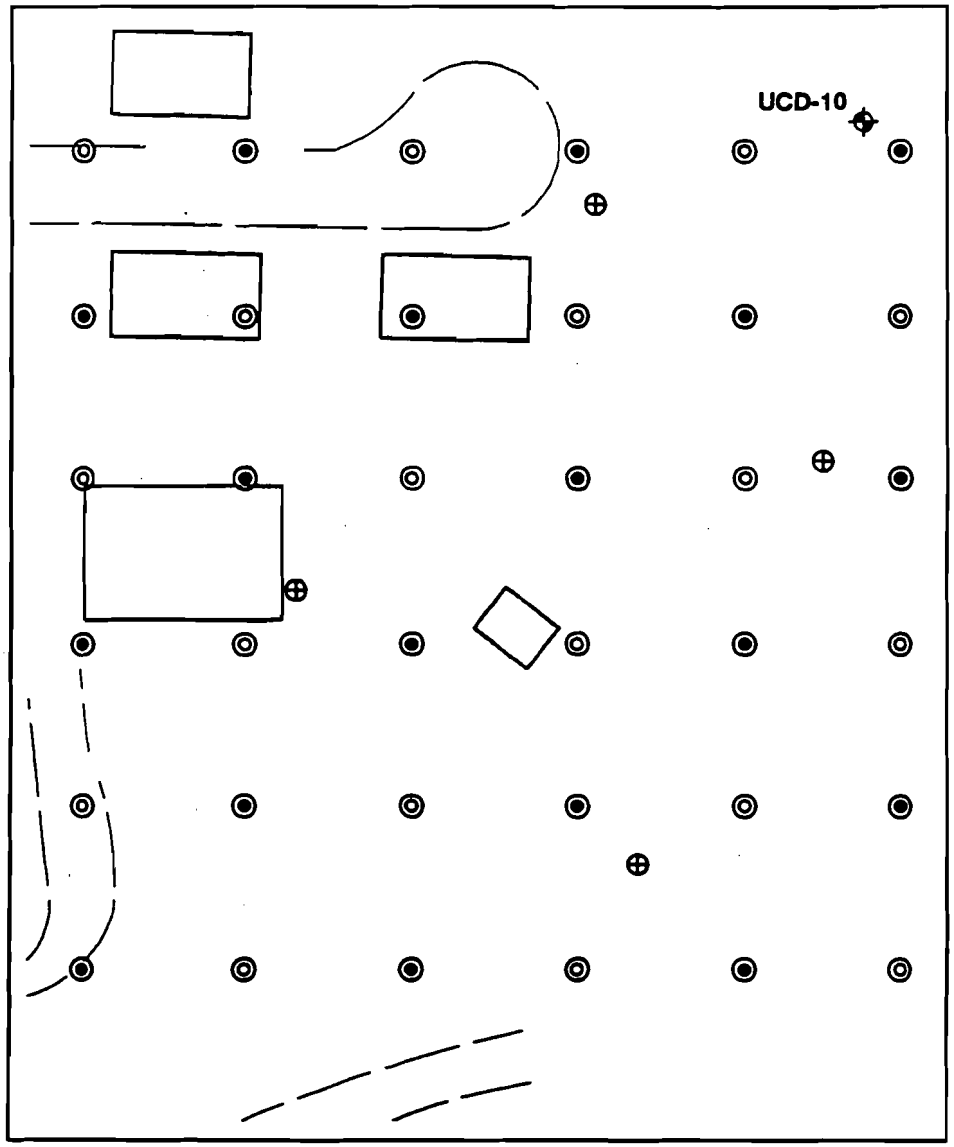


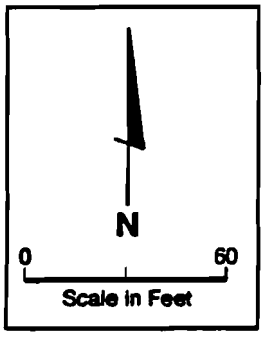
LOCATION MAP UC DAVIS LANDFILL UNIT NO. 2 SAMPLING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 sjr 2/23/94 5705DD

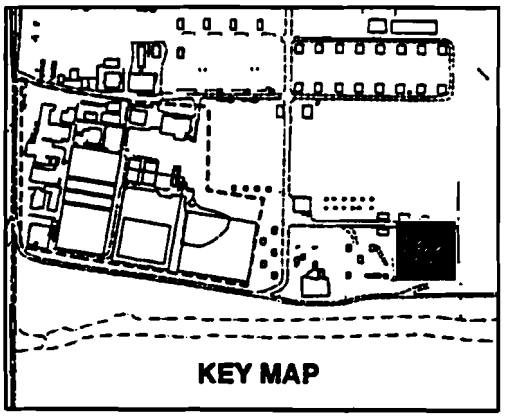
FIGURE A14





EXPLANATION

- Monitoring Well
- Proposed Soil Boring Location (To Be Based On Soil Gas Survey Results)
- Proposed Primary Soil Vapor Points
- Proposed Secondary Soil Vapor Points

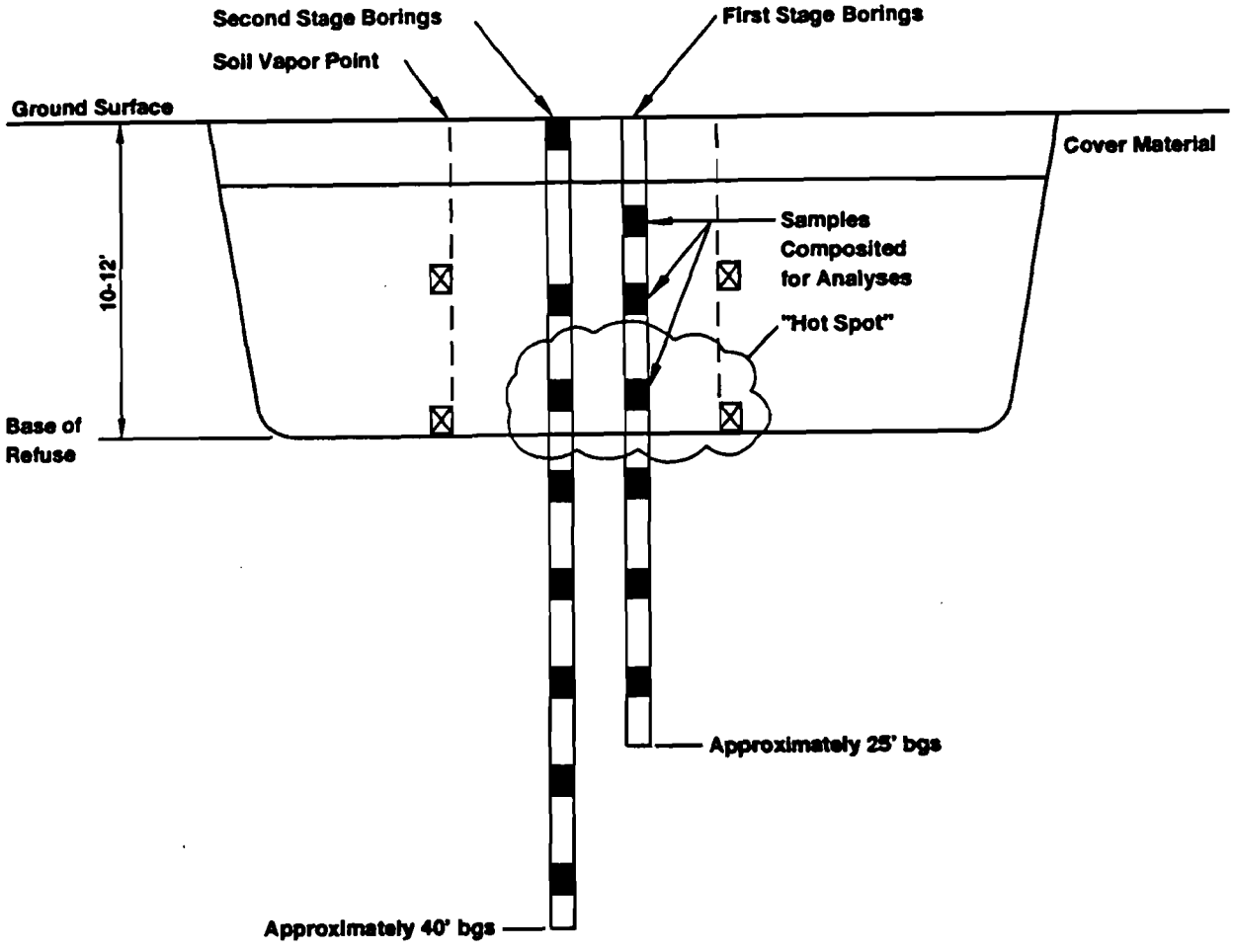


LOCATION MAP UC DAVIS LANDFILL UNIT NO. 3 SAMPLING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 sjr 2/23/94 5705AF

FIGURE A15



EXPLANATION

⊠ Discrete Vapor Samples

■ Discrete Soil Samples

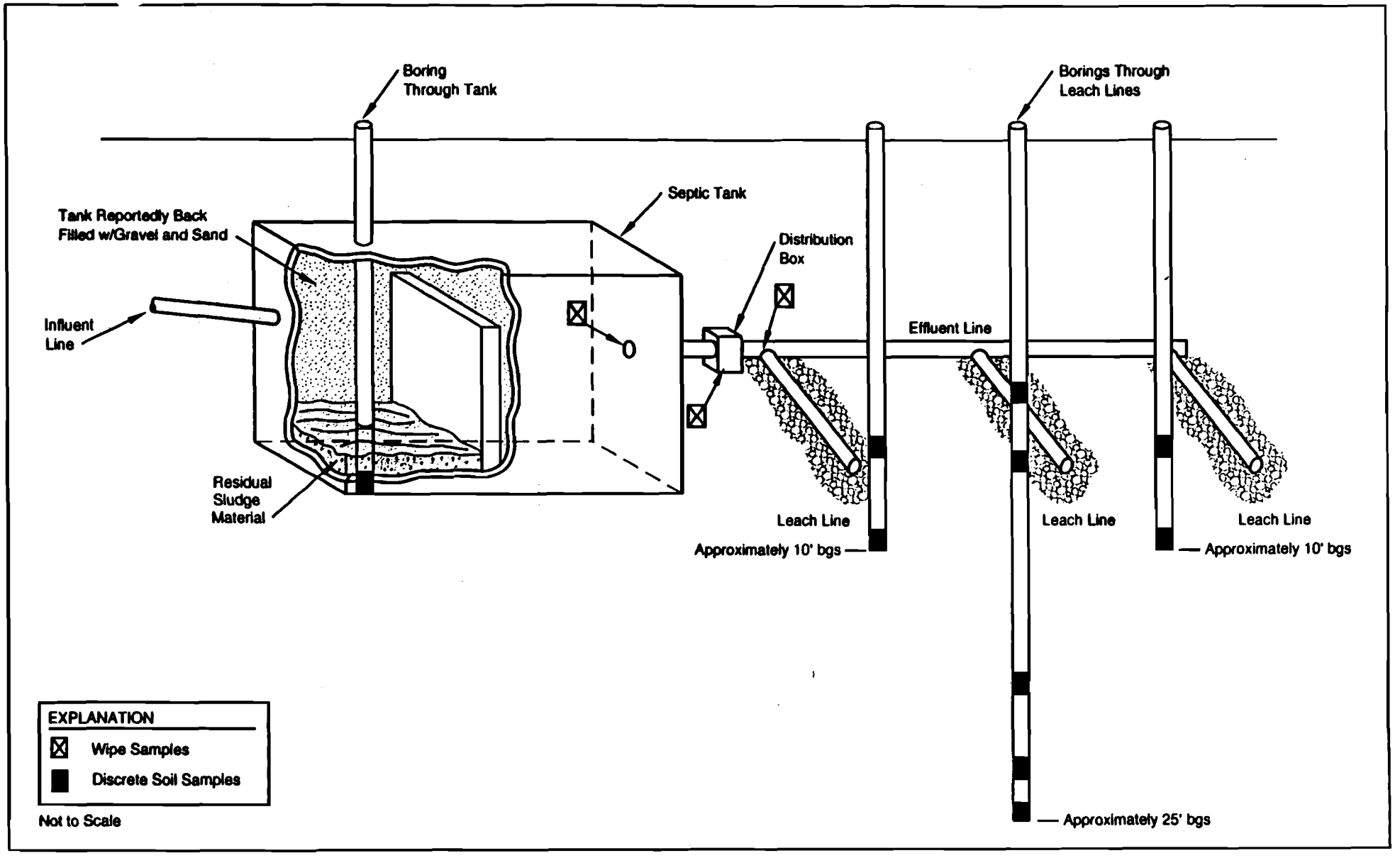
Not To Scale

SCHEMATIC DRAWING DISPOSAL TRENCHES AND LANDFILL SAMPLING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 sjr 2/23/94 5705AH

FIGURE A16

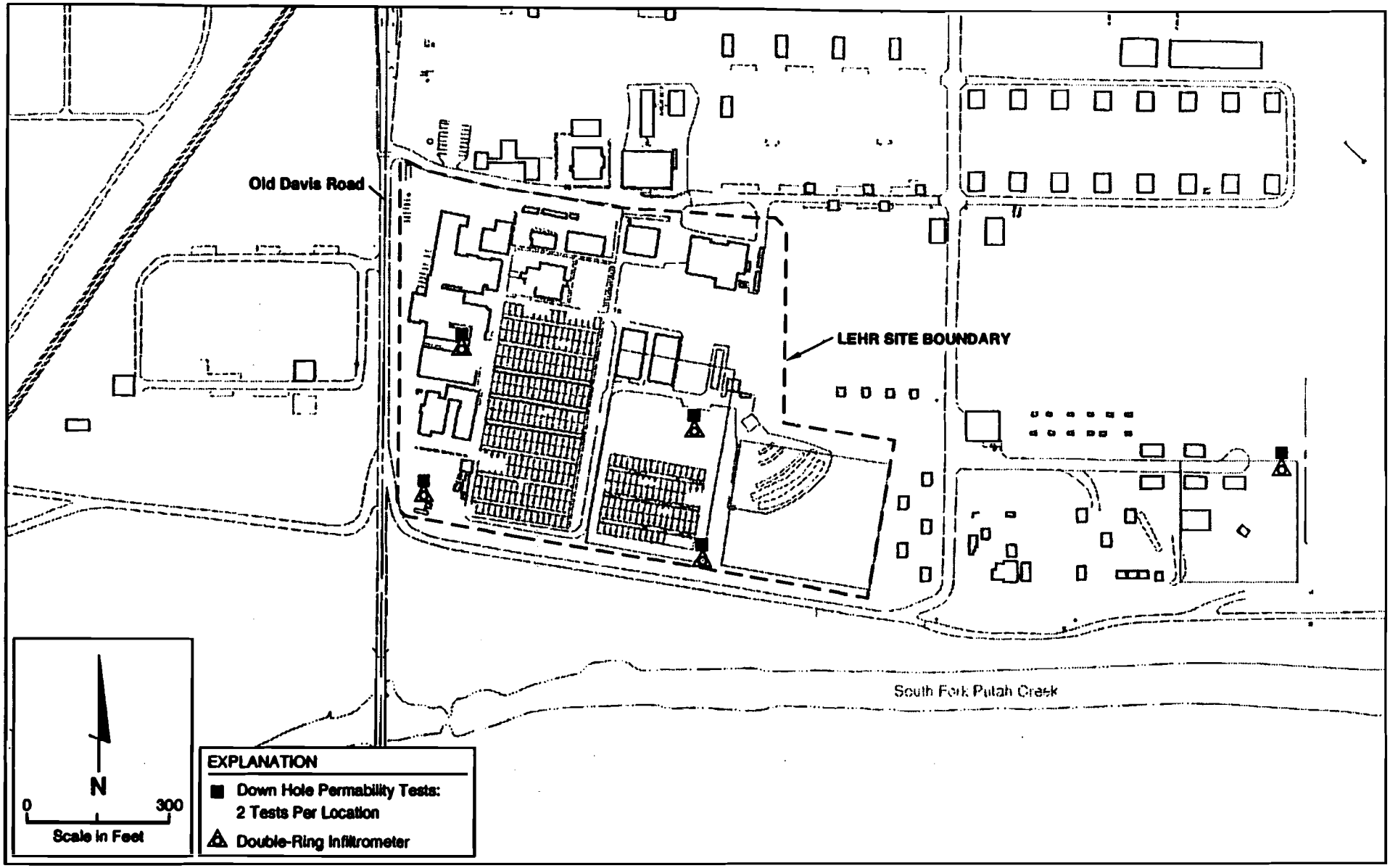


CONCEPTUAL DIAGRAM OF DOMESTIC SEPTIC TANK SAMPLING LOCATIONS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 SJR 2/24/94 5705U

FIGURE A17

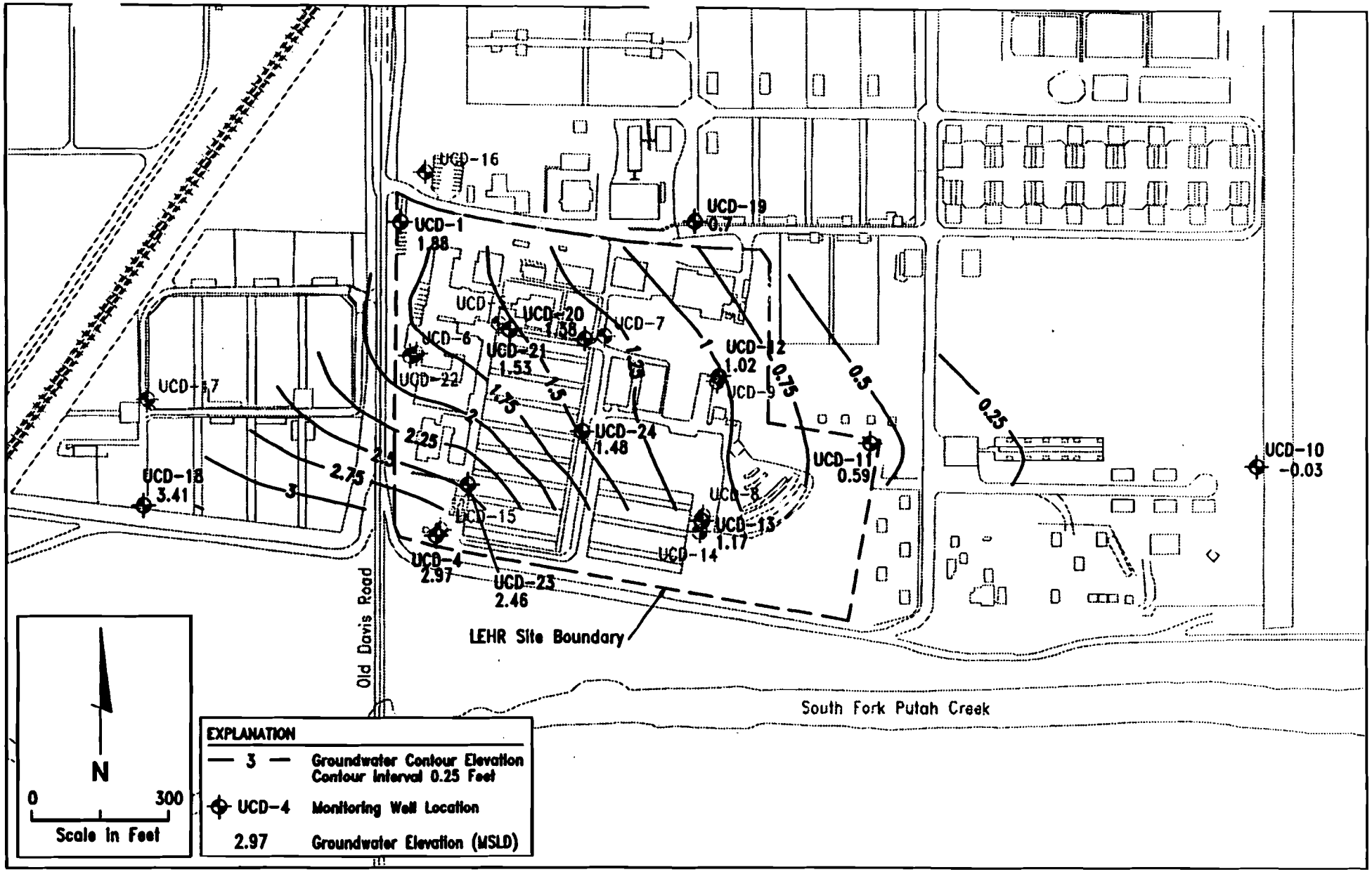


LOCATION MAP
DOUBLE RING/DOWN HOLE PERMABILITY TESTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 SJR 2/23/94 5705V

FIGURE A18

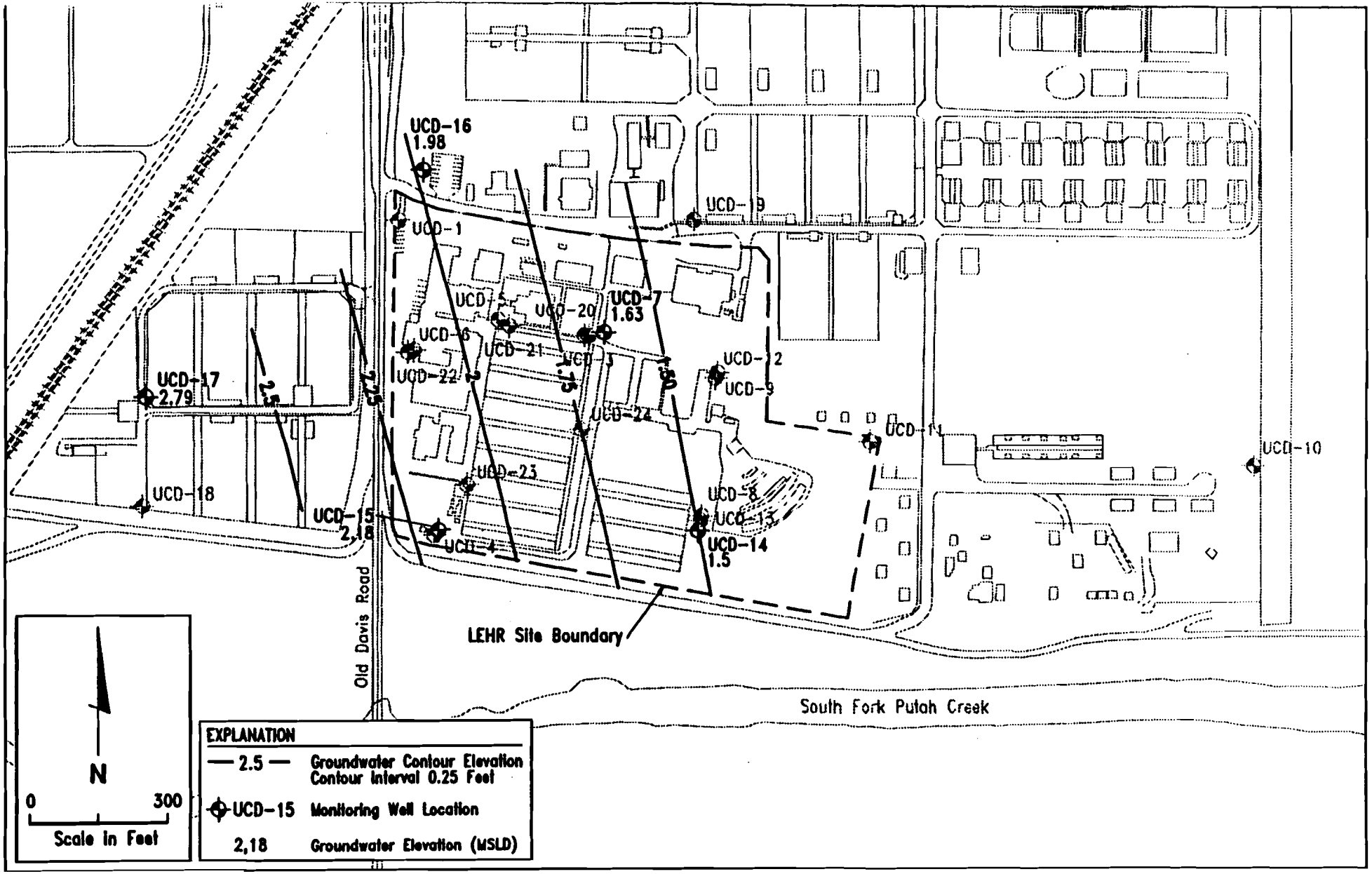


FIRST HSU GROUNDWATER CONTOUR ELEVATIONS AUGUST 27, 1993

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 TXL 3/24/94 082793H1

FIGURE A19



SECOND HSU GROUNDWATER CONTOUR ELEVATIONS AUGUST 27, 1993

RI/FS Work Plan
LEHR Environmental Restoration
D[illegible]s, California

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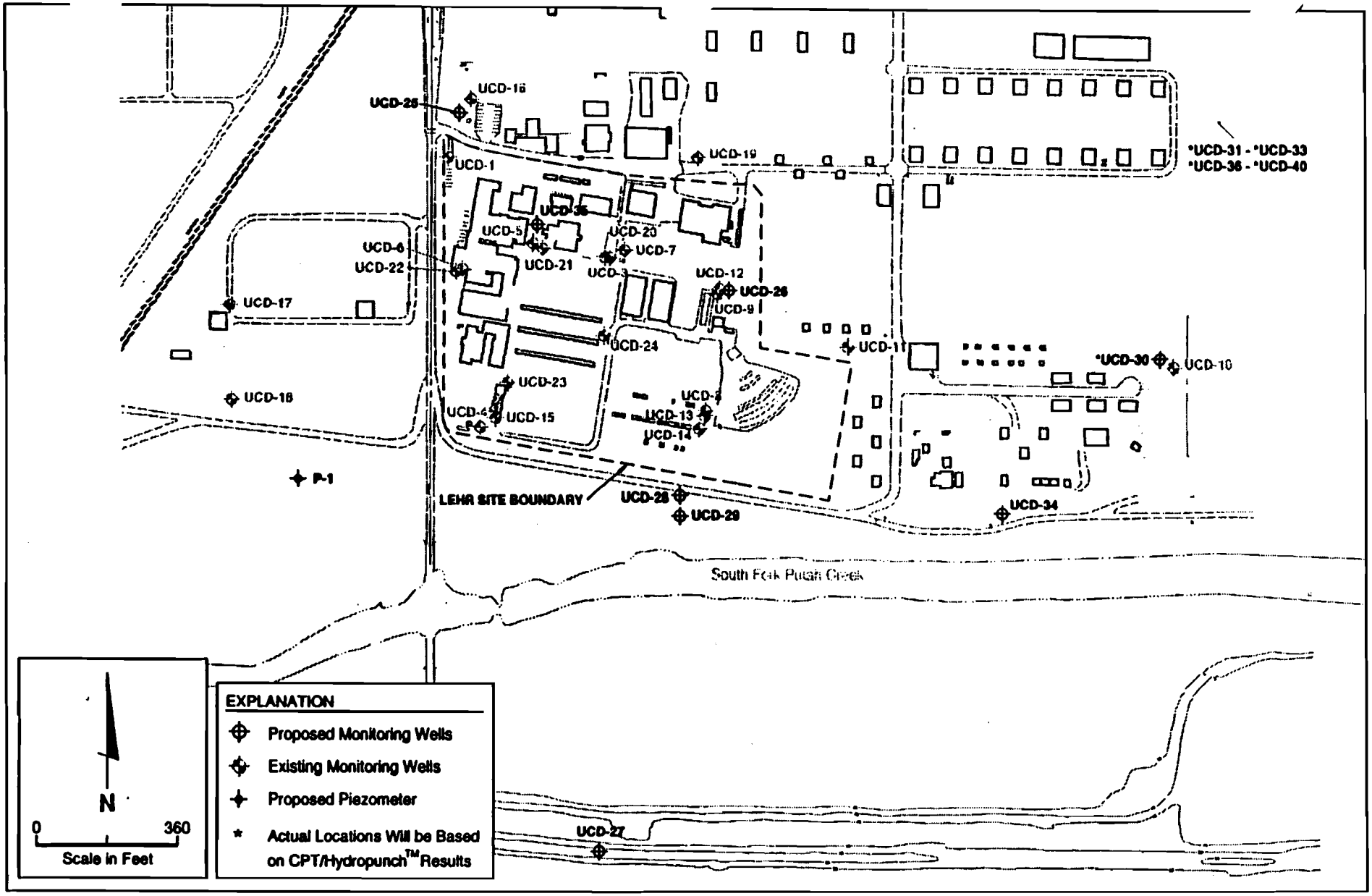
GURE A20

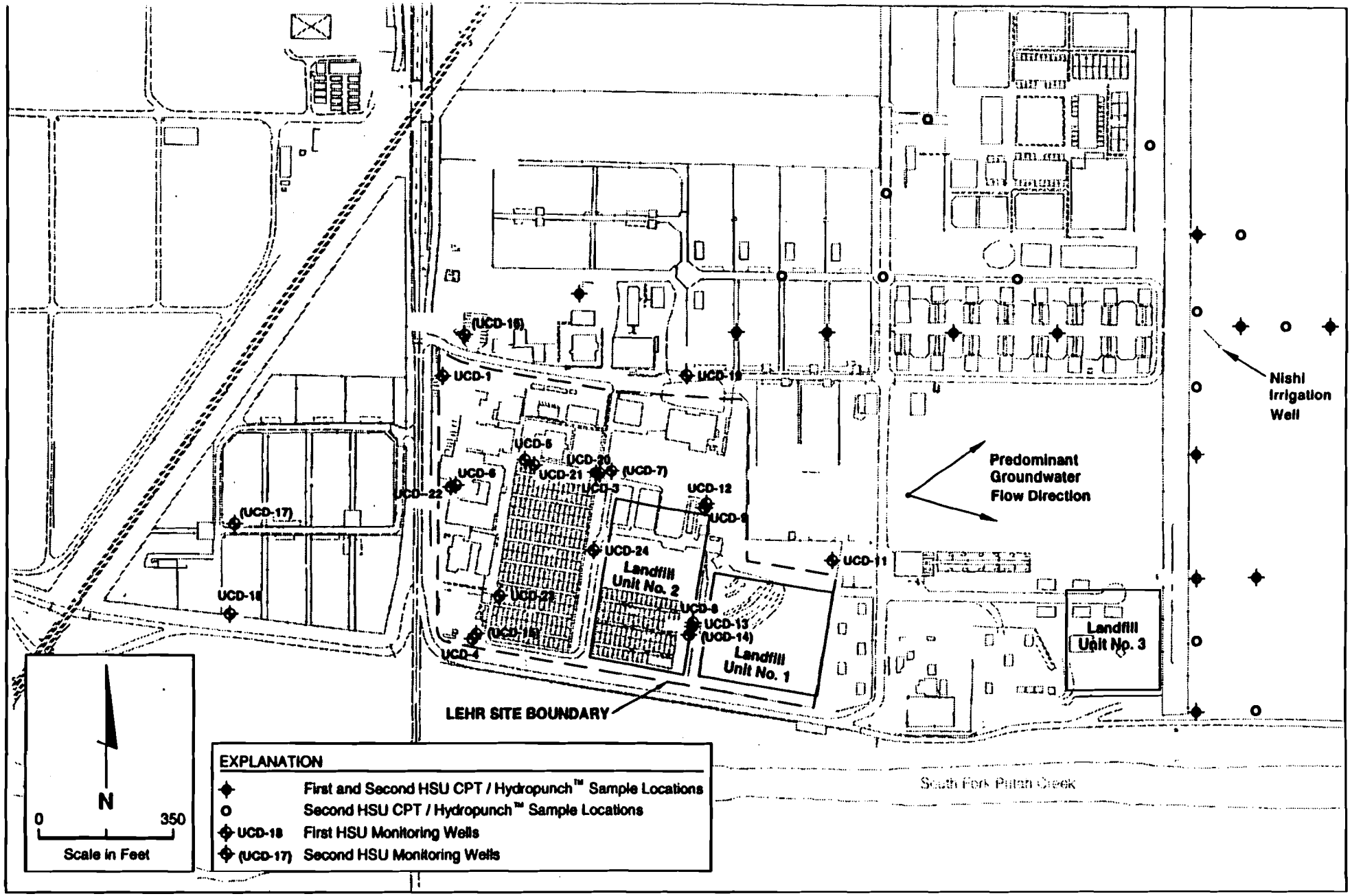


LOCATION MAP
PROPOSED GROUNDWATER MONITORING WELLS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 SJR 2/24/94 5705K

FIGURE A21

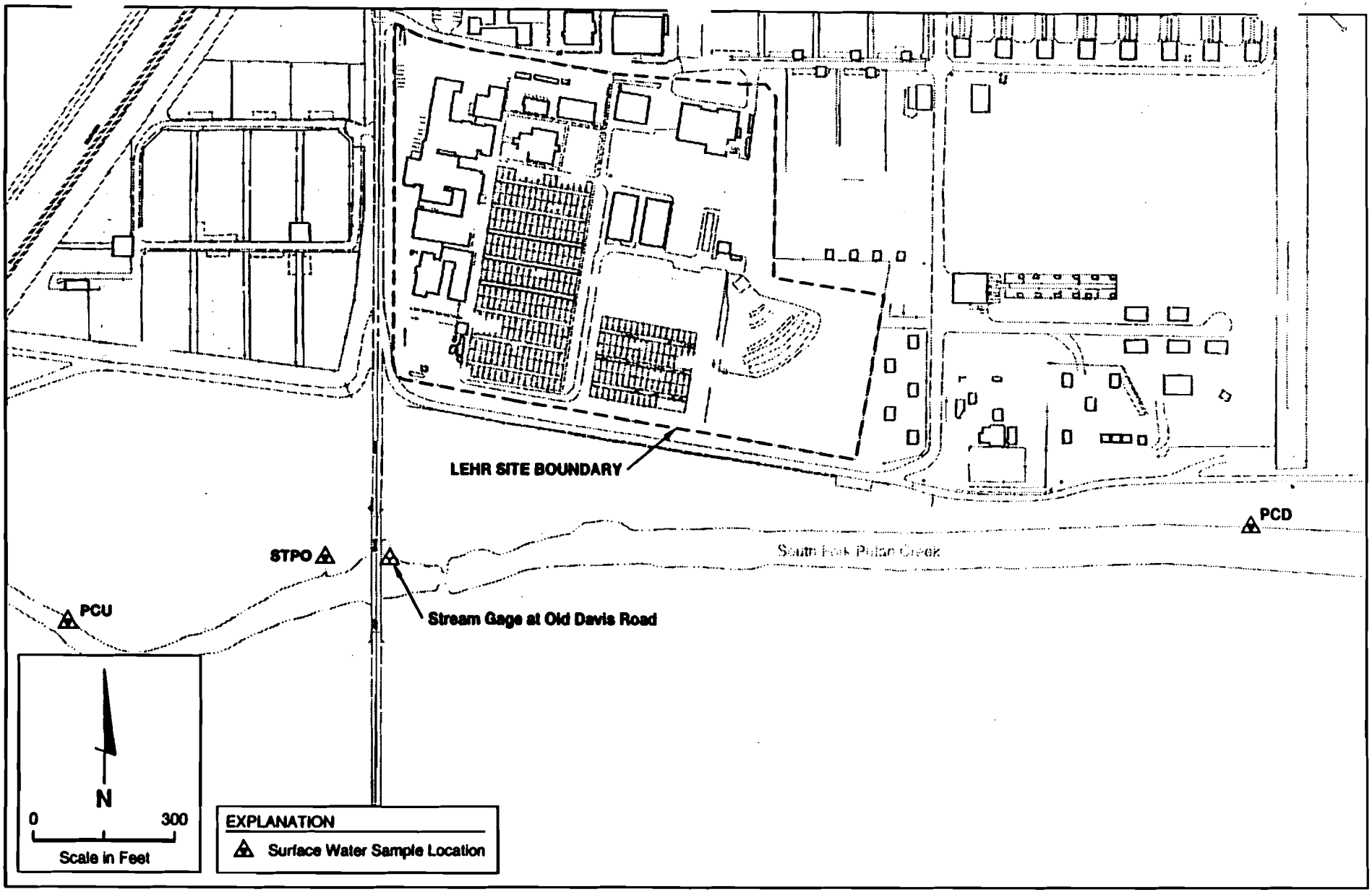


LOCATION MAP PROPOSED CPT / HYDROPUNCH™ LOCATIONS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 sir 2/24/95 5705S

FIGURE A22

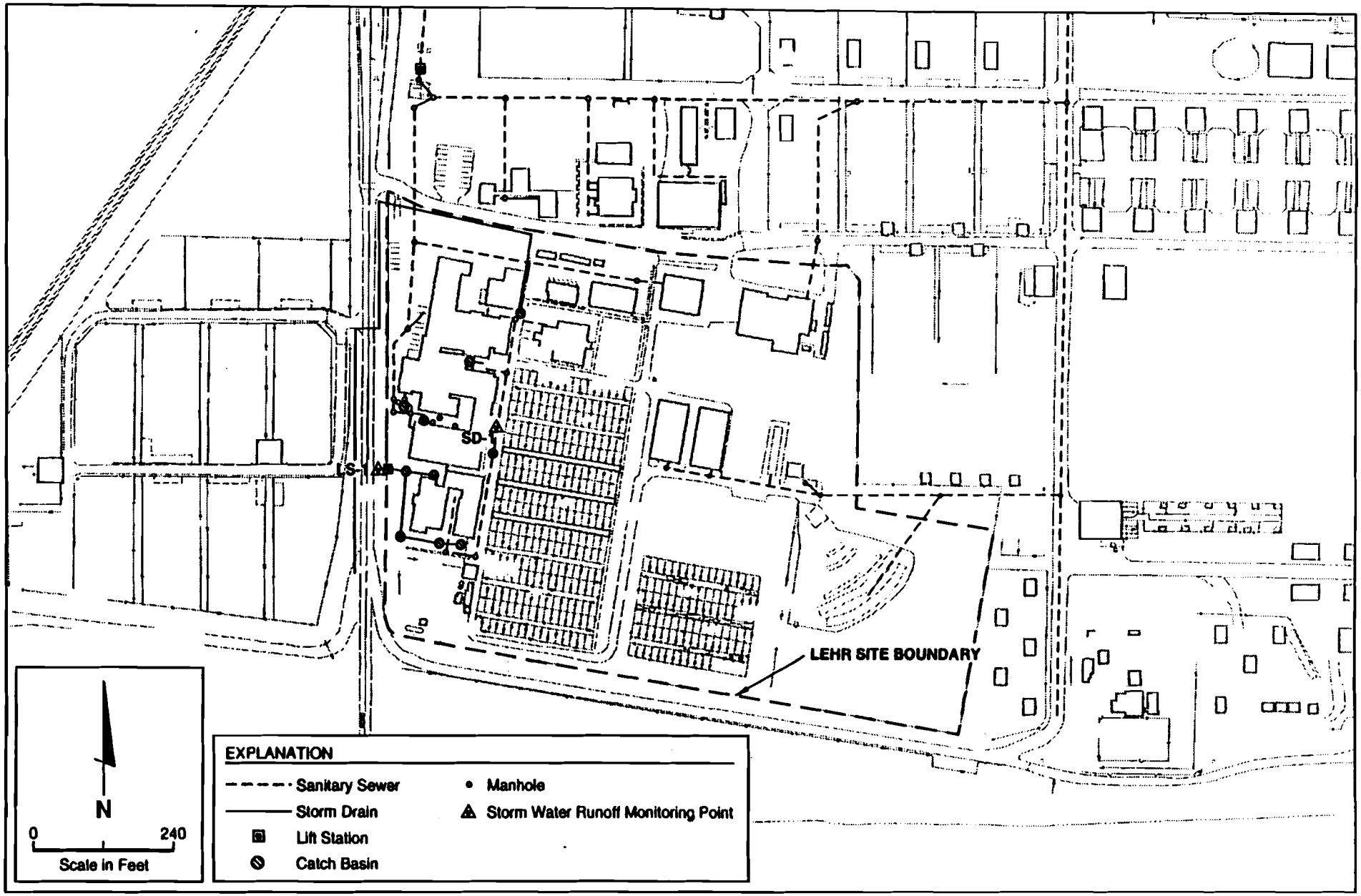


LOCATION MAP SURFACE WATER MONITORING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 SJR 2/24/94 5705L

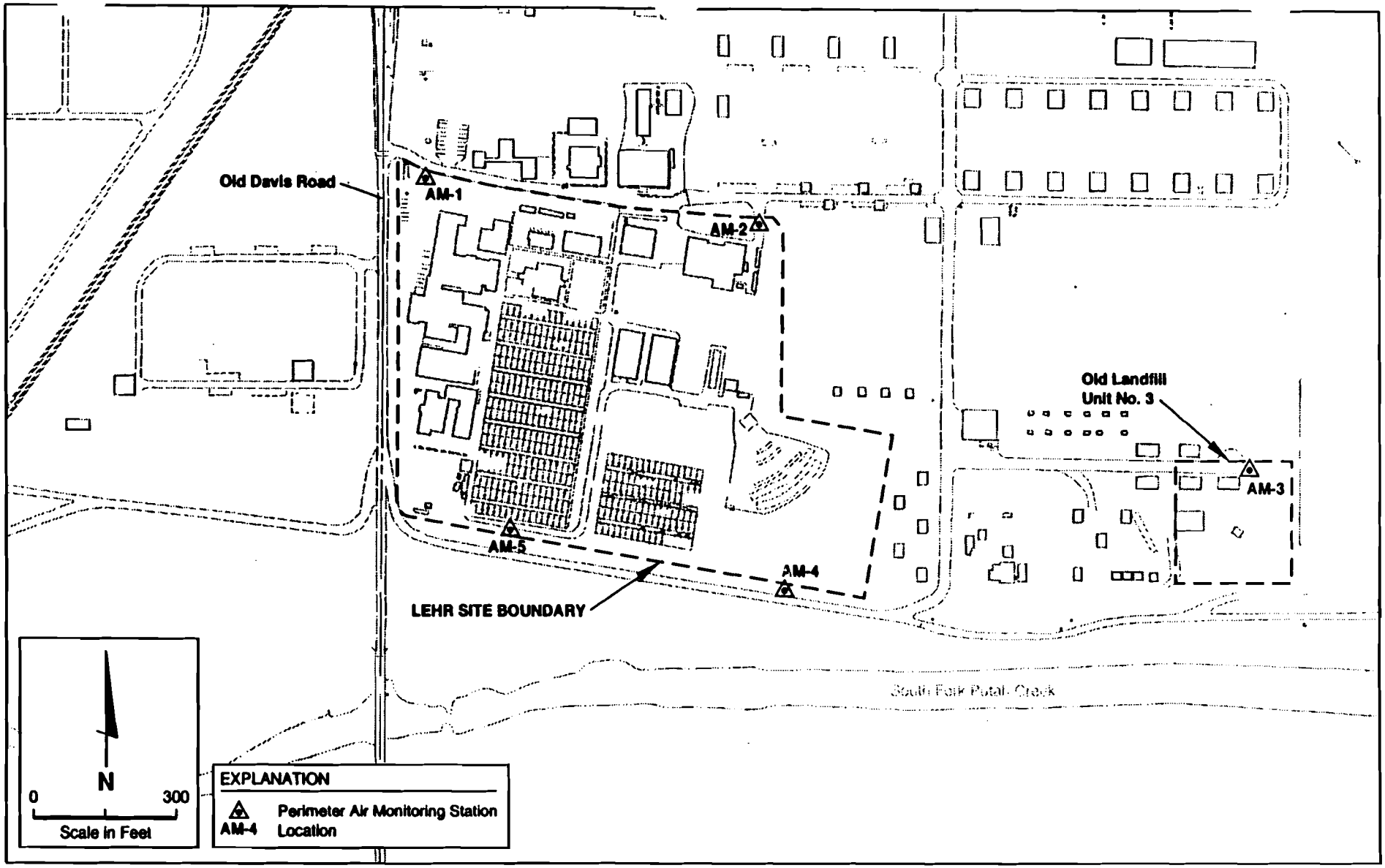
FIGURE A23



REFERENCE: FROM ENVIRONMENTAL SURVEY PRELIMINARY REPORT DOE MARCH 1988

LOCATION MAP
STORM WATER RUNOFF MONITORING POINTS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California



LOCATION MAP PERIMETER AIR MONITORING STATIONS

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

10805-720-044 SJR 2/24/94 5705T

FIGURE A25

4.0 RATIONALE AND APPROACH

This chapter presents the rationale and technical approach for the sampling and analysis activities associated with the RI/FS. The project objectives are to obtain data of adequate quantity and quality to accomplish three basic tasks: (1) to conduct a remedial investigation which develops a refined LEHR site model identifying the lateral and vertical extent of LEHR site constituents and transport processes of those constituents; (2) to assess sources, transport pathways, potential receptors and the actual and potential risks to the public and the environment; and (3) to complete a feasibility study to assess the effectiveness and implementability of potential remedial actions. To complete these objectives, it is anticipated that a variety of investigative, exploration and sampling methods, including literature review, geophysical and soil gas surveys, backhoe excavation, soil borings, monitoring well installation, wipe sampling, soil sampling, groundwater sampling, surface water, and storm water sampling will be conducted.

Rationale for collecting soil chemical, physical, and radiologic data from specific OUs and areas of investigation are presented in Section 4.1. Section 4.2 presents the water monitoring program which includes rationale and technical approach for collecting groundwater, surface water, and storm water samples for analysis of chemical and radiologic parameters. Additional investigations of groundwater chemical and physical characteristics necessary for hydrogeochemical characterization and modeling parameters are discussed in Section 4.3. Rationale for air quality investigation and monitoring activities are described in Section 4.4.

Chapter 5 presents the anticipated sampling techniques of soil, water, and air samples that will be collected for each area of investigation. The scope of the RI has been staged so as to sequentially build on existing data to the point where the quality and quantity is sufficient to meet the objectives for the project as noted above.

4.1 SOIL INVESTIGATION

The following sections present the rationale for investigative methods at each of the areas of investigation that make up the soil OUs. A more detailed description is presented in Chapter 5 of the RI/FS Work Plan.

4.1.1 Background Study

A background study will be conducted to refine regional background concentrations of metals, organic, and radiologic constituents of concern previously reported in soils at the LEHR site. Preliminary background concentrations were established during the Phase II Investigation based upon soil samples collected from UCD-17 and UCD-18. These levels were used to evaluate possible impacts on-site. The background levels established during this RI will provide the basis to develop remedial objectives. Background levels will be developed for two depth intervals: 1) surface to 10 feet bgs; and 2) 10 feet bgs to 40 feet bgs. Different background levels for each depth interval may be important in evaluating risk to human and environmental receptors and in evaluating feasible remedial alternatives. The background study will consist of four specific activities including:

- Literature review;
- Vadose zone soil sampling;
- Analysis of selected soil samples;
- Geodetic surveying; and
- Statistical development of background levels.

Details on each of these investigative activities are presented Section 5.1 of the RI/FS Work Plan.

4.1.2 DOE Burial Trenches, and DOE Disposal Box (OU-1)

An investigation will be performed to characterize the DOE disposal trenches and the disposal container known as the "DOE Disposal Box". This area makes up part of preliminary soil OU-1. The DOE disposal trenches are located in the southwest corner of the LEHR site. The trenches are reported to be approximately 120 feet long, and are oriented roughly in a north/south direction. The DOE Disposal Box is reportedly a steel dumpster-like container located east of the western set of dog pens. These disposal areas reportedly received wastes generated during research conducted at the LEHR site. Reportedly, the DOE Disposal Box received wastes with higher levels of radioactivity.

To date, no samples have been collected from the area directly adjacent to the DOE disposal trenches. It is anticipated that the data collected during the Phase II Investigation will be used as lateral control for constituents of concern that may be identified in the DOE disposal trenches.

Accurate location of the DOE trenches and the DOE Disposal Box is required to optimize discrete sample locations. Therefore, the initial activities conducted for this task will be focused on locating these structures. Because of the unknowns, and the associated human and environmental health and safety concerns, the sample-collection tasks will be phased starting with the least invasive methods. Information from activities conducted early in the investigation will be evaluated and used to guide subsequent more invasive activities.

Evaluation of the DOE burial trenches and the DOE Disposal Box will consist of the following activities:

- Personnel interviews and literature review;
- Geophysical surveys;
- Gas and radiologic surveys;
- Backhoe exploration;
- First-stage soil borings;
- Second-stage soil borings (if necessary);
- Chemical testing;
- Physical testing; and
- Geodetic Surveying.

Each of these activities is described in Section 5.2 of the RI/FS Work Plan.

4.1.3 UC Davis Disposal Trenches (OU-1)

An investigation will be performed to characterize the UC Davis disposal trenches and pits, collectively known as the UC Davis trenches. The UC Davis trenches are located along the southern boundary of the LEHR site and between UC Davis Landfill Units 1 and 2, and are included in preliminary soil OU-1. The 19 known trenches and 49 known pits are reported to have been used to dispose of campus generated low-level radioactive

waste, organic chemicals, and laboratory wastes. The trenches and pits are reported to be between 6 and 10 feet deep. The general area of the known trenches and pits is known; however, specifics as to the exact number, location, and depth of the trenches has yet to be assessed. To date, limited data have been generated that characterize the contents of the UC Davis trenches. Some samples were collected during the Phase II Investigation and analyzed for radiologics. These samples had reported activity of carbon-14 and tritium.

Accurate locations of these trenches is required to identify specific sampling locations. Therefore, the initial activities conducted for this task will be focused on accurately locating the trenches and pits. Because of the unknowns, and the associated human and environmental health and safety concerns, the investigative tasks will be phased starting with the least invasive methods. Information from activities conducted early in the investigation will be evaluated and used to guide subsequent more invasive exploration and sampling activities.

Evaluation of the UC Davis trenches will consist of the following activities:

- Personnel interviews and literature review;
- Geophysical surveys;
- Gas and radiologic surveys;
- Backhoe exploration;
- First-stage soil borings;
- Second-stage soil borings (if necessary);
- Chemical testing;
- Physical testing; and
- Geodetic surveying.

Each of these activities is described in detail in Section 5.3 of the RI/FS Work Plan.

4.1.4 Radium-226 Treatment Tank and Leach System (OU-2)

The radium-226 treatment system is included in preliminary soil OU-2 and reportedly received radioactive waste from facilities in Animal Hospital-2 (AH-2). The radium-226 treatment tanks are located underground between the Imhoff Building and

AH-2. The associated distribution box, dry wells, and seepage trench, collectively identified as the leach systems, are reportedly located in the parking area west of the Imhoff Building. In 1992, liquids and sludge remaining in the treatment tanks were removed, solidified, and shipped to the Hanford facility in the State of Washington (Chemical Waste Management, 1992).

The radium-226 leach system is comprised of three dry wells and a seepage trench; the dry wells are each approximately 30 inches in diameter and 40 feet deep, while the seepage trench is approximately 91 feet long, 3 feet wide, and 14 feet deep. A description of these systems is presented in Section 3.1 of the RI/FS Work Plan.

Analytical data obtained during the Phase II Investigation and LEHR site historical data were used to develop the scope of sampling presented in the RI/FS Work Plan. Data collected during the Phase II Investigation from this area focused on the general area near the dry wells. No samples were collected from immediately adjacent to the dry wells or seepage trench. The 1992 liquid and sludge removal project focused only on the contents of the treatment tanks. Analysis of the data collected during the Phase II Investigation indicates that levels of suspected LEHR site constituents are relatively consistent throughout the area. However, it is suspected that the data may be biased low because sample locations may have been away from suspected sources and that lateral migration of constituents in soil has been minimal. It is anticipated that the Phase II data will be used to supplement data generated during this RI and provide additional lateral control for LEHR site constituents that may be identified in the seepage systems.

To ensure that soil samples are collected adjacent to and below the tanks, and from within the leach system areas, the tanks and leach systems must be located. Because the tanks were positively located during the liquid and sludge removal project, only the leach systems associated with the radium-226 treatment system remain to be located.

Following location of the leach systems, soil samples will be collected for chemical and physical analysis following procedures outlined in SOP 10 (Soil Sampling). Additionally, wipe samples from within the structures will be collected for radiologic screening purposes. Chemical analysis results will be used to evaluate the nature and extent of potential LEHR site constituents in these systems and physical analysis results

will be used to evaluate physical properties of the soils for use in fate-and-transport modeling and risk assessment. Assessment of the radium-226 treatment system will be accomplished through the implementation of specific activities including:

- Literature review;
- Geophysical survey;
- Backhoe exploration;
- Soil borings;
- Wipe sampling;
- Chemical testing;
- Physical testing; and
- Geodetic setting.

Each of these activities are described in detail in Section 5.4 of the RI/FS Work Plan.

4.1.5 Strontium-90 Treatment (Imhoff) System (OU-2)

The strontium-90 treatment system, also known as the Imhoff system, is comprised of the Imhoff treatment tanks and two leach fields of differing ages. This investigation area is included in preliminary soil OU-2. The system received radioactive waste, predominantly strontium-90, from facilities in Animal Hospital-1 (AH-1), until 1987. A description of the Imhoff system is presented in Section 3.1 of the RI/FS Work Plan. The Imhoff tanks are located underground beneath the Imhoff Building. The most recently used leach field is reportedly located east of the Imhoff Building. The original leach field is reportedly located under the eastern portion of the Imhoff building. Reportedly, the original leachfield was abandoned when the Imhoff Building was constructed.

Data collected during the Phase II Investigation focused on the most recent strontium-90 leach field area. No samples were collected from the original leach field or from below the Imhoff tanks. In 1992, liquids and sludge remaining in the Imhoff system were removed, solidified, and shipped to the Hanford facility in the State of Washington (Chemical Waste Management, 1992). The liquid and sludge removal project focused on the contents within the Imhoff system and did not evaluate the soil beneath the tanks. The Imhoff building is scheduled for demolition as part of the ongoing facility

Decontamination and Decommissioning operations. It is anticipated this characterization will be conducted after the Imhoff Building has been demolished, after which the Imhoff tanks and the original leach system should be accessible.

The analytical data obtained during the Phase II Investigation and LEHR site historical data were used to develop the scope of sampling presented in the RI/FS Work Plan. Analysis of data collected during the Phase II Investigation indicates that levels of suspected LEHR site constituents are relatively consistent in the area of the leach field. However, as in the radium-226 system, it is suspected that the data are biased low because sample locations may have been away from suspected sources, such as the older leach field and the treatment tank, and that lateral migration of constituents in soil has been minimal. It is anticipated that the Phase II data will be used to supplement data generated during this RI and provide additional lateral and vertical control for LEHR site constituents that may be identified in the leach field area.

To ensure that samples are collected adjacent to and below the tanks, and from within the leach field areas, the tanks and leach fields must be located. After the leach fields have been located, soil and wipe samples will be collected for chemical and physical analysis. Results of chemical and physical analyses will be used to evaluate the nature and extent of LEHR site constituents in the areas, refine the conceptual LEHR site model, and provide parameters for fate-and-transport modeling, risk assessment, and feasibility. Assessment of the strontium-90 treatment system will be accomplished through the implementation of specific activities including:

- Literature review;
- Geophysical survey;
- Backhoe exploration;
- Soil borings;
- Wipe sampling;
- Chemical testing;
- Physical testing; and
- Geodetic Surveying.

Each of these activities is discussed in detail in Section 5.5 of the RI/FS Work Plan.

4.1.6 Western Dog Pen and North Chemical Dispensing Areas (OU-3)

Beagles used in the research conducted at the LEHR site were housed in outdoor dog pens. Excreta from these dogs was picked up on a daily basis and urine was allowed to evaporate or infiltrate into the soils. The north chemical dispensing area was used to store and dispense a variety of chemicals used in operations at the LEHR site. These areas make up preliminary soil OU-3.

During the Phase II Investigation, soil samples were collected from the dog pens and from the north chemical dispensing area. The samples were collected from the surface and approximately 12 to 18 inches below ground surface to evaluate potential impacts to shallow soils. Results of the chemical and radiologic analyses indicate minimal impacts to the soils, primarily from chlordane and nitrate. Additional characterization of the dog pens during this RI focusses on vertical delineation of areas previously identified as having slightly elevated levels of these constituents, and an assessment of an area that contained dog pens until 1975 when 64 dog pens were removed to allow for construction of the Cellular Biology laboratory.

The focus of investigation in the north chemical dispensing area is to collect samples from beneath the chemical storage area. Samples collected from the north chemical dispensing area during the Phase II Investigation also had reported detections of nitrate, chlordane and some radiologics. Based on review of aerial photographs during the preparation of this RI/FS Work Plan, it was determined that the Phase II sample locations may not have been located in the area of the majority of the chemical storage containers. Therefore, additional samples are proposed to be collected from the area of the chemical storage containers. The western dog pen area and the north chemical dispensing area will be further characterized through the implementation of the following specific activities:

- Literature review;
- Soil borings;
- Chemical testing;
- Physical testing; and
- Geodetic surveying.

Each of these activities is described in detail in Section 5.6 of the RI/FS Work Plan.

4.1.7 Domestic Septic Tanks (OU-4)

During the initial operations at the LEHR site, the offices were serviced by domestic septic systems. Reportedly, there are seven domestic septic tanks and associated leach fields at the LEHR site. Together these areas comprise soil OU-4. The tanks of the LEHR site were reportedly abandoned and filled with clean sand when the LEHR site was hooked up to the main UC Davis wastewater treatment plant. Three of the septic tanks at LEHR were located during the Phase II Investigation. The location of one tank at the LEHR site was also tentatively confirmed. Locations of the remaining tanks at the LEHR site have not been determined.

Relatively non-invasive exploration techniques including a review of literature and geophysical methods, will be used in initial attempts to locate the tanks. If a tank cannot be positively located using these methods, more invasive exploration methods including exploration trenching and drilling may be implemented. Assessment of the seven domestic septic systems will consist of the following activities:

- Personal interviews and literature review;
- Geophysical surveys;
- Backhoe exploration;
- Wipe sampling;
- Soil borings;
- Chemical testing;
- Physical testing; and
- Geodetic surveying.

A more detailed discussion of the activities that will occur in this area is presented in Section 5.7 of the RI/FS Work Plan.

4.1.8 UC Davis Landfill Units (OU-5)

An investigation will be performed to characterize the three UC Davis landfill units associated with the LEHR site. Together, these units make up soil OU-5. The landfill units reportedly received UC Davis campus wastes from the 1940s through the early 1970s. Although the landfills reportedly received primarily municipal wastes, the potential exists that they may have received laboratory wastes related to DOE and UC Davis activities.

The UC Davis landfill units were reportedly excavated in parallel trenches approximately 10 to 12 feet below grade then backfilled with refuse. Approximately 3 to 4 feet of cover material was reportedly placed over the refuse material when an individual trench within the landfill unit was filled. None of the three landfill units has an engineered landfill cover or cap.

To date, no data have been generated that characterize the contents of the UC Davis landfill units. Because of the unknowns, and the associated human and environmental health and safety concerns, the investigation tasks will be phased starting with the least invasive methods. Information from activities conducted early in the task will be evaluated and used to guide subsequent more invasive sampling activities. Evaluation of the UC Davis landfill units will consist of the following activities:

- Personnel interviews and literature review;
- Geophysical Surveys;
- Landfill Gas Survey;
- First-stage soil Borings;
- Second-stage soil borings (if necessary);
- Chemical Testing;
- Physical Testing; and
- Geodetic Surveying.

Each of these activities is described in detail in Section 5.8 of the RI/FS Work Plan.

4.2 WATER MONITORING

Water monitoring at the LEHR site will consist of field parameter measurements, sample collection, and laboratory analysis of groundwater, surface water, and stormwater runoff. The purpose of this water monitoring program is to evaluate the extent of LEHR site constituents in groundwater beneath the LEHR site and surrounding area, in Putah Creek, and in storm water runoff generating on the LEHR site. Data from previous investigations conducted at the LEHR site have indicated impacts to groundwater primarily from nitrate, volatile organic compounds, and tritium. A more detailed discussion of the water monitoring program is presented in Chapter 6 of the RI/FS Work Plan.

4.2.1 Groundwater

The purpose of the groundwater monitoring program is to evaluate the vertical and lateral extent of LEHR site constituents and to evaluate variations in concentrations of these constituents during the annual hydrogeologic cycle. The vertical and lateral extent of LEHR site constituents in groundwater will be evaluated by monitoring the upper two hydrostratigraphic units (HSUs) that occur beneath the LEHR site. Currently, 13 wells are used to monitor the first HSU and 5 wells are used to monitor the second HSU. During the RI/FS, 4 new first HSU wells, and 12 ~~seven~~ new second HSU wells, are proposed to be installed and included in the groundwater monitoring program.

The lateral extent of LEHR site constituents will be evaluated by collecting field measurements and samples from monitoring wells upgradient and downgradient of potential source areas. Statistically supportable background values will be developed after completion of a regional groundwater quality assessment and after additional analysis of groundwater collected from existing upgradient monitoring wells UCD-17 and UCD-18. ~~with data collected from sampling and analysis of existing upgradient wells and additional evaluation of regional background levels.~~

Variation in concentrations of LEHR site constituents during the annual hydrologic cycle will be evaluated by conducting groundwater monitoring on a quarterly schedule. The quarterly monitoring program presented in the RI/FS Work Plan and FSP is modified from the Water Monitoring Plan. These modifications are pending concurrence from the

regulatory agencies and are presented here for completeness. ~~Field parameters and analytes of most concern for the LEHR site (designated "quarterly parameters") will be measured or analyzed each quarter. Annual analytes will be analyzed for once each year (spring quarter only).~~

4.2.2 Surface Water

Surface water monitoring will be conducted to evaluate the extent of LEHR site constituents of concern in Putah Creek. The purpose of monitoring will be to identify potential impacts from the LEHR site and surrounding areas on Putah Creek, and to identify potential impacts from Putah Creek to the groundwater system.

Surface water monitoring will be conducted at three locations along Putah Creek. To identify potential impacts from the LEHR site, Putah Creek will be sampled at locations upstream and downstream of the LEHR site. Because there is no flow in the Creek during dry months and most of the water in the Creek during these periods is due to discharge from the UC Davis wastewater treatment plant, the wastewater treatment plant outfall tributary will also be sampled each quarter. Each of the three surface water monitoring locations will be sampled quarterly in conjunction with groundwater monitoring.

4.2.3 Storm Water

Storm water monitoring will be conducted to evaluate the presence of LEHR site constituents in storm water runoff from the LEHR site. Monitoring will be conducted two times each year. The first sampling event will occur early in the rainy season (November through April) in order to sample runoff that may carry material that accumulated on the ground surface during the summer months. The second sampling event will occur during the middle to late portion of the rainy season.

Storm water runoff monitoring will consist of collecting field measurements and samples from two separate runoff collection points. The exact monitoring locations will be based on observed storm water flow path; however, basic locations will include the lift station located in the southwest corner of the LEHR site, and a storm drain located along the western side of the western dog pen area. The lift station samples and measurement

will monitor the storm water that runs off the southwest corner of the LEHR site, and pumped across Old Davis Road and subsequently discharged to Putah Creek. The storm drain samples will monitor water that runs off the southern portion of the LEHR site and the dog pen area. Because the storm drain is part of the combined system that collects storm water runoff and sanitary sewage from the LEHR site, the storm drain sample will be collected upstream from the first input of sanitary sewage. Storm water runoff samples will be analyzed for the entire suite of water monitoring parameters.

4.3 HYDROLOGIC INVESTIGATION (OU-6)

The RI/FS will include a hydrogeologic investigation that will be conducted to further understand the sediments and groundwater that underlay the LEHR site and surrounding area. The objectives of this hydrologic investigation will be to collect additional stratigraphic and groundwater analytical data to evaluate the vertical and lateral extent of LEHR site constituents in groundwater, and to collecting aquifer permeability data to develop a better quantitative understanding of the hydrogeologic system. In general, the hydrologic program will utilize a phased approach in which data from one phase will be collected and evaluated prior to beginning the next phase. Phases of this ~~This~~ program will include performing cone penetrometer tests (CPT), collecting in situ water samples using a Hydropunch™, installation of new groundwater monitoring wells, and collecting data to evaluate saturated zone modelling parameters. Chapter 6 of the RI/FS Work Plan presents a more detailed discussion of the hydrologic investigation.

4.3.1 CPT/Hydropunch™

The CPT and discrete depth in situ groundwater sampling (Hydropunch™) will be conducted to aid in evaluating the lateral and vertical extent of impacts to the first and second HSUs. The rationale behind the CPT and Hydropunch™ program is to collect stratigraphic and groundwater chemical data quickly and over a larger area than is possible from installing and sampling groundwater monitoring wells. The results from the CPT/Hydropunch™ program will be used to design a groundwater monitoring network.

During the RI/FS program, CPT/Hydropunch™ samples will be collected from 24 locations to evaluate impacts to the first and second HSUs downgradient of the LEHR site.

Approximately five locations will be placed downgradient of UCD Landfill Unit No. 3, seven locations identified in the area of the Nishi irrigation well located northeast of the LEHR site, and twelve locations will be located north of monitoring wells UCD-19 and UCD-12 (Figure A22). The focus of this CPT/Hydropunch™ program will be on the second HSU because it has been identified as the most likely migration pathway from disposal areas at the LEHR site.

4.3.2 Monitoring Well Installation

Sixteen ~~Ten~~ new monitoring wells will be installed to provide long-term data to evaluate potential LEHR site impacts to groundwater. Four new wells will be screened in the first HSU, and twelve ~~six~~ wells will be screened in the second HSU. The rationale for each proposed well is described below.

New first HSU wells will include UCD-25, UCD-28, UCD-33, and UCD-34 (Figure A21). Well UCD-25 will be a replacement well for UCD-1, in the northwest corner of the LEHR site. Well UCD-28 will be used to evaluate lateral extent of LEHR site constituents and assess interaction with Putah Creek. Well UCD-33 will be used to evaluate lateral extent of impacts in the first HSU. Well UCD-34 is located upgradient of Old UC Davis landfill unit No. 3.

New second HSU wells will include UCD-26, UCD-27, UCD-29, UCD-30, UCD-31, UCD-32, UCD-35 and wells UCD-36 through UCD-40 (Figure A21). UCD-26 will be used to evaluate impacts in the second HSU in the area adjacent to first HSU well UCD-12. UCD-27 will be installed on the south side of Putah Creek to assess water quality and groundwater flow direction in that area. Well UCD-29 will be used to evaluate lateral and vertical extent of LEHR site impacts and interaction with Putah Creek. UCD-30 will be used to evaluate extent of impacts to the second HSU downgradient of landfill unit No. 3. ~~Well UCD-31 will be used to evaluate lateral and downgradient extent of impacts in the second HSU. Well UCD-32 will be used to evaluate the downgradient extent of impacts to the second HSU.~~ UCD-35 will be installed to assess impacts to the second HSU downgradient of the radium-226 and str. ntium-90 treatment systems. The final locations of wells UCD-31 through UCD-33, and wells UCD-36 through UCD-40 are anticipated to be north and east of the LEHR Site, and will be located based on the CPT/hydropunch results.

In addition to the sixteen new monitoring wells, one piezometer will be installed in the first HSU. This piezometer will be located between surface water sample location STPO on Putah Creek, and monitoring well UCD-18. The purpose of this piezometer is to provide data to evaluate the interaction between Putah Creek and shallow groundwater.

4.3.3 Saturated Zone Modelling Parameters

Saturated zone modelling parameters will be evaluated by conducting slug tests on the 16 new monitoring wells and possibly by conducting a pump test. Slug tests will be conducted on each of the 16 monitoring wells installed during the RI. Rising and falling head tests will be conducted to evaluate hydraulic conductivity in the immediate area around the new monitoring wells. Graphical procedures, based on groundwater flow equations will then be used to estimate hydraulic conductivity.

In addition to the aquifer slug tests, an aquifer pump test in the second HSU may also be conducted to more accurately estimate the hydraulic conductivity, transmissivity, and aquifer yield. However, due to concerns about the anticipated logistical difficulty and cost of disposal of potentially contaminated water, and the potential to accelerate migration or temporarily alter the general groundwater flow direction, a pump test at the LEHR site may be difficult to implement.

Several options are available to obtain more detailed aquifer data and will be evaluated for technical and financial feasibility. These options include: 1) performing a pump test on an upgradient monitoring well screened in the second HSU; 2) performing a pump test on a nearby agricultural well (of known integrity and under UC Davis' control) screened in the second HSU; and 3) performing a pump test on an existing agricultural well near the LEHR site. These options have been discussed in detail in Chapter 6 of the RI/FS Work Plan.

4.4 AIR QUALITY INVESTIGATION

The air quality investigation will be conducted in order to assess the baseline air quality on and near the LEHR site. Five sample-collection stations arranged on the perimeter of the LEHR site, are intended to detect the presence of airborne chemical or

radiologic constituents (Figure A25). The air monitoring station locations have been selected based on the prevailing wind directions and locations of potential sources. Three sample-collection stations are located near the LEHR site and are intended to detect background concentrations.

Radiologic and chemical parameters will be analyzed in order to account for constituents in the vapor phase as well as suspended dust particles in the solid phase. This information will be used to assess risks and exposures in background as well as from the LEHR site. Samples will be analyzed monthly during the RI.

In addition to the analytical sampling, a temporary meteorological station may be installed at the LEHR site to obtain on-site meteorological data. Additional details on the air monitoring program are discussed in Chapter 7.

5.0 SAMPLE ANALYSIS

The purpose of this chapter is to identify analytical methods, sample handling procedures, preservation methods, and sample holding times so that samples are delivered to the laboratory in the proper condition and are analyzed by the appropriate methods. Laboratory quality assurance and quality control procedures for the methods listed below are described in the QAPjP (Appendix B) along with analyte-specific Data Quality Objectives.

5.1 SUMMARY OF ANALYSES

Proposed analytes, analytical methods, container types, sample handling procedures, detection limits, and holding times for soil, water, and air monitoring are presented in Tables A-5.1, A-5.2, and A-5.3 respectively. Sampling locations, depths, and frequencies are described in Chapters 5, 6, and 7 of the RI/FS Work Plan. Analytical methods listed in these tables were selected based on data requirements for the RI/FS and Risk Assessment.

Information presented in Tables A-5.1, A-5.2, and A-5.3 will be used to request laboratory analyses for soil, water, and air samples. As samples are collected in the field, they will be handled and placed into containers as specified in these Tables. A list of the appropriate analytes for each sample will be included on a completed Sample Chain-of-Custody (COC) form (see SOP 5.0). A blank copy of the COC is included in Attachment 2 to this Appendix. In addition, the COC will include the sample identification, location, date and time of sampling, number and type of containers, and a list of analyses to be performed. Sample documentation will be completed in the field, and the COC will accompany the samples through transportation and analysis.

TABLE A-5.1 SAMPLE ANALYSES - SOIL

Organic Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRQL	HOLDING TIME
Volatile Organic Compounds	CLP SOW OLM 01.8	2½ inch diameter Stainless Steel Ring	4°C	Page C-2 of SOW OLM 01.8*	7 days
Semivolatile Organic Compounds	CLP SOW OLM 01.8	2½ inch diameter Stainless Steel Ring	4°C	Page C-4 & C-5 of SOW OLM 01.8*	14 days to extraction, 40 days to analysis
Organochlorine Pesticides	CLP SOW OLM 01.8	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	Page C-8 of SOW OLM 01.8*	14 days to extraction, 40 days to analysis

* Table A-5.1a is attached for reference.

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Radiologic Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Gross Alpha	9310	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	5 pCi/g	180 days
Gross Beta	9310	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	10 pCi/g	180 days
Tritium	906.0	500 ml Glass Jar	None	300 pCi/L[b]	180 days
Radium-226	903.1(M)	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	1 pCi/g	180 days
Carbon-14	LSC	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	50 pCi/g	180 days
Strontium-90	905.0	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	1 pCi/g	180 days
Thorium - Isotopic	LAS 0108[c]	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	1.0 pCi/g	180 days

[b] Extracted water is tested.
[c] Laboratory Standard Operating Procedure.

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Radiologic Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Uranium - Isotopic	LAS 0108[c]	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	0.6 pCi/g	180 days
Americium-241	LAS 0108[c]	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	0.1 pCi/g	180 days
Plutonium-241	LAS 0108[c]	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	1.0 pCi/g	180 days

[b] Extracted water is tested.
[c] Laboratory Standard Operating Procedure.

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Radiologic Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Gamma Spectral Analysis	901.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None		180 days
TH-234				130 pCi/g	
PB-214				10 pCi/g	
BI-214				10 pCi/g	
PB-210				250 pCi/g	
U-235				5 pCi/g	
U-238				1 pCi/g	
NA-22				1 pCi/g	
AC-228				15 pCi/g	
PB-212				10 pCi/g	
BI-212				60 pCi/g	
TL-208				5 pCi/g	
K-40				50 pCi/g	
CO-60				4 pCi/g	
CS-137				6 pCi/g	

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Metals Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL[d]	HOLDING TIME
Hexavalent Chromium	7196	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.5 mg/Kg	24 hours
Total Chromium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days
Antimony	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	12 mg/Kg	180 days
Arsenic	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days
Barium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	40 mg/Kg	180 days
Beryllium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg	180 days
Cadmium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg	180 days

[d] Values calculated using formula in CLP SOW ILM02.1 (Section G, Page D-8) and applied to water CRDL values identified on Page C-1.

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Metals Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL[4]	HOLDING TIME
Cobalt	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	10 mg/Kg	180 days
Copper	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	5 mg/Kg	180 days
Iron	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	20 mg/Kg	180 days
Lead	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.6 mg/Kg	180 days
Manganese	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	3 mg/Kg	180 days
Mercury	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.1 mg/Kg	28 days
Molybdenum	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days

[4] Values calculated using formula in CLP SOW ILM02.1 (Section G, Page D-8) and applied to water CRDL values identified on Page C-1.

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Metals Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL[d]	HOLDING TIME
Nickel	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	8 mg/Kg	180 days
Selenium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg	180 days
Silver	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days
Thallium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days
Vanadium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	10 mg/Kg	180 days
Zinc	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	4 mg/Kg	180 days

[d] Values calculated using formula in CLP SOW ILM02.1 (Section G, Page D-8) and applied to water CRDL values identified on Page C-1.

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

General Chemical Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Alkalinity	310.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	300 mg/Kg	14 days
Nitrate (as Nitrogen)	300.0	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.2 mg/Kg	48 hours
Total Kjeldahl Nitrogen	351.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg*	7 days
Water Soluble Anions	300.0	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.1 - 1.0 mg/Kg	48 hours
Formaldehyde	3500 Modified NIOSH	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg	7 days to extraction, 30 days to analysis
Total Organic Carbon	9060(M)	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	10 mg/Kg*	28 days
Ammonia (as N)	350.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1.5 mg/Kg	28 days

* Reporting Limit based on advisory method detection limit.

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

General Chemical Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Sulfide	9030A	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	50 mg/Kg	7 days
Kerosene	8015(M)	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	10 mg/Kg	14 days to extraction, 40 days to analysis
pH	ASTM 4972	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	None	Upon Receipt
EC	ASTM G-57	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	None	Upon Receipt

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

General Physical Tests:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Hydrometer	D-422	Ring or plastic bag	N/A	N/A	None
Grain Size	C-136	Ring or plastic bag	N/A	N/A	None
Permeability	D-2434	Sealed ring	N/A	N/A	None
Moisture Release	D-3152 and D-2325	Sealed 6" ring	N/A	N/A	None
Moisture Content	D-2216	Sealed ring or plastic bag	N/A	N/A	None
Mineralogy	XRD	Ring or plastic bag	N/A	N/A	None
Specific Gravity	D-854	Ring or plastic bag	N/A	N/A	None
Atterberg Limits	D-4318	Ring or plastic bag	N/A	N/A	None
Bulk Density	D-4531	Sealed ring	N/A	N/A	None

TABLE A-5.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Soil Vapor Analyses - Mobile Field Laboratory:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Volatile Organic Compounds[1]	TBD	TBD	TBD	TBD	N/A
Oxygen	TBD	TBD	TBD	TBD	N/A
Carbon Dioxide	TBD	TBD	TBD	TBD	N/A
Methane	TBD	TBD	TBD	TBD	N/A
Gross Beta	SOP 33	TBD	TBD	TBD	N/A
Gross Gamma	SOP 33	TBD	TBD	TBD	N/A

Soil Vapor Analyses - Stationary Laboratory:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Volatile Organic Compounds	TO-14	Stainless Steel Canister	TBD	TBD	TBD
Oxygen	TBD	Stainless Steel Canister	TBD	TBD	TBD
Carbon Dioxide	TBD	Stainless Steel Canister	TBD	TBD	TBD
Methane	TBD	Stainless Steel Canister	TBD	TBD	TBD

[1] Field laboratory analyses of VOCs will be conducted for a limited analyte list: chloroform; 1,1 dichloroethane; 1,1 dichloroethene; 1,2 dichloroethane; trichloroethene; and methylene chloride.

TABLE A-5.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Volatiles (Method CLP SOW OLM 01.8):			
1.	Chloromethane	74-87-3	10
2.	Bromomethane	74-83-9	10
3.	Vinyl Chloride	75-01-4	10
4.	Chloroethane	75-00-3	10
5.	Methylene Chloride	75-09-2	10
6.	Acetone	67-64-1	10
7.	Carbon Disulfide	75-15-0	10
8.	1,1-Dichloroethene	75-35-4	10
9.	1,1 Dichloroethane	75-34-3	10
10.	1,2-Dichloroethene (total)	540-59-10	10
11.	Chloroform	67-66-3	10
12.	1,2 Dichloroethane	107-06-2	10
13.	2-Butanone	78-93-3	10
14.	1,1,1-Trichloroethane	71-55-6	10
15.	Carbon Tetrachloride	56-23-5	10
16.	Bromodichloromethane	75-27-4	10
17.	1,2-Dichloropropane	78-87-5	10

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE A-5.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Volatiles (Method CLP SOW OLM 01.8) - continued:			
18.	cis 1,3 Dichloropropene	10061-01-5	10
19.	Trichloroethene	79-01-6	10
20.	Dibromochloromethane	24-48-1	10
21.	1,1,2-Trichloroethane	79-00-5	10
22.	Benzene	71-43-2	10
23.	trans-1,3-Dichloropropene	10061-02-6	10
24.	Bromoform	75-25-2	10
25.	4-Methyl-2-pentanone	108-10-1	10
26.	2-Hexanone	591-78-6	10
27.	Tetrachloroethene	127-18-4	10
28.	Toluene	108-88-3	10
29.	1,1,2,2-Tetrachloroethane	79-34-5	10
30.	Chlorobenzene	108-90-7	10
31.	Ethyl Benzene	100-41-4	10
32.	Styrene	100-42-5	10
33.	Xylenes (Total)	1330-20-7	10

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE A-5.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Semivolatiles (Method CLP SOW OLM 01.8)			
34.	Phenol	108-95-2	330
35.	bis(2-Chloroethyl) ether	111-44-4	330
36.	2 - Chlorophenol	95-57-8	330
37.	1,3 Dichlorobenzene	541-73-1	330
38.	1,4 Dichlorobenzene	106-46-7	330
39.	1,2-Dichlorobenzene	95-50-1	330
40.	2-Methylphenol	95-48-7	330
41.	2, 2'-oxybis (1-Chloropropane)	108-60-I	330
42.	4-Methylphenol	106-44-5	333
43.	N-Nitroso-di-n-propylamine	621-64-7330	330
44.	Hexachloroethane	67-72-1	330
45.	Nitrobenzene	98-95-3	330
46.	Isophorone	78-59-1	330
47.	2-Nitrophenol	88-75-5	330
48.	2,4-Dimethylphenol	105-67-9	330
49.	bis(2-Chloroethoxy) methane	111-91-1	330
50.	2,4-Dichlorophenol	120-83-2	330

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE A-5.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Semivolatiles (Method CLP SOW OLM 01.8) - continued:			
51.	1,2,4-Trichlorobenene	120-82-1	330
52.	Naphthalene	91-20-3	330
53.	4-Chloroaniline	106-47-8	330
54.	Hexachlorobutadiene	87-68-3	330
55.	4-chloro-3-methylphenol	59-50-7	330
56.	2- Methylnaphthalene	91-57-6	330
57.	Hexachlorocyclopentadiene	77-47-4	330
58.	2,4,6-Trichlorophenol	88-06-2	330
59.	2,4,5-Trichlorophenol	95-95-4	800
60.	2-Cloronaphthalene	91-58-7	330
61.	2-Nitroaniline	88-74-4	800
62.	Dimethylphthalate	131-11-3	330
63.	Acenaphthylene	208-96-8	330
64.	2,6-Dinitrotoluene	606-20-2	330
65.	3-Nitroaniline	99-09-2	800
66.	Acenaphthene	83-32-9	330
67.	2,4-Dinitrophenol	51-28-5	800

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE A-5.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Semivolatiles (Method CLP SOW LOM 01.8) - continued:			
68.	4-Nitrophenol	100-02-7	800
69.	Dibenzofuran	132 64 9	330
70.	2,4-Dinitrotoluene	121 14	330
71.	Diethylphthalate	84-66-2	330
72.	4-Chlorophenyl-phenyl ether	7005-72-3	330
73.	Fluorene	86-73-7	330
74.	4-Nitroaniline	100-01 6800	800
75.	4,6-Dinitro-2-methylphenol	534-52-1	800
76.	N-nitrosodiphenylamine	86-30-6	330
77.	4-Bromophenyl-phenylether	01-55 3	330
78.	Hexachlorobenzene	118-74-1	330
79.	Pentachlorophenol	87-86-5	800
80.	Phenanthrene	85-01-8	330
81.	Anthracene	120-12-7	330
82.	Carbazole	86-74-8	330
83.	Di-n-butylphthalate	84-74-2	330
84.	Fluoranthene	206-44-0	330

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE A-5.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Semivolatiles (Method CLP SOW OLM 01.8) - continued.			
85.	Pyrene	129-00-0	330
86.	Butylbenzylphthalate	85-68-7	330
87.	3,3'-Dichiorobenzidine	91-94-1	330
88.	Benzo(a)anthracene	56-55-3	330
89.	Chrysene	218-01-9	330
90.	bis(2-Ethylhexyl)phthalate	117-81-71	330
91.	Di-n-octylphthalate	117-84-0	330
92.	Benzo(b)fluoranthene	205-99-2	330
93.	Benzo(k)fluoranthene	207-08-9	330
94.	Benzo(a)pyrene	50-32-8	330
95.	Indeno(1,2,3-cd)pyrene	193 395	330
96.	Dibenz(a,h)anthracene	53-70-3	330
97.	Benzo(g,h,i)perylene	191-24-2	330

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE A-5.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Pesticides/PCBs (Method CLP SOW OLM 01.8)			
98.	alpha-BHC	319-84-6	1.7
99.	beta-BHC	319-85-7	1.7
100.	delta-BHC	319-86-8	1.7
101.	gamma-BHC (lindane)	58-89-9	1.7
102.	Heptachlor	76-44-8	1.7
103.	Aldrin	309-00-2	1.7
104.	Heptachlor epoxide	1024-57-3	1.7
105.	B-Endosulfan I	959-98-8	1.7
106.	Dieldrin	60-57-1	3.3
107.	4,4'-DDE	72-55-9	3.3
108.	Endrin	72-20-8	3.3
109.	Endosulfan II	33213-65-9	3.3
110.	4,4'-DDD	72-54-8	3.3
111.	Endosulfan sulfate	1031-07-8	3.3
112.	4,4'-DDT	50-29-3	3.3
113.	Methoxychlor	72-43-5	17.0
114.	Endrin ketone	53494-70-5	3.3

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE A-5.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Pesticides/PCBs (Method CLP SOW OLM 01.8) - continued:			
115.	Endrin aldehyde	7421-36-3	3.3
116.	alpha-Chlordane	5103-71-9	1.7
117.	gamma-ChLordane	5103-74-2	1.7
118.	Toxaphene	8001-3[illegible]	170.0
119.	Arochlor-1016	12674-11-2	33.0
120.	Arochlor-1221	11104-28-2	67.0
121.	Arochlor-1232	11141-16-5	33.0
122.	Arochlor-1242	53469-21-9	33.0
123.	Arochlor-1248	12672-29-6	33.0
124.	Arochlor-1254	11097-69-1	33.0
125.	Arochlor-1260	11096-82-5	33.0

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE A-5.2 SAMPLE ANALYSES - WATER

Field Parameters:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
pH	SOP	NA	NA	NA	NA
EC	SOP	NA	NA	NA	NA
Temperature	SOP	NA	NA	NA	NA
Turbidity	SOP	NA	NA	NA	NA
Eh	SOP	NA	NA	NA	NA

TABLE A-5.2 SAMPLE ANALYSES - WATER (CONTINUED)

Organic Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRQL	HOLDING TIME
Volatile Organic Compounds	CLP SOW OLC 02.0	2, 40 ml, G	4°C HCl, pH < 2	Page C-2 & 3 of SOW OLC 02.0[a]	14 days
Semivolatile Organic Compounds	CLP SOW OLM 01.8	2 Liter, Amber G	4°C	Page C-4 & 5 of SOW OLM 01.8[a]	7 days to extraction, 40 days to analysis
Organochlorine Pesticides	CLP SOW OLM 01.8(M)[b]	2 Liter, Amber G	4°C	Page C-6 of SOW OLC 02.0[a]	7 days to extraction, 40 days to analysis

[a] Table A-5.2a is attached for reference.
[b] CRQLs reported at OLC 02.0 levels.

TABLE A-5.2 SAMPLE ANALYSES - WATER (CONTINUED)

Radiologic Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA[d]	HOLDING TIME
Gross Alpha	9310	1 Liter P,G	Filter HNO3, pH < 2	2 pCi/L	180 days
Gross Beta	9310	1 Liter P,G	Filter HNO3, pH < 2	3 pCi/L	180 days
Tritium	906.0	1 Liter G	None	300 pCi/L	180 days
Carbon-14	LSC	1 Liter P,G	None	20 pCi/L	180 days
Strontium-90	905.0(M)[c]	2 Liter P,G	Filter HNO3, pH < 2	1 pCi/L	180 days
Radium-226	903.1	1 Liter, G	Filter HNO3, pH < 2	1 pCi/L	180 days
Americium-241	LAS 0108[e]	1 Liter, G	Filter HNO3, pH < 2	0.1 pCi/L	180 days
Plutonium-241	LAS 0178[e]	1 Liter, G	Filter HNO3, pH < 2	1 pCi/L	180 days

[c] Modified procedure specified in laboratory SOP.
[d] Minimum Detectable Activity (MDA) may vary from sample to sample, depending on possible matrix interferences such as dissolved solids.
[e] Laboratory Standard Operating Procedure.

TABLE A-5.2 SAMPLE ANALYSES - WATER (CONTINUED)

Radiologic Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA[d]	HOLDING TIME
Gamma Spectral Analysis	901.1	4 Liter P,G	Filter		180 days
TH-234			HNO3, pH < 2	170 pCi/L	
PB-214				10 pCi/L	
BI-214				10 pCi/L	
PB-210				380 pCi/L	
U-235				5 pCi/L	
U-238				10 pCi/L	
NA-22				1 pCi/L	
AC-228				20 pCi/L	
PB-212				10 pCi/L	
BI-212				70 pCi/L	
TL-208				5 pCi/L	
K-40				55 pCi/L	
CO-60				4 pCi/L	
CS-137				4 pCi/L	

TABLE A-5.2 SAMPLE ANALYSES - WATER (CONTINUED)

Metals Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL	HOLDING TIME
Hexavalent Chromium	7196	1 Liter, P	Filter, 4°C	20 µg/L	24 hours
Total Chromium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Antimony	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	5 µg/L	180 days
Arsenic	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	2 µg/L	180 days
Barium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	20 µg/L	180 days
Beryllium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	1 µg/L	180 days
Cadmium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	1 µg/L	180 days
Cobalt	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Copper	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days

TABLE A-5.2 SAMPLE ANALYSES - WATER (CONTINUED)

Metals Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL	HOLDING TIME
Iron	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	100 µg/L	180 days
Lead	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	2 µg/L	180 days
Mercury	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	0.2 µg/L	28 days
Molybdenum	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Nickel	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	20 µg/L	180 days
Selenium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	3 µg/L	180 days
Silver	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Thallium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days

TABLE A-5.2 SAMPLE ANALYSES - WATER (CONTINUED)

Metals Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
				CRDL	
Vanadium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Zinc	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	20 µg/L	180 days

TABLE A-5.2 SAMPLE ANALYSES - WATER (CONTINUED)

General Chemical Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Alkalinity	310.1	1 Liter P	Filter, 4°C	10 mg/L	14 days
Sodium	6010	1 Liter, P	Filter, 4°C HNO3, pH < 2	2 mg/L	180 days
Potassium			Filter, 4°C HNO3, pH < 2	2 mg/L	180 days
Calcium			Filter, 4°C HNO3, pH < 2	2 mg/L	180 days
Magnesium			Filter, 4°C HNO3, pH < 2	2 mg/L	180 days
Chloride	300.0	1 Liter P,G	Filter, 4°C	1 mg/L	28 days
Sulfate				1 mg/L	28 days

TABLE A-5.2 SAMPLE ANALYSES - WATER (CONTINUED)

General Chemical Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Phosphorous, all forms	365.2	1 Liter P,G	Filter, 4°C H2SO4, pH<2	1 mg/L	28 days
Nitrate (as Nitrogen)	300.0	1 Liter P,G	Filter, 4°C	0.1 mg/L	48 hours
Total Kjeldahl Nitrogen	351.2	500 ml P,G	Filter, 4°C H2SO4,pH<2	0.5 mg/L	28 days
Total Dissolved Solids	160.1	1 Liter P,G	Filter, 4°C	20 mg/L	7 days
Formaldehyde	3500 Modified NIOSH	2, 40 ml G	4°C H2SO4, pH<2	1 mg/L	30 days
Total Organic Carbon	415.2	1 Liter G	Filter, 4°C H2SO4, pH<2	1 mg/L	28 days
Ammonia	350.1	500 ml P,G	Filter, 4°C H2SO4, pH<2	0.05 mg/L	28 days
Turbidity	180.1	500 ml P,G	4°C	0.1 NTU	48 hours
Chemical Oxygen Demand	410	125 ml P	4°C H2SO4, pH<2	50 mg/L*	28 days
Biochemical Oxygen Demand	405.1	1 Liter P	4°C	5 mg/L*	48 hours

* Reporting limit is based on advisory method detection limit.

TABLE A-5.2a WATER SAMPLE ANALYSES
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/L)
Volatiles (Method CLP SOW OLC 02.0):			
1.	Chloromethane	74-87-3	1
2.	Bromomethane	74-83-9	1
3.	Vinyl chloride	75-01-4	1
4.	Chloroethane	75-00-3	1
5.	Methylene chloride	75-09-2	2
6.	Acetone	67-64-1	5
7.	Carbon disulfide	75-15-0	1
8.	1,1-Dichloroethene	75-35-4	1
9.	1,1-Dichloroethane	75-34-3	1
10.	cis-1,2-Dichloroethene	156-59-4	1
11.	trans-1,2-Dichloroethene	156-60-5	1
12.	Chloroform	67-66-3	1
13.	1,2-Dichloroethane	107-06-2	1
14.	1-Butanone	78-93-3	5
15.	Bromochloromethane	74-97-5	1
16.	1,1,1-Trichloroethane	71.55-6	1
17.	Carbon Tetrachloride	56-23-5	1
18.	Bromodichloromethane	7[illegible]27-4	1
19.	1,2-Dichloropropane	78-87-5	1
20.	cis-1,3-Dichloropropene	10061-01-5	1

TABLE A-5.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Volatiles (Method CLP SOW OLC 2.0) - continued:			
21.	Trichloroethene	79-01-6	1
22.	Dibromochloromethane	124-48-1	1
23.	1,1,2-Trichloroethane	79-00-5	1
24.	Benzene	71-43-2	1
25.	trans-1,3-Dichloropropene	10061-02-6	1
26.	Bromoform	75-25-2	1
27.	4-Methyl-2-pentanone	108-100-1	5
28.	2-Hexanone	591-78-6	5
29.	Tetrachloroethene	127-18-4	1
30.	1,1,2,2-Tetrachloroethane	79-34-5	1
31.	1,2-Dibromoethane	106-93-4	1
32.	Toluene	108-88-3	1
33.	Chlorobenzene	108-90-7	1
34.	Ethylbenzene	100-41-4	1
35.	Styrene	100-42-5	1
36.	Xylenes (total)	1330-20-7	1
37.	1,3-Dichlorobenzene	541-73-1	1
38.	1,4-Dichlorobenzene	106-46-7	1
39.	1,2-Dichlorobenzene	95-50-1	1
40.	1,2-Dibromo-3-chloropropane	96-12-8	1

TABLE A-5.2a WATER SAMPLE ANALYSES (continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Semivolatiles (Method CLP SOW OLC 01.8):			
41.	Phenol	108-95-2	10
42.	bis(2-chloroethyl)ether	111-44-4	10
43.	2-Chlorophenol	95-57-8	10
44.	1,3-Dichlorobenzene	541-73-1	10
45.	1,4-Dichlorobenzene	106-46-7	10
46.	1,2-Dichlorobenzene	95-50-1	10
47.	2-Methylphenol	95-48-7	10
48.	2,2'-oxybis (1-Chloropropane)#	108-60-1	10
49.	4-Methylphenol	106-44-5	10
50.	N-Nitroso-di-n-propylamine	621-64-7	10
51.	Hexachloroethane	67-72-1	10
52.	Nitrobenzene	98-95-3	10
53.	Isophorone	78-59-1	10
54.	2-Nitrophenol	88-75-5	10
55.	2,4-Dimethylphenol	105-67-9	10
56.	bis(2-Chloroethoxy)methane	111-91-1	10
57.	2,4-Dichlorophenol	120-83-2	10
58.	1,2,4-Trichlorobenzene	120-82-1	10
59.	Naphthalene	91-20-3	10
60.	4-Chloroaniline	106-47-8	10

TABLE A-5.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Semivolatiles (Method CLP SOW OLC 01.8) - continued:			
61.	Hexachlorobutadiene	87-68-3	10
62.	4-Chloro-3-methylphenol	59-50-7	10
63.	2-Methylnaphthalene	91-57-6	10
64.	Hexachlorocyclopentadiene	77-47-4	10
65.	2,4,6-Trichlorophenol	88-06-2	10
66.	2,4,5-Trichlorophenol	95-95-4	25
67.	2-Chloronaphthalene	91-58-7	10
68.	2-Nitroaniline	88-74-4	25
69.	Dimethylphthalate	131-11-3	10
70.	Acenaphthylene	208-96-8	10
71.	2,6-Dinitrotoluene	606-20-2	10
72.	3-Nitroaniline	99-09-2	25
73.	Acenaphthene	83-32-9	10
74.	2,4-Dinitrophenol	51-28-5	25
75.	4-Nitrophenol	100-02-7	25
76.	Dibenzofuran	132-64-9	10
77.	2,4-Dinitrotoluene	121-14-2	10
78.	Diethylphthalate	84-66-2	10
79.	4-Chlorophenyl-phenylether	7005-72-3	10
80.	Fluorene	86-73-7	10

TABLE A-5.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Semivolatiles (Method CLP SOW OLC 01.8) - continued:			
81.	4-Nitroaniline	100-01-6	25
82.	4,6-Dinitro-2-methylphenol	534-52-1	25
83.	N-nitrosodiphenylamine	86-30-6	10
84.	4-Bromophenyl-phenylether	101-55-3	10
85.	Hexachlorobenzene	118-74-1	10
86.	Pentachlorophenol	87-86-5	25
87.	Phenanthrene	85-01-8	10
88.	Anthracene	120-12-7	10
89.	Carbazole	86-74-8	10
90.	Di-n-butylphthalate	84-74-2	10
91.	Fluoranthene	206-44-0	10
92.	Pyrene	129-00-0	10
93.	Butylbenzylphthalate	85-68-7	10
94.	3,3'-Dichlorobenzidine	91-94-1	10
95.	Benzo(a)anthracene	56-55-3	10
96.	Chrysene	218-01-9	10
97.	bis-2-Ethylhexyl)phthalate	117-81-7	10
98.	Di-n-ocytlphthalate	117-84-0	10
99.	Benzo(b)fluoranthene	205-99-2	10
100.	Benzo(k)fluoranthene	207-08-9	10

TABLE A-5.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Semivolatiles (Method CLP SOW OLC 01.8) - continued:			
101.	Benzo(a)pyrene	50-32-8	10
102.	Indeno(1,2,3-cd)pyrene	193-39-5	10
103.	Dibenz(a,h)anthracene	53-70-3	10
104.	Benzo(g,h,i)perylene)	191-24-2	10

TABLE A-5.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Pesticides/PCBs (Method CLP SOW OLM 01.8 [modified to report CRQLs at OLC 02.0 levels]):			
105.	alpha-BHC	319-84-6	0.01
106.	beta-BHC	319-85-7	0.01
107.	delta-BHC	58-89-9	0.01
108.	Gamma-BHC (Lindane)	58-89-9	0.01
109.	Heptachlor	76-44-8	0.01
110.	Aldrin	309-00-2	0.01
111.	Heptachlor epoxide	1024-57-3	0.01
112.	Endosulfan I	959-98-8	0.01
113.	Dieldrin	60-57-1	0.02
114.	4,4'-DDT	72-54-8	0.02
115.	Methoxychlor	72-43-5	0.10
116.	Endrin ketone	53494-70-55	0.02
117.	Endrin aldehyde	7421-36-3	0.02
118.	Alpha-chlordane	5103-71-9	0.01
119.	Gamma-chlordane	5103-74-2	0.01
120.	Toxaphene	8001-35-2	1.0
121.	Aroclor-1016	12674-11-2	0.20
122.	Aroclor-1221	11104-28-2	0.40
123.	Aroclor-1232	11141-16-5	0.20
124.	Aroclor-1242	53469-21-9	0.20
Pesticides/PCBs (Method CLP SOW OLM 01.8 [modified to report CRQLs at OLC 02.0 levels]):			

TABLE A-5.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
125.	Aroclor-1248	12672-29-6	0.20
126.	Aroclor-1254	11097-69-1	0.20

Note: Except for methylene chloride, the quantitation limits in this table are set at the concentrations in the sample equivalent to the concentration of the lowest calibration standard analyzed for each analyte. In the case of methylene chloride, the CRQL value in this table is based on the lowest level of contamination of samples with this common laboratory solvent that can be achieved by reasonable means in a production laboratory.

TABLE A-5.3 SAMPLE ANALYSES - AIR

Radiologic Analyses:				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Gross Alpha	7110*	Store filter in individual glassine envelope	3×10^{-6} µCi/sample	None
Gross Beta	7110*	Store filter in individual glassine envelope	3×10^{-6} µCi/sample	None
Gamma Emitters	40 CFR 61	Store filter in individual glassine envelope	Dependent on Compound	None
Tritium	7500-^{3}H*	Store filter in individual glassine envelope	2×10^{-4} µCi/sample	48 hours
Cobalt-60	40 CFR 61	Store filter in individual glassine envelope	5×10^{-6} µCi/sample	None
Strontium-90	7500-Sr*	Store filter in individual glassine envelope	3×10^{-7} µCi/sample	None
Cesium-137	40 CFR 61	Store filter in individual glassine envelope	3×10^{-6} µCi/sample	None
Radium-226	7500-Ra*	Store filter in individual glassine envelope	1×10^{-6} µCi/sample	None

* Standard Methods for the Analysis of Water and Waste Water (1985).

TABLE A-5.3 SAMPLE ANALYSES - AIR (CONTINUED)

Radiologic Analyses (continued):				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Isotopic Uranium (-238, 234, 235)	7500-UC*	Store filter in individual glassine envelope	3×10^{-7} µCi/sample	None
Isotopic Thorium (-232, 230, 228)	HASL 300 and Method A-1, A-3 Alpha spectrometry	Store filter in individual glassine envelope	4×10^{-8} µCi/sample	None
Radon-222	N/A	N/A	Requires either a gas sample or charcoal absorbent	N/A

* Standard Methods for the Analysis of Water and Waste Water (1985).

TABLE A-5.3 SAMPLE ANALYSES - AIR (CONTINUED)

Metals Analyses:				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Antimony	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.05 $\mu g/m^3$	None
Beryllium	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.004 $\mu g/m^3$	None
Chromium	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.1 $\mu g/m^3$	None
Copper	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.002 $\mu g/m^3$	None
Molybdenum	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.04 $\mu g/m^3$	None
Selenium	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.04 $\mu g/m^3$	None

TABLE A-5.3 SAMPLE ANALYSES - AIR (CONTINUED)

Organochlorine Pesticide Analyses:				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
Chlordane	TO-4	1 Liter Stainless Steel Canister	TBD	None

Volatile Organic Compound Analyses:				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
Chloroform	TO-14	1 Liter Stainless Steel Canister	0.11 $\mu g/m^3$	None
Methylene Chloride	TO-14	1 Liter Stainless Steel Canister	1.7 $\mu g/m^3$	None

5.2 ANALYTICAL AND LABORATORY QUALITY CONTROL PROCEDURES

Quality control procedures for sampling and chemical analysis in this FSP will comply with the QAPjP (Appendix B). Equipment calibration procedures and criteria are described in Chapter 6 of the QAPjP. Preventative maintenance procedures shall be followed to minimize downtime for laboratory analytical instruments and field devices. General preventative maintenance procedures for field and laboratory equipment are described in Chapter 11 of the QAPjP.

6.0 FIELD METHODS AND PROCEDURES

This chapter describes the field procedures that will be used during the RI/FS. The field procedures themselves are described in Standard Operating Procedures (SOP) that are presented in Attachment 1 of this Appendix. Summaries of the soil investigations and water sampling activities for one year are presented in Tables A-6.1 and A-6.2.

The field procedures for geophysical investigation are presented in Section 6.1. The soil vapor survey is presented in Section 6.2. The exploratory trench investigation is presented in Section 6.3, followed by soil borings in Section 6.4. Soil permeability testing is described in Section 6.5. Well installation and abandonment procedures are described in Section 6.6, and well development procedures are described in Section 6.7. The CPT/Hydropunch™ investigation is presented in Section 6.8. Groundwater, surface water, and storm water sampling procedures are presented in Section 6.9. Saturated zone permeability testing is described in Section 6.10. Air sampling procedures are described in Section 6.11.

6.1 GEOPHYSICAL INVESTIGATIONS

Geophysical methods will be used to identify buried tanks, leach lines, pipes, utility lines, and contrasting material types indicative of landfills, trenches, and other buried wastes. In addition to locating equipment, geophysical methods will be used to clear the anticipated locations of exploratory trenches and soil borings to avoid obstructions and damaging utilities. More than one geophysical method will be utilized for most areas. For each area, geophysical methods will be chosen based on the material properties of the structure or object in question. The geophysical methods which yields the most definitive information during a preliminary field evaluation in each area will be used. The geophysical techniques to be considered include:

- Ground Penetrating Radar (GPR);
- Electromagnetics (EM);
- Magnetics;
- Transient Electromagnetics (TEM);
- Seismic Refraction;
- Utility Line Location; and
- Borehole Geophysical Logging (tentative).

TABLE A-6.1 SUMMARY OF SOIL INVESTIGATION ACTIVITIES

Areas of Interest	Vapor Probes/ Samples	Backhoe Excavation/Samples	Soil Borings/Samples		Concrete Coring		Wipe Samples
			First Stage	Second Stage	Concrete	Soil	
Background Study	NA	NA	6/24 (2)	NA	NA	NA	NA
DOE Disposal Trenches and Southwest Chemical Disposing Area	22/44 (2)	4-6/20-30 (2)	5/15 (1)	TBD	NA	NA	NA
DOE Disposal Box	5/10 (1)	3/9 (1)	3/9 (1)	TBD	NA	NA	NA
UC Davis Disposal Trenches	39/78 (3)	8/32 (1)	19/57 (6)	TBD	NA	NA	NA
Radium-226 Treatment System	NA	8/17 (2)	6/24 (2)	NA	10	6	14 (1)
Strontium-90 Treatment System	NA	2/10 (1)	6/24 (2)	NA	10	6	6
Western Dog Pen Area and North Chemical Dispensing Area	NA	NA	19/31 (2)	NA	NA	NA	NA
Domestic Septic Tanks	NA	14/14 (1)	21/49 (3)	NA	NA	NA	21 (1)
UC Davis Landfill Units	68/204 (11)	NA	16/64 (4)	TBD	NA	NA	NA
TOTALS[1]	134 PROBES 336 SAMPLES + 17 QA/QC	41 TRENCHES 112 SAMPLES + 8 QA/QC	101 BORINGS 297 SAMPLES + 23 QA/QC	TBD	20 SAMPLES	12 SAMPLES	41 SAMPLES + 2 QA/QC

NA No samples anticipated.
Number in parentheses indicates number of QA/QC samples collected.
TBD - To be determined.
[1] Sample numbers are anticipated maximum number of samples to be submitted for chemical analysis. The actual number of samples to be submitted for analysis will be determined in the field and after evaluation of data from previous phases.

TABLE A-6.2 PROPOSED WATER MONITORING SCHEDULE FOR ONE MONITORING YEAR

Monitoring Point	Samples	Dupli-cates	Event Total	Monitoring Events per Year[1]	Total
Eighteen Existing Monitoring Wells	18	1	19	4 (quarters — spring, summer, fall, winter)	76
Sixteen Proposed Monitoring Wells	16	1	17	4 (quarters — spring, summer, fall, winter)	68
Surface Water Samples	3	1	4	4 (quarters — spring, summer, fall, winter)	16
Storm Water Runoff Samples	2	1	3	2 (storm events)	6

(1) Annual monitoring will occur during the spring quarterly round.

A description of these methods is provided in SOP 9 (Borehole Geophysical Logging) and SOP 20 (Shallow Subsurface Geophysical Methods) in Attachment 1 to this Appendix. A brief discussion of the anticipated geophysical methods that will be used for each of the areas of investigation is presented below.

6.1.1 Background Soils Investigation

A geophysical survey will be conducted prior to the background soil investigation to confirm utility clearance for the six proposed soil boring locations. Figure A5 presents the soil boring locations for the background study. Geophysical methods such as utility line location and GPR may be used to confirm utility clearance for the proposed soil boring locations.

6.1.2 DOE Burial Areas, Trenches and DOE Disposal Box (OU-1)

Geophysical methods will be used in this area in an attempt to assess the perimeter of the burial areas and trenches and to locate the DOE Disposal Box, a buried metal dumpster approximately 30 feet wide by 10 feet long and 5 feet deep (see Section 4.1.2). Figure A6 presents the approximate locations of the DOE Burial Areas, and Trenches and Figure A7 for the DOE Disposal Box. Potentially useful geophysical methods include magnetics, EM and GPR.

6.1.3 UC Davis Burial Trenches (OU-1)

Geophysical methods will be used in an attempt to define the perimeter of the burial areas and trenches. Figure A8 presents the approximate locations of the UC Davis Burial Trenches.

6.1.4 Radium-226 Treatment System (OU-2)

Geophysical methods will be used to locate buried pipes, a distribution box, and three dry wells and the 90-foot-long seepage trench associated with the radium-226 treatment system, as described in Chapter 4 of the FSP. Two septic tanks have been located and their contents have been removed in 1992. Figure A9 presents the

approximate locations of the radium-226 seepage system components. Potentially useful geophysical methods, which will be evaluated in the field, include EM and GPR.

6.1.5 Strontium-90 Treatment System (OU-2)

Geophysical methods will be used to locate buried pipes and two sets of leach lines, one of which may no longer be connected to the tank, as described in Chapter 4 of the FSP. Figure A10 presents the approximate locations of the Strontium-90 Leach System components. Geophysical methods will be used to locate the active and inactive leach lines, and the buried pipe. The Imhoff tanks have been located and their contents removed. Potentially useful geophysical methods, which will be evaluated in the field, include EM and GPR.

6.1.6 Western Dog Pens and North Chemical Dispensing Areas (OU-3)

No specific geophysical tasks have been identified for this area other than clearing anticipated boring locations. As discussed in Chapter 4 of the FSP, there is no known buried equipment or waste associated with these areas. Figure A11 presents the anticipated locations of the proposed 19 soil borings in this area.

6.1.7 Domestic Septic Systems (OU-4)

Seven domestic septic systems are distributed throughout the LEHR site, as discussed in Chapter 4 of the FSP. Each septic system is composed of a septic tank, leach lines, and in some cases a distribution box connecting the tanks with the leach lines. Figure A12 presents the approximate locations of each of the seven septic systems to be investigated. Details of their construction and/or their location may be obtained prior to initiating the geophysical survey. Geophysical methods will be used to locate tanks, buried pipes, and leach lines. Potentially useful geophysical methods, which will be evaluated in the field, include EM and GPR.

6.1.8 UC Davis Landfill Units (OU-5)

Geophysical methods will be used in an attempt to assess the perimeter and depth of the UC Davis Landfill Units. Figures A13, A14, and A15 present the approximate locations of the UC Davis Landfill Units. Potentially useful geophysical methods include magnetics, EM, GPR, TEM and seismic refraction. Geophysical methods will not be required to confirm utility clearance for the 16 proposed soil boring locations.

6.1.9 Regional Stratigraphic Evaluation

Geophysical methods will be used to evaluate the regional stratigraphy in the LEHR site vicinity. Specifically, the use of TEM is proposed to evaluate the vertical and lateral extent of the second and third HSU, and the aquitard separating them. The location of TEM transects will be determined following an evaluation of existing lithologic logs from nearby agriculture and production wells.

6.2 SOIL VAPOR SURVEY

A soil vapor survey will be conducted in several areas for the potential presence of volatile constituents, as discussed in Chapter 4 of the FSP. The soil vapor survey will attempt to identify hot spots — areas of soils with higher concentrations of volatile constituents compared with background soils — which will be investigated in greater detail in subsequent exploratory trench and soil boring investigations. The data obtained from the soil vapor survey are key to determining the final locations of exploratory trenches, and soil borings.

The primary constituents to be measured in the vapor survey are:

- Volatile organic compounds;
- Volatile radionuclides: tritium, and radon;
- Landfill gases including methane, carbon dioxide, and oxygen; and
- Gross gamma and gross beta radiation.

Soil vapor samples will be collected using a truck-mounted rig after driving steel sampling probes to the desired sampling depth and purging the probe (see SOP 21). Several types of samples may then be collected for analysis at each location:

- Samples for analysis of VOCs, oxygen, carbon dioxide, and methane will be collected and analyzed in an on-site, mobile laboratory. One duplicate sample will be analyzed for every 20 samples;

- Confirmatory samples will be collected into stainless-steel canisters and analyzed for VOCs, oxygen, carbon dioxide, and methane. One confirmatory sample will be collected and analyzed by an off-site laboratory for every 20 mobile laboratory samples; and

- Downhole field readings for gross beta and gross gamma will be collected by lowering a Geiger-Meuller tube into the vapor probe hole.

Mobile laboratory samples for VOCs, oxygen, methane, and carbon dioxide, and field readings for gross gamma and gross beta will be collected from each vapor probe sample location and depth.

Results of these analyses and measurements will be used as screening level data indicative of the presence of these constituents but not quantitative measures of concentration or activity. Table A-6.1 summarizes the locations and total number of vapor samples collected from each area of the LEHR site.

6.2.1 Background Soils Investigation

No soil vapor sampling is planned in background soils at this time because no volatile wastes are anticipated.

6.2.2 DOE Burial Areas, Trenches and DOE Disposal Box (OU-1)

Figure A6 presents the anticipated locations for the 22 soil vapor survey points in the DOE Burial Areas and Trenches, Figure A7 presents the proposed locations for the 5 locations for the DOE Disposal Box. Vapor samples will be obtained at two depths, 2 and 6 feet bgs. The locations and depths of these sampling points is designed to obtain soil vapor samples within the buried wastes and beyond the perimeter of these trenches and the DOE Disposal Box, in undisturbed soil.

6.2.3 UC Davis Burial Trenches (OU-1)

Figure A8 presents the anticipated locations for the 39 soil vapor survey points in the UC Davis Burial Trenches. Samples will be obtained at two depths, 3 and 6 feet bgs. The locations and depths of these sampling points is designed to obtain soil vapor samples within the burial trenches and beyond the perimeter of these buried wastes in undisturbed soil.

6.2.4 Radium-226 Treatment System (OU-2)

No soil vapor sampling is planned in the radium-226 treatment system because no volatile wastes are anticipated.

6.2.5 Strontium-90 Treatment (Imhoff) System (OU-2)

No soil vapor sampling is planned in the strontium-90 treatment (Imhoff) system at this time because no volatile wastes are anticipated.

6.2.6 Western Dog Pens and North Chemical Dispensing Areas (OU-3)

No soil vapor sampling is planned in the western dog pens and north chemical dispensing area at this time because no volatile wastes are anticipated.

6.2.7 Domestic Septic Systems (OU-4)

No soil vapor sampling is planned in the domestic septic systems because no volatile wastes are anticipated.

6.2.8 UC Davis Landfill Units (OU-5)

Figures A13, A14, and A15 present the anticipated locations for the soil vapor survey points in the UC Davis landfill units. Samples will be obtained at three depths, 4, 8 and 12 feet bgs. The locations, sampling depths, and grid spacings of these sampling points is designed to obtain soil vapor samples within the landfills and along the perimeter of these buried wastes in undisturbed soil.

6.3 EXPLORATORY TRENCH INVESTIGATION

Following the soil vapor survey, an exploratory trench investigation will be conducted throughout the LEHR site. The objectives of the exploratory trench investigation are: (1) to characterize the contents of landfill and other buried wastes; (2) to collect waste samples from buried wastes, underground tanks, pipes, distribution boxes and leach lines; (3) to collect wipe samples from buried pipes, and tanks for radiologic screening; and (4) to collect soil samples from below and adjacent to the wastes.

During excavation of each trench, materials will be segregated as soil cover, native soil, and waste, and stockpiled on visqueen. Photographs of the trenches will be taken for additional documentation of trench contents. The materials in the trenches will be screened for VOCs and radiologic activity. Because of health and safety concerns, no LEHR site personnel will enter a backhoe excavation if it is greater than 5 feet deep, or if the excavation is considered unsafe based on physical characteristics, VOC, or radiologic field monitoring readings, as described in the Health and Safety Plan, Appendix C. Soil samples from greater than 5 feet deep will be collected from the backhoe bucket, or from an extended drive sampler, as appropriate. Upon backfilling of each excavation, materials will be placed back in approximately the same areas and depth from which they were excavated.

The exploratory trenches will be logged according to USCS, as described in SOP 11 (Test Pit Excavation). Organic Vapor Analysis (OVA) and radiologic activity readings will be taken continuously with field meters, as described in SOP 11, and these readings, along with other criteria will guide selection of waste and soil samples for analysis of LEHR site constituents listed on Table A-6.2.

Soil waste sampling is described in SOP 10 (Soil Sampling), and describes the collection of disturbed and undisturbed solid and other waste material. The criteria for selecting waste samples in the exploratory trenches include:

- Radionuclide activity or OVA readings which exceed background;
- Discoloration or stained soils;
- Odors;
- Fill or gravel material used in dry wells, seepage trenches, infiltration galleries, leach lines, etc.
- The contents of containers, or other recognizable objects; and
- Sludges, liquids or solids of tanks, distribution boxes, or leach lines.

In addition to sampling wastes, soil samples will be collected below the base of trenches and landfill units. Soil samples will also be collected outside the trench or landfill to assess lateral migration of constituents. These samples will be collected as undisturbed drive samples, if possible, or from a backhoe bucket. Both disturbed and undisturbed samples must be capped and cooled immediately for analysis of volatile samples as described in SOP 10.

After logging the exploratory trench and obtaining OVA and radiologic screening measurements, the field geologist will select samples for analysis after consulting with the project geologist. Samples selected for analysis for primary parameters identified in Table A-6.3 will be chosen based on location, depth, material type, and field screening results. Typically in each trench, at least one sample from waste material, one sample from native soil below waste, and one sample from native soil adjacent to waste will be selected for analysis based on results from field VOC and radiologic screening. Samples collected from waste (see above criteria) will typically be composited by the lab into one sample for analysis. Additional samples may be selected for analysis to characterize soils

below and adjacent to waste disposal trenches and systems. Target sample depths and locations are discussed below for each investigation area.

In addition to sampling described above, several more samples in each investigation area may be selected for analysis of additional parameters (Table A-6.3). Samples in or directly below waste may be analyzed for kerosene based on field VOC screening. Several samples from each investigation area may be analyzed for fate-and-transport parameters, such as alkalinity, TKN, ammonia, anions, pH, EC, and sulfide. These samples will be selected from waste, the waste-native soil contact, and from soil adjacent to or below waste. Table A-6.3 presents the list of analytical parameters for the trench soil, liquid, or waste samples.

Whenever possible, a duplicate sample will be collected for QA/QC or archived at 4°C for additional chemical and physical analysis, as described in Chapter 5 of the RI/FS Work Plan. The number of QA/QC samples for each trench is described in the specific sampling requirements for each area. The archived samples will be refrigerated immediately and inspected for possible additional analysis by the project geologist. Duplicate soil samples are collected by filling two containers with the same material or by collecting adjacent drive samples, as discussed in SOP 10. QA/QC samples will also include the collection of equipment blanks. One equipment blank will be collected during trenching activities for each investigation area. Methods for collecting equipment blanks are described in SOP 10. Each equipment blank will be analyzed for volatile organic compounds (VOCs), metals, hexavalent chromium, nitrate, gross alpha, gross beta, tritium, radium-226, strontium-90, carbon-14, and gamma emitters.

The number and locations of the exploratory trenches are summarized in Table A-6.1. The proposed locations for these trenches are presented for each area in Figures A6 through A16. However, these numbers and locations are subject to change depending on the results of the soil vapor survey. After each sample is collected, wooden stakes will be used to mark the sample locations as well as the location of any buried tanks, pipes to leach lines encountered.

TABLE A-6.3 SOIL ANALYTICAL PARAMETERS

Primary Parameters Soil Samples, Splits, and Duplicates	Parameters Equipment Blanks
Gross Alpha	Gross Alpha
Gross Beta	Gross Beta
Tritium	Tritium
Carbon-14	Carbon-14
Radium-226	Radium-226
Strontium-90	Strontium-90
Thorium (isotopic) - background samples only	Gamma Emitters
Uranium (isotopic) - background samples only	Volatile Organic Compounds
Americium-241 - ~~Imhoff area only~~OU-2 only	Nitrate
Plutonium-241 - ~~Imhoff area only~~OU-2 only	Total Chromium
Gamma Emitters	Hexavalent Chromium
Volatile Organic Compounds	Antimony
Formaldehyde	Arsenic
Semi-Volatile Organic Compounds	Barium
Organochlorine Pesticides	Beryllium
Nitrate	Cadmium
Total Organic Carbon	Cobalt
Total Chromium	Copper
Hexavalent Chromium	Iron
Antimony	Lead
Arsenic	Manganese
Barium	Mercury
Beryllium	Molybdenum
Cadmium	Nickel
Cobalt	Selenium
Copper	Silver
Iron	Thallium
Lead	Vanadium
Manganese	Zinc
Mercury	
Molybdenum	
Nickel	
Selenium	
Silver	
Thallium	
Vanadium	
Zinc	

TABLE A-6.3 SOIL ANALYTICAL PARAMETERS (continued)

Additional Parameters
Kerosene
Alkalinity
TKN
Ammonia
Anions
pH
EC
Sulfide
Bacteria

Wipe samples will be collected from the interior of buried pipes, leach lines, distribution boxes, and tanks. The objective of obtaining wipe samples is to screen this buried equipment for presence of radiologic constituents only. SOP 18 (Wipe Sampling) describes the procedure for wipe samples. The number and locations of wipe samples are analyzed for radiologic parameters listed in Table A-6.2.

6.3.1 Background Soils Investigation

No exploratory trench investigation is planned in background soils.

6.3.2 DOE Burial Areas, Trenches and DOE Disposal Box (OU-1)

The proposed locations of the ~~four~~up to six exploratory trenches for the DOE Burial Areas and Trenches are shown in Figure A6. Trenches will be up to 30 feet in length and extend to a maximum depth of 12 to 15 feet. The analysis requirements for each backhoe excavation (based on 4 trenches) in the DOE Burial Areas and Trenches include (totals for 4 excavations are presented in parenthesis):

- Two composite waste samples (8 total);
- One soil sample 2 feet below the base of the disposal trench (4 total);
- Two soil samples from the sides of the waste (8 total); and
- In addition, two QA/QC soil samples (split sample) and one equipment blank will be collected for DOE burial and trench area.

These samples will be analyzed for the primary soil parameters listed in Table A-6.3. UP to eight of these samples may be analyzed for additional parameters. Up to 16 samples may be analyzed for kerosene.

For the DOE Disposal Box, up to three trenches are proposed in the location shown in Figure A7. Trenches will be excavated to a total depth of 12 to 15 feet. The analysis sampling requirements for each backhoe excavation near the DOE Disposal Box include (totals for 3 excavations are presented in parentheses):

- One soil sample 2 feet below the DOE Disposal Box; (3 total); and
- Two soil samples to the side of the DOE Disposal Box (6 total).

In addition, one QA/QC soil sample (split sample) and one equipment blank will be collected for DOE Disposal Box area. Refer to SOP 10 for sampling disturbed soils, refer to Table A-6.3 for request analytes.

6.3.3 UC Davis Burial Trenches (OU-1)

The proposed locations of the eight backhoe trenches are shown in Figure A8. Each backhoe trench will be excavated to approximately 1 to 2 feet below the identified waste-native soil interface. Each excavation will be up to 12 to 15 feet deep and 15 to 30 feet in length. The analysis requirements for each exploratory trench in the UC Davis Burial Trenches include:

- One composite waste sample (8 total);
- One soil sample 2 feet below the base of the disposal trench (8 total);
- Two soil samples from the soil to the sides of the waste (16 total).

In addition, one equipment blank and one QA/QC soil or waste sample (split sample) will be analyzed for the UC Davis burial trench area. These samples will be analyzed for the primary soil parameters listed in Table A-6.3. As many as 12 of these samples may be analyzed for additional parameters.

6.3.4 Radium-226 Treatment System (OU-2)

The proposed locations of up to eight ~~the four~~ trenches are shown in Figure A9. Three backhoe excavations will be located in the seepage trench area and three to five excavations will be located along the pipeline from the tanks to the distribution box. The sampling analysis requirements from the exploratory trenches in the radium-226 treatment system include:

Seepage Trench Excavations:

- One composite waste sample (3 total);
- One soil sample from below the waste (3 total); and
- Two soil samples, from adjacent soil on each side to the waste area (6 total).

Pipeline Excavations:

- One soil sample per excavation located along the pipeline (3 to 5 total)

In addition, one QA/QC soil sample (split sample), one equipment blank, and ~~a total of up to~~ 12 wipe samples from the dry wells, distribution box, influent, effluent, and leach lines will be collected from the radium-226 treatment system area. These soil samples will be analyzed for the primary soil parameters listed in Table A-6.3. As many as 19 of these samples may be analyzed for additional parameters.

6.3.5 Strontium-90 Treatment (Imhoff) System (OU-2)

The proposed locations of the two trenches are shown in Figure A10. Two exploration trenches will be excavated to locate the two leach fields associated with the Imhoff treatment system and expose the piping and distribution boxes. The trenches will each be up to 20 feet long and up to 15 feet deep, and will be oriented perpendicular to the leach fields. The trenches will be screened for VOCs and radiologic activity, and will be logged and photographed. The excavated material from each exploration trench will be placed in segregated stockpiles on visqueen. Following completion of trenching, the material will be backfilled into the excavations in approximately the same depth and area from which they were removed. The sampling and analysis requirements for each backhoe excavation in the radium-226 treatment system include (the totals for two excavations are presented in parentheses):

- Two waste samples from within the leach lines or in the gravel trenches (4 total);
- One soil sample 2 feet below the base of the leach lines (2 total);
- Two soil samples from both sides of the waste (4 total);

In addition, one QA/QC soil or waste sample (split sample), one equipment blank, and six wipe samples from the leach lines, effluent line, influent line and strontium-90 distribution box (Figure A10) will be collected from the strontium-90 treatment system area. The soil samples will be analyzed for the primary soil parameters listed in Table A-6.3. One sample may be analyzed for the additional parameters.

produce dense ionization tracks in the biological material that they traverse and damage biological tissue. Since fluids in the GI tract provide greater shielding than gases in the lung, inhalation is generally of greater concern.

Beta particles are electrons or positrons emitted in radioactive decay. Their penetration power in material is greater than that of alpha particles and they transfer much less energy and cause less biological damage. Their range is generally less than 20 feet in air and 8 millimeters in tissue. Due to the moderate penetrating ability, both internal and external exposures should be considered.

Gamma and x-rays are electromagnetic radiation and are distinguishable from beta particles by their greater penetrating power in material. Other than their origin from the nucleus of the atom, they are indistinguishable for radiation protection purposes and can be simply referred to as gamma. Gamma radiation from radionuclides external to a body can penetrate the body, transferring the energy and thereby harming internal organs. They may also be ingested or inhaled, and irradiate the body from within. Due to the great penetrating ability, both internal and external exposures should be considered.

The majority of radionuclides indicated in Table 6-1 are short-lived radionuclides, frequency used in medical research. ~~Radioactive materials are considered to be essentially gone (decayed) after the passage of 10 half-lives.~~ Due to radioactive decay, less than one-tenth of a percent of radioactive materials remain after the passage of ten half-lives. With this in mind, only the following relatively long-lived nuclides would remain in any significant quantity after approximately 20 years:

- ^{14}C
- ^{3}H
- ^{137}Cs
- ^{22}Na
- ^{238}U
- ^{226}Ra

- ^{60}Co
- ^{36}Cl
- $^{90}Sr/^{90}Y$
- ^{99}Tc
- ^{241}Pu
- ^{241}Am

6.3.3 Radiation Protection Regulations and Guidelines

Personal dosimetry, airborne monitoring, bioassay, whole-body counting, and other types of radiation monitoring (i.e., use of a hand-held meters with response appropriate to the expected radiation hazard) will be used to determine radiation dosage and exposure levels. The use of these measures will be governed by procedures in the work plan and properly determined by either the Radiological Control Technician or the Project Health Physicist. Federal and state guidelines define the allowable doses which can be received by members of the public and to radiation workers. Table 6-2 summarizes the annual dose limits mandated by the Department of Energy. The limits permitted for contractor personnel working at the LEHR site are presented in parentheses next to the annual limit located in Table 6-2.

6.3.6 Western Dog Pens and North Chemical Dispensing Areas

No exploratory trench investigation is planned in these areas.

6.3.7 Domestic Septic Systems (OU-4)

The locations of the seven septic systems are shown in Figure A12. Two exploratory trenches will be completed in the leach field of each septic system in order to locate and uncover the distribution system and leach lines. The sampling requirements from the exploratory trench investigation in the domestic septic systems include:

- Waste samples from the leach lines or in the gravel trenches (7 total);
- Soil samples from one side of the leach lines (7 total); and
- One QA/QC soil sample (split sample).
- One equipment blank.
- Wipe samples from the locations shown in Figure A18 (25 total).

These soil samples will be analyzed for the primary soil parameters listed in Table A-6.3. Up to eight samples may be analyzed for the additional parameters.

6.3.8 UC Davis Landfill Units (OU-5)

No exploratory trench investigation is planned in these areas.

6.4 SOIL BORINGS

Following the exploratory trench investigation, the soil boring program will be initiated. The objectives of the soil borings are to assess the lateral and vertical extent of LEHR site constituents and to gather data on the soil chemical, physical, mineralogical and microbiological soil properties of the LEHR site in order to support vadose zone and saturated zone modeling efforts. Soil borings will be conducted in two stages. First-stage borings will be conducted in each investigation area, as described below. Second-stage borings may be conducted in selected areas (preliminary soil Operable Units 1 and 5 only), based on results of first-stage borings.

The number and locations of the soil borings given for each area of investigation are subject to change based on the results of geophysical, soil vapor, and trenching investigations, and depending on clearance by UC Davis Physical Plant and Underground Services Alert personnel. The proposed boring locations are presented in Figures A5 to A18, and the total number of borings and samples are summarized in Table A-6.1. In general, soil samples will be collected by continuous core and by split spoon drive sample techniques every 2 1/2 feet while drilling in wastes, and every 5 feet by drive sample while drilling below or adjacent to waste. The general procedure for conducting soil borings is given in SOP 6 (Soil Borings). The soil core will be logged according to the USCS classification system as described in SOP 7.

During the logging of the soil core, an organic vapor analyzer (OVA) and survey meter will be used to screen vapors and radionuclide activity from the core as described in SOP 7. After screening the core for OVA readings and consulting with the Project Geologist, the Field Geologist selects the samples for analysis of LEHR site constituents listed in Table A-6.3. Samples selected for analysis for primary parameters (Table A-6.3) will be chosen based on location, depth, and field screening results. Typically, in each boring, at least one sample each from the waste, one sample from native soil below or adjacent to waste, and one sample from the bottom of borehole will be selected based on results of VOC and radiologic field screening. Waste samples will typically be composited into one sample for analysis. Soil samples will be selected from discrete depths to characterize soils adjacent to and below waste disposal trenches and systems. Target sample depths and locations are discussed below for each investigation area.

In addition to sampling described above, several more samples in each investigation area may be selected for analysis for additional parameters (Table A-6.3). Samples in or directly below waste may be analyzed for kerosene based on field VOC screening. Several samples from each investigation area will be analyzed for fate-and-transport parameters, such as alkalinity, TKN, ammonia, anions, pH, EC, and sulfide. These samples will be selected from waste, the waste-native soil contact, and from soil adjacent to or below waste. The total number of samples that will be selected for analysis in each area for each parameter is presented in Table A-6.1.

QA/QC samples will consist of split samples collected from adjacent rings in the core of the drive sampler, as described in SOP 6. One equipment blank will be collected for each investigation area. Procedures for collecting equipment blanks are presented in SOP 10. Preparation, handling, chain of custody, and shipment procedures are specified in SOP 5.

In addition to sampling for LEHR site constituents and QA/QC, drive samples that are collected every 5 feet will be refrigerated at 4°C, and archived for potential additional chemical and physical analysis. After each boring is complete and the boring has been grouted, a wooden stake will be used to mark the boring location.

6.4.1 Background Soils Investigation

Figure A5 shows the six locations proposed for the background soil borings. The rationale for selecting these locations is presented in Section 5.1.2 of the RI/FS Work Plan. Up to four samples will be collected from each location, two samples from representative material in the 0 to 10 feet bgs interval, and two samples from representative materials between 10 and 40 ~~55~~ feet bgs. Table A-6.3 presents the analytical parameters to be requested for these 24 samples, 2 QA/QC split samples, and 1 equipment blank. Up to six samples will be analyzed for a bacteriological count.

SOP 6 describes the soil boring procedure, SOP 7 describes logging of soil borings and SOP 5 describes sample shipment. The boring locations will be staked after the soil boring are complete.

6.4.2 DOE Burial Areas, Trenches and DOE Disposal Box (OU-1)

Figure A6 shows the five locations for first-stage soil borings in the DOE Burial Areas and Trenches. Each first-stage boring will be advanced to a total depth of 25 feet bgs. Borings will be drilled using resonant techniques, and will be continuously sampled. Discrete soil samples will be collected at 2½-foot intervals within the waste, and at 5-foot intervals below the waste using split-spoon techniques, described in SOP 10. Up to three ~~Two~~ samples will be analyzed from each boring location. One composite sample from the

waste, one sample 2 feet below the base of the trench, and one sample at the bottom of

Figure A7 shows the three locations proposed for soil borings adjacent to the DOE Disposal Box. Up to three ~~Two~~ samples will be analyzed from each of these locations, one next to the DOE Disposal Box, one sample from below the level of the Box, and one sample from the bottom of the boring. Table A-6.3 presents the analytical parameters to be requested for these 24 ~~36~~ samples, 2 ~~3~~QA/QC split samples, and 1 equipment blank. Up to five samples will be analyzed for the additional parameters. Up to 10 samples will be analyzed for kerosene.

6.4.3 UC Davis Burial Trenches (OU-2)

~~Nineteen~~As many as 19 soil borings will be drilled in the UC Davis Burial Trenches to obtain composite samples from the wastes and below the base of the trenches. Figure A8 shows the locations for soil borings in this area. Each first-stage boring will be advanced to a total depth of 25 feet bgs. Borings will be drilled using resonant techniques and will be continuously sampled. Discrete soil samples will be collected at 2½-foot intervals within the waste, and at 5-foot intervals below the waste using split-spoon techniques described in SOP 10. Up to three ~~Two~~ samples will be analyzed from each boring location: one composite waste sample, one soil sample 2 feet below the base of the trench, and one sample from the bottom of the borehole ~~will be submitted for analysis~~

Table A-6.3 presents the analytical parameters to be requested for these 57 ~~38~~ samples and 6 ~~3~~ QA/QC split samples. SOP 6 describes the soil boring procedure, SOP 7 describes logging of soil borings and SOP 5 describes sample shipment. The boring locations will be staked after the soil boring is complete. As many as 20 samples will be analyzed for the additional parameters listed in Table A-6.3.

6.4.4 Radium-226 Treatment System

Figure A9 shows the six ~~nine~~ locations for soil borings in this area. Two ~~Four~~ deep-soil borings will be drilled to approximately 40 feet bgs. ~~from the surface to groundwater,~~ and four ~~six~~ shallow borings will be advanced to 25 feet bgs. Up to four soil samples will

be analyzed from each boring, including at least one waste sample and samples from representative material types below and to the side of the radium-226 treatment system. Table A-6.3 presents the analytical parameters to be requested for these 24 ~~36~~ samples, 2 ~~3~~ QA/QC split samples, and 1 equipment blank. Fifteen samples will be analyzed for the additional samples listed in Table A-6.3.

6.4.5 Strontium-90 Treatment System (OU-2)

Figure A10 shows the six locations for soil borings in this area. Two deep-soil borings will be drilled to approximately 40 feet bgs ~~from the surface to groundwater~~, and four shallow borings will be drilled to 25 feet bgs. Each boring will be continuously cored using resonant techniques. Discrete drive samples will be collected every 5 feet. Up to four soil samples will be analyzed from each boring, including at least one waste sample and samples from representative material types below the wastes. Table A-6.3 presents the analytical parameters to be requested for these 24 samples, 2 QA/QC split samples, and 1 equipment blank. Up to seven of these samples will be analyzed for the additional parameters.

6.4.6 Western Dog Pen Area and North Chemical Dispensing Area (OU-6)

The location of the 19 ~~18~~ soil borings in these areas are presented in Figure A11. Nine ~~eight~~ shallow boring locations in the southern dog pens will be completed to 6 feet bgs. One sample at 6 feet bgs will be submitted for analysis for parameters listed on Table A-6.3. Two of the soil boring locations in the southern dog pens will be completed to 20 ~~25~~ feet bgs, and three samples at 5, 10, and 20 feet bgs will be collected from each location. Six additional soil borings near the Cellular Biology Laboratory will be completed to 5 feet bgs. The surface and 2.5 feet bgs sample will be submitted for analysis and the 5 feet bgs sample will be archived for possible future analysis. Five-foot soil borings will be completed using either hand auger or mobile drill rig. Twenty-five-foot borings will be continuously cored using resonant techniques. Discrete-depth samples will be collected by split-spoon techniques described in SOP 10.

Two borings in the north chemical dispensing area will be advanced to 5 ~~25~~ feet bgs, and samples from 2.5 and 5 feet bgs will be submitted for the analytes listed on

Table A-6.3. Table A-6.3 presents the analytical parameters to be requested for these 31 samples, 2 QA/QC split samples, and 1 equipment blank. As many as 12 of these samples will be analyzed for the additional parameters listed in Table A-6.3.

6.4.7 Domestic Septic Systems

Figure A10 shows the approximate locations of the seven septic tanks. Figure A17 shows a schematic diagram of the sampling effort at each of the septic system location. At each septic system, up to three ~~two~~soil borings will be completed: two borings will extent to 10 feet bgs, and one boring will extent to 25 feet bgs. Each boring will be continuously cored using resonant techniques. Discrete drive samples will be collected every 5 feet. ~~Five samples will be collected from each boring.~~ Two samples will be selected for analysis from each 10-foot boring; three samples will be analyzed from each 25-foot boring. Samples will be selected based on criteria discussed in Section 6.4. Table A-6.3 presents the analytical parameters to be requested for these 49 samples, 3 QA/QC split samples, and 1 equipment blank. As many as 24 of these samples will be analyzed for the additional parameters listed in Table A-6.3.

6.4.8 UC Davis Landfill Units

Figures A13, A14, and A15 show the 16 locations for soil borings in the UC Davis Landfills. Six borings will be drilled in Landfill Unit No. 1, six borings will be drilled in Landfill Unit No. 2, and four borings will be drilled in Landfill Unit No. 3. Each first-stage boring will be advanced to a total depth of 25 feet bgs. Borings will be drilled using resonant techniques and will be continuously sampled. Discrete soil samples will be collected at 2½-foot intervals within the waste, and at 5-foot intervals below the waste using split-spoon techniques described in SOP 10.

Up to four ~~Two~~ samples will be analyzed from each boring location. One composite waste sample and up to three ~~one~~ soil samples ~~2 feet~~ collected from below the base of the trench will be submitted for analysis. Table A-6.3 presents the analytical parameters to be requested for these 64 ~~63~~ samples, 6 ~~3~~QA/QC split samples, and 1 equipment blank. Fifteen of these samples will be analyzed for the additional parameters listed in Table A-6.3.

6.5 SOIL PERMEABILITY TESTING

In situ permeability testing will be conducted in order to assess the movement of water and constituents to groundwater. Two types of permeability tests will be performed. Double-ring infiltrometer tests and downhole permeability tests. SOP 12 (Permeability Testing - Unsaturated Zone)describes both of these methods. Figure A18 presents the proposed locations of these tests throughout the LEHR site. A total of five double-ring infiltrometer tests will be performed in the surface soils, approximately 0 to 5 feet bgs. A total of 10 down-hole permeability tests will be performed from approximately 10 to 55 feet bgs.

6.6 WELL INSTALLATION AND ABANDONMENT

Groundwater monitoring wells will be installed in soil borings completed by hollow stem auger, dual tube percussion, sonic coring, or casing hammer drilling methods. A Dames & Moore geologist will oversee each soil boring and well installation procedures. Locations of proposed monitoring wells are presented in Figure A21. Soil borings will be completed by methods described in SOP 6 (Soil Borings) and logged according to procedures in SOP 7 (Logging of Soil Borings). Groundwater monitoring wells will be installed according to procedures outlined in SOP 8 (Installation and Construction - Groundwater Monitoring Wells).

6.6.1 Well Borings

Borings for the ~~four~~ proposed monitoring wells in the first HSU (UCD-25, UCD-28, UCD-33, and UCD-34) will be drilled using a truck-mounted drilling rig equipped with 8- and 12-inch hollow-stem augers and continuous core capabilities. Pilot holes for well borings will be initially drilled using sonic resonant drilling techniques and will be continuously cored. Relatively undisturbed drive samples for chemical, radiological and physical analyses will be collected every 5 feet and archived at 4°C. After completion of the pilot boring, the well borings will be reamed with the 12-inch augers for monitoring well completion.

The twelve ~~seven~~ monitoring wells in the second HSU, UCD-26, UCD-27, UCD-29, UCD-30, UCD-31, UCD-32, and UCD-35 through UCD-40 will be drilled using resonant drilling and air-rotary methods. A pilot hole will be drilled and a continuous core collected from the surface to total depth. Drive samples will be collected at approximately 10-foot intervals from the surface to total depth and selected samples will be submitted for chemical, radiologic and physical testing. After completion of the pilot boring, the monitoring well boring will be reamed using 12-inch drill casing for monitoring well completion.

Details of the drilling methods are described in SOP 6 (Soil Borings) and SOP 8 (Installation and Construction - Groundwater Monitoring Wells).

6.6.2 Soil Logging and Sample Collection

Soil cuttings and cores from each well drilling operation will be logged by the field geologist according to procedures described in SOP 7 (Logging of Soil Borings). The log will contain a complete and detailed lithologic description of materials using the Unified Soil Classification System (USCS). Additionally, logs will contain information on sample collection, consistency of materials, penetration rates, and field screening data.

During drilling of the sixteen ~~eleven~~ planned groundwater monitoring wells, soil drive samples will be collected at 5-foot intervals for each monitoring well and at identified lithologic changes. All samples collected will be screened in the field for radiologic compounds and VOCs. Soil sampling procedures are described in SOP 10 (Soil Sampling). After samples have been collected, they will be screened for radiologic activity and volatile organic vapors, labeled with the appropriate information, sealed, and archived at 4°C. Radiologic screening is described in SOP 22 (Surface Contamination Survey); organic vapor screening is described in SOP 15 (Field Measurements - Air).

Selected samples will be submitted to the laboratory for chemical, radiologic and/or physical testing. Various criteria that will be used to select samples for analysis include: changes in lithology or moisture content; visual evidence of staining or discoloration; above-ba kground readings on field instruments; and the presence of fine-grained or organic material that may be more likely to retain analytical parameters. Analytical parameters for well soil borings are presented in Table A-6.4.

TABLE A-6.4 SOIL ANALYTICAL PARAMETERS - MONITORING WELL SOIL BORINGS

CHEMICAL TESTS	PHYSICAL TESTS	TOTAL # OF SAMPLES
Nitrate	Grain size	20
Pesticides	Atterberg Limits	20
Total Chromium	Permeability	20
Total Organic Carbon (TOC)	Porosity	20
pH	Moisture Content	20
EC	Bulk Density	20

In addition to chemical and physical samples, one equipment blank will be collected during drilling and sampling of the well borings. Equipment blanks from well borings will be analyzed for nitrate, pesticides, and total chromium and collected according to procedures included in SOP 10.

6.6.3 Monitoring Well Installation

Groundwater monitoring wells will be installed in accordance with procedures described in SOP 8 (Installation and Construction - Groundwater Monitoring Wells), and will be consistent with the "Standard Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers" (ASTM D-5092-90). Construction details for the sixteen ~~ten~~ new wells (total depth, screened interval, screen slot size, and filter pack size) will be evaluated by the geologist and project manager, based on data collected during each soil boring. However, based on data collected during the Phase II Site Characterization, general construction specifications for new wells are described below.

First HSU monitoring wells will be completed to a depth of approximately 70 feet bgs with 15-foot screened sections. 15-foot screened sections will maximize the potential for collecting samples from each well during the wide yearly fluctuations in ground water, Second-HSU wells will be completed to approximately 120 feet bgs with 25-foot screen sections to achieve well completion over approximately 75 percent of the second-HSU interval.

At each well, the ground surface will be graded away from the well head to minimize the potential for downward migration of water from precipitation or runoff. After completion, the elevation and location of new monitoring wells will be surveyed to the nearest 0.01 foot vertically and 0.3 foot horizontally. All surveying will be conducted by a California State-Licensed surveyor.

6.6.4 Well Construction Materials

New monitoring wells will be constructed of 4-inch-diameter, stainless steel, continuous wire-wrap screen and schedule 40 blank PVC. An appropriate filter pack will be evaluated based on data collected during the soil boring. A sanitary seal of

cement/bentonite grout will be placed from the top of the secondary seal up to the ground surface. Monitoring wells will be completed with an above-grade, locking, steel, protective casing or flush-mount, water-tight, locking well boxes. Flush-mount completions will be installed in high traffic areas. All PVC casing and stainless steel screen will be steam cleaned prior to installation. Detailed procedures of monitoring-well construction are presented below and in SOP 8 (Installation and Construction - Groundwater Monitoring Wells).

First-HSU monitoring wells will be screened using 15-foot lengths of 4-inch-diameter, stainless steel, wire-wrap screen with 0.010-inch slots will be used. Schedule 40 blank PVC casing will be used from the top of the screened interval to the ground surface. Lonestar 1C sand will be used as the primary filter pack material for these wells. The secondary filter pack consisting of a 2-foot layer of 30 mesh sand will be placed above the primary filter pack. Approximately 3 feet of 1/4-inch-diameter bentonite pellets will be placed on top of the secondary filter pack. A minimum 3- to 5-foot-thick secondary filter pack of 30 mesh sand will be placed on top of the bentonite seal. The remaining annulus will be grouted to the surface by tremmie methods with a 2- to 5-percent bentonite/cement grout mixture.

Second-HSU wells will be constructed using 4-inch-diameter, stainless steel, continuous wire-wrap screen with 0.020-inch-wide openings and with a No. 2/12 sand as the primary filter pack. Schedule 40 blank PVC casing will be used from the top of the screened interval to the ground surface. The secondary filter pack consisting of a 2-foot layer of 30 mesh sand will be placed above the primary filter pack. A minimum 5-foot-thick layer of volclay grout and bentonite slurry will be used instead of bentonite pellets to avoid potential bridging problems. A minimum 1-foot thick secondary filter pack of 30-mesh sand will be placed on top of the volclay grout seal. The remaining annulus will be pressure grouted to the surface by tremmie methods with a 2- to 5-percent bentonite/cement grout mixture.

6.6.5 Piezometer Installation

One piezometer is proposed to be installed in the first HSU during remediation and investigation activities in order to monitor groundwater levels. In general, piezometers will

be installed and constructed according to procedures used for first-HSU monitoring wells (SOP 9). Piezometers will be constructed of 2-inch-diameter PVC casing and screen in 8-inch-diameter boreholes. Piezometers will not be included in the regular quarterly groundwater monitoring program, but may be sampled periodically to provide groundwater quality information.

6.6.6 Monitoring Well Abandonment

Monitoring wells that are to be abandoned as part of the RI/FS program will be destroyed according to Solano County guidelines.

6.7 WELL DEVELOPMENT

New monitoring wells will be developed in two stages using a well development rig equipped with a surge block, stainless steel bailers and a submersible pump. The first stage of development occurs after placement of the filter pack, but before placement of the bentonite and grout. This stage of development is done with only the surge block. The second stage well development procedures are described in SOP 8 (Installation and Construction - Groundwater Monitoring Wells). Development of the monitoring wells will be observed by a geologist. The general sequence for monitoring well development includes the following steps:

- Surging the well screened interval using the surge block;
- Bailing the well to remove coarse-grained sediments;
- Surging the screened interval a second time;
- Bailing the well to remove coarse-grained sediments; and
- Pumping the well using a submersible pump, varying the pumping rate and elevation of the pump in the well.

During pumping, pH, electrical conductivity (EC), turbidity, and temperature of the groundwater will be measured at regular intervals. Development will continue until consecutive measurements of pH, temperature, and conductivity measured within 10 percent of previous readings and turbidity readings are below 5 NTU. Water produced during monitoring-well development will be placed in DOT-approved drums, closed and

placed in a designated storage area. The drums will be labeled to indicate monitoring-well number and date. The disposition of each drum of development water will be evaluated as described in the Waste Management Plan currently being prepared for investigation-derived wastes during the RI.

6.8 CPT/HYDROPUNCH™ INVESTIGATION AND IN SITU WATER SAMPLING

In addition to soil boring and monitoring well data, information on the stratigraphy of the LEHR site and the extent of LEHR site constituents in groundwater will also be provided during a CPT/Hydropunch™ investigation and with in situ groundwater samples. General procedures for the CPT/Hydropunch™ and in situ groundwater sampling are described below. Detailed description of methods are presented in SOP 19 (Cone Penetrometer Test and Hydropunch™ Sampling), and SOP 1 (Water Sampling).

The CPT/Hydropunch™ investigation will be conducted under the supervision of a Dames & Moore geologist and will include 24 ~~twelve~~ locations north and east of the LEHR site (Figure A22). At each location, the CPT tool will be advanced until it hits refusal. Based on previous investigations, refusal depth is anticipated to be three to 5 feet below the top of the second HSU (approximately 80 feet bgs). When completed, the CPT tool will be removed from the hole. The geologist will evaluate the CPT log and identify target depths to attempt Hydropunch™ sampling.

Hydropunch™ sampling will be attempted within the first HSU at 11 ~~seven~~ of the twelve locations (Figure A22), and within the second HSU at each of the 24 ~~12~~ locations. At first HSU sampling locations, the Hydropunch™ tool will be pushed to the selected depth and a sample will be collected. Upon completion, the probe will then be pushed to the selected depth in the second HSU and a second sample will be collected. At locations for which no first HSU sample will be collected, the Hydropunch™ will be advanced directly to the selected depth within the second HSU. If samples are attempted in fine-grained material, it may be necessary to wait for an extended period of time for the Hydropunch™ to fill with water. In these cases, the tool will be left in the ground to fill and the CPT rig will be moved to a new location. When the Hydropunch™ has filled, the tool will be retrieved and sample containers will be filled. Because only a limited volume of water will be available, analytical requests will be prioritized as follows:

- Volatile organic compounds;
- Total chromium and hexavalent chromium;
- nitrate and total nitrogen;
- tritium;
- pH, EC, and TOC;
- Carbon-14; and
- Strontium-90.

When sampling has been completed, CPT and Hydropunch™ holes will be grouted to the surface with a cement/bentonite mix.

6.9 WATER SAMPLING

This section presents field methods to be used in sample collection, field measurements, sample packaging, and sample shipment for the water monitoring program. As discussed in Section 6.1 of the RI/FS Work Plan text, the quarterly monitoring program presented in Table A-6.5 is modified for the program in the Water Monitoring Plan. These modifications are pending concurrence from the regulatory agencies and are presented here for completeness. Specific water sampling procedures are described in SOP 1 (Water Sampling) in Attachment 1 of FSP.

6.9.1 Preparation and Mobilization

The set-up procedures described below are essentially the same for groundwater, surface water, and storm water runoff sampling. Surface water and groundwater monitoring will take place concurrently, and preparation and mobilization for these tasks will be completed at the same time. Because storm water monitoring will take place during a rainfall event, most of the preparation will be completed separately and in advance, with personnel and equipment on standby. Groundwater, surface water, and storm water runoff monitoring points are presented in Figures A21, A22, A23, and A24.

TABLE A-6.5 MONITORING PARAMETERS GROUNDWATER SAMPLES [1]

Field	Quarterly	Annual
To be collected every quarter (spring, summer, fall, and winter)	To be collected every quarter (spring, summer, fall, and winter)	To be collected one quarter per year (spring)
pH Electrical Conductivity Temperature Turbidity EH Water Level	Volatile Organic Compounds Tritium, Radium-226, Strontium-90, Gross Alpha, Gross Beta, Gamma Emitters, and Carbon-14 Plutonium-241 Americium-241 Total Chromium Hexavalent Chromium Nitrate TKN Ammonia Total Organic Carbon Total Dissolved Solids Formaldehyde Turbidity	Semi-Volatile Organic Compounds Pesticides and PCBs Antimony, Arsenic, Barium, Beryllium, Cadmium, Cobalt, Iron, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Vanadium, and Zinc Alkalinity Cations Anions Chemical Oxygen Demand Biochemical Oxygen Demand

(1) UCD-1, UCD-4, UCD-7, UCD-10, UCD-11, UCD-12, UCD-13, UCD-14, UCD-15, UCD-16, UCD-17, UCD-18, UCD-19, UCD-20, UCD-21, UCD-22, UCD-23, UCD-24. New wells added during the RI/FS will be monitored for all quarterly and annual parameters on a quarterly basis for a minimum of one year.

6.9.2 Groundwater Monitoring

Groundwater monitoring will consist of water level measurements, field measurements and the collection of groundwater samples. Prior to beginning sampling activities, a water level measurement will be collected from each monitoring well in order to construct water level elevation contour maps. Water level measurements will be collected on the same day to minimize variations that may occur in elevations due to nearby pumping.

Prior to quarterly groundwater, surface water, and storm water runoff monitoring, the Field Operations Lead, who is responsible for collecting and shipping samples, will gather and inspect equipment and instruments to see that they are in proper working condition. These activities will include, where appropriate:

- Notifying the analytical laboratory three weeks in advance of sampling activities of the number of samples and types of analyses, and requesting the proper number of sample containers, ice chests, and blue ice. Upon receipt, sample containers will be inspected and the laboratory will be notified of any missing or broken bottles (Note: the appropriate sample containers will be kept at the field office for the storm water sampling);

- Notifying PNL and UC Davis staff of sampling schedule;

- Checking the combination HyDac pH/conductivity meter for accuracy by calibrating for pH with NIST traceable pH solution buffers, checking the electrical conductivity (EC) meter with 10 μmhos/cm, 100 μmhos/cm, 1,000 μmhos/cm NIST traceable EC solutions, and checking the temperature meter with a NIST traceable thermometer. Check Eh meter according to manufacturer's instructions;

- Checking that the turbidity meter, water-level indicator, electrical generator, oil-less air compressor, and bladder pump control box are in proper working condition;

- Assembling a bound field notebook that includes groundwater sample tracking forms, field memos, field records of water sampling, and instrument calibration forms (see SOP 1.0; Appendix C);

- Assembling additional forms including sample Chain of Custody (COC) and pre-addressed airbills for overnight shipment; and

- Reviewing proper sampling and health and safety protocol.

After the proper equipment is gathered and inspected, the Field Operations Lead will meet with the Task or Project Manager to review the monitoring program, health and safety protocol, sampling procedures, monitoring points (see Table A-6.6), quality control procedures, and field documentation.

Field instruments will be calibrated once prior to beginning daily sampling activities, and then every four hours (pH meter), or before each well is sampled (turbidity meter). Field measurement and calibration procedures are described in SOP 2.0 (Field Measurements - Water). Field observations, measurements, and calibration information will be recorded in the bound field notebook (see SOP 1.0).

Groundwater sampling at the LEHR site will be conducted by purging and sampling monitoring wells using dedicated sampling systems. The dedicated systems are submersible electric pumps. New wells installed as part of the RI/FS will be fitted with dedicated electric submersible pumps. If the static water level drops below the level of a pump, the well will not be sampled. Purging and sampling procedures are described in SOP 1.0 (Water Sampling). Purging of each well will continue until:

- Three to five casing volumes of water are removed from the well; and
- The field measurements of pH, electrical conductivity, temperature, turbidity, and Eh measurements of the purged water stabilize to within 10 percent of the previous readings.

Wells that are pumped or bailed dry prior to removing three casing volumes of water will be allowed to recover and then pumped or bailed dry a second time. Field measurements of temperature, Eh, pH, specific conductivity, and turbidity will then be collected as the well fills the second time. "Dry" wells will be confirmed by comparing field well depth measurements to well construction specifications, and documented in the bound field note book.

Groundwater samples will be collected directly from the sampling pumps into sample containers supplied by the laboratory. Samples will be collected for parameters listed in Table A-6.5. Sample containers will be labelled with LEHR site name, well identification, date, time, requested analyses, and preservation method.

TABLE A-6.6 MONITORING POINTS FOR THE WATER MONITORING PROGRAM

Groundwater Monitoring Points	Surface Water Monitoring Points	Storm Water Runoff Monitoring Points
UCD-1	PCU	LS-1
UCD-4	PCD	SD-1
UCD-7	STPO	
UCD-10		
UCD-11		
UCD-12		
UCD-13		
UCD-14		
UCD-15		
UCD-16		
UCD-17		
UCD-18		
UCD-19		
UCD-20		
UCD-21		
UCD-22		
UCD-23		
UCD-24		
Any additional wells from RI/FS program		

6.9.3 Piezometer Sampling

Piezometers installed during investigation or remediation activities may be sampled periodically to evaluate water quality. Piezometers will be sampled according to the procedures used to sample monitoring wells outlined in SOP 1. Piezometers will not contain dedicated pump systems, and therefore they will be sampled with either non-dedicated or disposable equipment.

6.9.4 Surface Water Monitoring Procedures

Surface water monitoring will consist of the collection of field measurements and water samples. Monitoring will be conducted at two Putah Creek locations (PCU and PCD) and the UC Davis Wastewater Treatment Plant outfall (STPO) according to sampling procedures described in SOP 1.0. Surface water monitoring locations are presented in Figure A23. Samples will be collected each quarter for analytes listed in Table A-6.7. Prior to sampling at each location, 3 field measurements of pH, electrical conductivity, temperature, turbidity, and Eh will be recorded. Field measurements will be conducted according to procedures described in SOP 2.0. Grab samples will then be collected using clean glass sample bottles and transferred to the appropriate laboratory-supplied sample containers. Samples will be filtered and preserved as indicated in Table A-6.7. Sample containers will be labelled with LEHR site name, well identification, date, time, requested analyses, and preservation method.

6.9.5 Storm Water Sampling Procedures

Storm water runoff samples will be collected from locations LS-1 and SD-1 twice per year according to procedures described in SOP 1.0. Proposed storm water runoff monitoring locations are presented in Figure A23. Runoff monitoring points were selected so that water is sampled before mixing with sewers connected to existing UC Davis operations (location SD-1) and sampled just prior to discharge to the wastewater treatment plant outfall pipe outfall (location LS-1). Exact locations may be modified based on observed runoff flow patterns. Samples will be collected from a storm event early in the rainy season and in the middle of the rainy season.

TABLE A-6.7 MONITORING PARAMETERS - SURFACE WATER [1]

Field	Quarterly	Annual
To be measured every quarter for each surface water monitoring point	To be collected every quarter (spring, summer, fall, and winter) from each surface water monitoring point	To be collected one quarter per year (spring) from each surface water monitoring point
pH Electrical Conductivity Temperature Turbidity Eh Approximately Flow Rate[2]	Volatile Organic Compounds Pesticides and PCBs Tritium, Radium-226, Strontium-90, Gross Alpha, Gross Beta, Gamma Emitters, and Carbon-14 Plutonium-241 Americium-241 Total Chromium Hexavalent Chromium Alkalinity Cations Anions Nitrate Total Organic Carbon Total Dissolved Solids Formaldehyde Turbidity	Semi-Volatile Organic Compounds Antimony, Arsenic, Barium, Beryllium, Cadmium, Cobalt, Lead, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Vanadium, and Zinc Chemical Oxygen Demand Biochemical Oxygen Demand

(1) To be collected at locations PCD, PCU, and STPO.

(2) STPO discharge rates will be obtained from UC Davis; flow measurements for Putah Creek will be obtained from the Solano Irrigation District.

During each event, the two storm water samples will be collected within as small a time interval as possible to maximize the comparability of the results. Samples will be collected each event for analytes listed in Table A-6.8. A minimum of three field measurements for pH, electrical conductivity, temperature, turbidity, and Eh will be collected from each storm water runoff location. Procedures for conducting field measurements and calibrating field instruments are described in SOP 2.0.

Samples from location LS-1 will be collected out of the sump while it is actively receiving runoff and while the lift station pump is running. Grab samples will be collected using a disposable bailer and transferred into the proper sample containers. Samples from the SD-1 location will be collected as grab samples out of a clean, disposable container, such as a disposable bailer, and transferred into the proper sample containers provided by the laboratory. Samples will be filtered and preserved as indicated in Table A-5.2. Sample containers will be labelled with LEHR site name, well identification, date, time, requested analyses, and preservation method.

6.9.6 Field Quality Assurance Sampling - Water

Water monitoring field quality control will consist of trip blanks, field blanks, and "blind" duplicates. Trip blanks will be supplied by the laboratory and will accompany the sample containers to and from the laboratory. One set of trip blanks will be included with each daily sample shipment and analyzed for volatile organic compounds.

During each quarterly monitoring round, "blind" duplicate samples will be collected one for every 20 groundwater samples and one per quarter for surface water samples by simultaneously filling a second, identical set of sample containers, and labelling the containers with a fictitious well identification. Duplicate samples will be collected from different wells and surface water monitoring points each quarter and documented in the bound field notebook. During storm runoff monitoring, one blind duplicate sample will be collected for each monitoring event, and one trip blank per daily shipment. Duplicate samples will be filtered, preserved, packaged, and shipped in an identical fashion to groundwater and surface water samples.

A complete table presenting the proposed sample-collection schedule for one monitoring year is included in Table A-6.9. This table includes an estimate of the number of duplicate and field blank samples that will be collected per sampling event.

TABLE A-6.8 MONITORING PARAMETERS - STORM WATER RUNOFF [1]

Field	Each Storm Event
To be measured during two storm events per year from both locations	To be collected two storm events per year from both locations
pH Electrical Conductivity Temperature Turbidity Eh Approximate Flow Rate	Total Oil and Grease Volatile Organic Compounds Semi-Volatile Organic Compounds Pesticides and PCBs Tritium, Radium-226 Strontium-90, Gross Alpha, Gross Beta, Gamma Emitters, and Carbon-14 Americium-241 Plutonium-241 Antimony, arsenic, Barium, Beryllium, Cadmium, Cobalt, Lead, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Vanadium, and Zinc Total Chromium Hexavalent Chromium Nitrate Alkalinity Cations Anions Total Organic Carbon Total Suspended Solids Total Dissolved Solids Formaldehyde Chemical Oxygen Demand Biochemical Oxygen Demand Turbidity

* After two years of monitoring (four events) several parameters may modified.
(1) LS-1 and SD-1.

TABLE A-6.9 PROPOSED WATER MONITORING SCHEDULE FOR ONE MONITORING YEAR

Monitoring Point	Samples	Dupli-cates	Event Total	Monitoring Events per Year[1]	Total
Eighteen Existing Wells	18	1	19	4 (quarters — spring, summer, fall, winter)	76
Sixteen Proposed Monitoring Wells	16	1	17	4 (quarters — spring, summer, fall, winter)	68
Surface Water Samples	3	1	4	4 (quarters — spring, summer, fall, winter)	16
Storm Water Runoff Samples	2	1	3	2 (storm events)	6

(1) Annual monitoring will occur during the spring quarterly round.

6.9.7 Water Sample Packaging and Shipping

Each water sample, duplicate sample, and trip blank container will be packaged and shipped according to procedures described in SOP 5.0. Samples will be packed in ice chests containing sealed blue ice and a completed, signed, and dated Chain of Custody (COC) form. Special care will be taken to pack sample containers to minimize breakage. Ice chests will be secured with a custody seal and will be delivered daily to Federal Express for overnight delivery to the analytical laboratory. Upon receipt of the sample shipment, the laboratory will transmit a copy of the completed COC form by facsimile to Dames & Moore, noting any missing or damaged containers. If necessary and appropriate, sample water will be taken from undamaged bottles from the same well. If sufficient sample water cannot be extracted from remaining bottles, analyses for that sample will be halted and the well resampled. Samples will not be collected or shipped on Fridays to avoid potential Saturday delivery and analysis problems.

6.10 SATURATED ZONE PERMEABILITY TESTING

Saturated zone permeability testing will be conducted to evaluate hydrogeologic parameters for input into computer models. Hydraulic conductivities of the saturated formation within the screened interval of each will be estimated by completing slug tests. Slug tests are conducted by raising and lowering a solid PVC "slug" to displace water inside a well. As the water level in the well recovers to static, water level measurements are collected at specific time intervals. By analyzing the rate of recovery, the saturated hydraulic conductivity can be estimated. Procedures for conducting slug tests are described in SOP 13 (Aquifer Testing).

If warranted, an aquifer pump test may be conducted on a well screened in the second HSU. A pump test would provide a more accurate estimate of hydrogeologic parameters; however, it will be logistically difficult, due to purge water disposal. A discussion of options for potential pump tests is presented in Chapter 6 of the RI/FS Work Plan. A description of pump test procedures is presented in SOP 13.

6.11 BASELINE AIR MONITORING INVESTIGATION

Baseline air monitoring measures the windspeed and direction adjacent to the LEHR site as well as chemical and radiologic constituents identified at the LEHR site. The locations of the five perimeter air monitoring stations are presented in Figure A25.

Air sampling procedures are described in SOPs 16 and 17. Sampling for radio nuclides will be performed weekly, and composited into monthly samples. The radio nuclide parameters are listed in Table A-6.10. Sampling for non-radionuclides will be performed for a single 24 hour period per month. The analytical non radio nuclides are also presented in Table A-6.10. The rationale for selecting the air monitoring analytical parameters is presented in Section 7.2.1.3 of the RI/FS Work Plan.

Additional meteorologic data such as wind speed and wind direction may be developed, as described in Section 2.3.5 of the RI/FS Work Plan. The data would be recorded with an automated data acquisition system, which retains hourly averaged measurements with a sensitivity of 0.5 meters per second.

6.12 BIOTA INVESTIGATION

The biota investigation at the LEHR site will consist of the sampling and analysis of vegetation. ~~The three types of vegetation and biota sampling that may be performed at the LEHR site include the sampling and analysis of vegetation, mammal, and fish.~~ The goals of vegetation ~~biota~~ sampling are to characterize pertinent aspects of the local ecology and evaluate potential effects of chemical migration on terrestrial and aquatic life through the food chain. Rationale and for vegetation ~~and biota~~ sampling are presented in the RI/FS Work Plan text. Methods for sampling vegetation are presented in SOP 32 - Vegetation Sampling. If evaluations of chemical analytical data in soil or vegetation indicate the potential for adverse impacts to terrestrial receptors, then mammals may be collected for tissue analysis. Fish in Putah Creek will only be collected and submitted for chemical analysis if analytical data in surface water and sediments indicate elevated contaminant levels.

TABLE A-6.10 ANALYTICAL PARAMETERS - AIR MONITORING

Radiological Parameters	Non-Radiologic Parameters
Gross Alpha	Antimony
Gross Beta	Beryllium
Gamma Emitters	Copper
Tritium	Molybdenum
Cobalt-60	Selenium
Strontium-90	Chlordane
Cesium-137	Chloroform
Radium-226	Methylene Chloride
Isotopic Uranium (-238, -234, -235)	Chromium
Isotopic Thorium (-232, -230, -228)	
Radon-222	

7.0 REFERENCES1

40 CFR 61. Appendix B; National Emission Standards for Hazardous Air Pollutants; Radionuclides, Final Rule, December 15, 1989.

American Public Health Association Intersociety Committee (APHA). 1977. Methods of Air Sampling and Analysis - Section Edition. American Public Health Association, New York NY.

Bates, L.A., 1977. Soil Survey of Solano County, California, U.S. Department of Agriculture Soil Conservation Service, 112 p.

Bouwer, H., 1989. The Bouwer and Rice Slug Test - An Update, Groundwater, Vol. 27, No. 3., pp. 304-309.

Bouwer, H. and Rice, R.C., 1976. A Slug Test for Determining Hydraulic Conductivity of Unconformed Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, Vol. 12, No. 3, pp. 423-428.

California Division of Oil and Gas, 1982. California Oil and Gas Fields, Northern California: Fourth edition.

California Air Resources Board, 1984, California Surface Wind Climatology, June 1984.

California Code of Regulations Title 14 (14 CCR).

Code of Federal Regulations (CFR). 1992. Good Laboratory Practices. 40 CFR 792.

Dames & Moore, 1990a. Evaluation of On-Site Wells, UCD LEHR Facility, Davis, California for the University of California, Davis.

Dames & Moore, 1990b. Final SWAT Report, Old UCD Landfill for the University of California, Davis.

Dames & Moore, 1990c. Contaminant Pathway Analysis for the U.C. Davis Campus from the LEHR Study Site, for the University of California, Davis.

Dames & Moore, 1990d. Evaluation of Potential Nitrate and Hexavalent Chromium Sources in the Vicinity of the UCD LEHR Facility for University of California, Davis.

Dames & Moore, 1990e. Putah Creek Sediment and Water Sampling for the University of California, Davis.

Dames & Moore, 1990f. Work Plan, Phase II Site Characterization, LEHR Environmental Restoration, University of California, Davis, California.

Dames & Moore, 1990g. Data Quality Review, Phase II Site Characterization, LEHR Environmental Restoration Project, University of California, Davis, California.

Dames & Moore, 1991. Second Round CPT/Hydropunch Investigation for the University of California, Davis.

Dames & Moore, 1991. Transmission Routing Study for Power System Additions, Prepared for Sacramento Municipal Utility District, Sacramento, California.

Dames & Moore, 1991a. Old UCD Landfill Additional Characterization - CPT and Hydropunch Investigation - UCD South Campus Inactive Disposal Sites for the University of California, Davis.

Dames & Moore, 1991c. CEQA Preliminary Environmental Study for Site Characterization Work at the Inactive UCD Landfill for the University of California, Davis.

Dames & Moore, 1991b. Waste Burial Trench Investigation LEHR Facility for the University of California, Davis.

Dames & Moore, 1993a. Phase II Site Characterization Report, LEHR Environmental Restoration, University of California, Davis.

Dames & Moore, 1993b. Draft Water Monitoring Plan, LEHR Environmental Restoration. University of California, Davis.

Department of Water Resources, 1978. Evaluation of groundwater resources: Sacramento Valley, Bulletin 118-6, 136 pp.

Division of Oil and Gas (DOG), 1982, California Oil and Gas Fields, Northern California.

EMSL-LV-0539-17, Radiochemical Analytical Procedures for Analysis of Environmental Samples, U.S. Environmental Protection Agency, 1979.

EPA, 1986a. Superfund Public Health Evaluation Manual. Office of Solid Waste and Emergency Response.

EPA, 1986b. Guidelines for Carcinogen Risk Assessment. Federal Register 51:33992-34003.

EPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. Office of Emergency and Remedial Response. OSWER Directive 9355.3-01.

EPA, 1988a. Guidance for Conducting Remedial Investigations & Feasibility Studies under CERCLA, Office of Emergency & Remedial Response, Washington, D.C. EPA 540/G-89/004.

EPA, 1988b. Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites.

EPA, 1988c. Technology Screening Guide for Treatment of CERCLA Soils and Sludges. EPA 540 2-88004.

EPA, 1989. Risk Assessment Guidance for Superfund. Volume I, Human Health Evaluation Manual Part A. Interim Final. Office of Solid Waste and Emergency Response. OSWER Directive 9285.701A.

EPA, 1989a. Risk Assessment Guidance for Superfund. Volume I, Human Health Evaluation Manual Part A. Interim Final. Office of Solid Waste and Emergency Response. OSWER Directive 9285.701A.

EPA, 1989b. Risk Assessment Guidance for Superfund. Volume II, Environmental Evaluation Manual. Interim Final. Office of Solid Waste and Emergency Response. EPA/540/1-89/001A. OSWER Directive 9285.7-01.

EPA, 1989c. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms. EPA Environmental Monitoring Systems Laboratory. EPA/600/4-89/001.

EPA, 1990. National Oil and Hazardous Substances Pollution Contingency Plan Final Rule. 40 CFR Part 300.

EPA, 1992. Administrative Order on Consent for Remedial Investigation/Feasibility Study and Focused Feasibility Study. USEPA Docket No. 92-13.

EPA, 1990. Guidance for Data Useability in Risk Assessment. October 1990. Office of Solid Waste and Emergency Response. EPA/540/G-90/008.

EPA, 1991. Risk Assessment Guidance for Superfund. Volume I, Human Health Evaluation Manual. Supplemental Guidance "Standard Default Exposure Factors." Draft Final. March 25, 1991. OSWER Directive 9285.6-03

EPA, 1992a. Health Effects Assessment Summary Tables, Annual, FY 1992. Office of Research and Development and Office of Emergency and Remedial Response.

EPA, 1992b. Framework for Ecological Risk Assessment. Risk Assessment Forum. Washington, D.C. EPA/630/R-92/001. February, 1992.

EPA, 1993. Integrated Risk Information System (IRIS). Data Base. Environmental Criteria and Assessments Office.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York.

HASL-300, HASL Procedures, Environmental Measurements Laboratory.

Holzworth, George C., 1972, Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States.

Hubbard, Janice, A., 1989. Texture Distribution of the Younger Alluvial Sediments and Parts of the Tehama Formation in Portions of Yolo, Solano, Colusa, and Sacramento Counties, California, Master's Thesis, University of California, Davis, 83 pp.

National Climatic Data Centers (NCDC), 1992. National Oceanic and Atmospheric Administration Database, information obtained through the University of Nevada Desert Research Institute, Western Regional Climate Data Center (Davis 2 WSW station).

National Oceanic and Atmospheric Administration (NOAA), 1985. Local Climatological Data, 1985, Sacramento, California, ISSN 0198-0963, National Climatic Data Centers, Asheville, North Carolina.

Nebeker, A.A., M.A. Cairns, J.H. Gakstatter, K.W. Malueg, G.S. Schuyterns and D.F. Karswezyk. 1984. Biological methods for determining toxicity of contaminated freshwater sediments to invertebrates. Environ. Toxicol. Chem. 3:617-630.

NIOSH. February 1984. NIOSH Manual of Analytical Methods. NTIS PB 85-179018. National Institute for Occupational Safety and Health. Cincinnati, OH 45226.

Norris, R.M., and R.W. Webb, 1976. Geology of California, John Wiley & Sons, 365 pp.

Olmsted, F.H., and G.H. Davis, 1961. Geologic features and groundwater storage capacity of the Sacramento Valley, California, U. S. Geological Survey Water Supply Paper 1497, 241 pp.

PNL, 1992. Methods for Estimating Doses to Organisms from Radioactive Materials Released into the Aquatic Environment. Pacific Northwest Laboratory, PNL-8150. June 1992.

Rockwell International, 1984. Initial Assessment Survey of the DOE LEHR Site of University of California, Davis, Contract No. DE-AT03-845F15160.

Ruffner, J.A., 1985, Climates of the States, Volume 1 (Third edition), Gale Research Company.

Sacramento Area Council of Governments, 1991. 1990 Census- P.L. 94-171 Reapportionment Data, Sacramento, California.

Thomasson, HG.G., J.F. Olmsted, and E.F. LeRoux, 1960. Geology, Water Resources and Usable Groundwater Storage Capacity of Port of Solano County, California; Geological Survey Water-Supply Paper, 1464.

United States Department of Energy (DOE), 1988, Environmental Survey Preliminary Report, March 1988.

United States Department of Energy, 1992. Environmental Assessment for the decommissioning and Decontamination of Contaminated Facilities at the Laboratory for Energy-Related Health Research, University of California, Davis, September 1992.

United States Environmental Protection Agency (US EPA), 1989. Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance. EPA/530-SW-89-026.

United States Environmental Protection Agency (US EPA), 1987. Data Quality Objectives for Remedial Response Activities, Development Process, EPA 540/G-87/003.

United States Department of Energy, 1988. Environmental Survey Preliminary Report Laboratory for Energy - Related Health Research, Davis, California.

United States EPA, 1988. Compendium Method TO-14: The Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using SUMMA Passivated Canister Sampling and Gas Chromatographic Analysis. Research Triangle Park, NC 27711, June.

United States EPA, 1987. Compendium Method TO-10: The Determination of Organochlorine Pesticides in Ambient Air Using Low Volume Polyurethane Foam (PUF) Sampling with Gas Chromatography/Electron Capture Detector (GC/ECD). Research Triangle Park, NC 27711, June.

United States Department of Energy (DOE), Environmental Monitoring and Surveillance Plan for the LEHR Environmental Restoration Project, September 1992.

Wahler Associates, 1988. Groundwater and Soils Investigation, U.C. Davis Research Facility, Davis, California.

Wahler Associates, 1989. Groundwater and Soils Investigation, U.C. Davis LEHR Facility, Davis, California.

Warren J., 1985. Radioactive Waste Burial at the Laboratory for Energy Related Health Research, University of California, Davis.

APPENDIX A
ATTACHMENT 1

STANDARD OPERATING PROCEDURES

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES

SECTION **PAGE**

STANDARD OPERATING PROCEDURE 1.0
WATER SAMPLING 1
1.1 SET-UP 1
1.2 GROUNDWATER SAMPLING 2
1.2.1 Groundwater Monitoring Wells 2
1.2.2 Piezometer Sampling 5
1.2.3 In-situ Groundwater Sampling 5
1.3 SURFACE WATER SAMPLING — GRAB SAMPLE 6
1.4 STORM WATER RUNOFF SAMPLING — GRAB SAMPLE 6

STANDARD OPERATING PROCEDURE 2.0
FIELD MEASUREMENTS - WATER 1
2.1 SET-UP 1
2.2 WATER LEVEL MEASUREMENT 2
2.3 pH MEASUREMENT 2
2.4 ELECTRICAL CONDUCTIVITY 4
2.5 TEMPERATURE 6
2.6 TURBIDITY 6
2.7 Eh (OXIDATION-REDUCTION POTENTIAL) 7
2.8 LUDLUM MODEL 2929 DUAL CHANNEL SEALER 8

STANDARD OPERATING PROCEDURE 3.0
EQUIPMENT DECONTAMINATION 1
3.1 DECONTAMINATION PROCEDURES 1

STANDARD OPERATING PROCEDURE 4.0
SOIL, WATER, AND WASTE DISPOSAL 1
4.1 CONTAINMENT 1
4.2 DISPOSAL 1

STANDARD OPERATING PROCEDURE 5.0
SAMPLE SHIPMENT 1
5.1 PROCEDURES 1

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES (continued)

SECTION **PAGE**

STANDARD OPERATING PROCEDURE 6.0
SOIL BORINGS 1
6.1 SET-UP PROCEDURES 1
6.2 DRILLING METHODS 2
6.2.1 Dual Tube Percussion and Casing Hammer Methods 2
6.2.2 Hollow-stem Auger Method 3
6.2.3 Rotary Drilling Methods 3
6.2.4 Enviro-Core® Method 4
6.2.5 Resonant Sonic Drilling (Sonic Coring) 5

STANDARD OPERATING PROCEDURE 7.0
LOGGING OF SOIL BORINGS — USCS 1
7.1 BORING LOGS 1
7.2 LOGGING PROCEDURES 3

STANDARD OPERATING PROCEDURE 8.0
INSTALLATION, CONSTRUCTION, AND ABANDONMENT
GROUNDWATER MONITORING WELLS AND PIEZOMETERS 1
8.1 PREPARATION AND SET-UP 1
8.2 MONITORING WELL DESIGN 2
8.3 WELL INSTALLATION 3
8.4 WELLHEAD COMPLETION 4
8.5 WELL DEVELOPMENT 4
8.6 WELL CONSTRUCTION SUMMARY DIAGRAMS 5
8.7 EXTRACTION AND RECHARGE WELL CONSTRUCTION AND INSTALLATION 6
8.8 PIEZOMETER INSTALLATION 6

STANDARD OPERATING PROCEDURE 9.0
BOREHOLE GEOPHYSICAL LOGGING 1
9.1 SET-UP 1
9.2 METHODS 2

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES (continued)

SECTION **PAGE**

9.2.1 Electrical Logging Surveys (Resistivity and Spontaneous Potential 2
9.2.2 Natural Gamma Ray Logging Survey 2
9.2.3 Temperature Logging Survey 2

STANDARD OPERATING PROCEDURE 10.0
SOIL SAMPLING 1
10.1 GENERAL PROCEDURES 1
10.2 SUBSURFACE SOIL SAMPLING 2
10.2.1 Set-up Procedures 3
10.2.2 Penetration Test and Split-Barrel Sampling 3
10.2.3 Dames & Moore Type - U Sampler 5
10.2.4 Continuous Core Sampling System Methods 7
10.2.5 Cuttings Collection Methods 7
10.2.6 Shelby Tube Sampling 7
10.3 SURFACE SOIL SAMPLING 8
10.4 MICROBIOLOGICAL SOIL SAMPLES 9
10.5 BULK SOIL SAMPLING 9
10.6 SOIL SAMPLE COMPOSITING 10
10.7 SOIL SAMPLING EQUIPMENT BLANKS 11

STANDARD OPERATING PROCEDURE 11.0
TEST PIT EXCAVATION 1
11.1 SET-UP PROCEDURES 1
11.2 TEST PIT EXCAVATION PROCEDURES 2

STANDARD OPERATING PROCEDURE 12.0
PERMEABILITY TESTING — UNSATURATED ZONE 1
12.1 DOWN HOLE FALLING HEAD TEST 2
12.1.1 Set-Up 2
12.1.2 Procedures 2
12.2 DOUBLE-RING INFILTROMETER TEST 4
12.2.1 Preparation and Set-Up for Double-Ring Test 4

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES (continued)

SECTION **PAGE**

12.2.1.1 Soil Preparation 4
12.2.1.2 Maintaining Liquid Levels 5
12.2.2 Preparation and Set-Up for Single-Ring Test 6
12.2.2.1 Maintaining Liquid Level 6
12.2.3 Calculations 7

STANDARD OPERATING PROCEDURE 13.0
AQUIFER TESTING 1
13.1 SLUG TESTS 1
13.1.1 Equipment and Documentation 1
13.1.2 Set-Up 1
13.1.3 Slug Test Procedures 2
13.2 STEP DRAWDOWN TEST 3
13.3 CONSTANT RATE DISCHARGE PUMP TESTS 4
13.3.1 Equipment and Documentation: 4
13.3.2 Set-Up 5
13.3.3 Procedures 6
13.4 DISCHARGE MEASUREMENTS 8
13.5 ABORTED TEST 8
13.6 STORAGE AND DISPOSAL OF PURGED WATER 8

STANDARD OPERATING PROCEDURE 14.0
FIELD MEASUREMENTS - SOIL 1
14.1 SET-UP 1
14.2 CALIBRATION AND MEASUREMENT 1

STANDARD OPERATING PROCEDURE 15.0
FIELD MEASUREMENTS - AIR 1
15.1 CALIBRATION 1
15.2 MEASUREMENT 2

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES (continued)

SECTION **PAGE**

STANDARD OPERATING PROCEDURE 16.0
AIR SAMPLING - ROTAMETERS AND MASS FLOW 1
16.1 SET-UP 1
16.2 CALIBRATION AND MEASUREMENT 1
16.3 ADMINISTRATIVE CONTROLS 5
16.4 MAINTENANCE 5
16.5 AUTHORITY 5
16.6 REFERENCES 6
16.7 PRESSURE, VOLUME, AND ERROR COMPENSATION FORMULAE 6

STANDARD OPERATING PROCEDURE 17.0
AIR SAMPLING — RADIONUCLIDES IN AMBIENT AIR 1
17.1 SET-UP, ORGANIZATION AND DOCUMENTATION 1
17.2 SAMPLING AND CALIBRATION PROCEDURES 2
17.2.1 General Sampling Train Configuration 2
17.2.2 Continuous Operation 3
17.2.3 General Sample Retrieval 3
17.2.4 Specific Sample Collection Media 4
17.3 MAINTENANCE 6
17.3.1 Initial Sampler Installation 6
17.3.2 Routine Sampler Maintenance 8
17.3.3 Reporting of Abnormal Operation 9
17.4 AUTHORITY 10
17.5 REFERENCES 11

STANDARD OPERATING PROCEDURE 18.0
ANALYTICAL WIPE SAMPLING FOR ORGANIC CHEMICALS 1
18.1 SET-UP PROCEDURES 1
18.2 WIPE SAMPLE COLLECTION PROCEDURE 1

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES (continued)

SECTION **PAGE**

STANDARD OPERATING PROCEDURE 19.0
CONE PENETROMETER TEST AND HYDROPUNCH™ SAMPLING — IN-SITU WATER .. 1
19.1 CONE PENETROMETER TEST (CPT) 1
19.2 HYDROPUNCH™ IN-SITU GROUNDWATER SAMPLING 2

STANDARD OPERATING PROCEDURE 20.0
SHALLOW SUBSURFACE GEOPHYSICAL SURVEY METHODS MAGNETICS, ELECTROMAGNETICS, GROUND PENETRATING RADAR TRANSIENT ELECTROMAGNETICS AND SEISMIC REFRACTION 1
20.1 SET-UP PROCEDURES 1
20.2 GEOPHYSICAL METHODS 2
20.2.1 Magnetics 2
20.2.2 Electromagnetics (EM) 3
20.2.3 TEM 3

STANDARD OPERATING PROCEDURE 21.0
SOIL VAPOR SURVEY 1
21.1 SET-UP 1
21.2 PROCEDURES 2
21.3 QUALITY ASSURANCE 3

STANDARD OPERATING PROCEDURE 22.0
SURFACE CONTAMINATION SURVEY FOR RADIOLOGICAL MATERIALS 1
22.1 SET-UP 1
22.1.1. Review of Survey Data 1
22.1.2 Survey Preparations 2
22.1.3 Instrumentation Requirements 2
22.1.4 Survey Precautions 3
22.2 SURVEY INSTRUCTIONS 4
22.2.1 Requirements for Routine Contamination Survey of Areas 4
22.2.2 Direct Measurement Technique 4
22.2.3 Smear Technique 5
22.2.4 Baseline Surveys 7

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES (continued)

SECTION **PAGE**

22.2.5 Release for Unrestricted-Use Surveys 7
22.2.6 Records 8

STANDARD OPERATING PROCEDURE 23.0
PERFORMANCE TEST AND OPERATIONAL CHECKS FOR ALPHA AND BETA-GAMMA CONTAMINATION SURVEY INSTRUMENTS 1
23.1 GENERAL 1
23.1.1 Servicing Instruments with Expired Calibration Dates 1
23.1.2 Additional Servicing of Instruments 1
23.2 INSTRUCTIONS 2
23.2.1 Operational Checks 2
23.2.2 Performance Tests 3

STANDARD OPERATING PROCEDURE 24.0
PERFORMANCE CHECKING AN OPERATION OF THE ALPHA SCINTILLATION SMEAR COUNTING INSTRUMENTS 1
24.1 GENERAL 1
Servicing of Alpha-Scintillation Counting Instruments 1
24.2 INSTRUCTIONS 1
24.2.1 Background Count Rate 1
24.2.2 Operation of the Alpha-Scintillation Counting Instrument 3

STANDARD OPERATING PROCEDURE 25.0
PERFORMANCE TESTING AND OPERATION OF THE BETA SMEAR COUNTING INSTRUMENTATION 1
25.1 GENERAL 1
25.2 INSTRUCTIONS 1
25.2.1 Conducting Background Count Rate and Performance Test 1
25.2.2 Operation of the Beta Smear Counting Instrument 4

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES (continued)

SECTION **PAGE**

STANDARD OPERATING PROCEDURE 26.0
RADON WORKING LEVEL MONITORING - GRAB SAMPLE TECHNIQUE 1
26.1 GENERAL 1
26.2 INSTRUCTIONS 1
26.2.1 Equipment 1
26.2.2 Sample Collection 2
26.2.3 Sample Counting 2
26.2.4 Analysis 3
26.2.5 Kusnetz Factor Chart 3

STANDARD OPERATING PROCEDURE 27.0
PERFORMANCE OF THE GAMMA RADIATION SURVEY 1
27.1 GENERAL 1
27.1.1 Review of Survey Data 1
27.1.2 Survey Preparations 1
27.1.3 Instrumentation Requirements 2
27.2 INSTRUCTIONS 3
27.2.1 Survey of Radiation Areas 3
27.2.2 Survey Records 3
27.2.3 Control for Radiation Areas 4

STANDARD OPERATING PROCEDURE 28.0
USE OF THE BICRON FIDLER (FIELD INSTRUMENT FOR THE DETECTION OF LOW ENERGY RADIATION) 1
28.1 GENERAL 1
28.1.1 The FIDLER Unit Components 1
28.1.2 Low-Energy Radiation Detection 1
28.2 INSTRUCTIONS 1
28.2.1 Instrument Inispection 1
28.2.2 Instrument Failure 2
28.2.3 Instrument Controls 2
28.2.4 Background Reading 2
28.2.5 Probing 3

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES (continued)

SECTION **PAGE**

28.2.6 Scanning 3
28.2.7 Surveying 3

STANDARD OPERATING PROCEDURE 29.0
PERFORMANCE OF PERSONNEL CONTAMINATION MONITORING 1
29.1 GENERAL 1
29.1.1 Radiological Occurrence Response Actions 1
29.1.2 Emergency Medical Care 1
29.1.3 Transporting Contaminated Personnel 1
29.2 INSTRUCTIONS 2
29.2.1 Monitoring Personnel for Contamination 2
29.3 CALIBRATION 4

STANDARD OPERATING PROCEDURE 30.0
AIRBORNE RADIOACTIVITY MONITORING 1
30.1 GENERAL 1
30.1.1 Airborne Radioactivity 1
30.2 INSTRUCTIONS 2
30.2.1 Sample Collection 2
30.2.2 Sample Counting 2
30.2.3 Analysis 2

STANDARD OPERATING PROCEDURE 31.0
CHANGE IN STANDARD OPERATING PROCEDURES 1

STANDARD OPERATING PROCEDURE 32.0
VEGETATION SAMPLING 1
32.1 RESPONSIBILITIES AND QUALIFICATIONS 2
32.2 GENERAL PROCEDURES 2
32.3 SAMPLING PREPARATION 2
32.3.1 Sample Locations 3
32.3.2 Select Sites for Quality Assurance/Quality Control (QA/QC) Samples 3

RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

INDEX OF STANDARD OPERATING PROCEDURES (continued)

SECTION **PAGE**

32.3.3 Preparation of Sample Labels 3
32.3.4 Personal Protective Equipment (PPE) 4
32.3.5 Buddy System 4
32.4 DECONTAMINATION OF EQUIPMENT 4
32.5 SELECTION OF SAMPLING LAYOUT 4
32.5.1 Quadrant Formation Sample Collection 5
32.5.2 Transect Formation Sample Collection 7
32.5.3 Sample Selection Using Random Numbers 9
32.6 SAMPLE HANDLING AND STORAGE 9
32.7 SPLIT SAMPLE PREPARATION 9
32.8 SAMPLE PACKAGING AND SHIPPING 10
32.9 CHAIN OF CUSTODY RECORD 10

STANDARD OPERATING PROCEDURE 33.0
DOWN-HOLE RADIATION MONITORING 1
33.1 GENERAL 1
33.2 OPERATION 1

ATTACHMENT 1

STANDARD OPERATING PROCEDURES

INTRODUCTION

This Attachment describes 32 Standard Operating Procedures (SOP) for field tasks to be completed during RI/FS-EA activities at the LEHR facility. The SOPs are intended to augment the descriptions of sampling, monitoring, and data collection in the text of the FSP. These procedures were developed as general descriptions of field methods that will be employed at various locations and phases of the field investigation. The purpose of the SOPs is to standardize and document field procedures and the collection of field data.

Each SOP describes the purpose, equipment needs, proper field documentation forms, and methodology for a general field task. Specific Health and Safety procedures and information are presented in the site-specific Health and Safety Plan (Appendix C). Field personnel will be familiar with the Health and Safety Plan prior to implementing field procedures. Full-size copies of field documentation forms referenced in the SOPs are as Attachment 2 to Appendix A. Many SOPs are subdivided into more specific procedures, when necessary. Overall, the SOPs listed below provide general methods and procedures which may be changed due to variations in field conditions. Changes in procedures will be documented by issuing a Revised SOP. Significant changes made to SOPs that are not documented in a Revised SOP will be controlled and documented using SOP-31.0 (see below), and the Interim Change Notice procedure described in the QAPjP.

Procedures for the following field tasks are described in this Attachment:

SOP 1.0	Water Sampling
SOP 2.0	Field Measurements - Water
SOP 3.0	Equipment Decontamination
SOP 4.0	Soil Water and Waste Disposal
SOP 5.0	Sample Shipment
SOP 6.0	Soil Borings
SOP 7.0	Logging of Soil Borings

SOP 8.0	Installation and Construction - Groundwater Monitoring Wells
SOP 9.0	Borehole Geophysical Logging
SOP 10.0	Soil Sampling
SOP 11.0	Test Pit Excavation
SOP 12.0	Permeability Testing - Unsaturated Zone
SOP 13.0	Aquifer Testing
SOP 14.0	Field Measurements - Soil
SOP 15.0	Field Measurements - Air
SOP 16.0	Air Sampling - Ratameters and Mass Flow
SOP 17.0	Air Sampling - Radionuclides in Ambient Air
SOP 18.0	Analytical Wipe Sample for Organic Chemicals
SOP 19.0	Cone Penetrometer Test and Hydropunch Sampling
SOP 20.0	Shallow Subsurface Geophysical Methods
SOP 21.0	Soil Vapor Survey
SOP 22.0	Surface Contamination Survey for Radiological Materials
SOP 23.0	Performance Test and Operational Checks for Alpha and Beta - Gamma Contamination Survey Instruments
SOP 24.0	Performance Checking and Operation of the Alpha Scintillation Smear Counting Instruments
SOP 25.0	Performance Testing and Operation of the Beta Smear Counting Instrumentation
SOP 26.0	Radon Working Level Monitoring - Grab Sample Technique
SOP 27.0	Performance of the Gamma Radiation Survey
SOP 28.0	Use of Bicron FIDLER
SOP 29.0	Performance of Personal Contamination Monitoring
SOP 30.0	Airborne Radioactivity Monitoring
SOP 31.0	Change in Standard Operating Procedure
SOP 32.0	Vegetation Sampling
SOP 33.0	Down-Hole Radiation Monitoring

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 1.0
WATER SAMPLING

Purpose and Scope: The purpose of these procedures is to describe the general methodology for collecting representative groundwater, surface water, and storm water runoff samples for chemical analysis. The following procedures describe the techniques to be implemented for water-level measurements, well purging, sampling withdrawal, and sample collection.

Equipment:
Bailer - stainless-steel, teflon, PVC, or disposable polyethylene;
Bailer reel with twine;
A tarp or plastic sheet;
Water level indicator (100-foot length);
pH meter, conductivity meter(EC), and thermometer;
Eh meter;
Turbidity meter;
Sample containers (laboratory cleaned and provided);
Electric generator;
Electric submersible pump control box;
Oil-less compressor;
Bladder pump control box;
Ice chests; and
Blue ice.

Documentation:
Field Memorandum;
Water Sample Tracking Form;
Field Record of Water Sampling form;
Sample Chain of Custody; and
Instrument Calibration Log.
(All forms are to be included in a bound field notebook.)

1.1 SET-UP

Prior to the sampling event, an appropriately trained professional will be responsible for reviewing available information and preparing the proper equipment. Preparation and set-up for water sampling will include the following:

- Review the sample locations and number of samples to be collected with Project Manager;

- Confirm analyte list with Project Manager;
- Notify the laboratory 2-3 weeks in advance of sampling of the number of samples and types of analyses. Request the proper number and type of sample containers. Upon receipt, inspect sample containers, notify laboratory of any missing or damaged containers;
- Notify on-site personnel of sampling schedule, and clear access to wells and/or surface water sampling locations;
- Check and calibrate water level meter, pH, EC, temperature, and turbidity meters to ensure the meters are accurate and are in good working condition (see SOP 2.0);
- Assemble all required equipment and check that it is in proper working condition; and
- As part of preparation and mobilization, a bound field notebook will be compiled to be used during the sampling event. The notebook will include blank copies of the necessary documentation forms including: field memoranda, water sample tracking forms, field records of water sampling, and instrument calibration forms. The notebook may also include well specification information and sample location maps. Upon completion of the monitoring event, the notebook will be turned into the Project Manager for review and approval.

1.2 GROUNDWATER SAMPLING

Groundwater samples will be collected from monitoring wells installed as part of the LEHR Environmental Restoration Program, and from in-situ water encountered during drilling of soil borings. Monitoring wells, piezometers, and boreholes will be sampled after adequate purging and after field measurements have stabilized. These procedures are described below.

1.2.1 Groundwater Monitoring Wells

Groundwater samples from monitoring wells will be collected after purging so that fresh formation water is sampled. Prior to purging, the field technician will visually check the well for damage and prepare the Field Record of Water Sampling form. All non-

dedicated equipment will be decontaminated, assembled, calibrated, and tested prior to sampling. Monitoring well construction logs, along with available water level data, will be reviewed.

Field instruments will be calibrated prior to beginning daily sampling activities according to procedures outlined in SOP 2.0. Instruments will be calibrated periodically during continuous use as outlined in the QAPP. Calibration information will be recorded on the Instrument Calibration Form and noted on Field Memorandums. All field groundwater measurements will be recorded on Field Record of Water Sampling forms.

The static water level will then be measured with an electric water level indicator. Depth-to-water measurements will be recorded to the nearest 0.01 foot on the Field Record of Water Sampling form. Each well will then be purged to allow sample collection of fresh formation water. Monitoring wells will be purged at rates of two to five gallons per minute with dedicated electric submersible pumps. Purged water will be contained in 55-gallon, DOT-approved drums. If the static water level drops below the level of dedicated pumps, no sample will be collected for that well. Purging of each monitoring well will continue until the following two conditions are met:

- Three casing volumes are removed from the well or piezometer. To calculate the volume of water in the well, use the equation:

$$CV = \left(7.48 \frac{g}{ft^3} \right) \times \pi \times r^2 \times H$$

where:

CV = one casing volume of water in well (gallons)
H = height of water column (feet)
r = radius of well casing (feet)

- The field pH, specific conductivity, temperature, and turbidity measurements of the discharged water have stabilized to consecutive readings within 10% of previous readings.

Wells that are pumped or bailed dry prior to removing three casing volumes of water will be allowed to recover and then pumped or bailed dry a second time. Field

measurements of temperature, pH, specific conductivity, and turbidity will then be collected as the well fills again. Samples will be collected when measurements have stabilized.

Samples will be collected as soon as recharge has occurred or at the completion of purging. Samples will be collected for volatiles at 100 ml/minute, and other parameters at rates of 500 to 1,000 ml/minute. The dedicated sample pump or a disposable bailer will be used to obtain the samples from the well. For sample collection, the bailer will be lowered with minimum splash to just below the water surface. Samples will be collected in the following order:

- Volatile Organic Compounds;
- Semi-Volatile Organic Compounds;
- Metals; and
- Other Parameters.

Volatile organic compounds will be collected in containers with no headspace. Sample fractions for metals and other inorganic compounds will be filtered and preserved in the field according to laboratory instruction. Sample preservative requirements are presented in Table A-5.2. Samples that require filtering will be filtered using a disposable 0.45 μm (micron) filter. If the sample is turbid, a pre-filter will be used to prevent clogging. An adequate sample volume will be pumped through the filter and into the sample containers. The filter will be disposed of and all filtering information will be recorded on the Field Record of Water Sampling form.

Labels will be affixed to each sample bottle recording sample number, well number, date, time, analysis required, preservative used, and collectors initials. In addition, all information will be recorded on the Field Record of Water Sampling form and field log along with a description of the physical appearance of the sample including color, clarity, suspended solids, etc.

A Chain-of-Custody Form will accompany each sample to establish the required documentation necessary to trace sample possession. Information on this form includes

project number, name, signature of collector, sample number, date and time of collection, sample type (grab or composite), number of containers, analyses required, signature of persons involved in the chain of possession, and inclusive dates of possession. A copy of the Chain-of-Custody Form will be maintained by the sampling personnel. The Chain-of-Custody Form will be maintained as part of the project files once analyses have been completed and the signed Chain-of-Custody Form has been returned by the laboratory. Sample handling will be conducted as described in SOP 5.0.

Non-dedicated and non-disposable bailers, pumps, meters, reels, water levels meters, and teflon tubing will be decontaminated upon completion of sampling (see SOP 3.0- Equipment Decontamination). Disposable materials will be discarded according to the LEHR Waste Management Plan.

1.2.2 Piezometer Sampling

Piezometers installed during investigation or remediation activities may be sampled periodically to evaluate water quality. Piezometers will be sampled according to procedures outlined above the sampling of monitoring wells. However, piezometers will not have dedicated pump systems installed so that purging will be completed using a non-dedicated pump or bailer, and samples will be collected using a disposable polyethylene bailer. Any non-dedicated and non-disposable equipment will be decontaminated upon completion of sampling (see SOP 3.0 – Equipment Decontamination).

1.2.3 In-situ Groundwater Sampling

In-situ groundwater samples may be collected during drilling by the dual-tube percussion or casing hammer methods. See SOP 6.0 for a discussion of these drilling methods.

This method of sampling is essentially the same as that for monitoring wells, except that the groundwater sample is collected directly from the borehole. The water-bearing formation should be penetrated to a depth that will allow adequate production of water for purging and sampling. A water level reading should be obtained from which to calculate

the purge volume. The diameter of the drill casing should be used to calculate the purge volume. Purging may be accomplished either by circulating the water from the hole and through the cyclone with compressed air, or lowering a pump or bailer into the hole. Field groundwater measurements and sample collection procedures are the same as that described above in Section 1.2.1.

1.3 SURFACE WATER SAMPLING — GRAB SAMPLE

Surface water samples will be collected by a grab sampling method. Prior to collecting surface water samples, the following procedures will be followed:

- Measure and record water depth and time of measurement; and
- Measure pH, conductivity, turbidity, and temperature (see SOP 2.0).

Grab samples will be collected directly into the sample containers or into disposable containers or a glass bottle and then transfered into the sample containers. Sample containers will be filled in the following order (i.e., the order of parameter volatilization sensitivity):

- Semi-volatile organic compounds;
- Metals; and
- Other parameters.

Samples for volatile organic compounds will be collected directly into the sample vials to minimize potential volatilization of the sample. Sample bottles will be labeled with the required information. Complete information will also be included on the Chain-of-Custody and Field Records of Water Sampling Forms.

1.4 STORM WATER RUNOFF SAMPLING — GRAB SAMPLE

Storm water samples from storm drain or sewer systems will be collected by a grab sampling method. Prior to collecting a runoff sample, the following procedures will be followed:

- Measure and record water depth with a water level indicator, and record condition of drain or sewer, including floating debris or distinct odors emanating from water; and

- Measure pH, conductivity, turbidity, and temperature 2 to 3 times (SOP 2.0 Field Measurements - Water).

Grab samples will be collected directly into the sample containers or by using a disposable container or disposable bailer and then transfered into the sample containers.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 2.0
FIELD MEASUREMENTS - WATER

Purpose and Scope: These procedures describe the techniques to be implemented when field measurements of groundwater, surface water, and storm water runoff are collected. The methods described are intended to provide uniformity and continuity in operation, calibration, and maintenance of both the equipment and measuring techniques by different qualified field analysts or technicians. Measurements described below include pH, electrical conductivity (EC), turbidity, temperature, Eh, dissolved oxygen, and groundwater elevation. Procedures below were derived from manufacturer's recommendations and include methods for calibration and measurement.

Equipment:

pH Meter (one that can perform a two-point calibration) and electrode;
pH buffer solutions (pH 4.0, 7.0, 10.0) (NIST traceable);
Electrical Conductivity (EC) Meter;
EC Reference Standards (NIST traceable);
Thermometer (NIST traceable);
Eh Electrode;
Zoebell's Solution;
Turbidity Meter;
Eh Meter;
Water Level Indicator;
Distilled or deionized Water;
Spray water bottle;
Sample cup or beaker; and
Extra batteries.

Documentation:

Field Memorandum;
Field Record of Water Sampling Form;
Instrument Calibration Form; and
Water Sample Tracking Form.

2.1 SET-UP

Prior to taking any field measurements, the geologist will assemble all necessary equipment and check all instruments to be used to ensure they are in proper working

condition. Each meter will then be calibrated. Calibration data will be recorded on an Instrument Calibration Form.

2.2 WATER LEVEL MEASUREMENT

Water level measurements will be referenced to a known elevational datum. The measuring point at the top of the casing will be permanently marked and surveyed and measurements will be consistently taken from the same marked point. Water levels will be measured prior to well evacuation with a hydrocarbon interface measuring device, electrical sounding device, or equivalent device. A hydrocarbon interface measuring device will be used as the primary instrument for measuring and detecting light non-aqueous phase liquids (LNAPLs) and dense non-aqueous phase liquids (DNAPLs). Measurements will be made following manufacturer's specifications.

Water levels will be measured by lowering the probe or tape measure into the well until contact with the water surface is indicated. The electric tape will be marked at the reference measuring point and partly withdrawn. Readings will be verified by repeating the procedure until successive measurements differ by less than 0.01 foot, and then recorded. Measuring devices will be decontaminated prior to and after use in each monitoring well.

If the water level measurement indicates the well is dry, the total well depth measurement will be recorded and compared with well construction specifications. If the total depth measurement and the well specifications do not match, the dedicated pumps will be temporarily removed from the well and placed into a plastic bag. The total depth will then be remeasured to ensure that there is no interference from the pump with the water level probe.

2.3 pH MEASUREMENT

The general procedures for the operation, calibration, and maintenance of a field pH meter and its accessories are described below. Manufacturer's specifications and recommendations should be followed or referred to when the need arises.

Prior to use, the pH meter should be examined for cleanliness and checked for defects and any possible need of repair. The checks should include the battery and electrode.

- Battery check will include measurements to determine if it is functional to full scale. Batteries will be replaced if found weak.

- Electrode check will consist of checking that the electrode is properly connected to the meter. The electrode tip should be covered by a rubber sleeve or cap that protects the electrolyte from flowing out of the opening or from drying. Pull the cap off and save for storage. If bubbles are seen in the bulb area of the electrode, shake the electrode downward. This action will help eliminate bubbles that may have been generated during storage or shipment.

- The meter and electrode will be checked daily by trained personnel according to procedures provided by the equipment's manufacturer.

Procedures for calibrating the meter and for measuring the pH of a water sample are listed below:

- Turn on power;

- Allow meter to stabilize for three to five minutes. Caution: Do not leave or use meter in direct sunlight, cold wind, or rain;

- Calibrate the meter. Calibration schedule should include daily calibration, as well as periodic calibration (see QAPP) during continuous use of the meter. Instrument calibration consists of the following steps:

  - Select two buffer solutions obtained from a commercial supplier (pH 4 and 7 if acidic conditions are expected of sampling water or pH 7 and 10 if alkaline conditions are expected).

  - Measure temperature of buffers using a clean thermometer. Ensure that the thermometer is rinsed with distilled water before and after each use.

  - Rinse electrode with distilled water and replace protective cap.

- Place pH electrode in pH 7.0 buffer solution and set the temperature knob at the mark indicating the solution temperature.

- Switch the control knob to the "pH" position. Gently swirl the solution and allow reading to stabilize. When reading is stable, enter or adjust the meter to read the appropriate value for the pH 7 buffer at that temperature (the exact procedure will vary for different meters).

- Measure the temperature of the second buffer solution and set the temperature knob at the mark indicating the solution temperature.

- Rinse the electrode with distilled water and place in the buffer solution, allowing reading to stabilize. When reading is stable, enter or adjust the meter to read the appropriate value for the second pH buffer solution After calibration to 2 buffer solutions, rinse the probe with distilled water and place it in the pH 7 buffer. If the meter reads the appropriate value for the pH 7 buffer, it is calibrated.

• Measure pH of unknown solution as follows:

- Measure temperature of unknown sample solution.

- Set the temperature knob at the mark indicating the solution temperatures.

- Place probe into sample and allow meter reading to stabilize.

- Record data on appropriate form or log.

2.4 ELECTRICAL CONDUCTIVITY

This procedure describes the operation, calibration, and maintenance of a conductivity meter for conductivity measurements and use in field sampling activity. Manufacturer's specifications and recommendations for the instrument used should be followed or referred to when needed.

Prior to using in the field, the conductivity meter should be examined for cleanliness and checked for defects and any possible need of repair. The checks should include whether the battery is operable, whether the conductivity meter is zeroed, and whether its

probe is conditioned for proper functioning. Scheduled maintenance will include daily checks by trained personnel according to procedures provided by the equipment's manufacturer.

Procedures for calibrating an EC meter and taking an EC reading of an unknown solution are listed below:

- Check battery level (see above) before using the meter;
- Calibrate or standardize the instrument using a standard solution. Select a standard solution having a conductivity value near expected value of water sample. The standard solution should be of known integrity;
- Measure temperature of the standard solution;
- Turn conductivity "RANGE" selector to lowest position that will accommodate the conductivity of the value standard solution on the readout meter;
- Set power switch to "ON" and immerse probe in solution, ensuring that probe is immersed to a depth to cover the electrodes. When immersing probe, dip it up and down in solution to expel any air bubbles inside and immediately outside the probe body; and
- Allow meter to equilibrate, then adjust the "CALIBRATION" knob until meter indicates known value of standard solution on conductivity scale.

To take a reading of an unknown sample solution:

- Immerse probe in sample solution, being certain that electrodes are covered, that all air has been expelled, and that probe is not in contact with the walls or bottom of the sample container;
- Turn "RANGE" selector counterclockwise to obtain the appropriate on-scale indication;
- Note meter indication on conductivity scale;
- Remove probe from sample solution and rinse it thoroughly in distilled water before proceeding to measure next samples or putting away the equipment; and

- Record data on log.

2.5 TEMPERATURE

This operating procedure describes the operation, calibration, and maintenance of a thermometer and its accessories for use in the field. Manufacturer's specifications and recommendations should be followed or referred to when the need arises.

Prior to measuring a sample, examine the thermometer for cleanliness, defects, and any possible need of repair. The checks should include the battery and probe.

Procedures:

- Slide switch toward display to turn the unit on;
- If the "LOW-BAT" notation is present in the display, replace battery;
- Take temperature as soon as possible after removing from well or stream and do not take reading when sample is in direct sunlight;

  Stir liquid continuously while measuring temperature;
- Record measured temperature in field log and other required information on the Field Sampling Sheets; and
- Decontaminate probe when finished.

2.6 TURBIDITY

The general procedures for the operation, calibration and maintenance of a field turbidity meter are discussed below. Manufacturers' specifications and recommendations should be followed or referred to, as necessary.

Prior to use, check that the meter is clean and that the battery is charged. If the battery is low, the low-battery light will light up. Calibrate and operate the meter as follows:

- Turn meter on by turning scale knob to "20";
- Place vial with 0.10 NTU standard solution into the measuring chamber. Place cover on chamber to eliminate outside light sources;
- after the digital reading has stabilized, adjust calibration knob to read 0.10 NTU;
- Remove calibration vial and place sample vial (with sample) in measurement chamber. If necessary, clean vial of water droplets or dirt with a clean paper towel; and
- Wait for digital read-out to stabilize and record value on Field Record of Water Sampling form.

2.7 Eh (OXIDATION-REDUCTION POTENTIAL)

The Eh probe and meter are factory calibrated and checked in the field against Zoebell's solution. Zobel Solution has a known value of 231 ±25 mV at 25°C when using an ORP Electrode. The potassium ferric-ferrocyanide Zobell Solution is recommended by the United States Geological Survey (U.S.G.S.), as the standard reference solution. The check is accomplished by the following procedures:

1. Place the shorting cap on the pH input jack. Rinse the ORP electrode and a temperature sensor with deionized or distilled water and connect them to the meter. Pat dry with a laboratory tissue. Follow with a rinse of a small amount of reconstituted Zobell Solution.
2. Pour the Zobell Solution into a sample cup and immerse the ORP electrode and temperature sensor in the solution.
3. Turn on the instrument and allow the sensors to equilibrate inthe solution.
4. Set the function switch to the mV mode. Read the temperature and calcualte the correction to 25°C by adding 1.3 mV for each degree below 25°C, or by subtracting 1.3 mV for each degree above 25°C; or determine the correction by use of the table provided in the Zobell Solution instrument sheet. A corrected reading within 25 mV of the value indicated assures correct electrode function.

2.8 LUDLUM MODEL 2929 DUAL CHANNEL SEALER

See SOP 24.0 Performance checking and Operation of the Alpha Scintillation Smear Counting Instruments, or SOP 25.0 Performance Testing and Operation of the Beta Smear Counting Instrumentation.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 3.0
EQUIPMENT DECONTAMINATION

Purpose and Scope: The purpose of this procedure is to describe the SOP's for equipment decontamination to minimize the potential for cross contamination between wells or sampling locations. This procedure describes the methodologies to be followed to maximize proper decontamination of drilling and sampling equipment.

Equipment:
Steam Cleaner;
Four 5-gallon buckets;
Bottle brushes;
Distilled water;
Potable water;
Non-Phosphate Cleaning Solution (Alconox®); and
4-ml plastic sheeting.

Documentation: Field Memorandum

3.1 DECONTAMINATION PROCEDURES

Decontamination procedures described in this section are applicable to any non-dedicated, non-disposable equipment. Disposable equipment will be disposed according to procedures described in SOP 4.0. All investigative-derived wastes will be stored in 55-gallon, DOT-approved drums, pending characterization for disposal.

Sampling Equipment

Prior to use and after each sample is collected, all soil, groundwater and surface water sampling equipment will be washed twice in a non-phosphate (Alconox®) solution, rinsed with potable water and rinsed again with distilled water. Hard bristle bottle brushes may be used in the first two wash buckets to remove mud and debris. Samplers should be allowed to drain dry after the final distilled water rise.

Potable water will be obtained from on-site sources. Distilled water will be supplied in 5-gallon containers by Alhambra Water.

Drilling and Excavating Equipment

Drilling and excavating equipment, including backhoe buckets, drill bits, casing, augers, and tools or other equipment that may have come in contact with potentially impacted soils or water, will be steam cleaned between each location. The steam cleaner will be capable of generating a working pressure of 2,000 pounds per square inch (psi), a discharge rate of 5 gallons per minute (gpm), and an operating temperature of 200°F.

An on-site area will be designated as the decontamination area. The area will be lined and bermed with two layers of 4 mil visqueen to contain rinsate from steam cleaning operations. The steam cleaning area will be designed to allow the backhoe and drilling rig and support vehicles to drive onto the visqueen. After completion of each boring, drill casing or augers, drill bits and drill rods are transported by truck to the steam cleaning area. Drill casing from the monitoring well drilling procedures will be cleaned while on the support truck. Hollow-stem augers (if used) will be placed on lumber in the decontamination area for cleaning. Rinsate collected in the decontamination area will be collected and disposed of according to the Waste Management Plan.

In addition to the drilling equipment, all monitoring-well casing, stainless steel screen, and centralizers will be steam cleaned prior to installation. Cleaned well materials will be covered with 4 mil visqueen, and transported to the well site.

Submersible Pumps

If a non-dedicated submersible pump is necessary to properly evacuate a well, it will be cleaned using a three step wash. First, the pump intake device is submersed into non-phosphate cleaning solution and run until the bucket is empty. Second, the pump is submersed into a bucket containing potable water and run until the bucket is empty. The second step can be repeated twice to sufficiently rinse the pump. The third step involves rinsing the pump with distilled water using the same method as Steps 1 and 2. Tubing will be dedicated to each well and will not be decontaminated after each use.

Personnel Decontamination

All personnel will follow the personnel decontamination procedures outlined in the project Health and Safety Plan.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 4.0
SOIL, WATER, AND WASTE DISPOSAL

Purpose and Scope: This SOP describes the general procedure for proper handling, storage and disposal of potentially impacted on-property and off-property soil cuttings and purge water generated during drilling and water sampling. Activities which would generate soil cuttings include: soil borings monitoring well installation; and downhole falling head permeability tests. Activities which would generate purge water and decontamination water include: water sampling; and all activities where decontamination water is generated.

Equipment: DOT-approved transport containers with covers for soil and water (e.g., 55-gallon drums, 20-yard roll-off bins, Baker Tanks, etc.); and Appropriate sample containers and sampling equipment.

Documentation: Field memorandum

4.1 CONTAINMENT

Drill cuttings and water generated during drilling may be containerizeded in DOT-approved transport containers. Purge water resulting from water sampling will also be contained. Containers will be labeled by field personnel to identify contents, date, and source location (well or boring ID). Labels will be weather-resistant vinyl, and waterproof ink markers will be used. Additionally, disposable equipment, including personnel protective equipment, will be contained pending characteriziation.

4.2 DISPOSAL

Disposal of any waste from the LEHR facility will be conducted under appropriate state and federal regulations and according to procedures described in the Waste Management Plan.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 5.0
SAMPLE SHIPMENT

Purpose and Scope: The activities described in this procedure outline general methodology to be used during the shipment of soil, water and sediment samples to the analytical laboratory. The objectives of this SOP are as follows:

- Ensure quality control in the shipping of soil, water and sediment samples;
- To develop uniformity of operation between different field personnel;
- To serve as a means that will allow traceability of error(s) during shipment; and
- To set forth procedures by which legal chain-of-custody documentation is followed.

Equipment:
Cooler suitable for sample shipment and holding ice ;
Custody seals;
Shipping tape and packaging materials;
Absorbent material;
Labels;
Zippered storage bags;
"Blue" type ice;
Ludlum Model 2929 Dual Channel Sealer; and
Swipes.

Documentation:
Field Memorandum
Sample Tracking Form
Sample Chain-of-Custody (COC) Form

5.1 PROCEDURES

Samples collected in the field will be stored during the day in the field in ice-cooled containers. Samples collected during the morning may be temporarily stored in a refrigerator (if available) until shipment in the afternoon. All samples stored in the coolers or the refrigerator will be documented on the sample tracking form. When samples are being packaged for shipment, the procedures listed below will be followed.

1. Field personnel will see that each sample in the cooler has been screened for loose surface contamination is listed on the sample tracking form and the COC.

2. Each cooler will be numbered. The number of each cooler will be noted on the sample tracking form and the COC. In addition, the freight identification number will also be noted on the sample tracking form and the COC.

3. Samples will be packed with abundant packaging material to minimize the potential for damage during shipment. Samples will be packaged with either "wet" ice or "blue-ice".

4. The completed COC will be signed and placed in a plastic zippered storage bag and taped to the inside cover of the cooler.

5. Custody seals will be placed on the cooler, then the cooler will be taped shut with clear shipping tape.

6. Samples will typically be shipped to the laboratory daily. Copies of the completed COC will be kept in the field office by the field manager.

7. Upon receiving the sample shipment, the analytical laboratory will inspect the sample containers for damage, compare the shipment to the COC, and conduct a radiologic survey.

8. The laboratory will sign and date the COC, noting the appropriate information and deficiencies, and immediately fax a copy of the COC to Dames & Moore.

9. Upon receiving the fax of the COC, Dames & Moore will authorize analysis of the sample shipment or provide appropriate direction to the laboratory to address the deficiencies

10. Daily contact will be made with the laboratory Project Manager to inform them of the coming shipment.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 6.0
SOIL BORINGS

Purpose and Scope: The activities described in this procedure outline general methodology to be used in drilling penetrative soil borings. The resulting borings can be used for stratigraphic description, well construction, physical and chemical sampling, and down-hole hydrogeologic tests. This procedure describes the equipment and forms required, as well as set-up procedures to be completed for each boring. In addition, various drilling methods that may be used during remedial action, and borehole abandonment procedures are detailed.

Equipment: Drilling rig, drilling tools, and support truck with water tanks;
Steam cleaner;
Grout plant and tremmie pipe;
Portland cement, Types I through V;
Powdered bentonite; and
Plastic Sheeting;

Documentation: Field Memorandum; and
Soil Boring Log.

6.1 SET-UP PROCEDURES

All set-up and soil boring procedures will be conducted under the supervision of a Dames & Moore Geologist, Hydrogeologist, or Engineer. Dames & Moore field personnel are responsible for:

- Identifying each borehole location;
- Confirming the drilling location with the project manager and UC Davis personnel;
- Review Health and Safety Plan;
- Obtaining proper clearance for potential above- and below-ground hazards; and,
- Obtaining proper permitting prior to initiating drilling.

Prior to drilling, and between each borehole location, all down-hole drilling and sampling tools will be steam cleaned. The work area will be well marked with traffic

cones and barricade tape. In some cases, special arrangements may need to be arranged to penetrate surface paving (concrete). Cuttings generated during drilling will be controlled by lining the borehole area with plastic sheeting and by storing in 55-gallon drums or bins.

Upon completion of each boring, all by-products will be properly stored and labelled (see SOP 4.0 Soil, Water, and Waste Disposal). The location will be clearly marked or staked for surveying.

6.2 DRILLING METHODS

This section provides a brief description of five drilling methods that may be used during remedial activities on the Site. The method actually used will depend on the use and anticipated depth of the boring, and the material anticipated to be encountered.

6.2.1 Dual Tube Percussion and Casing Hammer Methods

The dual tube percussion and air rotary casing hammer methods will be used in cases where boreholes penetrate unconsolidated material containing intervals of cobbles or boulders.

Where dual tube percussion methods are specified, ten-foot-long dual flush threaded casing sections fitted with O-rings will be used. The outer diameter is approximately 10 inches, the inner diameter is approximately 9 inches. Compressed air will be used to circulate drill cuttings up the inside of the inner tube. Water level measurements and drive samples can be collected from within the inner tube. A boring log based upon continuous or interval sampling and observed cuttings, will be prepared in accordance with the lithologic logging procedures outlined in SOP 7.0 Logging of Soil Borings.

Where casing hammer methods are specified, ten-foot flush threaded drive casing sections fitted with hollow drill rod will be used. The outer diameter of the drive casing is approximately 10 inches. Compressed air will be forced down the drill stem and out the drill bit to circulate drill cuttings up the annulus. Drill cuttings will be collected at least

every five feet and stored in plastic bags. Water level measurements can be collected with the drill rods in place, however drive samples can be collected only after the drill bit and rod have been removed from the borehole. Drive samples can usually only be collected at breaks in the drive casing (in this case every ten feet). A boring log based upon recovered drive samples and observed cuttings, will be prepared in accordance with the lithologic logging procedures outlined in SOP 7.0.

6.2.2 Hollow-stem Auger Method

The hollow-stem auger method will be used in cases where shallow penetrative work is to be conducted in unconsolidated sediment.

Where hollow-stem auger drilling methods are specified, hollow-stem augers, with lock bolt jointed 5-foot sections, and drill rod, plug, and bit assembly will be used. Auger diameter will be selected based upon auger availability, drilling rig capability, anticipated boring depth, sampler type, and intended boring use. A boring log based upon continuous or interval sampling and observed cuttings, will be prepared in accordance with the lithologic logging procedures outlined in SOP 7.0.

Drilling fluids will be used with hollow-stem augers only in cases where flowing sands require maintenance of a positive hydraulic gradient between the inside and outside of the augers. In those cases, potable water will be pumped directly to the inside of the augers. If the drill rod assembly within the auger should become bound by flowing sands, potable water will be pumped to the top of the drill rod assembly and the assembly will be raised and lowered through the augers until they become unbound. The source, time, and duration of use, and rate of flow of drilling water, as well as justification for water use, will be recorded on the boring log.

6.2.3 Rotary Drilling Methods

Rotary drilling methods (non-air) will be used in cases where deep penetrative work is to be conducted in unconsolidated sediments or shallow penetrative work is to be conducted in soft rock and other deposits containing boulders.

Where rotary drilling methods are specified, a drill pipe fitted with a roller, drag bit, or drive shoe will be used. The type and diameter of the bit or shoe will be specified based upon availability, formation characteristics, drilling rig capability, anticipated boring depth, sampler type, and intended boring use (i.e., for monitoring well construction).

A boring log, based upon continuous or interval sampling and observed cuttings, will be prepared in accordance with the lithologic logging procedures outlined below in SOP 7.0.

Where appropriate, temporary surface casing may be installed to prevent migration of ground water through the borehole. Sealing of the surface casing will be specified based upon site geology and aquifer characteristics.

Potable water mixed with bentonite will be the only drilling fluid used in direct rotary applications. A portable, steel, two-stage drilling mud pit with steel gate will be used. The mud pit base will be fitted with a rubber, bentonite, or cloth gasket to prevent circulation loss at the ground surface. Make-up drilling water will be added directly to the mud pit. Settled fines will be periodically removed from the first stage of the pit. The rate of necessary drilling water make-up will be recorded on the boring log.

6.2.4 Enviro-Core® Method

The Enviro-Core® drilling and sampling method will be used for shallow penetrative work in unconsolidated sediments where no permanent groundwater well is planned and where minimal cuttings should be generated. Continuous core, discrete soil drive samples, or groundwater samples can be collected with this method.

The Enviro-Core® drilling drives two nested sampling rods with a hydraulic hammer, or vibrator, or by pushing. The small-diameter inner rods are used to obtain and retrieve the soil cores; the larger-diameter outer rods serve as temporary drive casing.

As the Enviro-Core® rods are advanced, soil is driven into a 1 5/8-inch-diameter, 3-foot-long sample barrel that is attached to the end of the inner rods. Soil samples are

collected in 1 1/2-inch-diameter by 6-inch-long stainless steel sleeves inside the sample barrel as both rods are advanced. After being driven 3 feet, the inner rods are removed from the borehole with a hydraulic winch. The stainless steel sleeves containing the soil samples are removed from the drive sampler, and can then be preserved for chemical analysis or used for lithologic identification. After adding new stainless steel sleeves, the drive sampler and inner rods are then lowered back into the borehole to the previous depth, an additional 3-foot section of Enviro-Core® rods (both inner and outer) is attached, and the process is repeated until the desired depth is reached.

The use of outer rods prevents sloughing of the formation while the inner rods are withdrawn from the hole. This ensures that the drive sampler will always be sampling soil from the desired interval, rather than potentially contaminated soil that has sloughed in from higher up in the hole. Sampling equipment will be decontaminated as described in SOP 3.0.

6.2.5 Resonant Sonic Drilling (Sonic Coring)

The resonant sonic drill head is a hydraulically activated unit that imparts high frequency sinusoidal wave vibrations into a drill string to effectuate a cutting action at the bit face. The resultant cutting action forces a circular continuous core of the formation up into the drill string. Due to the high forces developed by the resonant head and the external flush nature of the specialized drill string, excess formation material generated by the cutting face of the bit is forced into the borehole wall thus resulting in the generation of no cuttings in the drilling process. Through the development of various sizes and types of tooling, boreholes of different depths and dimensions can be drilled. The sonic method of drilling yields continuous relatively undisturbed cores; uses no air, mud, water, or other medium for penetration; drills through most types of formation; can drill at any angle from horizontal to vertical; and yields no cuttings in the drilling process.

6.3 BOREHOLE DESTRUCTION

All soil borings will be permanently sealed to prevent vertical migration of contaminants. Soil borings shall be destroyed by backfilling, from bottom to the surface,

with Holeplug™, Enviroplug™, Volclay™, or a cement-bentonite grout slurry. Boreholes that extend below the water table will be backfilled by tremmie method. Grout material in boreholes that do not penetrate the water table can be poured from the surface.

- Holeplug™ and Enviroplug™ bentonite do not require mixing but are poured into the borehole dry and charged with clean water.
- Volclay™ and cement-bentonite grout (herein termed cement grout) require mixing with clean, potable water. The mix should not contain more than 5 percent bentonite.

Soil borings that penetrate two or more HSU levels will be plugged with cement grout from bottom to top.

After 24 hours, the grouted borehole shall be checked for grout settlement. That day, any settlement depression shall be filled with grout and checked 24 hours later. This process shall be repeated until firm grout remains at the ground surface.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 7.0
LOGGING OF SOIL BORINGS — USCS

Purpose and Scope: This procedure describes basic methods for logging soil borings. Logging of soil borings assures that data, information, and descriptions generated from each borehole are properly collected and documented. This procedure describes equipment and forms required, the information necessary to complete a boring log, and methods for describing drill cuttings and soil samples.

Equipment:
Hand Lens;
Dilute HCl;
Soil Knife;
Water Level Indicator;
Rock Hammer;
Measuring Tape;
Compass; and
Plastic Bags.

Documentation:
Field Memorandum; and
Soil Boring Log.

7.1 BORING LOGS

The boring log form that will be used to record information during drilling is included in Attachment 2. The procedures which will be followed in completing the boring log are outlined below.

On the first page of the log for each boring, the following information at the top of the boring log will be filled in completely and will include:

- Job Number
- Client's Name
- Job Location
- Boring Number
- Drilling Contractor
- Operator's Name
- Rig Number, if there is more than one at the site

- Name of Person Conducting the Logging
- Elevation and Reference Datum
- Complete and accurate location sketch with dimensions to landmarks. Important features such as road intersections, corners of large buildings, or other man-made structures are best used. A north arrow will be included.

Water levels will be recorded each day prior to drilling start-up and as appropriate. The casing depth must be noted for each water level reading. Drilling mud use must be noted, if appropriate. Water levels will be referenced to ground surface, unless otherwise noted. The field personnel will identify a specific static water level at the conclusion of the boring. However, any questions about the water level having reached equilibrium will be noted. When more than one boring is drilled, the elevations of the water levels will be tabulated to permit a field check of the consistency of readings from boring to boring.

The exact drilling and sampling methods used will be indicated, as well as the bit type and size, drill rod size, hammer weight and drop, types of samplers, and the rig type. Surface conditions will be noted, including vegetation or ground cover and land use, general topography (rolling, level, etc.), and physical features (hillside, river bottom, etc.). Sheet (Page) Number. The time and date of the commencement and conclusion of the boring down time, and the end and start of each shift should also be noted on the log. Each succeeding page of the field log should contain at a minimum:

- Job Number
- Client Name
- Boring Number
- Permit Number (where applicable)
- Sheet Number
- Any Water Level Measurements

Upon completion of each boring, a standard completion note will be placed at the bottom of the last page of the boring log. The note will include:

- Boring Completed at (Depth) Feet on (Date)
- Casing Used to a Depth of (Depth) Feet on (Date)
- Ground Water Level Recorded at (Depth) Feet on (Date)
- Hole Backfilled to Ground Surface on (Date)
- The casing size and depth will be recorded
- All depth numbers will be recorded in decimals.

7.2 LOGGING PROCEDURES

The left side of the boring log will be filled out accurately and completely for each soil sample and sampling attempt. The following information will be included:

- The sampler type. The abbreviations for sampler types are TW for thin-wall, P for piston, ST for Shelby Tube, and SS for standard split spoon. These abbreviations, or notations as to other sampler types, will be used in the "sampler type" column.

- The inches driven and recovered for each sample attempt.

- The depth of casing for each sample attempt.

- The sample number and depth. The sample depth is always measured to the top of the sample. A sample attempt where no sample is recovered will not be numbered, but the fact that a sampling attempt was made must be noted.

- The blow count for each 6-inch interval will be recorded opposite the appropriate interval on the depth scale.

- The sampling attempts will be marked in the "depth in feet" column.

The right side of the log will contain a detailed description of the soil strata encountered and all pertinent information regarding drilling operations and estimated soil and ground water properties.

- Soil will be classified according to the Unified Soil Classification System (USCS) (Figure SOP7.1). The textural name for the soil will

be written in the "soil graph" column at the appropriate depth interval.

- Abrupt soil changes will be marked by a solid horizontal line and the appropriate depth in the "soil graph" column. Gradational soil changes will be marked by a dashed line. Diagonal lines should not be used. (Field personnel are best qualified to estimate the depth of changes. This task will not be delegated to office personnel, who have not observed the drilling operation.)

- Soil color descriptions will be consistent with the Munsell Soil Color Chart.

- Abbreviations will be used on the logs to save space for editing purposes

Comments on the field log are extremely important. Some important aspects of the drilling operation that will be recorded follow:

- The organic content of the soil and the depth of topsoil and roots;

- Any sudden change in the speed, sound, or penetration rate of the drill rig;

- If sampling is not continuous, drill cuttings will be used to complete the log; and

- Any sample that is suspect of being disturbed, contaminated, or chemically or physically altered during the drilling process.

On jobs lasting more than a few days, field personnel will make specific arrangements for sending boring logs to the Project Manager, or someone designated by the Project Manager. Field personnel will retain one copy in the field for reference throughout the job.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 8.0
INSTALLATION, CONSTRUCTION, AND ABANDONMENT
GROUNDWATER MONITORING WELLS AND PIEZOMETERS

Purpose and Scope: This operating procedure describes the procedures for the construction, installation, and development of groundwater monitoring wells. These methods assure construction of monitor wells that will: provide representative samples of groundwater for analysis; permit collection of representative water level data; and effectively isolate the separate hydrogeologic strata penetrated during drilling.

Equipment:
Drilling rig, drilling tools, and support truck with water tanks;
Steam cleaner;
Grout plant and tremmie pipe;
Portland cement, Types I through V;
Powdered bentonite;
Well casing and screen, cap and bottom plug (screen slot size based upon target geologic formation);
Stainless steel centralizers;
Bentonite pellets;
Washed, graded sand (grain size based on formation and screen slot size utilized);
Protective casing and padlock;
Concrete mix; and
Plastic sheeting.

Documentation:
Field Memorandum;
Soil Boring Log;
Well Construction Form; and
Well Development Form.

8.1 PREPARATION AND SET-UP

All necessary drilling/well permits and utility clearances shall be obtained prior to the start of drilling operations. A Dames & Moore hydrogeologist experienced in design and construction of monitoring wells will be present to supervise the well construction. Unless otherwise arranged, well construction supplies and equipment will be supplied by the drilling subcontractor. Prior to drilling and well construction, all drilling equipment, tools, and well materials to be used in well construction will be cleaned thoroughly with a

portable steam cleaning system supplied by the drilling subcontractor. Between well installations, drilling equipment and tools will be cleaned at the designated contaminant reduction zone (see SOP 3.0-Equipment Decontamination).

8.2 MONITORING WELL DESIGN

During completion of the soil boring (SOP 6.0-Soil Boring), the Dames & Moore geologist will prepare a boring log and keep a time log of significant events during each working day. Logs will indicate field classification of soils, sampling depths, first encountered and static groundwater levels, progress of drilling, final completion depth, and the nature and resolution of any problems encountered (see SOP 7.0-Logging of Soil Borings). Based on data gathered from the borehole, the desired purpose of the well, and previously collected information from other boreholes and monitoring wells, the Dames & Moore geologist and project manager will determine the well specifications. These specifications will be consistent with ASTM 5095-90 and other applicable ASTM standards and include:

- Total depth of well;
- Screened interval placement;
- Screen slot-size;
- Location of centralizers;
- Filter pack size;
- Filter pack interval;
- Thickness and placement of bentonite seal ; and
- Grouting method.

Figure 8.1 presents a schematic diagram for a groundwater monitoring well. Monitoring wells installed during remedial activities will be constructed of some combination of either stainless steel or Schedule 40 PVC blank and screen. The diameter of the screen and casing will be a minimum of 4 inches less than the diameter of the borehole. Stainless steel centralizers will be placed at the top of the screen and every 40 feet along the blank casing. The bottom of each well will consist of a slip cap mounted with stainless steel screws to a flush-threaded endcap. Holes of 1/16" diameter will be drilled through both caps prior to installation to prevent water from sitting in the bottom of

the well if the static water level drops below the bottom of the well. A locking cap will be used to secure the top of the well.

8.3 WELL INSTALLATION

Once the desired depth of the borehole has been determined, the borehole will be prepared for installation of the well casing. The well casing/screen assembly will be inserted into the borehole. The casing/screen assembly will be installed as follows:

- The well casing, including the bottom cap and screen, will be suspended in the borehole at the desired depth;
- The primary filter pack, consisting of washed, graded sand that is appropriate for the formation and slot size of the screen, will be poured from the surface or tremmied to the bottom of the annulus between the well casing and the borehole. The filter pack will extend at least 2 feet above the top of the screen. The level of filter pack in the annulus will be verified by tag-line measurement during emplacement. The volume of sand versus the annular volume will be compared to verify proper placement of the filter pack;
- When the primary filter pack is installed to the desired depth, the screened interval will be surged to settle the sand around the well screen (preliminary development). During surging, the well casing will be secured at the surface to prevent settling of the casing. Surging will continue until the filter pack stops settling. Upon completion, sand will be added to bring the filter pack up to the desired depth;
- A bentonite seal at least three feet thick will be placed immediately above the primary filter pack. The level of the top of the bentonite seal will be verified by tag-line measurement. If pellets are used, adequate time for hydration with distilled water of the pellets will be allowed before grouting the remaining annulus;
- Boring cuttings will not be used as backfill. The borehole annulus will be grouted with a cement-bentonite grout mix which will extend to within approximately 2 feet of the ground surface. The top 2 feet will be filled with a concrete mix used to make the concrete pad and secure the protective casing; and

The grout will then be allowed to settle. If significant settlement of grout occurs, additional grout will be added to the prescribed depth of approximately 2 feet below ground surface prior to the installation of the protective casing and the concrete pad.

8.4 WELLHEAD COMPLETION

For wells completed above ground surface, steel security pipe with a hinged, lockable cover will be installed in the grout to a depth of 1 to 2 feet and equipped with a padlock. For flush-mount wells a steel protector and cover with water-tight seal will be installed in the grout. The integrity of the well will be protected with a lockable sanitary sealing well cap with an expandable O-ring which forms an air-tight seal. All locks will be keyed alike.

For wells completed above ground surface, the drilling subcontractor will construct a concrete apron (3ft × 3ft × 0.5ft) around each well. Concrete aprons will be crowned to provide positive runoff away from the well. Concrete pads may be constructed within 3 days after wells have been installed. If necessary steel guard posts 2-inches in diameter and filled with concrete will be installed around the pads. Posts will be five feet long and will have a minimum stickup of 2.5 feet above ground surface and 2.5 feet below ground surface. For flush mounts, the space around the protective casing will be filled with concrete and sloped to direct surface water away from the well.

8.5 WELL DEVELOPMENT

Well development consists of preliminary and final development. Preliminary well development will be conducted after installation for the well screen, casing, and primary filter pack, but prior to installation of seals and grout. Additional filter pack will be added, as needed, after completion of preliminary well development to bring the filter pack up to the desired depth.

Final well development will begin no earlier than 24 hours after the grout has been placed. Typically, well development will be performed using one more of these methods: surging, jetting, overpumping, or bailing. The method to be used will be selected based on

specific hydrogeologic conditions at the site but will generally consist of a sequence of bailing, surging, bailing, and then pumping. Approximately ten casing volumes of water will be removed. Water exiting the well will be collected and properly disposed of as described in the Waste Management Plan. Well development will continue until the water is reasonably sand free and turbidity is reduced. As appropriate, pH, specific conductance, turbidity, and temperature will be measured to judge the adequacy of monitoring well development. (See SOP 2.0-Field Measurement — Water). Generally, development will continue until turbidity values are less than 5 NTU.

Measurement of development parameters will be recorded on the Well Development Form which will include the time of each measurement, approximate volume of water removed prior to each measurement, and the time intervals during which development is conducted.

8.6 WELL CONSTRUCTION SUMMARY DIAGRAMS

Upon completion of well construction and development, the standard Dames & Moore well log form (see Attachment II) will be completed. The following information will be included:

- Job name and number;
- Job location;
- Well number;
- Permit number (where applicable);
- Land-surface elevation and datum;
- Date of installation;
- Drilling method (i.e., hollow-stem auger, air hammer, air rotary, or mud-rotary);
- Drilling contractor;
- Drilling fluids (where applicable);
- Amount of fluids lost during drilling;
- Well construction details, such as:
  - Type of well (i.e., flush-mount or stick-up);

- Hole diameter;
- Well casing diameter, material, and amount;
- Final well depth;
  Depth and type of filter pack;
- Depth of bentonite seal; and
- Depth and type of grout mixture.

- Well development method;
- Date of well development;
- Amount of water removed during development;
- Static depth to water;
- Pumping depth to water;
- Duration of pumping;
- Yield;
- Specific capacity; and
- Well purpose (i.e., monitoring, production, or recovery).

8.7 EXTRACTION AND RECHARGE WELL CONSTRUCTION AND INSTALLATION

Recharge wells to be installed during remedial activities will be constructed according to the procedures outlined for Monitoring Well Installation and Construction with the following exceptions. Boreholes for recharge wells will be at least 16 inches in diameter and will be drilled by either casing hammer or tri-tube (similar to dual tube) methods. Casing will be between 8 and 10 inches in diameter. Casing material, diameter and thickness, screen slot sizes, and filter pack design will be determined based on design criteria and on material encountered during soil boring.

8.8 PIEZOMETER INSTALLATION

Piezometers installed during investigation or remedial activities will be constructed according to procedures for first-HSU wells outlined above and described for Monitoring Well Installation and Construction, with the following exceptions:

- Boreholes for piezometers may be as small as 8 inches in diameter;

- Casing will generally be 2 inches in diameter;
- Piezometer screen may be constructed of either PVC or stainless steel.

Exact specifications for each piezometer, including screen material, casing diameter, screen slot size and filter pack design, will be based on material encountered during the soil boring.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 9.0
BOREHOLE GEOPHYSICAL LOGGING

Purpose and Scope: This procedure describes requirements for conducting borehole geophysical logging. The activities described in this SOP are intended to assure appropriate and standard logging methods are utilized.

Equipment:
Electrical resistance probe ("single-point" resistance);
Standard resistivity probe (both long and short normal);
Natural gamma ray scintillation detector probe;
Spontaneous potential probe (SP);
Caliper tool (three-arm);
Mechanical winch (if applicable); and
Geophysical logging unit.

Documentation:
Field Memorandum; and
Soil Boring Log.

9.1 SET-UP

Borehole geophysical logging will be performed by a qualified subcontractor. A Dames & Moore geologist or hydrogeologist shall oversee all geophysical logging activities and perform the following steps prior to logging:

- Obtain and evaluate available logs from wells in close proximity to the test boring;
- Select appropriate probes or tools required to provide meaningful data; and
- Ensure that equipment and/or tool calibrations are performed in accordance with manufacturing user manual prior to logging.

The field procedures used for borehole geophysical surveys will be controlled by the specific type of survey equipment used to perform the survey. All geophysical survey equipment utilized at the site should be calibrated and operated in accordance with manufacturer's guidelines and specifications. Boreholes will be logged while lowering and raising the wireline probes to evaluate instrument response and data reproducibility.

9.2 METHODS

Physical properties that may be measured in soil borings on site include electrical resistance, the electrical potential of a fixed surface electrode (or spontaneous potential), natural radiation, and temperature. Typical applications include stratigraphic correlation, identification of lithology, formation thicknesses, definition of aquifer boundaries, limited water quality determination, and identification of borehole temperature gradients. The following are brief descriptions of possible methods.

9.2.1 Electrical Logging Surveys (Resistivity and Spontaneous Potential

Electrical resistivity and spontaneous potential (SP) logs are commonly recorded simultaneously. The resistivity tool measures the ability of the soil or rock, and its interstitial fluid, to resist the flow of electrical current and is expressed in units of ohm-meters. The SP log is a recording of depth versus the differences in the electrical potential in millivolts of a moveable electrode in the borehole. The electrical resistivity and spontaneous potential equipment cannot be used in a cased hole or if a conductive fluid (generally water) is not in the hole.

9.2.2 Natural Gamma Ray Logging Survey

The gamma ray log provides a profile of naturally occurring radiation emitted from geologic formations and is expressed in counts per second. The gamma ray log is most useful for lithologic identification and stratigraphic correlation. The gamma ray log may be run in boreholes which are cased or uncased, and is not affected by the presence or absence of borehole fluid.

9.2.3 Temperature Logging Survey

A temperature log provides a profile of the borehole temperature and can be used to locate significant points of fluid entry. This log may be run in both uncased and cased boreholes.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 10.0
SOIL SAMPLING

Purpose and Scope: Soil samples will be collected for identification/classification purposes, physical and chemical analysis, and to evaluate behavior of subsurface materials. This SOP describes the techniques to be implemented for a variety of methods of soil sampling, soil coring, surface soil sampling, and sample compositing. In addition, equipment and documentation requirements necessary for sampling are described.

Equipment:
Stainless steel spatulas;
Stainless steel spades;
Stainless steel hand auger buckets and hand auger accessories;
Power auger/drilling rig;
Split spoon samplers;
Continuous core samplers;
Shelby tubes;
Teflon sheets;
Plastic sheeting;
Stainless steel sampling rings;
Plastic ring caps;
Stainless steel measuring cup;
Silicon-based tape;
Stainless steel trowel;
Cleaning and decontamination equipment;
Sample labels;
Ice chest
"Blue" ice; and
Zipper storage bags.

Documentation:
Field Memorandum;
Soil Boring Log;
Field Record of Soil Sampling (Field Record); and
Sample Chain of Custody (COC).

10.1 GENERAL PROCEDURES

Due to the wide variety of sampling conditions, types of samples, and purpose for collecting soil samples, several possible methods may be used to collect the soil sample. Specific procedures for various methods are described below. However, there are

numerous procedures that will be followed for most soil sampling methods. These procedures include:

- Prepare Field Record sheets and record relevant data on Field Memorandum prior to sampling;
- Decontaminate sampling equipment as specified in SOP 3.0, if samples destined for chemical analysis are to be collected;
- Clear surface vegetation, rocks, and other material not designated for sampling from the sampling point;
- Use drilling or penetration methods (SOP 6.0-Soil Borings) if necessary to reach the desired sampling depth;
- Collect sample using appropriate sampling method described in Section 10.3;
- Lithologically log the sample and boring (SOP 7.0 - Logging of Soil Borings).
- Fill necessary sample containers;
- Affix sample container with appropriate labels, being sure to provide required information;
- Place the properly labeled sample container in an appropriate carrying container at required temperature;
- Either discard or decontaminate all items which contact the sample such as trowel, split-spoon sampler, and gloves before proceeding to the next sampling location;
- Add information pertaining to the sample to the COC, Field Memorandum, and Field Record of Soil Sampling forms; and
- Package and ship samples as described in SOP 5.0 - Sample Shipment.

10.2 SUBSURFACE SOIL SAMPLING

Several methods may be used to collect subsurface soil samples. Some of the Dames & Moore procedures for the more common sampling methods are described below.

10.2.1 Set-up Procedures

Several drilling methods may be used to reach desired depths for soil sampling. Generally, samples are collected at regular intervals (approximately every five feet). Potential drilling methods and general soil boring procedures are described in SOP 6.0 (Soil Borings). In addition to drilling methods, subsurface depths can be reached by a power auger, a hand bucket auger, or a backhoe.

When the desired depth has been reached, the borehole will be prepared for sampling. To prepare for sampling, the borehole should be cleaned out to the desired sampling depth using equipment that will ensure that the material to be sampled is not disturbed by the operation. When drilling in saturated sands and silts, the bit should be withdrawn slowly, to prevent loosening of the soil around the hole. When using dual tube or casing hammer methods, care will be taken not to drive the casing below the desired sampling depth before the sample is collected.

When the desired sampling depth has been reached and the borehole has been prepared, there are several subsurface methods that will be used to collect samples. These methods include:

- Penetration Test and Split-Barrel Sampler (split-spoon);
- Thin Wall Sampler (Dames & Moore Type U Sampler);
- Continuous Sampling System;
- Collection of Cuttings; and
- Shelby Tube Sampling.

10.2.2 Penetration Test and Split-Barrel Sampling

Penetration test and split-barrel sampling are methods used to collect representative disturbed soil samples. Samples collected by these methods will be used for description and identification, chemical analysis, and in some cases physical analysis. A split-barrel sampler consists of a section of pipe that splits into two pieces along its axis. A driving shoe and waste barrel screwed to the ends hold the split section together during driving.

Aids for sample retention may also be incorporated into the split-barrel sampler. These include catchers, spring or gravity traps (in the lower end), and check valves (in the top end). The standard sampler has an outside diameter of 2 inches and an inside diameter of 1-3/8 inches.

The penetration test samplers have been used to develop an empirical relationship between driving resistance and the relative density of soil. The procedure for determining and interpreting penetration resistance or relative density is collectively referred as the Standard Penetration Test (SPT);

- After the boring has been advanced to the desired sampling depth, and extracted drill cuttings have been suitably removed, a split-barrel sampler (outside diameter 2 inches inside diameter 1-3/8 inches) attached to drill rods is lowered to the bottom of the cleaned-out borehole;
- Once the sampler is on the bottom of the borehole, three 6-inch increments are marked on the drill rods above a convenient fixed datum;
- The sampler is driven by a 140-lb hammer free falling a distance of 30 inches onto a collar or drive head attached to the top of the rods. The sampler is driven a total of 18 inches into the undisturbed soil, and the number of blows required to advance each 6-inch increment is recorded.
- The standard penetration test should be terminated if one of the following occurs:
    - A total of 50 blows has been applied during any one of the three 6-inch increments;
    - A total of 100 blows has been applied;
    - There is no observed advance of the sampler during the application of 10 successive blows of the hammer.
- After the total penetration of the sampler has been achieved, the sampler is retrieved to the surface and opened.

The sample is then logged and removed and the sampler is decontaminated before reassembly. If the standard split spoon samples are to be retained for future reference, they will be placed in sealable plastic bags and labeled according to standard procedures.

Typically, samples are taken at each lithologic change and at intervals not greater than 5 feet (unless otherwise stipulated by the field engineer or geologist).

10.2.3 Dames & Moore Type - U Sampler

Relatively undisturbed soil samples will be obtained with a Dames & Moore Type-U (Figure SOP10.1) or similar split-barrel (split-spoon) sampler fitted with new 2.5-inch diameter, 3-inch long stainless steel rings. Procedures for sampling with the Dames & Moore Type-U sampler are similar to procedures described for the standard penetration test (see Section 10.2.2. Soil samples will be collected by driving the split-barrel sampler 18 inches (or until refusal) into undisturbed soil at the bottom of the borehole. The drill rig is equipped with a 140-pound hammer to drive the sampler. Hammer blows required to drive the sampler in 6-inch increments will be recorded on the Dames & Moore Boring Log.

Upon retrieval from the borehole, the sampler will be dismantled, and the sample rings removed and placed on clean plastic. Sample rings will be separated with a clean steel knife, then logged by the on-site geologist (noting any lithologic variations between rings) using the Unified Soil Classification System (Figure SOP7.1). After logging, the exposed ends of the rings will be covered with 2-mil Teflon sheets, plastic end caps, and silicone-based tape. Sample labels will be affixed to the end caps and will contain the following information: boring number; sample locations; sample number; sample depth; date of sampling; time of sampling; sample collector's name; soil type; and name of client or facility owner.

Three rings will be retained from each sample interval (Figure 10.2). These samples will be identified by depth collected and the postscripts "A, B, or C", depending on position in the sampler. Sample "A" will be retained for chemical or physical testing, sample "B" will be submitted as a duplicate or archived for possible future use, and the "C" sample will be retained for physical testing.

It is anticipated that up to 2,000 grams of soil will be necessary to complete the chemical analyses for each sample. Therefore, additional soil will be required to augment the "A" ring collected from the drive sample. The additional soil will be collected from the

base of the preceding core run and placed into glass jars. If the core sample is inadequate, a second drive sample will be attempted and the additional sample collected in sample rings.

Appropriately sealed and labeled samples will be placed in ice chests cooled with "Blue Ice." Ice chests will be used to ship samples to the analytical laboratory. Samples delivered to the laboratory will remain refrigerated until analyzed.

Thin wall sampling tube methods (with a Dames & Moore - Type U Sampler) will be used where undisturbed samples of fine-grained materials are to be obtained for chemical analysis, saturated vertical hydraulic conductivity or other geotechnical analysis. Other larger diameter samples (3 to 6 inches in diameter) are helpful in sampling gravel deposits and retrieving samples of sufficient volume to perform compaction tests. If a larger diameter sampler is used, however, the size should be conspicuously noted on all penetration records.

The thin wall sampling method is conducted by attaching a sampling tube to the nose-end of the Dames & Moore Type - U sampler and pushing the tube in one continuous motion, into the material to be sampled. Once the tube is retrieved, slough material will be removed from the tube and the actual sample length will be measured. If the sample is to be retained for future reference or analysis, it will be trimmed, logged, capped, sealed, and labeled.

The bottom and top of the tube will be indicated on the tube in indelible marker. The following information will be noted on the side or top of the tube:

- Project Number and Name;
- Sampling Date and Time;
- Boring and Sample Numbers;
- Sample Depth;

10.2.4 Continuous Core Sampling System Methods

Continuous core sampling system methods may be specified where continuous soil cores are to be recovered by hollow-stem auger drilling methods. The continuous sampling system utilizes a core barrel which recovers a soil core from the interval drilled. The core barrel is recovered after each interval is drilled.

Representative samples of the soil cores can be placed in 8-ounce jars for future analysis. The entire length of the soil cores will be placed in plastic-lined core boxes should it be necessary to retain them. Care will be taken to mark intervals of core loss with styrofoam blocks. All soil cores will be logged according to procedures outlined in SOP 7.0 (Logging of Soil Borings).

10.2.5 Cuttings Collection Methods

Cuttings collection methods will be used with rotary, dual tube, and casing hammer drilling methods. Cuttings will be collected at a minimum of every five feet and at changes in lithology. Samples will be collected into plastic bags, labeled, and logged according to procedures outlined in SOP 7.0.

10.2.6 Shelby Tube Sampling

Shelby tube samples will be collected when undisturbed soil samples for physical or geotechnical analyses are required. Soil to be sampled should be have a high clay content, or contain predominantly loose silts or sands. Procedures for collecting a Shelby tube sample are listed below:

- Clean the bottom of the hole in which the Shelby tube will be inserted to the sampling elevation;
- Attach the Shelby tube sampler assembly to the lower end of the drill rods and secure set screws with allen wrenches;
- Lower the Shelby tube sampler assembly to the sampling depth at the bottom of the hole with the drilling apparatus;

- Mark off on the drill rods an interval length equivalent to the length of the Shelby tube;

- Push the Shelby tube into the ground with a continuous motion without impact or twisting. This is typically performed using the hydraulic mechanism on the drilling rig. Push the tube into the ground until the uppermost mark on the drill stem aligns with the initial location of the lower mark;

- If soils are so hard that the Shelby tube cannot be pushed, a driving hammer may be used to advance the sampler. If this is the case, record the weight, height, and number of blows in the field log;

- When the tube has been advanced to the appropriate depth, twist the tube at least two revolutions to shear off at the bottom. Raise the sample; and

- Disconnect the Shelby tube and sample from the drill rods.

If the sample is to be extracted from the Shelby tube in the lab, remove about 1/4 inch of the soil from each end of the tube, wipe the tube end (inside and out) with a clean towel, and seal the ends of the tube with paraffin wax. Place a plastic shipping cap over each end of the tube and wrap with plastic tape. If the sample is to be extracted from the Shelby tube at the site, seal the extracted sample in a glass jar and decontaminate the tube before collecting next sample.

10.3 SURFACE SOIL SAMPLING

Methods to be used for collection of surface soil samples include the scoop or trowel, hand bucket auger, and the hand drive sample method. The scoop or trowel samplers are used to collect shallow soil samples, up to 6 inches in depth.

When collecting a surface soil sample, the following steps are required:

- Clear surface vegetation, rocks, leaves, debris, and other material not designated for sampling from the sample point. Document the removal of this material;

- Decontaminate sampling equipment (see SOP 3.0);
- Collect samples;
- Lithologically log samples;
- Transfer sample into a container (with the aid of a spatula or trowel). Minimize exposure to air for any sample to be analyzed for organics;
- Label sample containers;
- Handle and preserve samples as outlined in the sections on sample handling and preservation;
- Discard or decontaminate all items which contact the sample such as trowel, auger, and gloves before proceeding to the next sampling location; and
- Add information pertaining to the sample to the Chain-of-Custody record, Analysis Request Form, and Field Memorandum.

In the case of the hand drive-sampler method, samples will be collected in stainless steel rings, the ends will be covered with a Teflon sheet, capped, and sealed with a silicon-based tape.

10.4 MICROBIOLOGICAL SOIL SAMPLES

Soil samples collected for microbiological analysis can be collected by surface sampling, split-barrel sampling, or thin wall sampling methods. Samples will be collected into sterile vials provided by the laboratory or into decontaminated stainless steel rings. All equipment and rings used for microbiological samples will be decontaminated using the standard three-bucket wash and rinse, and then rinsed with isopropyl alcohol (see SOP 3.0).

10.5 BULK SOIL SAMPLING

Bulk soil samples for some physical and mineralogical tests will be collected from test pits and soil borings. Samples from test pits less than 5 feet deep will be collected from the wall of the pit with a stainless steel trowel. In test pits deeper than 5 feet,

samples will be collected out of the backhoe bucket. Bulk samples from soil borings will be collected from the cuttings produced during drilling or retrieved from the sampler.

Samples of sand, silt, and clay-size material will be collected into gallon sized plastic bags or in sample sleeves. Coarse-grained gravels will be collected into 5-gallon buckets. In general, the size of the bulk sample will be at least 10 times greater than the weight of the largest clast. Samples will be labeled with the sample number, date, location, depth, and test pit or borehole.

10.6 SOIL SAMPLE COMPOSITING

Soil sample compositing is used to combine soil from two or more samples to ensure that soil submitted for analysis is representative of the entire mass of soil sampled.

Individual samples to be composited will be identified on their labels by their own sample identification and by the sample identification for the composite sample. Samples to be composited will also be clearly identified on the COC and on the Field Record of Soil Sampling by both identifications.

In the case of bulk samples, mineralogical samples, or any other soil samples to be composited for archiving or non-chemical analysis, the procedure is described below. In general, compositing consists of the following steps:

- Taking a sub-sample from each sample to be composited;
- Combining and homogenizing the sub-samples; and
- Taking a sub-sample of homogenized soil for analysis.

If samples are small, they can simply be combined as described below under "Combining Sub-samples." Often, however, mixing the samples to be combined would make an inconveniently large mass of soil, so a sub-sample must be taken from each.

Grab samples are disturbed samples obtained by shovel, hand trowel, bucket auger, or similar means. A grab sample can be sub-sampled by taking a smaller grab sample if it

is reasonably homogeneous or if the grab sub-sample will contain the various types of materials in approximately the proportions present the larger sample. Otherwise, it should be homogenized and subdivided by quartering as described below.

Split-spoon and similar samples may be more easily subdivided by splitting the sample lengthwise with a spatula into halves or smaller functions. Another approach is to cut a v-shaped channel from the side of the sample and use the material from the channel. Carry out these operations on a tray covered with aluminum foil. Plastic sheeting may be used.

All sub-samples should be the same size. A measuring cup is satisfactory for determining size. The size of each sub-sample should be chosen in advance on the basis of the final sample volume and the amount of material available. Make the size of the sub-sample after quartering or splitting larger than the desired volume, then mix the sub-sample thoroughly in the measuring cup with a spatula and discard the excess.

- Combining Sub-samples. Combine the sub-samples on a tray covered with aluminum foil, or with plastic sheeting. Chop cohesive materials into pieces considerably smaller than the final sample with a trowel or spatula. Mix the composite sample until it appears homogeneous.

- Taking Composite Sample. If the composite sample is too large, subdivide it as follows: Pile the soil in a cone. Flatten the cone to a uniform thickness. Draw two lines across the pile, dividing it into quarters. Discard two opposite quarters re-mix the remaining quarters, and repeat the process until the sample is not much larger than the sample container. Fill the container and discard the excess. Label the container and complete field notes the sampling forms.

- Recordkeeping is generally the same as for other soil samples. However, be sure to identify the sample as a composite and to identify the number and locations of samples that were composited. Record any differences between procedures described in this SOP and those used in the field.

10.7 SOIL SAMPLING EQUIPMENT BLANKS

Equipment blanks will be collected during soil sampling activities to provide an additional check on possible sources of contamination related to field sampling instruments. Laboratory-supplied distilled or deionized water is passed through or over

clean sampling equipment and collected directly into empty sample containers for analysis. Equipment blanks will be handled and transported in the same manner as the samples acquired that day. Equipment blanks will be analyzed for a specific parameter list according to water analytical methods. One equipment blank will be collected for each investigation activity, in each investigation area. For example, three equipment blanks would be collected in an investigation area during sampling activities that include a backhoe exploration, stage 1 soil boring, and stage 2 soil boring. The equipment blanks will be tested for volatile organic compounds (VOCs), metals, hexavalent chromium, nitrate, gross alpha, gross beta, tritium, radium-226, strontium-90, carbon-14, and gamma spectral analysis.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 11.0
TEST PIT EXCAVATION

Purpose and Scope: The activities described in this procedure outline general methodology to be used in excavating and logging test pits. The resulting test pits can be used for shallow stratigraphic description and physical and chemical sampling. This procedure describes the equipment and forms required, as well as set-up procedures to be completed for each test pit.

Equipment:
Backhoe;
Steam cleaner;
Soil hand sampling equipment;
Shovel; and
Camera.

Documentation:
Field Memorandum; and
Test Pit Excavation Log.

11.1 SET-UP PROCEDURES

All set-up procedures and test pit excavations will be conducted under the supervision of a Dames & Moore geologist, hydrogeologist, or engineer. Dames & Moore field personnel are responsible for:

- Identifying each test pit location;
- Confirming the test pit location with the project manager and UC Davis personnel; and
- Obtaining proper clearance for potential above- and below-ground hazards.

Prior to test pit excavation, the backhoe bucket and sampling tools should be steam-cleaned. The work area should be well-marked with traffic cones and barricade tape. In some cases, special arrangements may need to be arranged to penetrate surface paving (concrete or asphalt). Each test pit should be backfilled following logging and photographing.

11.2 TEST PIT EXCAVATION PROCEDURES

This section provides a brief description of test pit excavation procedures. Test pit procedures described below adhere to guidelines and requirements of Title 8 CCR, Article 6, Sections 1541 and 1542.

Once the test pit location is selected and approved by the project manager, the test pit will be excavated using a backhoe. The standard backhoe bucket width is 24 inches, but a larger bucket (36-inch) may be used. The width of the excavation, regardless of the width of the backhoe bucket, will be such that movement inside the pit is not restrictive to the geologist. The initial excavation will be no greater than five feet in depth and will be cut with appropriately sloped sides if the soil being excavated is not stable. Test pits will be greater in length than in depth in order to accommodate a relatively easy and safe entry and exit route. Specifically, entry and exit will be via a ramp at the end of the test pit opposite the backhoe.

Once the test pit is excavated as described above, the test pit walls will be scraped smooth with a shovel or other scraping device. If necessary, engineering controls, such as water spray, will be implemented to minimize generation of dust. This provides the best possible exposure for logging and photographing the exposed soil profile. Soils will be described in a similar fashion to methods outlined in SOP 7.0 for logging soil in boreholes. The exposed test pit wall(s) will then be logged by the field geologist using the standard Test Pit Logging Form and photographed.

If detailed logging is required at depths greater than five feet and entry is required to perform the logging, the test pit will be appropriately shored. Shoring will be placed as specified in Title 8 CCR, Article 6, Section 1541. No confined space entry work will be conducted.

If possible, test pits greater than five feet in depth will not be entered and observations for logging purposes will be made from the surface. In no case will a test pit greater than five feet in depth be entered without proper shoring. If soil samples from greater than five feet are required, samples will be collected from soil in the backhoe

bucket taken from the desired depth. Soil sample collection methods are described in SOP 10.0. Decontamination of sampling equipment is described in SOP 3.0.

Test pits will be backfilled using the backhoe and compacted by driving the backhoe over the area after backfillind complete.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 12.0
PERMEABILITY TESTING – UNSATURATED ZONE

Purpose and Scope: Permeability testing will be performed to measure vertical permeabilities in the unsaturated zone. This SOP describes general procedures for conducting falling head tests at discrete depths in soil boreholes and describes a procedure for field measurement of the rate of infiltration of water into soils using double-ring and single-ring infiltrometers.

Equipment:

Casing hammer or hollow-stem auger drill rig;
6-inch diameter PVC casing;
5- or 15-psi pressure transducers;
Data logger;
Personal laptop computer;
Bentonite pellets or chips;
Water level indicator;
Computer disks;
Clean graded sand;
Two infiltrometer rings: 24-in. and 12 in.;
Two driving caps of heavy-gauge aluminum or steel having diameters slightly larger than that of their respective rings;
Driving equipment: 12-lb. sledge or backhoe and 2-3 foot length of wood;
Depth gauge: a hook gauge, steel tape or rule, or long nail or spike;
Shovels: one long-handled shovel and one flat-bottomed spade;
Tap water supply and appropriate containers;
Watch with seconds hand;
Carpenter's or bull's eye level;
Two thermometers for measuring soil temperatures;
Splash guards (several pieces of rubber sheet);
Rule or tape;
Tamp;
Rubber mallet;
Two graduated head tanks for measurement of liquid flow during the test. (These may either be graduated cylinders or Mariotte tubes having a minimum volume capacity of about 3,000 mL.); and
Mariotte tube support stands and tubing.

Additional Single-Ring Equipment:

80 lb. bags of powdered bentonite;
5-gallon buckets; and
Serving spoon with at least a 10-inch handle.

Documentation: Field memorandum; and
Double-ring infiltration test data sheet.

12.1 DOWN HOLE FALLING HEAD TEST

Procedures for conducting a down-hole falling head test are described below. Set-up methods are presented in 12.1.1, test procedures are presented in 12.2.2.

12.1.1 Set-Up

Prior to going into the field, all necessary equipment should be checked and tested to assure it is in good working condition. This includes:

- Checking and recharging batteries for water level indicator, computer, and data logger; and
- Running a test with the computer, data logger, and transducers to ensure that data is being recorded and that transducers are working properly.

Once in the field, soil borings will be completed to the desired depth by either casing hammer or hollow-stem auger methods (see SOP 6.0 - Soil Borings). When the desired depth is reached, the bottom of the drive casing or augers will be pulled 1 to 2 feet off the bottom and the boring will be cleaned of cuttings and caved material so that a clean, fresh, undisturbed surface is exposed. Care will be taken to ensure that either the drive casing or lead auger has not disturbed or penetrated this surface.

12.1.2 Procedures

When the borehole has been prepared, a section of 6-inch-diameter PVC blank casing will be placed on the bottom of the borehole inside the drive casing or the hollow-stem augers. Six inches to one foot of clean, graded sand will be placed inside the PVC casing to prevent scouring of the bottom when water is added. At least one foot of bentonite pellets or chips will then be added to the bottom of the borehole in the annulus outside the PVC casing. Sand will be placed inside the casing first to prevent bentonite from entering the casing from the bottom. The bentonite will be hydrated with distilled or

deionized water to form a seal to prevent leakage during the test. When the seal is sufficiently hydrated, the drive casing or lead auger will be carefully pushed into the bentonite seal. Procedures for conducting the falling head test are as follows:

- Record the borehole number in the field log;
- Measure and record the depth to the top of the sand inside the PVC casing from top of casing (TOC);
- Insert pressure transducer into the casing approximately 6 to 12 inches above the top of the sand. To prevent damage to the transducers, 5-psi transducers should be placed so that they will read no more than 10 feet of head during the test; 15-psi transducers should not read more than 30 feet of head during the test;
- Program computer and data logger to perform a "falling head" test as described below. Readings should be collected at a higher frequency at the beginning of the test, and less frequently as the test progresses. An example for a schedule of readings would be: 60 readings at 1-second intervals; 12 readings at 5-second intervals; 32 readings at 15-second intervals; 20 readings at 60-second intervals; 24 readings at 5-minute intervals; 60 readings at 10-minute intervals. The exact program and schedule will depend on the type of data logger and may be modified for the conditions encountered in the field;
- Turn on logger and check input values. Values displayed on the computer screen should be zero because no water has been placed in the casing;
- Begin "falling head" program and record the time;
- Quickly (instantaneously") but carefully, add clean tap water to the inside of the casing, being sure not to scour the bottom. Add water until approximately 10 feet of head is read by the transducer. Check values displayed for the transducers to ensure that the equipment is functioning properly;
- Record water levels with data logger until at least 75 percent of the water column has dissipated. This time may range from less than 30 minutes to overnight, depending on site-specific conditions. Usually it is not necessary to continue measurements for more than a few hours, since longer periods indicate extremely low permeabilities;

- Decontaminate the transducer and water level indicator; and
- Download data onto a floppy disk, making sure data was recorded and transferred properly.

If time permits, additional trials for the location and depth will be run by reprogramming the datalogger and repeating the above procedures. Upon completion of the falling head tests, the borehole may be either advanced or abandoned by procedures described in SOP 6.0 (Soil Borings).

12.2 DOUBLE-RING INFILTROMETER TEST

Procedures for conducting a double-ring and single-ring infiltrometer test are described below. Preparation and set-up procedures are presented in 12.2.1 and 12.2.2. Test methods and calculations are presented in 12.2.3 and 12.2.4.

12.2.1 Preparation and Set-Up for Double-Ring Test

Prior to initial use, the test rings should be calibrated by determining the area of the small ring and the annular space between the large and small rings. Determine the area using a measuring technique that will provide an overall accuracy of 1%. The area of the annular space between the rings is equal to the internal area of the small ring minus the external area of the large ring.

12.2.1.1 Soil Preparation

The soil strata to be tested will be established from a nearby test pit or shallow soil boring. The test area should be at least four by four feet, and be nearly level. The test may be conducted in a test pit should the desired test depth be below ground surface. In such instances, excavate either with hand tools or with a backhoe to just above the desired test depth, and remove soil that was compacted and/or smeared during excavation to leave a fresh soil surface. Check this surface with the level and bring down any high areas, if necessary. Using the hand broom, sweep any loose soil from the test surface.

To install the large ring, center the driving cap on the ring and place the wood block on the cap. Drive the outer ring into the soil either with blows of a heavy sledge on the wood block or with steady pressure from the flat portion of a backhoe bucket. Drive the outer ring to a depth that will (1) prevent the test fluid from leaking to the ground surface surrounding the ring, and (2) be deeper than the depth to which the inner ring will be driven; 6 inches is usually adequate. When using the sledge hammer, use blows of medium force to prevent fracturing of the soil surface. With the driving cap still on the ring, check the cap with the level and lightly hammer on the high side of the ring until level.

To install the small ring, center the smaller ring inside the larger ring, and, using the same technique just described, drive the ring to a depth that will prevent leakage of the test fluid; usually, 2 to 4 inches is adequate. If the surface of the soil surrounding the wall of the ring(s) is excessively disturbed, reset the rings using a technique that will minimize such a disturbance. For minor disturbances adjacent to the wall of the rings, tamp the disturbed soil until the soil is as firm as it was prior to disturbance.

12.2.1.2 Maintaining Liquid Levels

To maintain liquid levels within the inner ring and within the annular space use a graduated cylinder or a Mariotte tube. When manually controlling the flow of liquid use a depth or point gauge to visually maintain a constant head. Install the depth gauges or Mariotte tubes in such a manner that the reference head will be at least 1 inch and not greater than 6 inches. Locate the depth gauges midway between the two rings. Measure the ground temperature by inserting the temperature gauge at a depth of about 12 inches or at the mid-depth of the test zone. Measure the temperature of the water being used for the test. The water temperature should be greater than the soil temperature, to prevent dissolved gasses in the water from forming gas bubbles in test soil pore space upon infiltration.

Prior to adding water, cover the soil surface within the center ring and between the two rings with the rubber splash guards to prevent scouring of the soil when the initial liquid supply is poured into the rings. Fill both rings with liquid to the same depth. Do not

record this initial volume of liquid. Remove the splash guards and start flow of fluids from the graduated cylinders or Mariotte tubes. Measure and record each addition of water to the rings. As soon as the fluid level becomes constant, determine the fluid depth in the inner ring and in the annular space to the nearest 1/6 inch using a ruler or tape measure. Record these depths. If the depths between the inner ring and annular space varies more than 1/4 inch, raise the depth gauge or Mariotte tube having the shallowest depth. Maintain the liquid level at the selected head in both the inner ring and annular space between rings as near as possible throughout the test, to prevent flow of fluid from one ring to the other.

12.2.2 Preparation and Set-Up for Single-Ring Test

Where coarse-grained soils are encountered at the surface or at depth, the single-ring test method may be employed. This method makes use of only the large ring, therefore ring calibration consists of determining the area of the large ring. Test surface preparation is the same as that for the double-ring test. In loose gravels or cobbles with little or no fines, test surface preparation may consist only of excavating to a level test surface using the flat-bottomed spade.

Since it is not possible to drive the ring into coarse-grained material, a seal between the ring and soil is formed using bentonite powder. The seal is made by thoroughly mixing roughly equal volumes of bentonite powder and water, and applying the resulting paste with the long-handled spoon to where the outside wall of the ring meets the test surface. Approximately 5 gallons of paste should be used to adequately seal one 24 inch diameter ring onto a test surface. Care should be taken to avoid introducing the bentonite paste to the test surface within the ring. Remove such paste prior to conducting the test. Follow the same instructions for adding and controlling the liquid to the single-ring as that described for the double-ring in Section 12.2.1.2.

12.2.2.1 Maintaining Liquid Level

During the test, the geologist will determine and record the volume of liquid that is added to maintain a constant head. For average soils, the volume of liquid used will be

recorded at intervals of 15 minutes for the first hour, 30 minutes for the second hour, and 60 minutes during the remainder of a period of at least 6 hours, or until after a relatively constant rate is obtained. Measurement intervals will vary, based on the permeability. For high-permeability materials readings may be more frequent then for low-permeability materials. For any test, the volume of liquid used in any one reading interval should not be less than approximately 25 mL.

To minimize evaporation, place the driving cap or some other covering over the ring during the intervals between liquid measurements.

12.2.3 Calculations

Convert the volume of liquid used during each measured time interval into an incremental infiltration velocity for both the inner ring and annular space using the following equation:

Incremental Infiltration Velocity = Vol.of fluid infil./(Area × time) = cm/sec.

Record all information on the Single Ring or Double-Ring Infiltration Test Data Sheet.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 13.0
AQUIFER TESTING

Purpose and Scope: Aquifer tests are used to assess hydraulic properties of water bearing stratigraphic intervals. Parameters such as transmissivity, storage coefficient, and leakage coefficient (if applicable) will be derived from aquifer test data for input into groundwater flow and transport models. Both aquifer pump tests and slug tests will be used in estimating aquifer parameters.

Equipment: Described below

Documentation: Described below

13.1 SLUG TESTS

This operating procedure describes methods used in performing single well aquifer or slug tests to measure aquifer hydraulic conductivity. The test involves changing the water level in a well and observing recovery to static water level. Because slug tests stress only a small part of the aquifer, longer-term pumping tests are considered more accurate in the estimation of aquifer parameters.

13.1.1 Equipment and Documentation

The following equipment and documentation will be used in conducting aquifer slug tests:

- Water level indicator;
- Decontamination equipment;
- Calculator;
- Stainless steel or solid PVC slug;
- Data logger;
- Pressure transducer (5 to 15 psi);
- Laptop Portable computer;
- Computer disks; and
- Field Memorandum.

13.1.2 Set-Up

Prior to going into the field, all necessary equipment should be checked and tested to assure it is in good working condition. This includes:

- Checking batteries for water level indicator, computer, and data logger; and

- Running a test with the computer, data logger, and transducers to assure data is being recorded and that transducers are working properly;

Once in the field, water levels in all wells to be tested will be measured and recorded. Dedicated pumps will then be removed (if necessary). Slug tests will not be performed on wells in which pumps were removed until the water level returns to the previously measured elevation.

13.1.3 Slug Test Procedures

Slug tests will be conducted only after the water level has equilibrated to static elevations. Procedures for "falling head" and "rising head" tests are as follows:

- Record the well number in the field log;

- Measure and record the depth to water from top of casing (TOC). Measure and record the depth of bottom of well from TOC, if possible;

- Insert pressure transducer into well. The transducer should be at least 1 foot above the bottom of the well, and at least six feet below the static water level. To prevent damage to the transducers, 5 psi transducers should be placed so that they read no more than 10 feet of head during the test, 15 psi transducers should not read more than 30 feet of head during the test;

- Program computer and data logger to perform a "falling head" test as described below. Readings should be collected at a higher frequency at the beginning of the test, and less frequently as the test progresses. An example for a schedule of readings would be: 60 readings at 1-second intervals; 12 readings at 5-second intervals; 32 readings at 15-second intervals; 20 readings at 60-second intervals; 12 readings at 5-minute intervals; 30 readings at 10-minute intervals. The exact program and schedule will depend on the type of data logger and may be modified for the conditions encountered in the field;

- Turn on logger and check input values. Values displayed on the computer screen indicate depth of submergence (feet of head) and should be stable and within the range expected from the previous step, if not, wait until well stabilizes. Write down initial head value on the Field Memorandum.

- Begin "falling head" program and record the time;

- "Instantaneously," but smoothly, lower a clean decontaminated slug into the well. Tie off the line to the slug when it is completely submerged below the initial static water level;

- Record water levels with data logger until at least 90 percent of the change in water level has dissipated (compare reading to initial value recorded before the test). This time may range from 1 minute to less than 1 day due to site specific conditions. Usually it is not necessary to continue measurements for more than a few hours, since longer periods indicate extremely low hydraulic conductivity;

- Reprogram the datalogger to perform a "rising head" test. Reading will be collected on a schedule similar to that other falling head test. Turn the datalogger on and check head values against initial values;

- Begin "rising head" program and record the time;

- "Instantaneously," but smoothly, remove the cylinder from the water column, being sure that the bottom of the slug is above the original static water level. Tie the slug off while it is still in the well so that the transducer cable is not disturbed by removing the slug;

- Continue collecting water level measurements until at least 90 percent of the change in water level has dissipated. End test;

- Decontaminate the slug, transducer, and water level indicator; and

- Download data onto a floppy disk, making sure data was recorded and transferred properly.

13.2 STEP DRAWDOWN TEST

Step drawdown aquifer tests may be conducted on selected wells. In a step drawdown test, the well is pumped at successively higher pumping rates and the drawdown for each rate, or step, is recorded. The results of these tests provide information to help identify well efficiency and the appropriate pumping rate for the constant discharge tests (see below). The initial discharge rate of each step drawdown test will be based upon the results of the well development (see SOP 8.0). Each step drawdown test will consist of three 1-1/2-hour steps. Where feasible, the aquifer will be allowed to fully recover before the next step is commenced.

During the step drawdown tests, drawdown and recovery in the pumping well and observation wells will be monitored by using the data logger. Additional information for the data logger, equipment, and specific pump test procedures are discussed in the Constant Rate Discharge Test section below.

13.3 CONSTANT RATE DISCHARGE PUMP TESTS

This operating procedure describes the methods involved in conducting a constant-rate discharge pumping test. The activities covered by this procedure are designed to ensure quality control in conducting pumping tests to determine aquifer parameters, and to provide quantitative data on aquifer parameters such as saturated hydraulic conductivity, specific yield, and storativity.

13.3.1 Equipment and Documentation.

The following equipment and documentation will be used in conducting constant rate discharge pump tests:

- Water level measuring tape(s);
- Flow meter;
- Steel register flow meter;
- Portable computer;
- Program diskettes;
- Data diskettes;
- Field log;
- Stopwatches;
- Calculator;
- Stainless-steel submersible pump;
- Teflon or polyethylene flexible piping;
- 4,500-watt generator;
- Stainless-steel hose clamps;
- Calibrated 5-gallon bucket;
- Flashlights, etc.; and
- Field Memorandum.

13.3.2 Set-Up

Prior to going into the field, all necessary equipment should be checked and tested to assure it is in good working condition. This includes:

- Checking batteries for water level indicators, computers, and data loggers; and

- Running a test with the computer, data logger, and transducers to assure data is being recorded and that transducers are working properly;

Once in the field, an area will be located to conduct the pumping test where the water table or potentiometric surface is relatively flat; where the aquifer is believed to be relatively homogeneous and isotropic and of constant thickness; and where there are no nearby influences on groundwater flow, such as other pumping wells, streams, lakes, or no-flow boundaries. Observation well(s) will be chosen that are within 50 to 3,000 feet of the pumping well.

Water levels in all wells to be included in the test will be measured and recorded. Dedicated pumps will then be removed (if necessary), and the well will be allowed to equilibrate for at least 72 hours prior to the pumping test. The pumping well will not be pumped for at least two days prior to conducting the pump test.

Install pressure transducer into the pumping well and observation wells several days prior to the test to obtain data on both natural and artificial regional groundwater level fluctuations and to assure all equipment is working properly. Decontamination will be conducted on all of the downhole testing equipment and will occur prior to the start of each test and upon completion of test (see SOP 3.0 Equipment Decontamination).

Install a barometer on site to continually record local barometric pressure. If there is a NOAA or Weather Service station near the site, data from the official station can be obtained as a substitute.

13.3.3 Procedures

The distance between the observation well(s) to the pumping well will be measured prior to beginning the pump test. A general pumping rate will be estimated based on results from a step drawdown test or, if no step drawdown test is performed, based on data collected from well development and from the distance of observation wells. In general, the closer observation well(s) are to the pumping well, the lower the pumping rate that will be used.

The constant rate discharge tests will be conducted for at least 24 hours. If steady-state conditions occur before 24 hours, the test will be terminated at 24 hours. If steady-state conditions are not met within 24 hours, the test will be continued until steady-state conditions occur or 72 hours have elapsed, whichever occurs first.

The pumping well and at least two observation points, if feasible, will be monitored during the constant rate test. A multi-channel data logger should be utilized during the aquifer test so that several observation points can be monitored. Drawdown in the pumping well and the nearest observation well will be measured with pressure transducers and data logger at the following intervals:

Elapsed Time	Measurement Interval
0 - 2 sec.	0.2 sec.
2 - 20 sec.	1 sec.
20 - 120 sec.	5 sec.
2 - 12 min.	30 sec.
12 - 120 min.	2 min.
120 - 1,440 min.	10 min.
1,440 - 4,320 min.	100 min.
> 4,320 min.	500 min.

The data logger will be checked every 10 minutes for the first hour of each step drawdown test and at least once every half hour thereafter.

Observation points which cannot be connected to the data logger because of distance from the equipment will be monitored with the water level meter. Observation wells will be checked every 15 minutes until drawdown is detected in the observation well. Once drawdown is detected, water levels will be measured at the following intervals:

Elapsed Time	Measurement Interval
0 - 5 min.	30 sec.
5 - 10 min.	1 min.
10 - 20 min.	2 min.
20 - 40 min.	5 min.
40 - 80 min.	10 min.
80 - 120 min.	20 min.
120 - 180 min.	30 min.
> 180 min.	60 min.

At the completion of the constant rate discharge test, recovery measurements will be made according to the same schedule as the drawdown measurements. Recovery will be measured until the residual drawdown is less than 10 percent of the total drawdown or for an equal duration as pumping.

After 48 hours, the data loggers, pressure transducers, and cables will be removed from the observation wells. Dump the data onto data diskettes using the portable computer.

Data will be recorded by the data logger as feet of water above the pressure transducer. Reduce these data to changes in potentiometric head (in feet), relative to the initial water level as measured from the top of the casing, and record this with the respective changes in time.

13.4 DISCHARGE MEASUREMENTS

Pump discharge during the aquifer testing will be measured with a totalizing flow meter. The meter will be sized so that the rate of pumping is no less than 25 percent of the meter capacity. A pressure gauge and adjusting gate valve will be installed in the discharge line ahead of the flow meter to control the pump discharge rate. The flow meter will be checked during each test by measuring and recording the time taken to fill a known volume (e.g., a 55-gallon drum) with water. If the flow meter malfunctions, the bucket and stopwatch method will be used to measure discharge during the aquifer test.

The rate of discharge during the test will be controlled to within plus or minus five percent of the designated rate. Discharge will be checked, and adjusted, every ten minutes from 30 minutes to 90 minutes of pumping, and every half hour from 90 minutes of pumping to the end of the test. Any adjustment or pertinent information will be recorded.

13.5 ABORTED TEST

Failure or shutdown of the pump for more than one percent of the elapsed pump time will constitute an aborted test. If the test is aborted, pumping will not resume until: (1) the water level in the pumped well has recovered to its static level; or (2) three successive water-level measurements spaced twenty minutes apart show no change greater than 0.01 foot; or, (3) the well has been allowed to recover for a period of time equal to or greater than the elapsed pumping time of the aborted test.

13.6 STORAGE AND DISPOSAL OF PURGED WATER

Water removed during a pump test will be stored and disposed of as outlined in SOP 4.0 (Soil, Water, and Waste Disposal) and the Waste Management Plan.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 14.0
FIELD MEASUREMENTS - SOIL

Purpose and Scope: The purpose for this procedure is to describe methods for measuring the pH of a 1:1 soil-water paste. These measurements will be used as a field estimate of soil pH.

Equipment:
pH meter;
pH buffer solutions (pH 4, 7, and 10);
Plastic cup or beaker;
Distilled or deionized water;
Graduated eye dropper;
Spray bottle; and
Field balance.

Documentation:
Field Memorandum;
Instrument Calibration Log;
Soil Boring Log; and
Test Pit Excavation Log.

14.1 SET-UP

Prior to going into the field, all equipment will be assembled and checked to ensure it is in proper working condition. Measurements of soil pH can be conducted on soil samples collected by any of the methods described in SOP 10.0 (Soil Sampling).

14.2 CALIBRATION AND MEASUREMENT

The pH meter will be checked and calibrated prior to taking any measurements according to procedures outlined in SOP 2.0 (Field Measurements - Water). Upon calibration, measurements of soil pH will be taken as follows:

- Weigh or measure 5 g of air-dry soil into a paper cup;
- With graduated dropper, add 5 ml of distilled water to the soil;
- Mix thoroughly for 5 sec, preferably with portable mechanical stirrer (a small stirrer motor, 1,550 rpm, mounted on a handle with a short, slightly bent plastic or glass rod agitator serves very well);

- Let stand for 10 min;
- Insert the electrodes into the container, and stir the soil suspension by swirling the electrodes slightly;
- Read the pH immediately on the pH meter, and record as soil pH in water, or Ph_w; and
- Rinse probe and other equipment thoroughly in distilled or deionized water.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 15.0
FIELD MEASUREMENTS - AIR

Purpose and Scope: The purpose for this procedure is to describe methods for measuring the concentration of volatile organic compound vapors for compliance with the health and safety plan and to screen soil samples collected during test pit excavations, and soil borings.

Equipment:
Photoionization detector (PID);
Calibration gases;
Gas cylinder gauge;
Gas sampling bag; and
Batteries and recharger.

Documentation:
Field Memorandum;
Instrument Calibration Log;
Soil Boring Log; and
Test Pit Excavation Log.

15.1 CALIBRATION

Calibration and measurement procedures in this SOP are based on those written for a MICROTIP™ MP-100 PID. If another brand is used, consult the user's manual for calibration and measurement methods.

Prior to going into the field, the PID will be checked to assure it is in proper working condition. The check will include: an inspection for damage or missing pieces; check of batteries; check of calibration gasses to assure sufficient quantity for calibration for duration of field activities; and calibration of instrument to assure it is working properly. When in the field, the instrument will be properly maintained as indicated in the operators manual, and will be calibrated periodically as indicated in the QAPP.

The PID will be calibrated using two gases: a zero gas or clean outdoor air, and a span gas (usually 100 ppm isobutylene in air). The PID will be calibrated as follows:

- Turn instrument ON and allow it to equilibrate. Check battery;

- Switch to calibration mode (press CAL). Expose the PID to the zero gas sampling bag or to clean outdoor air. Press ENTER to zero the instrument;
- Enter the concentration of the span gas (usually 100 ppm), and connect the span gas bag to the instrument inlet. Press ENTER to set the sensitivity of the instrument; and
- Enter calibration information onto the Calibration Log form.

15.2 MEASUREMENT

Field measurements for VOC vapors will be conducted to monitor the operator breathing zone (OBZ) to ensure worker safety. Measurements of the OBZ will be conducted according to procedures in the H&S Plan.

Field measurements of VOCs will also be used as a screening tool for soil samples. Measurements of VOCs in soil samples will be conducted on continuous core samples, drive samples, drill cuttings (see SOP 6.0 - Soil Borings and SOP 10.0 - Soil Sampling), and samples collected from test pits (see SOP 11.0 - Test Pit Excavation Procedures). The soil sample will be placed into plastic zippered storage bag, the bags will be sealed and the soil broken up. After several minutes, a reading will be taken of the air inside the bag and recorded on the boring or test pit log.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 16.0
AIR SAMPLING - ROTAMETERS AND MASS FLOW

Purpose and Scope: This procedure describes the method of calibration for the individual rotameters or mass flow meters that are used at air stations for the determination of air flow rates through the sampling head and total flow through dry gas meters used in the sampling train. This procedure is applicable to the calibration of the rotameter, or mass flow meter, dry gas meter and associated sampling train configuration described in Figure 16.1. Should a different configuration of the sampling train be installed, recalibration is required and shall be documented per this procedure.

Equipment: Rotameter - A variable orifice gravity-dependent floating indicator, subject to pressure and geo-orientation variables; and
Mass Flow Meter - A flow-indicating device which is not subject to anything but specific heat of the flowing gas.

Documentation: Field Memorandum;
Calibration Certificates;
Vacuum Leak Testing;
Air Monitor Dry Gas Meter; and
Air Monitor Rotameter.

16.1 SET-UP

Prior to collecting data, the Environmental Engineer shall ensure that the measurement devices which are used at the air sampling stations are (National Institute of Standards and Testing (NIST) traceable) calibrated. The Environmental Engineer or his qualified representative shall maintain the air sampling rotameters, dry gas meters, and ensure that the calibration equipment is calibrated and functional.

16.2 CALIBRATION AND MEASUREMENT

Set up the sample head, blank filter, rotameter or mass flow meter, and vacuum system in the configuration to be used for the actual sampling. The air sampling stations are connected to the normal vacuum source or a vacuum test pump. These should be

calibrated in this configuration unless a special sampling train is necessary and documented on the Calibration Certificate (CAL-AIRR).

Step 1 Inspect the entire sampling train for damaged or loose fittings which may cause air leakage. After replacing or repairing damaged parts and confirming all connections are tight, perform the vacuum leak test as follows:

- For ambient air sampling systems, remove the air particulate filter. In its place, secure plastic and duct tape across the face of the opened sampling head. This will serve as an air-tight seal during the test. Isolate the tritium sampling branch, if so equipped.

  For effluent air sampling and monitoring systems, isolate the system to be leak tested. Maintain flow through system not being tested;

- Attach the leak-test rig to the three-way valve located immediately in front of the sampling train's air pump (Figure 16.2). Confirm the water level in bottle #1 is above the black line (approximately 700 mL). Confirm the water level is below the green "zero" line of bottle #2. Fully open the metering valve and start the vacuum pump. Carefully close the metering valve until a steady vacuum of inches Hg is witnessed on the test rig manometer. Invert bottle #1. Water should not transfer from bottle #1 to bottle #2. Water transfer indicates a leak in the test rig which must be corrected before continuing. Return bottle #1 to an upright position. Switch the three-way valve to bring the sampling train on line with the test rig. When the test rig manometer again indicates 5 inches Hg and remains steady, invert bottle #1. If water does not transfer to bottle #2, activate the stopwatch. If water still has not transferred to bottle #2 after one minute, the air sampling train has passed the leak test. Should water begin transferring to bottle #2 upon inverting bottle #1, wait for the level in bottle #2 to reach the green "zero" line. Activate the stopwatch. If the level in bottle #2 passes the black line within one minute (500 cc), the sampling train has failed the leak test. Locate and repair the leak source; then repeat the test;

- If the sampler is equipped with a tritium column, isolate the air particulate sampling branch, plug the inlet to the column and perform the leak test in a manner similar to that described above. Should water begin to transfer from bottle #1, wait for it to pass the first has mark on the clear tubing between bottles. Activate the stopwatch. If the water passes the second hash mark within one minute (7 cc), the sampling train has failed the leak test. Locate and repair the leak source; then repeat the test;

- Upon conclusion of the test, complete the "Certificate of Vacuum Leak Testing" and return the system to its operating condition;

Step 2 Check the batter on the Kurz flow calibrator. Should the display not indicate the BATT OK, recharge the unit overnight prior to field use.

Step 3 Attach the mass flow meter (Kurz Model 544 or Kurz Model 1544) to the sample head using the appropriate sample head adapter and the least amount of connecting tubing necessary. Check to ensure the flow is in the correct direction (in-atmosphere, out-sample head).

Step 4 Connect the Kurz flow calibrator to the matched Kurz mass flow meter using the transducer cable (Figure 16.1, Calibration Sampling Train). Power Kurz after ensuring that cables are properly attached. Verify that the meter balances to zero on the lowest scale.

Step 5 The sampler flow rate can be adjusted with the rotameter valve or, if equipped with a mass flow meter, a flow adjustment screw. Calibrate the rotameter (flow meter) at 20 percent, 50 percent, and 80 percent full scale. Record schematic diagram of actual sampling train used, rotameter model, manufacturer and serial number, location, flow meter and rotameter readings, date, and calibrator's initials. If there is no unique identification code on the meter being calibrated, one must be assigned before the calibration is valid.

Step 6 Plot the rotameter (flow meter) flow rate versus the actual flow rate from Kurz meter on graph paper. At the desired flow rate, if the plot indicates by inspection that the rotameter requires a correction factor of more than 50 percent, deviates from previous calibrations by more than 10 percent, or is nonlinear by more than 10 percent of full scale, the unit must be replaced. In the case of the SIERRA sampler units, the mass flow meter should be adjusted as appropriate.

NOTE: **The Kurz flow calibrator automatically compensates for pressure and temperature to read in SLPM (liters per minute at 20°C, 760 mm Hg). A laboratory thermometer will be used to measure the ambient condition during the test. Barometric pressure (uncompensated) will be taken within two hours of any test. If barometric measurements are not available at the site, readings from the official Sacramento area weather service will be acceptable under the conditions that:**

- **The area weather system is table within the testing time frame (i.e., a storm front is not moving through the local region); and**

- **The weather service source is representative of and can be elevation compensated for the test site.**

Step 7 Calculate and record the results per steps 12 through 14.

Step 8 Calibration of the dry gas meter may be performed at the same time as calibration of the associated rotameter. A separate calibration form is required for this procedure (CAL-AIRT). To expedite replacement and to be available for emergency response, dry gas meters may be calibrated as "stand alone." Calibration will be performed monthly.

Step 9 Leak test the sampling train per step 1.

Step 10 Set and hold the flow rates for at least three minutes at each of the three levels in Step 5 recording the following data for each point:

- Schematic of sample train and location;
- Identification (model, serial number, etc.) of meter;
- Barometric pressure (mm Hg uncompensated) and time;
- Temperature;
- Calibrator reading, start/finish (slpm);
- Total cubic feet (liters) indicated on dry gas meter using the proving circles indictor; and
- Manometer inches of water (mm Hg) at meter outlet.

Step 11 Using the appropriate formulae (Section 16.7), calculate the corrected volume (STP, 25°C, 760 mm Hg) of indicated flow and the total volume through the calibrator.

Step 12 Calculate and record the correction factor and the cumulative error factor near the operating flow rate. Remove the dry gas meter from service if the correction factor is outside the 0.90 - 1.10 range.

Step 13 Post a calibration sticker including the correction factor with the calibrator's initials and next calibration date on the calibrated meter.

Step 14 The Certification of Calibration and original plot shall be maintained in the instrument file under the file heading Air Sampling Rotameter or Air Sampling Totalizer, as applicable. Instrument files shall be maintained at the project office for each sampling location.

16.3 ADMINISTRATIVE CONTROLS

Air measuring devices used at sampling stations shall be calibrated semi-annually. The correlation between the rotameter and totalizer in a given sampling train shall be checked quarterly. Sampling systems shall be leak tested on a quarterly basis.

Instruments that do not meet calibration specifications shall be repaired or replaced as soon as possible. Replacement meters upon installation or repair shall be calibrated per this procedure. An instrument will not be permanently removed from service until a replacement is available for installation.

The Kurz units should be used in clean areas only.

Perform a radiological survey on any calibrator unit used in this procedure within the plant facility building controlled areas before returning it to storage.

The Kurz units shall be calibrated on an annual cycle. This calibration shall be traceable to the National Institute of Standards and Technology.

16.4 MAINTENANCE

The Kurz flow calibrator shall be recharged following each use. The Kurz mass flow sensor shall be inspected and cleaned as necessary before each use. To clean the sensor, use a small camel's hairbrush and water, followed by an alcohol rinse. The sensor shall be dry before resuming use.

16.5 AUTHORITY

WVNS Radiologicals Controls Manual, WVDP-010.

A Guide for Environmental Radiological Surveillance at ERDA Installations, ERDA 77-24.

DOE/EP - 0023.

Draft DOE 5400.6, March 1990

16.6 REFERENCES

Air Sampling Instruments for Evaluation of Atmospheric Contaminants, Fifth Edition, ACGIH, 1978.

Kurz Model 544 and Model 1544 Portable Flow Calibrator Instruction Manual.

RC-I[illegible] 26 (WVNS).

Calibration and Error Limits of Air Sampling Instruments for Total Volume of Air Sampled, U.S. Nuclear Regulatory Commission Regulatory Guide 8.25, August, 1980.

ANSI N510-1980.

16.7 PRESSURE, VOLUME, AND ERROR COMPENSATION FORMULAE

For volume correction for temperature and pressure:

$$V_s - F_1 \times \frac{P_1}{760} \times \frac{298}{T_1}$$

(STP, 25°C and 760 mm Hg)

V_1 = volume measured at conditions P and T
T_1 = temperature of V_1 in °K
P_1 = pressure of V_1 in mm Hg

To connect to actual volumetric conditions from compensated mass flow readings:

$$Q\ act = Q\ ind \times \frac{ds}{da}$$

Where:

ds	=	air density at STP (25°C 760 mm Hg)
da	=	actual air density in the sample train at the calibration point
Q act	=	volumetric flow rate (lpm)
Q ind	=	indicated mass flow rate (slpm)

Cumulative error, E_v, should be less than 10 percent of total volume for air sampling instruments using the following formula:

$$E_v = \left[Es^2 + Ec^2 + En^2\right]^{\frac{1}{2}}$$

Where:

Ec	=	Percent error of the standard calibration instrument
Es	=	Intrinsic error in reading the meter scale (an acceptable estimate is the percent equivalent of one tenth the smallest scale division compared to scale reading)
Et	=	Percent error in measurement of sampling time (should be less than 1 percent)
En	=	Other errors, known or estimated in the overall system

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 17.0
AIR SAMPLING — RADIONUCLIDES IN AMBIENT AIR

Purpose and Scope: Collection of representative ambient air samples from various locations is necessary to determine radionuclide concentrations and monitor environmental air quality which may be affected by site operations. The data obtained from analysis of the air samples is an indicator of environmental trends and efficiency. This procedure describes the general siting requirement, configuration, and operation of air sampler systems utilized to determine the radionuclide content of ambient air. This procedure does not apply directly to stack effluent monitoring.

Equipment:
Glass fiber filters - 47 mm diameter, Gelman Sciences Type A/E;
Tweezers;
Plastic bags approximately 4.5" x 3", zippered storage type, for transport of air filters;
Permanent marker, narrow point, black preferred;
Fully calibrated air sampling system;
Watch/clock;
Desiccant column for collection of tritiated water vapor;
Charcoal cartridge for collection;
Plastic bags, zippered storage type for transport of charcoal cartridges; and
Two-way radio/walkie/talkie.

Documentation: Field Memorandum

17.1 SET-UP, ORGANIZATION AND DOCUMENTATION

Prior to calibration or collecting measurements, all sampling equipment will be checked by the field operations lead to ensure that it is in proper working condition. The Task Manager responsible for ensuring that the placement of air sampling systems is appropriate to the needs and requirements of the environmental monitoring program. The technician collecting the sample is responsible for following the procedural steps and using proper techniques and for accurately recording the appropriate data on the designated worksheet or worklog at each sampling station.

The air sampling systems obtain 110V AC electrical power from standard line service. Exercise extreme caution when working with the systems to prevent possible electrical shock. Be aware of dangers inherent with electrically energized systems.

Do not perform maintenance until the system is properly shut down.

17.2 SAMPLING AND CALIBRATION PROCEDURES

The following procedures detail the configuration, operation, and sample collection procedures for ambient air samples:

The flow rate through the desiccant columns is adjustable to compensate for seasonal changes in relative humidity. To collect an adequate sample and to prevent "breakthrough" (saturation of the desiccant), raise the flow to 500 milliliters per minute or higher during the dry winter months (less than 25 percent relative humidity), then reduce to approximately 250 mL/min during the humid (greater than 75 percent relatively humidity) summer months.

Flow rates may need adjustment weekly. When compensating for humidity levels, all ambient tritium samplers should be adjusted to approximately equal rates on the same day in order to maintain consistency.

17.2.1 General Sampling Train Configuration

Typically, air sampling systems consist of a filtration sampling head for collection of air particulates, a desiccant column for collection of water vapor (specific locations), a charcoal cartridge for collection of radioiodine (specific locations), a rotameter or mass flow meter, a dry-gas or mass-flow totalizer, an elapsed time indicator (optional), and an air pump capable of sustaining continuous flow through the system at an established rate (Figure 17.1).

In all air sampling situations, accurate air flow rate, totalizer, and calibration factors are required to determine the total volume of air sampled. The accuracy of radionuclide analysis depends directly upon the accuracy of the volume sampled.

17.2.2 Continuous Operation

The flow rate through air filters and charcoal canisters should be maintained between 30 and 60 liters per minute. The nominal target value, with compensation, is 40 standard liters per minute. Sampling head dimensions will be selected based on manufacturer's recommendations for filter-specific linear flow rate.

17.2.3 General Sample Retrieval

Samples will be retrieved by the following steps:

- Unlock the exterior enclosure containing the sampler and open door. If sampler is not operating, determine cause and correct;

  A. Notify the Environmental Laboratory Manager or Designee immediately to report the problem. Notification will be by two-way radio if in range, or by telephone if at a remote location; and

  B. Document sampler status and actions taken to correct any problems in sampler maintenance log.

- Compare and record the flow rate on the gauge to the flow rate value (including correction factor) posted on the calibration sticker;

- Record the flow rate;

- Turn off the air pump power switch;

- Record the sample period ending date, time, to nearest minute and dry-gas meter or totalizer reading in the appropriate spaces on the Laboratory Information Management System (LIMS) Sampling Worksheet;

- Remove the sample collection medium taking care to handle it minimally (see Section 17.2.4 for instructions appropriate to the medium used);

- Install a new or regenerated collection medium;

  Note: Regenerated medium would be the desiccant used in the tritium columns. The moisture is distilled off and desiccant is then completely dried in an oven. New desiccant is put into service each quarter.

- Turn on the air pump power switch;

- Inspect the rotameter (or mass flow meter) to ensure that the flow rate is within the acceptable range. Adjust as needed to the nominal 40 standard liters per minute flow rate;

- Record the sample period starting date, time, and totalizer meter reading on the LIMS Sampling worksheet (Attachment B);

  A. Record the Hour Meter reading on the field data sheet; and

  B. Immediately calculate the time in minutes from the last visit using 10,080 minutes per week and correcting from any seasonal time changes. Compare the calculated time to the recorded time and determine the difference (calculated minus recorded). Any indicted down time must be documented.

- Visually inspect the system for possible air leakage and damaged components. Repair or replace faulty components and test the system per EM-8;

- Record results of inspection in the sampler maintenance log; and

- Close the sampler door and lock the enclosure.

17.2.4 <u>Specific Sample Collection Media</u>

Collect air particulates weekly on 47mm-diameter type A/E glass fiber filters as follows:

- Turn off the air sample pump per Section 17.2.3;

- Open the filter head and remove the filter. Filters should be manipulated with tweezers by grasping the outer edge. After the filter's exposure period, take care to avoid displacing adhered material, thus compromising the

sample. During humid conditions, the filters are particularly delicate; be careful to avoid tearing the filter. (Extra care must be taken during severe weather conditions to prevent loss or damage to the filter due to rain, wind, etc.);

- Record sampler statistics on the LIMS Sampling Work Sheet and a plastic zippered storage bag using a permanent marker. To ease identification, place the exposed filter in the bag with the darkened side toward the clear side of the bag;

- Place a new filter in the head. Avoid contacting the filter in any manner which may result in deposition of contaminants. Confirm that the woven side of the filter is against the head (i.e., "rough" side out); and

- turn on the air pump to draw the filter against the mesh. The head may now be reassembled with little risk of damage to the filter.

Note: Wrinkles or tears are unacceptable and must be rectified by replacing the damaged filter.

Retrieve desiccant columns weekly as follows:

- Record time collected and tritium dry-gas meter readings on the LIMS Sampling Work Sheet;

- Remove the lines connected in the service column;

- Cap the column orifices to prevent air exchange prior to analysis;

- Observe the color change. As moisture is adsorbed, the desiccant changes from deep blue (dry) to light pink (moist). Ideally, between 40% and 50% of the desiccant should be light pink;

- Adjust the flow rate as needed to maintain this level of moisture trapping;

- Substitute a dedicated column (specific to the sampling system) with fresh or regenerated desiccant for the one removed. Ensure that the lid of the "fresh" column is secure. All connections ad seals must be secure to prevent air leakage; and

- Weekly, Environmental Laboratory personnel will provide "fresh" columns for tritium sampling.

Retrieve charcoal cartridges monthly. Cartridges are located in series behind he air particulate head. Collection should occur during the routine collection nearest the calendar month end:

- Record ending date and time removed on the plastic zippered storage bag and on the cartridge itself;
- Open the cartridge holder and substitute a new cartridge in place of the exposed one. Orient according to the flow direction arrow on the side of the cartridge;
- Place the exposed cartridge in a plastic bag for transport to the laboratory; and
- Environmental laboratory Personnel will provide new charcoal cartridges.

17.3 MAINTENANCE

Maintenance of the sampling system will include initial installation, routine maintenance during operation, and identification of abnormal operation. These procedures are described below.

17.3.1 Initial Sampler Installation

The location selected for installation of ambient air samplers should be within the sector (octant) identified by using the Waite methodology given in DOE/EH-0173T, Section 5.7. The site-specific factors used in the application of the Waite method should be documented by the task manager.

Placement of samplers within the selected sector or area should follow the recommendations provided in DOE-EH-0173T to the extent practicable. Structures, roads, trees, and other anomalous areas are to be avoided. The following requirements are the minimum acceptable for new or replacement siting of ambient air samplers. Whenever possible, the ideal conditions should be met:

- Samplers should be sited at least 50 feet from the edge of dirt roads. This does not apply to low-traffic driveways;

  Generally, avoid siting locations immediately downwind of or near dusty areas, such as plowed fields, industrial yard activities, or heavily traveled unimproved roads;

- Samplers should be sited away from structures or trees such that a 90-degree cone of obstruction-free air exists above the sample, with the apex originating at the sampler head 2.0 meters from the ground. Note that ideally, a 128-degree cone is recommended (2-to-1 distance-to-height ratio) for single structures or trees, and 144 degrees for extended structures or rows of trees. Use of a Brunton pocket transit or clinometer should provide adequate accuracy to ± 1 degree;

- Clearance from obstacles should be measured when foliage is present. For each sampler, a record of the actual vertical angle and geodetic azimuth of obstructions within the "cone" and/or closest to the "cone" should be recorded in the Maintenance Log;

- The location chosen should be assessed for security concerns including vandalism. Avoid colored sampler housings which contrast with the background or provide a silhouette suitable for a firearms target. The sampler housing should be painted to blend in with the surroundings. Proximity to public places such as recreation areas or schoolyards should be avoided to limit opportunity for vandalism. The ideal conditions include a site on State or Federal lands in an area not usually accessed by the general public, or on private property where the landowner limits access to the site;

- Line power should be from a separate 30-amp metered service with a local disconnect switch. The sampler should be connected to a weatherproof receptacle (instead of "hard wiring") so that the entire sampling unit may be replaced quickly. Power cords should be sized to exceed the expected sampler requirements to allow replicate samplers to be attached occasionally; and

  Protection devices must be installed and functional. Ground fault interrupting devices shall be installed at the receptacle, and a line voltage two-pole electronic protection device installed to protect the sampler electronics.

17.3.2 Routine Sampler Maintenance

Quarterly, an inspection of hoses, connections, and general conditions should be conducted per EM-8 to assure integrity of the system. If maintenance requiring sample train disassembly or evidence of system deterioration has occurred, the system should also be leak tested per EM-8. The inspection and any further testing should be recorded in the Maintenance Log. If sampler removal is required, turn off all power switches, including the service disconnect ***prior to*** unplugging the sampler unit for removal (see Section 17.5 for precautions).

Semi-annually during the routine calibration/leak check (see EM-8), encroaching vegetation growth and other obstructions shall be noted and recorded in the Maintenance Log. The obstruction should be measured at least annually per Step 7.2.3 and the records used to generate work order requests to control the obstructing vegetation as needed to maintain the minimum criteria.

Preventive maintenance will be conducted periodically and include:

- An inspection of the power line installation and the power cords shall be performed and documented, preferably by a qualified electrician. Replacement of deteriorated or damaged electrical cords or equipment must be performed by a qualified electrician;

- Each continuously operating air sampler vacuum pump assembly (motor and pump) shall be replaced with another unit and returned to the manufacturer for servicing. The unit shall be disassembled and inspected. At minimum, the pump carbon vanes (and motor brushes if part of the assembly) shall be replaced and the unit tested for proper operation. The unit shall be excessed if it is not repairable. The specific inspection, repairs, and parts replaced shall be recorded in the maintenance log such that any action pertaining to a specific piece of equipment is traceable.

Sampling train calibration and leak testing shall occur routinely as directed by EM-8.

17.3.3 Reporting of Abnormal Operation

Upon determining a sampler has stopped operating, or indication that a hiatus has occurred per step 6.3.9, the Environmental Scientist collecting the sample will take the following steps. Immediate reports are to be made by radio for conditions described below.

- Downtime over 10% of the week (16.8 hours) or finding an inoperative sample for categorized* ambient air sampling equipment must be reported immediately to the Environmental Lab Manager.

  Actions for downtime over 10% of the week are as follows:

  1. An Event Fact Sheet (Form WV-1098, per WV-987) and an Occurrence Report will be filed.

  2. Lab Manager will confirm with Environmental Lab Radiological group leader and main plant Shift Supervisor on facility airborne radioactivity release events (or lack thereof) for the previous week during downtime.

  3. Lab Field Group will investigate and document the cause of the sampler failure or hiatus in operation.

- Downtime under 10% of the week but greater than a standard error of ±15 minutes (or over 10% for non-categorized equipment) must be reported to the Environmental Lab Manager upon return to the lab after routine sample collection.

  Actions are as follows:

  1. An Event Fact Sheet will be filed.

  2. Lab Manager will confirm with Environmental Lab Radiological group leader and main plant Shift Supervisor on facility airborne radioactivity release events (or lack thereof) for the previous week during the downtime.

  3. Environmental Lab Field Group will investigate and document cause.

- Downtime is under 10% of the week and less than the standard error (± 15 minutes). There will be no action.

  Note:

Categorized* Samplers	Non-Categorized Samplers
AFRSPRD	AFDNKRK
AFTCORD	AFGRVAL
AFFXVRD	
AFSPRVL	
AFWEVAL	
AFBOEHN	
AFRT240	

  *Categorized "Class B" under current DOE 5000.3A criteria.

  If the sampler is operating, but shows abnormality (strange noises, indicator fluctuations, etc.), the unit should be replaced or repaired before it fails.

- Replace the unit as soon as possible per Section 17.3.

- Bench test the unit to determine and document problem.

- Repair and return unit to service per Section 17.3.

17.4 AUTHORITY

- DOE Order 5400.1 General Environmental Protection Program (November 1988)

- DOE Order 5400.5 Radiation Protection of the Public and the Environment (February 1990)

- DOE/EH-0173T Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (January 1991)

- DOE Order 5000.3A Occurrence Reporting and Processing of Operations Information

17.5 REFERENCES

- Air Sampling Instruments for Evaluation of Atmosphere Contaminants, Fifth Edition
- ANSI N13.1 - 1969 Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities
- SOP 00-11, Trouble Shooting and Maintenance of Electrical Equipment
- Calibration and Error Limits of Air Sampling Instruments for Total Volume of Air Sampled, NRC Reg. Guide 8.25, August 1980
- WVDP-098, Rev. 2 WVDP Site Environmental Monitoring Plan, April 1992
- Instruction Manual, Constant Flow Air Sampler Model 251-2-SP, Sierra Instruments
- Instruction Manual, Constant Flow Air Sampler, Kurz Userguide, 251 Brushless Motor Constant Flow Air Sampler
- WV-987, Occurrence Investigation and Reporting
- EM-8, Calibration Procedure for Air Flow Rate Rotameters and Air Flow Totalizer Gas Meters

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 18.0
ANALYTICAL WIPE SAMPLING FOR ORGANIC CHEMICALS

Purpose and Scope: The activities described in this procedure outline the general methodology to be used in collecting wipe samples from surfaces. Wipe samples are used to evaluate surfaces on which contaminated material may reside in quantities too small to sample with conventional soil sampling techniques. This procedure describes the equipment and forms required, as well as set-up procedures to be completed prior to sample collection.

Equipment:
Cotton gauze swabs;
High-purity alcohol;
Sample containers and labels; and
Personal Protective Equipment (see site-specific Health & Safety Plan).

Documentation:
Field Memorandum;
Field Record - Soil Samples; and
Sample Chain-of-Custody.

18.1 SET-UP PROCEDURES

All sampling procedures will be performed by Dames & Moore field personnel. Dames & Moore field personnel are responsible for:

- Reviewing Health and Safety protocol;
- Identifying each sampling location;
- Confirming sample locations and the analyte list with the Project Manager;
- Assembling all required equipment; and
- Assembling and maintaining proper field documentation as listed above.

18.2 WIPE SAMPLE COLLECTION PROCEDURE

Wipe samples will be collected from surfaces that may have come into contact with and retained potentially contaminated soil or other media. A wipe sample is collected when an insufficient volume of the potentially contaminated media exists for standard sample collection procedures. To collect a wipe sample:

- Soak a clean cotton gauze pad (typically 2 inches by 2 inches) in high-purity alcohol;

- Wearing clean rubber gloves; wipe a 100-square-centimeter area of the surface using straight back-and-forth strokes. Both sides of the gauze pad may be used;

- Place a sample pad in a clean, pre-labeled 4- or 8-ounce jar and seal; and

- Add information pertaining to the chain-of-custody form, analysis request form, field record of soil sample form, and field memorandum.

Include with the submittal of samples to the analytical laboratory some clean, unused cotton gauze pads for their analysis of "blank" samples and 40 milliliters of the alcohol if organic analyses are to be performed.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 19.0
CONE PENETROMETER TEST AND HYDROPUNCH™ SAMPLING — IN-SITU WATER

Purpose and Scope: The purpose of this procedure is to describe the general methodology for collecting Cone Penetrometer Test (CPT) data and Hydropunch™ water samples.

Equipment: CPT rig;
Hydropunch™ sampler; and
Appropriate sample bottles.

Documentation: Field Memorandum

Cone penetrometer testing (CPT) and in-situ groundwater sampling techniques (Hydropunch™) will be conducted in order to evaluate the lateral and vertical extent of impact to groundwater. An advantage to the use of the CPT and in-situ groundwater sampling techniques in combination is that stratigraphic and groundwater quality data can be obtained faster and less expensively than with well installations and generate little or no waste. The CPT and in-situ groundwater sampling should enable more accurate placement of wells for future detection monitoring and/or remediation of groundwater, if necessary.

19.1 CONE PENETROMETER TEST (CPT)

The CPT consists of a 1.5-inch diameter metal cone which is pushed into the ground at a constant rate of loading. The maximum reaction load for the CPT used is 20 tons. Instrumentation in the cone measures resistance at the tip and side friction along a sleeve just above the tip. Continuous plots of sleeve friction and tip resistance are obtained from the device and presented as tons/square foot. The ratio of sleeve friction to tip resistance is also produced on the data printout as percent. Refusal occurs when tip resistance exceeds about 400 tons/square foot.

The most common method of obtaining CPT-derived stratigraphic information is by the means of established correlations between soil type and the measured cone tip and sleeve friction resistance. The resistance to the continuous penetration encountered by the cone tip and sleeve is transmitted via electronic cable through hollow push rods and into analog and digital recorders at ground surface. The resulting data is utilized to

develop a detailed evaluation of subsurface site stratigraphy. In addition, site-specific correlation is typically developed through comparison with lithologic boring logs.

Decontamination of the CPT rods will be provided on the truck-mounted rig which has a self-contained rod-washing attachment which directs a hot-water jet from a steam cleaner onto the rods. The waste fluids generated will be pumped directly from the sealed washer into Department of Transportation (DOT) approved 55-gallon drums. Drums will be stored and disposed according to procedures described in the Waste Management Plan. Upon completion of each exploratory hole, a bentonite slurry will be pumped down the hole through a 1-inch PVC pipe placed down the hole. The surface of each hole is finished with road surface material or a non-shrinking, high-strength concrete, as appropriate.

19.2 HYDROPUNCH™ IN-SITU GROUNDWATER SAMPLING

Hydropunch™(HP) in-situ sampling is designed to provide the capability to obtain a representative formation water sample without a permanent well installation. The tool body consists of a stainless steel outer tube, an inner sample chamber, sample chamber Teflon check balls, and a drive point on the bottom, all of which can be dismantled for cleaning. The outside diameter of the tool is 1.66 inches and the length is 63.25 inches.

At each HP sample location, a solid (dummy) cone will be advanced to a few feet above the shallow sampling interval, just below the top of the saturated zone. The tool will then be replaced with the HP, and subsequently advanced to the desired shallow sample depth and a sample obtained. The HP will then be retracted out of the hole and replaced with a clean HP, and pushed to the next desired deeper depth, if warranted, and a sample obtained. This sampling technique provides depth-discrete chemical samples while minimizing the potential for cross contamination of the upper and lower sampling intervals. When collecting water samples in silty-clays, it may be necessary to leave the HP in the ground for an extended time (possibly overnight) in order to allow the sampler to fill.

At each sampling interval, once the target depth is reached with the sampling device, an upward pull opens the inlet section of the tool to allow groundwater to flow into the sample chamber. Teflon check balls in the HP seal the sample chamber when the inlet is closed, which allows the groundwater sample to be brought to ground surface. The sample will then be transferred from the sample chamber through a Teflon tube to the appropriate sample container. Sample containers will be documented and labeled according to SOP 1 - Water Sampling, and shipped according to SOP 5 - Sample Shipment.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 20.0
SHALLOW SUBSURFACE GEOPHYSICAL SURVEY METHODS
MAGNETICS, ELECTROMAGNETICS, GROUND PENETRATING RADAR
TRANSIENT ELECTROMAGNETICS AND SEISMIC REFRACTION

Purpose and Scope: The purpose of this procedure is to describe the general methodology for shallow subsurface investigations using magnetics, electromagnetics (EM), ground penetrating radar (GPR) transient electromagnetics (TEM) and seismic refraction. The resulting data can be used to identify underground objects, buried trenches, or buried waste and evaluate regional stratography. This SOP describes the equipment and necessary documentation, and the set-up procedures to be completed for the areas to be surveyed. In addition, the general methodology for collecting magnetic, EM, TEM, GPR and Seismic Refraction data are reviewed.

Equipment:
Ground Penetrating Radar;
Electromagnetic Instrument;
Transient Electromagnetic Instrument;
Magnetometer;
Seismograph and geophones;
Data logger;
Laptop computer;
Spray paint;
Flagging; and
Nylon rope for grid

Documentation: Field Memorandum.

20.1 SET-UP PROCEDURES

Set-up and execution of the geophysical survey will be conducted under the supervision of a Dames & Moore geologist, geophysicist, or engineer. Prior to conducting a survey, the following tasks will be completed:

- Identify and visit locations to be surveyed noting the presence of nearby buildings, structures, overhead, or buried powerlines, etc., that may interfere with data collection;

- Evaluate the geophysical methodologies best suited for the investigation objectives and the site conditions;
- Confirm survey locations and methods with project manager;
- Procure necessary equipment or subcontractors needed to collect the desired data. If warranted, test equipment to ensure it is in proper working condition; and
- Notify the proper on-site personnel of survey schedule. If necessary, mark or secure the area a day in advance to be sure there are no obstructions (e.g., parked cars) to collecting data.

Prior to collecting magnetic, EM, or GPR data, a data collection grid will be set up across the area to be surveyed. The exact grid spacing will be based on the estimated size of objects or subsurface features to be located.

20.2 GEOPHYSICAL METHODS

This section describes the background and general procedures for collecting data using magnetic, EM, GPR, TEM and seismic refraction methods. The method used will depend on the type of feature to be located, and the nature of the terrain.

20.2.1 Magnetics

Magnetometer surveys consist of measuring variations in the earths magnetic field. This may include measuring its total intensity and/or its vertical gradient. Vertical gradient measurements can be used to accurately locate buried ferrous objects such as tanks, pipes and metallic debris.

Magnetic data is collected by carrying a hand held magnetometer across the survey area. Individual readings are collected at evenly spaced points within a grid. Each magnetic measurement will be transmitted to a data logger. Magnetic measurements will be retrieved from that data logger and contoured using a personal computer. Contour maps will be used to identify areas of anomalous magnetization. These identified areas will be marked on the ground surface following identification.

20.2.2 Electromagnetics (EM)

Electromagnetic methods are used to measure earth conductivity values at specified points. The measured EM values, referred to as terrain conductivity, are obtained through electromagnetic induction as the instrument is carried 3 feet above the ground surface. The basic EM instrument consists of two coils and an electronics module. The transmitter coil is separated from the receiver coil by a specified distance. When energized, the transmitter coil induces circular eddy current which loops into the earth. The magnitude of each current loop is a function of subsurface conditions. In turn, each of these current loops generates a secondary magnetic field proportional to the value of the current flowing within the loop. A portion of this secondary magnetic field is intercepted by the receiver coil and results in an output voltage which is amplified by the instrument. The magnitude of this voltage is linearly related to the terrain (ground) conductivity. EM methods are used where shallow, penetration is required to qualitatively map lateral variations only. Depth or thickness determinations cannot be made solely by this method.

EM data is collected by carrying a hand held electromagnetic instrument across the survey area. Individual terrain conductivity measurements are collected at evenly spaced points over a grid. Each terrain conductivity measurement will be digitally recorded using a data logger. The terrain conductivity data will be downloaded from the data logger to a personal computer. Contour maps of terrain conductivity will be produced using a personal computer. Areas of anomalous conductivity will be identified and marked on the ground surface.

20.2.3 TEM

The transient electromagnetic (TEM) method can provide subsurface information similar to other electrical methods; however, it provides increased depths of investigation with significantly greater resolution.

A square wave signal is transmitted into a rectangular coil placed on the ground surface. When the current in the coil is rapidly terminated, the flow of electrical current is induced at the surface of the earth; this generates a secondary current signal. The

resulting secondary field is detected by a second coil and is measured over a period of time as the induced current diffuses into the earth and the secondary signal decays. This provides an indication of the change in resistivity/conductivity with depth. The depth of penetration is dependent on the area and number of turns of the transmitting coil, the current transmitted in the coil, and the repetition rate of the transmitted current.

TEM can be used to perform vertical electric soundings (VES) or to measure subsurface variations along profiles. For vertical electric soundings, the two coils remain stationary, while signals are recorded using different repetition rates. For profiling, a variation of this method is used. Both coils are moved from station to station along a profile, and a single signal sweep is used at each location. This will provide information regarding the vertical distribution of resistivities at each station.

TEM profiling will be used to further evaluate stratigraphy in the site vicinity. Station spacing and location will be determined in the field.

20.2.4 Ground Penetrating Radar

The Ground Penetrating Radar (GPR) system most frequently used in hazardous waste site investigations is an impulse system which radiates short-duration electromagnetic pulses into the ground from an antenna near the surface. These pulses are reflected from various interfaces within the earth and are picked up by the receiver section of the antenna and returned to the control unit for processing and display. These reflections occur at different soil horizons, soil/rock interfaces, rock/air interfaces (voids), manmade objects, or at any interface which creates a contrast in complex dielectric properties. For example, digging a trench and filling it again can create a difference between the dielectric properties of the disturbed earth and those of the undisturbed material which can be sensed by the GPR.

For presentation of data, GPR signals are processed and displayed by a graphic recorder. As the antenna is moved along the surface, the graphic display results in a picture-like record showing a continuous profile along a traverse.

The depth of radar penetration is very site-specific. Depths of 10 to 30 feet can be attained. The depth is reduced if groundwater, increases in electrical conductivity, or if there ar sufficiently high concentrations of fine-grained materials (silts or clays) present. For example, high concentrations of salts or montmorillonite clay are highly attenuative of the radar pulse and penetration may not exceed three feet.

GPR data is collected by moving an antenna along the ground surface. GPR signals are processed and analog records are displayed on a strip recorder in real time. The resulting record is a continuous profile along the traverse. Records will be used to identify potential trench locations and buried debris. Suspected locations will be marked on the ground surface.

20.2.5 Seismic Refraction

The seismic refraction method consists of measuring the travel times of compressional waves through the subsurface. Seismic wave energy is transmitted into the ground where it is refracted along interfaces of contrasting velocities (materials) back to the ground surface. By measuring the travel time of seismic waves from a source (shotpoint) to detectors at known distances on the surface, the seismic velocities and thicknesses of the respective velocity layers can be determined. This information can be used to determine thickness of fill materials, depth to groundwater, and depth to bedrock.

The seismic refraction survey will be conducted using a 12 or 24 channel signal enhancement seismograph and geophones. Source energy will be provided by striking an alloy plate with a 12 to 16 pound sledge hammer. Signal enhancement capabilities of the receiver will allow the seismic response from several hammer blows to be stacked, decreasing the effects of interference from random noise. Seismic records will be used to determine the arrival time of compressional waves at each geophone locations. Each seismic line will consist of 5 shot points: one at both end geophones, one in the center of the geophone spread, and one offset beyond each end geophone. Line lengths and geophone spacing will be determined in the field and adjusted appropriately to evaluate the refractor of interest.

Travel time curves of first compressional wave arrivals will be plotted. Slope intercept methods and generalized reciprocal methods will be used to determine the depth and velocity of each refractor.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 21.0
SOIL VAPOR SURVEY

Purpose and Scope: This procedure describes the general methods for conducting a soil vapor survey. A soil vapor survey is designed to collect shallow subsurface soil vapor samples and on-site analysis for volatile organic compounds.

Equipment:
Soil vapor sample probes;
Sample collecting rig;
Mobile laboratory; and
Sample containers/syringes.

Documentation:
Field Memorandum; and
Sample tracking form.

21.1 SET-UP

Prior to initiating a soil vapor survey, the field operations lead will meet with the project manager to review the task objectives, survey locations, and target analytes. Set-up procedures for the survey will include:

- Contacting and procuring a soil vapor sampling and analysis subcontractor for the specified time. The subcontractor will be provided with the site location, approximate number of sampling points, a range of depths at which sampling will be attempted, expected subsurface conditions, and target analytes;

- The field operations lead will conduct a site walk-through of the areas to be surveyed. Sampling locations will be identified and marked and proper utility clearance obtained through UC Davis;

- If necessary, 24 hours prior to the beginning of the survey locations will be cordoned -off to prevent access problems for the soil vapor sampling rig;

- The field operations lead will notify the laboratory of the sampling schedule for analytes that are not to be analyzed on-site. The laboratory will provide the appropriate sample containers and preservatives;

- The field operations lead will review the Field Sampling Plan and Health & Safety Plan, prepare the necessary documentation, and review appropriate site information and stratigraphy; and

- Leak tests have been conducted and equipment has been calibrated.

21.2 PROCEDURES

The procedures described below for collecting and analyzing soil vapor samples are supplied from Tracer Research Corporation. Though exact procedures may vary depending on the hired subcontractor the general methods will be similar and include:

The soil vapor investigation will be conducted by a two man crew and over seen by a Dames & Moore geologist. The crew will utilize a field van equipped with a gas chromatograph(GC) and accompanying computer equipment. Power is supplied by built-in generators;

- Prior to initiating the survey, sampling equipment will be tested and mobil laboratory instruments will be calibrated;

- Sampling is conducted by driving steel sample probes with a hydraulic press or hydraulic hammer (when gravels, buried debris or cemented material are encountered). The probes consist of 7 and 14 foot lengths of three-quarter inch diameter hollow steel pipe fitted with detachable drive tips;

- Sample probes are pushed or driven to the desired sampling depth. the above ground end of the probe is then fitted with a steel reducer and a length of polyethylene tubing leading to a vacuum source;

- Two to five liters of soil vapor are then evacuated from the system to purge the probe. If a sufficient quantity cannot be removed, the probe is pulled up a short distance until the evacuation can be completed; and

- After sufficient evacuation, a glass syringe needle is extended through a silicone rubber septa in the evacuation line and a sample is collected. Samples for volatile organic compounds are analyzed immediately with the mobil laboratory.

21.3 QUALITY ASSURANCE

Quality assurance procedures to be followed in order to minimize any potential cross-contamination of soil gas samples are as follows:

- Steel probes are used only once during the day and washed at the end of each day with high-pressure soap and hot water spray or stem-cleaned to reduce the possibility for cross-contamination. Enough probes are carried on the van to avoid the need to reuse any rods during the day;

- Probe adapters are used to connect the sample probe to the vacuum pump. The adaptor is designed to eliminate the possibility of exposing the sample stream to any part of the adaptor. Associated tubing connecting the adaptor to the vacuum pump is replaced periodically as needed during the job to ensure cleanliness and good fit. At the end of each day, the adaptor is cleaned with soap and water and baked in the GC oven;

- Silicone tubing (connecting the adaptor to the vacuum pump) is replaced as needed to ensure proper sealing around the syringe needle. This tubing does not directly contact soil gas samples;

- Glass syringes are generally used for only one sample per day and are washed and baked at night. If they must be used twice, they are purged with carrier gas (nitrogen) and baked between probe samplings;

- Interior port septa through which soil gas samples are injected into the chromatograph are replaced on a daily basis to prevent possible gas leaks from the chromatographic column;

- Analytical instruments in the mobile laboratory are calibrated each day by analytical standards from Chem Service, Inc. Calibration checks are also run after approximately every five soil gas sampling locations;

- 2 cc sub-sampling syringes are checked for contamination prior to sampling each day by injecting nitrogen carrier gas into the gas chromatograph;

- Prior to sampling each day, system blanks are run to check the sampling apparatus (probe, adaptor, 10 cc syringe) for contamination by drawing ambient air from above ground through the system and comparing the analysis to a concurrently sampled air analysis;

- All sampling and 2 cc sub-sampling syringes are decontaminated each day and no equipment is reused before being decontaminated. Microliter size sub-sampling syringes are reused only after a nitrogen carrier gas blank is run to ensure that it is not contaminated by the previous sample; and

- Soil gas pumping is monitored by a vacuum gauge to ensure that an adequate gas flow from the vadose zone is maintained. A reliable gas sample can be obtained if the negative pressure reading on the vacuum pump is at least 2 inches Hg less than the maximum pump capacity.

Detection limits for the compounds of interest will be a function of the injection volume as well as the detector sensitivity for individual compounds. Thus, the detection limit will vary with the sample size. Generally, the larger the injection size, the greater the sensitivity. However, peaks for compounds of interest will be kept within the linear range of the analytical equipment. If any compound has a high concentration, it will be necessary to use small injections, and in some cases to dilute the sample to keep it within linear range. This may cause decreased detection limits for other compounds in the analyses.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 22.0
SURFACE CONTAMINATION SURVEY FOR RADIOLOGICAL MATERIALS

Purpose and Scope: This procedure covers the techniques for using swipes, performing direct instrument readings and taking smears to determine removable and total radioactive surface contamination for routine evaluations, and for performing baseline surveys. This procedure is intended for use by Dames & Moore Radiation Protection Technicians.

Equipment: Survey instruments equivalent to Ludlum Model 12 with 43-5 probe;
Ludlum Model 3 or 31 with 44-9 probe;
Smears;
Swipes;
Personnel Protective Equipment (see site-specific Health and Safety Plan);
Signs to post; and
Glassine envelopes.

Documentation: Field Memorandum
Radiological Contamination Survey Form

22.1 SET-UP

Set-up for the surface contamination survey will be conducted prior to collecting field data or samples. Set-up will be conducted by the Radiation Protection Technician (RPT) after review of project requirements with the project or task manager. Set-up will consist of a review of survey data, general survey preparations, review of instrument requirements and a review of survey precautions.

22.1.1. Review of Survey Data

The RPT will be aware of the radiological conditions present or expected in the area, by reviewing the area's current and/or historical survey data, making note of:

- The type of contamination;
- The range of loose surface and fixed contamination;

- Areas of higher or lower contamination;
- Areas of higher and lower radiation;
- The wind direction and levels of, or potential for, airborne radioactivity; and
- Any other information useful in reducing radiation exposure to the RPT or other workers.

22.1.2 Survey Preparations

Preparation for the survey will consist of:

- Pre-stage equipment and material in an uncontaminated, low radiation area when practical; and
- All radiological surveys required for an area should be performed at one time to minimize personnel exposure.

22.1.3 Instrumentation Requirements

Survey instruments will have an unexpired "calibration due date" on the calibration label and satisfactorily pass a performance test and operational check as specified in the use procedure for the applicable instrument. Instruments equivalent to those specified below may be used. Dames & Moore's Senior Health Physicists will determine if a given instrument is equivalent.

- Ludlum Model 12 with 43-5 Probe
- Ludlum Model 3 or 31 with 44-9 Probe

Smear-counting instrumentation will have an unexpired "calibration due date" on the calibration label. In addition, performance tests will be conducted as specified in Dames & Moore's Radiological Field Instrumentation Performance Test Procedure.

22.1.4 Survey Precautions

Latex rubber gloves will be worn (and changed when contaminated or torn) when taking smears where loose surface contamination is present or suspected.

- When changing gloves, hands should be checked for contamination.
- A pair of cotton gloves may be worn under surgeon's gloves.
- Leather gloves may be worn when surveying rough or sharp edges. Leather gloves may be worn over surgeon's gloves.

Smears and swipes taken from within a controlled area should be disposed of in the same manner as radioactive waste.

If survey results indicate contamination levels exceeding the limits for the current area posting take the following action:

- Promptly post and control the area; and
- Notify the Site Safety Officer (SSO) (see Health & Safety Plan).

Instruments used in contaminated or potentially contaminated areas should be wrapped or bagged ensuring the detectors' active area is not covered. Exercise caution when removing the covering to avoid contaminating the instruments.

22.2 SURVEY INSTRUCTIONS

22.2.1 Requirements for Routine Contamination Survey of Areas

The frequency with which routine surface contamination surveys are to be performed will be determined by the SSO, the RPT and the Work Plan. A smear survey will be performed as part of each pre- and post-job survey required by project-specific documents, such as the contamination control portion of a Health and Safety Plan.

Direct contamination survey of the localized affected area will be performed as part of each pre- and post-job survey. The post-job surveys will be performed over the affected area.

22.2.2 Direct Measurement Technique

Surfaces or items that have the potential for fixed contamination will be surveyed for such contamination before any work, movement, or handling of materials. Fixed contamination may readily become removable during such activities and must be identified so that proper precautions may be taken. Suspected surfaces or items may be identified in a guideline or a work permit, or by user personnel.

Use a Ludlum Model 12 count-rate instrument or its equivalent, equipped with an air proportional or scintillation detector for measuring direct alpha activity.

Use a Ludlum Model 3 or 31 count-rate instrument or its equivalent, equipped with a GM pancake detector for direct measurement of beta/gamma activity.

NOTE: A HEADSET OR AUDIBLE INDICATION SHOULD BE USED FOR FASTER RESPONSE TIMES BY THE OPERATOR.

Use a shoulder strap to carry a non-belted instrument while climbing a ladder, or use a length of rope to hoist the instrument up after ascending and achieving secure footing.

Sweep the detector over the surface at a maximum rate of 2 inches per second, holding the detector within approximately 1/4 inch of the surface for alpha, and within 1/2 inch of the surface for beta/gamma surveys.

CAUTION: CARE SHOULD BE TAKEN TO AVOID CONTAMINATING THE SURVEY INSTRUMENT PROBE BY CONTACT WITH A CONTAMINATED SURFACE.

If an increase in audible or meter response is noted, slow the scanning rate to locate the source of the increased count.

Determine the area of maximum activity and hold the probe stationary for at least 15 seconds in order to take a measurement.

Record the instrument readings in counts per minute (cpm) on the Radiological Contamination Survey Form.

22.2.3 Smear Technique

CAUTION: SMEAR SURVEYS ARE PERFORMED TO QUANTIFY REMOVABLE CONTAMINATION LEVELS.

Each smear paper will be numbered and correspond to a numbered location on a diagram or sketch showing the area or item surveyed.

WARNINGS:

USE CAUTION IN SURVEYING ROUGH SURFACES TO AVOID PERSONAL INJURY OR TEARING OF THE SMEAR PAPER.

HANDLE SMEAR PAPERS CAREFULLY TO PREVENT PERSONAL CONTAMINATION OR THE SPREAD OF CONTAMINATION.

Hold a smear paper between the thumb and fingers, with the back of the smear against the fingers. Place the face of the smear paper against the surface to be smeared.

Apply moderate pressure across the smear paper to ensure that at least one-half of the face of the smear comes in contact with the surface being surveyed.

Each smear should be taken from an area of approximately 100 square centimeters (16 square inches).

Place each smear paper in a "fold-over" or glassine envelope container to prevent cross-contamination.

Smears from out of the way locations on equipment, and from other potential sources of contamination, should be obtained to ensure that a complete assessment of the area or item is made.

Smear non-uniform objects and/or surfaces such as odd shapes, interior surfaces, and small items, ensuring that these surfaces are adequately monitored and that the face of the smear paper has come in contact with a representative portion of the object.

NOTE: WET OR MOIST SMEARS SHOULD BE DRIED WITH A HEAT LAMP BEFORE COUNTING SO THAT ALPHA ACTIVITY WILL NOT BE MASKED.

Count the smears according to instructions provided in SOP's 24.0 and 25.0.

Record the measured contamination on the Radiological Contamination Survey Form. Additional preprinted pages with continuing prenumbered spaces for recording survey results will be used as needed.

To reduce or eliminate false positive results when counting alpha smears taken in areas where the limit is 20 disintegrations per minute (dpm) per 100 cm^2 (for Uncontrolled Areas), the following steps will be followed when the initial count result is greater than 20 dpm but less than or equal to 60 dpm:

- Count the smear three additional times; and

- Average the four counts and enter the average as the final result on the standard survey form.

22.2.4 Baseline Surveys

Baseline survey results will be documented on Radiological Contamination Survey Forms separate from the results recorded for routine surveys.

- The SSO will file the completed survey forms in a master survey binder kept in the Site Health and Safety office

- Survey forms will be filed by area

22.2.5 Release for Unrestricted-Use Surveys

Surveys of property to be released for unrestricted use will be performed in accordance with the following:

- Direct Surveys - Perform direct surveys for fixed-plus removable contamination in accordance with section 22.2.2 of this procedure;

- Removable Contamination Surveys - Perform smear surveys for removable contamination in accordance with section 22.2.3 of this procedure;

- Documentation - Complete a Radiological Survey Form for each item surveyed. Multiple items may be grouped on a single survey form, space permitting;

    - Provide a sketch or written description of the property, noting survey locations. Provide the survey results corresponding to each survey location, in its appropriate place on the form.

- Survey results for removable and fixed-plus removable contamination will be recorded in dpm/100 cm^2.

22.2.6 Records

Surveys will be documented accurately and legibly in black ink. The data will be recorded in sufficient detail to ensure that the meaning and intent of the record is clear. Ditto marks and continuation lines are not acceptable for repeated data. In all cases each specific number or "< number" must be recorded independently.

Any corrections made to the recorded entries on the Radiological Contamination Survey Form will be made by drawing a single line through the incorrect entry and recording the correct entry. The originator of the recorded entry will initial and date the entry. When it is not possible for the originator of the error to make the correction, the SSO may enter a correction followed by his/her initials and the date the correction is made.

Record the results on the survey form in the space provided, matching the smear results to the location marked on the survey diagram or sketch. Smear results will be reported in dpm/100 cm^2.

The background level will be recorded on the survey form for all radiological instruments.

- Identify on the survey diagram any temporary (e.g., rope, tape) boundaries; and
- Identify on the survey diagram any step-off pads.

In addition to radiological survey data, the following information will be provided on the survey form:

- Site and site identification number (or other specific identification);

- Date and time survey initiated (if the survey is continued or completed on a shift, note this in the comments section after the date and time initiated);
- Survey description: identify the purpose of the survey (e.g., routine, post decon, etc.) and area or item surveyed;
- Type(s) of instrument(s) used, their serial number(s), the date calibrated, the date calibration is due; and
- Signature(s) of individual(s) performing the survey.

Submit the completed survey form to the SSO for review. Unacceptable survey forms will be corrected and promptly resubmitted.

Copies of completed survey forms will be posted at entrances to Radiological Areas and storage areas, as applicable.

A copy of the survey will be retained in the Site Health and Safety Office.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 23.0
PERFORMANCE TEST AND OPERATIONAL CHECKS FOR ALPHA AND BETA-GAMMA CONTAMINATION SURVEY INSTRUMENTS

Purpose and Scope: This procedure defines the method for performance testing and operational checking of the Ludlum Model 12 and Model 3 or 31 Survey Instruments, performance and operational criteria, and the documentation of test results. Equivalent instruments may be used. Dames & Moore's Senior Health Physicists will determine if a given instrument is equivalent. This procedure is intended for use by Dames & Moore Radiation Protection Technicians.

Equipment: Ludlum Model 12; and
Ludlum Model 3 or 31 survey instruments.

Documentation: Field Memorandum
Instrument Daily Source Check Log

23.1 GENERAL

23.1.1 Servicing Instruments with Expired Calibration Dates

Any instrument with an expired calibration date will be transferred to a certified calibration facility for servicing.

23.1.2 Additional Servicing of Instruments

The Radiation Protection Technician (RPT) is permitted to replace defective batteries, and mylar in the Model 12 and Model 3 or 31 survey instruments, and perform routine maintenance and repair on anything but the electronics.

The RPT may replace damaged cables as long as the same cable type and length is used. All other instrument servicing will be referred to a certified calibration facility.

23.2 INSTRUCTIONS

Ludlum Model 12 and Model 3 or 31 Instruments - All Ludlum Model 12 and Model 3 or 31 survey instruments (or their equivalents) will be operationally checked and performance tested before use, as specified in this procedure.

Visual Checks - The calibration label of each instrument to be used or tested will be visually checked to ensure the due date of calibration has not expired.

A visual inspection will be performed before using the instruments. This will include checking the cables, probes, meter faces, switches, and mylar for damage.

23.2.1 Operational Checks

The following operational checks will be conducted in the field for each instrument:

- A battery check will be conducted before each intermittent use of an instrument. Set the selector switch to the BATTERY position. The meter needle will come to rest over the meter scale area marked BAT TEST if the batteries are satisfactory;

- On the Ludlum instruments the High Voltage will be tested by placing the range selector switch to the X1000 scale and the HV test button depressed. Check the manufacturers operating instructions for the proper voltage;

- Instrument operation will be verified with a check source at the start of each job for which the instrument is used. The following method (or equivalent method) may be used to complete the operation check:

  - A known alpha source, approved for use by Dames & Moore's Senior Health Physicists, will be used with the Model 12 alpha instruments, and a known gamma or beta source, approved for use by Dames & Moore's Senior Health Physicists, will be used with the Model 3 or 31 beta-gamma instruments;

  - Instrument operation will be observed by holding the instrument probe against the check source;

- A positive deflection of the meter needle of ± 20% of source value corrected for efficiency indicates instrument operation;
- Non-operating instruments will be returned to a certified calibration facility for repair.

23.2.2 Performance Tests

A performance test to verify calibration of survey instruments will be performed before each day of instrument use and following the replacement of batteries, mylar or cables.

Checking of the instrument calibration label and batteries will follow the requirements outlined below. The serial number of the instrument, due date of calibration, date/time, and RPT name and employee number or social security number will be recorded on the Daily Source Check Log specified for each instrument.

Readings of the Model 12 alpha survey instrument will be obtained for a NIST traceable source and instrument range selections. Each instrument range should be checked.

- Meter readings will be recorded on the Instrument Daily Source Check Log;
- The serial number and standard calibration value of each source will be recorded on the source check logs;
- A percent error will be calculated for each scale reading by the following formula:

$$\left[\frac{Reading - NIST\ Standard\ Value}{NIST\ Standard\ Value}\right] \times 100 = \%\ E$$

Readings of the Model 3 or 31 beta-gamma survey instrument will be obtained and recorded for the NIST traceable source value.

- With the selector switch set to the 1X scale and in the "S" (slow) response mode, obtain and record a background reading taken away from the source;
- With the instrument set on the appropriate range, place the beta/gamma source on the probe;
- Allow approximately 10-15 seconds for the meter response to stabilize before taking a reading of the meter;
- Subtract the background reading from the source reading and record the result on the Instrument Daily Source Check Log;
- The serial number and standard value of each source will be recorded on the source check log; and
- A percent error will be calculated for each scale reading. by the following formula:

$$\left[\frac{Reading - NIST\ Standard\ Value}{NIST\ Standard\ Value}\right] \times 100 = \%\ E$$

Instruments with errors outside a ± 20% range for any scale tested are not within an acceptable tolerance level and will be returned to a certified calibration facility.

The Daily Source Check Logs will be checked to show whether or not instrument performance is within tolerance levels.

Instruments for which test results differ by more than ±20% will be transferred to a certified calibration facility. This finding and the action taken will be noted in the Instrumentation Log Book.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 24.0
PERFORMANCE CHECKING AN OPERATION OF THE ALPHA SCINTILLATION SMEAR COUNTING INSTRUMENTS

Purpose and Scope: This procedure provides the requirements for performance testing and operation of the Eberline Model SAC-4 and the Ludlum models 1000 and 2000 with the 43-10, and 2929 alpha scintillation smear counting instrumentation. It also covers documentation of test results. Equivalent instruments may be used, the procedures will be found in the manufacturers operating instructions. Dames & Moore's Senior Health Physicists will determine if a given instrument is equivalent. This procedure is intended for use by Dames & Moore Radiation Protection Technicians.

24.1 GENERAL

Servicing of Alpha-Scintillation Counting Instruments - The servicing of alpha-scintillation counting instruments will be referred to a certified calibration facility, the equipment vendor, or the equipment owner.

24.2 INSTRUCTIONS

24.2.1 Background Count Rate

Prior to use of alpha-scintillation counting instruments on each shift, the average background count rate will be determined and a performance test conducted.

The calibration label will be visually checked to ensure the due date of calibration has not expired.

Determine the instrument background count rate by completing the following steps:

- Open the sample drawer and carefully wipe the top of the drawer and planchet area using cotton swabs or kimwipes moistened with alcohol;
- Place a clean smear on the sample tray with tweezers. The smear must remain flat in the sample tray while closing the drawer;
- Set the control switches of the counter as follows:

(1) Power	ON
(2) Minutes	10
(3) Multiplier	× 1
(4) Count Mode	TIMED

Note: Ensure the instrument power is turned on, at least 10 minutes before operation.

- Press the START/RESET button. The counting lamp will be illuminated;
- At the completion of the count time, divide the total counts by 10 to determine the average background count rate;
- If the average background count rate is less than 1 cpm, record the value on the Instrument Performance Test Log;
- Record the time of the background determination and the employee number or social security number in the space provided on the log sheet; and
- If the determination is equal or greater than 1, repeat the steps in the background guideline in section 4.1.2. If the second determination remains equal or greater than 1, the instrument may not be used.

Determine the percent error using a NIST calibrated alpha source or similar calibrated alpha source, approved for use by Dames & Moore's Senior Health Physicists.

- Ensure the source has a current calibration label and that the source value is not less than 1,500 disintegrations per minute (dpm);
- Record the serial number of the source on the Instrument Performance Test Log;
- Record the Certified activity of the source on the log sheet;
- Open the sample drawer and carefully place the alpha source, activity side up, in the middle of the sample holder;
- Close the sample drawer;
- With the count mode set to one minute, and all other controls set as per section 4.1.2, press the START/RESET button. The counting lamp will be illuminated;

- When the counting lamp is no longer lit, record the counts per minute (cpm) on the log sheet;

- Determine the percent (%) error of the observed counts compared to the source standard value per the following:

$$\% \text{ Error} = \frac{(\text{cpm / efficiency}) - \text{Certified Activity (dpm)}}{\text{Certified Activity (dpm)}} \times 100$$

- Record the % error on the log sheet;

- The SSO will review and approve of each shift record of performance testing. These records will be available in the project files;

- If the % error does not lie within the ± 20% range on the chart, do not use the instrument and notify the SSO; and

- Remove the source from the sample holder and return it to the designated storage location.

24.2.2 Operation of the Alpha-Scintillation Counting Instrument

Normal operation of the alpha-scintillation counting instrument will be as specified.

- Verify that the electrical power to the instrument has been on for 10 minutes;

- Set the instrument controls as per section 24.2.1 of this procedure; however, one-minute counts will be obtained for routine smear counts unless a longer count time is directed by the Site Safety Officer (SSO);

- Pull the sample drawer open until fully extended and place the smear to be evaluated in the center of the sample holder, activity side up;

- Ensure the sample is a flat as possible to prevent contamination of the detector window. Carefully close the sample drawer;

- Press the START/RESET button;

- The instrument will count for the preset time. At the end of the count time, the instrument readout will display gross counts;

- Record the counts per minute and other information on the Alpha and Beta-Gamma Contamination Survey Form as required by SOP 23.0; and

- Open the sample drawer and dispose of the smear in the Radioactive Waste receptacle.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 25.0
PERFORMANCE TESTING AND OPERATION OF THE BETA SMEAR COUNTING INSTRUMENTATION

Purpose and Scope: This procedure provides instructions on performance testing, operation, use, and documentation of results when using the Eberline BC-4 or the Ludlum 2929. Equivalent instruments may be used, the procedures will be found in the manufacturers operating instructions. Dames & Moore's Senior Health Physicists will determine if a given instrument is equivalent. This procedure is intended for use by Dames & Moore Radiation Protection Technicians.

Equipment: Eberline BC-4;
Ludlum 2929; and
Thin substrate NIST Certified SrY-90 beta source.

Documentation: Field Memorandum; and
Instrument Performance Test Log.

25.1 GENERAL

The BC-4 and the beta-gamma portion of the 2929 has been modified to be insensitive to alpha radiation; therefore, the results obtained will be reported in dpm/100cm^2 beta-gamma equivalent. All servicing will be referred to a certified calibration facility, the equipment vendor, or the owner.

25.2 INSTRUCTIONS

25.2.1 Conducting Background Count Rate and Performance Test

Prior to first use on each shift, the background count rate of each instrument will be determined and a performance test conducted.

The calibration label will be visually checked to ensure the due date of calibration has not expired. If calibration due date has passed, refer the instrument to a certified calibration facility, the equipment vendor, or the owner for servicing.

Inspect the instrument for any physical damage that could affect its operations. If questionable, notify Site Safety Officer (SSO).

Ensure that the instrument is connected to a power source 110 VAC/60 Hz.

Determine the instrument background count rate by completing the following steps:

- Open the sample drawer and carefully wipe the top of the drawer and planchet area using cotton swabs or kimwipes moistened with alcohol;

- Place a clean smear on the sample tray with tweezers. The smear must remain flat in the sample tray while closing the drawer;

- Set the control switches of the BC-4 or 2929 counter as follows:

(1) Power	ON
(2) Minutes	10
(3) Multiplier	x1
(4) Count Mode	TIMED

Note: Ensure the instrument power is turned on, at least 5 minutes before operation.

- Press the START/RESET button. The counting lamp will be illuminated;

- At the completion of the count time, divide the total counts by 10 to determine the background count rate, in counts per minute (cpm);

- If the background count rate is between 25 and 60 cpm, record the value on the Instrument Performance Test Log. An acceptable background is between **25** and **60 cpm**;

Note: Background levels may vary depending on location; background levels outside the range of 25 to 60 cpm may not be an instrument problem.

- Record the time of the background determination and the employee's initials in the space in the log;

- If the determination is equal to or greater than 60 cpm, or equal to or less than 25 cpm, repeat the steps outlined above. If the second determination

remains less than 25 cpm, or greater than 60 cpm, do not use the instrument and notify the Site Safety Officer (SSO).

Determine the performance test percent error using a thin substrate NIST Certified SrY-90 beta source or another source approved by Dames & Moore's Senior Health Physicists. The source should be nominal activity 20,000 disintegrations per minute (dpm).

- Ensure that the source has a current calibration label;
- Record the source serial number on the Instrument Performance Test Log;
- Record the activity of the source in dpm according to month of use (if required), in the log;
- Open the sample drawer and carefully place the beta (or gamma) source, activity side up, in the middle of the sample holder;
- Close the sample drawer;
- With the count mode set to one minute and all other controls set as described above, press the START/RESET button. The counting lamp will be illuminated;
- When the counting lamp is no longer lit, record the cpm in the log;
- Determine the percent (%) error of the observed counts compared to the source standard value per the following:

$$\% \text{ Error} = \frac{(\text{cpm} / \text{efficiency}) - \text{Certified Activity (dpm)}}{\text{Certified Activity (dpm)}} \times 100$$

- Record the % error in the log;
- The SSO will review and approve each shift record of performance testing at the end of each week. The Performance Test Log will be available in the project files for review;
- If the % error does not lie within the ± 20% range on the chart, do not use the instrument and notify the SSO; and

- Remove the source from the sample holder and return it to the designated storage location.

25.2.2 Operation of the Beta Smear Counting Instrument

Operation of the beta smear counting instrument when counting smears will be as follows:

- Ensure the instrument power is turned on, at least 5 minutes before operation;
- Set the instrument controls as described above; however, one-minute counts will be obtained for routine smear counts unless a longer count time is directed by the SSO or Radiological Engineering;
- Pull the sample drawer open until fully extended and, using tweezers, place the smear to be evaluated in the center of the sample holder, activity side up;
- Ensure the sample is as flat as possible to prevent contamination of the detector window. Carefully close the sample drawer;
- Press the RESET/START button;
- The instrument will count for the preset time. At the end of the count time, the instrument readout will display gross counts;
- Perform the following to determine the dpm value for the smear;

$$\text{dpm} = \frac{\text{cpm - (instrument background per shift)}}{\text{count time in minutes x efficiency}}$$

this reduces to:

$$\text{dpm} = \frac{\text{CPM (net)}}{\text{efficiency}}$$

- Record the dpm smear value and other information on the Contamination Survey Form as required by SOP 23.0;

- Open the sample drawer and, using tweezers, dispose of the smear in the Radioactive Waste receptacle; and

- Repeat the above steps for all smears to be counted.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 26.0
RADON WORKING LEVEL MONITORING - GRAB SAMPLE TECHNIQUE

Purpose and Scope: This procedure covers the Kusnetz grab sample method for determining radon working levels. Equivalent instruments may be used. Dames & Moore's Senior Health Physicists will determine if a given instrument is equivalent. This procedure is intended for use by Dames & Moore Radiation Protection Technicians.

Equipment: Air sampling pump;
Filters and filter holder assembly;
Alpha Counting; and
Timer.

Documentation: Field Memorandum.

26.1 GENERAL

Radon and Radon Daughters - Radon (^{222}Rn) is a gas and radon daughters (^{218}Po, ^{214}Pb and ^{214}Bi known as RaA, RaB and RaC respectively) are particulates. This method involves trapping the daughter products in a filter, allowing a short time for decay and counting. This gives a "real time" results of radon working levels. A working level is any combination of radon and radon daughters that result in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy per liter of air.

26.2 INSTRUCTIONS

26.2.1 Equipment

The following equipment will be required:

Air Sampling Pump

- A pump capable of maintaining a flow rate of 2 to 25 liters per minute through the selected filter is required. The flow rate should not vary significantly during the sampling period. A calibrated air flow measurement device is also required.

Filters and Filter Holder Assembly

- Membrane type filters are recommended with a pore size not to exceed 0.8 microns and a filter holder assembly suitable for the type of filter being used. Adapters for the attachment of the filter holder to the pump are also required.

Alpha Counting System

- A detector and scaler setup, maintained, and performance tested in accordance with SOP 24.0.

Timer

- A stopwatch or timer to measure the sampling times and counting times is required.

26.2.2 Sample Collection

Install the filter in the filter holder assembly and attach to the pump

Operate the pump for exactly 5 minutes, pulling air through the filter. Record the starting time and air flow rate.

Stop the pump at the end of the 5 minute sampling period and start or reset the stopwatch.

26.2.3 Sample Counting

Carefully transfer the filter from the filter holder assembly to the detector. Orient the collection side of the filter towards the face of the detector.

Operate the counter over any 10 minute time interval between 40 minutes and 90 minutes after the sampling start time. Record the total counts for the sample and the time (in minutes after sampling) at the midpoint of the 10 minute count interval.

26.2.4 Analysis

Calculate working levels (WL) as follows:

$$WL = \frac{C}{K_t \times V \times E}$$

Where:

C = Sample cpm - Background cpm

V = Volume of Air Sampled in Liters, = flow rate (liters per minute) x time (minutes)

E = Counter Efficiency (cpm per dpm)

K_t = Kusnetz Factor - From the chart, time in minutes from stopping the pump to the midpoint of the count interval

26.2.5 Kusnetz Factor Chart

Time	K_t	Time	K_t
40	150	70	90
42	146	72	87
44	142	74	84
46	138	76	82
48	134	78	78
50	130		
52	126	80	75
54	122	82	73
56	118	84	69
58	114	86	66
		88	63
60	110		
62	106	90	60
64	102		
66	98		
68	94		

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 27.0
PERFORMANCE OF THE GAMMA RADIATION SURVEY

Purpose and Scope: This procedure defines the requirements for performing gamma radiation surveys and documenting survey results. This procedure is intended for use by Dames & Moore Radiation Protection Technicians.

Equipment: Gamma survey instrument; and
Watch.

Documentation: Gamma Survey Instrument Calibration Log; and
Gamma Radiation Survey Form.

27.1 GENERAL

27.1.1 Review of Survey Data

The Radiation Protection Technician (RPT) will be familiar with the radiological conditions present or expected in the area by reviewing the area's current and/or historical survey, making note of:

- The type of radiation;
- The range of loose surface and fixed contamination;
- Areas of higher or lower contamination;
- Areas of higher and lower radiation;
- The wind direction and levels of, or potential for, airborne radioactivity; and
- Any other information useful in reducing radiation exposure to the RPT or other workers.

27.1.2 Survey Preparations

Pre-stage equipment and material in a low radiation level area, when practical.

All radiological surveys required for an area should be performed concurrently to minimize the surveyor's exposure.

Use a carrying strap or lanyard to secure the instrument when climbing; or raise and lower the instrument to the appropriate elevation with a length of rope.

27.1.3 Instrumentation Requirements

Select the appropriate type instrument, using the following criteria. (The following list is a guideline for selection and is not intended as a requirement that all the instrumentation listed be available).

- Gamma survey instruments must be approved by Dames & Moore's Senior Health Physicists. They will also determine if an instrument is equivalent.
- The appropriate gamma survey instrument will depend on the expected radiation levels that will be encountered. No one instrument will cover all of the ranges that could be found on a radium site. This will have to be determined as the project develops.
- Appropriate calibration for the types and energy range of the radiation to be measured.
- Sufficiently high range to read the highest expected exposure rate.

The RPT will verify that performance testing of the instruments has been performed daily prior to use. The RPT will record the results in a calibration log for each instrument. Performance tests for instruments will be done in accordance with the manufacturer's recommendations.

Survey instruments will have an unexpired "calibration due date" on the calibration label. A battery check will be conducted before each intermittent use of the instrument.

27.2 INSTRUCTIONS

27.2.1 Survey of Radiation Areas

Enter the area with the instrument scale selector set to measure the highest expected radiation level. Hold the instrument at waist-level and walk slowly through the area. Through the use of headset or audible response and observation of instrument readings, locate all elevated radiation levels within the area. Adjust the instrument selector downscale, as necessary, to obtain the radiation level reading(s). Record instrument readings on Gamma Radiation Survey form. The instrument reading will be an average of the meter needle fluctuations after instrument response has stabilized or the digital readout if present.

27.2.2 Survey Records

The RPT will document the survey readings accurately and legibly on a standard preprinted survey form. Use sufficient detail to ensure that the meaning and intent of the record is clear. Survey points will be denoted on work area diagrams or sketches and attached to the completed survey form.

Record the radiation survey data as follows:

- Record the radiation measurement of each survey position for each identified survey location and any areas with elevated readings;
- Unless all radiation surveys are performed at the same position (distance from the source) and that position is stated on the survey (e.g., "all radiation measurements at 36 inches from ground level"), specify the position after each measurement;
- Note distances of instrument readings taken at distances other than 30 cm on the survey form;
- Identify all posted radiological boundaries in the area surveyed; and
- Note units for all readings (either with a note at the top, or for each reading. Underline or otherwise highlight any units out of the ordinary.

In addition to the radiological information, include the following information on the survey form:

- Client identification;
- Site designation and number (or other specific identification);
- Date and time survey initiated;
- Survey description: identify the purpose of the survey (e.g., routine, post decon, etc.) and area or item surveyed;
- Type(s) of instrument(s) used, their serial number(s), the date calibrated, the date calibration is due; and
- Signature(s) of individual(s) performing the survey.

The RPT will submit completed survey forms to the Site Safety Officer (SSO) for review. Unacceptable survey forms will be corrected by the RPT and promptly resubmitted.

A copy will be retained in the Site Safety Office.

27.2.3 Control for Radiation Areas

When a radiation level exceeding 5 mrem/h is identified initiate radiation controls as follows:

1. Post and control the area in accordance with the DOE Radiological Control Manual or the site-specific Radiologic Control Manual; and
2. Notify the SSO.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 28.0
USE OF THE BICRON FIDLER
(FIELD INSTRUMENT FOR THE DETECTION OF LOW ENERGY RADIATION)

Purpose and Scope: This procedure covers the general use of the Bicron FIDLER (Field Instrument for the Detection of Low Energy Radiation) to identify low-energy gamma and x-ray emitting radiation sources and to document survey findings. Equivalent instruments may be used. Dames & Moore's Senior Health Physicists will determine if a given instrument is equivalent. This Procedure is intended for use by Dames & Moore Radiation Protection Technicians.

Equipment: Bicron FIDLER (Field Instrument for the Detection of Low-Energy Radiation).

Documentation: Field Memorandum; and
Instrument Calibration Log.

28.1 GENERAL

28.1.1 The FIDLER Unit Components

The FIDLER unit consists of a Bicron Analyst meter, equipped with a scaler option, and a Bicron G-5 thin window scintillation probe connected by a signal cable. This instrument also includes a Bicron G-5 HV handle and a detector housing.

28.1.2 Low-Energy Radiation Detection

The use of the FIDLER provides a qualitative indication of the presence or absence of gamma and x-ray low-energy radiation sources. Other methods must be used for quantitative measurements of sources.

28.2 INSTRUCTIONS

28.2.1 Instrument Inispection

Prior to using the instrument, perform the following checks:

- Document that the manufacturer's calibration due date has not expired;
- Inspect the instrument for physical damage that could affect its operation;
- Document that the instrument has successfully passed a performance test within the last 24 hours by checking the field calibration log; and
- Perform a battery check and document that the needle reads in the BAT OK region.

28.2.2 Instrument Failure

If the instrument fails any of the above checks it may not be used.

28.2.3 Instrument Controls

Set the instrument controls as follows:

Response Mode	Slow
Audio	ON
Scale	x100
Mode	Channel 1

28.2.4 Background Reading

Determine a background reading in the area of use by holding the probe still and performing a one-minute scaler count. To perform the one-minute scaler count, press the count button. The red LED lamp will be illuminated, indicating that the scaler is counting. When the LED lamp goes out, the count is finished. Record the counts per minute (cpm) from the scaler display located on the instrument face. The background count should be taken at a minimum of 15 feet from the items to be surveyed and any other non-background radiation source. When doing a soil surface scan, it is recommended that the background be taken in an area where contamination is known not to exist or over a location where the background of the soil is known.

28.2.5 Probing

Hold the probe at least 12 inches from the item or surface being surveyed if the item is much larger than the probe. If the item is the same size or smaller than the probe, hold the probe on contact.

28.2.6 Scanning

Scan slowly, no faster than two inches per second, to give the instrument time to respond. Scan rates greater than two inches per second drastically reduce the probability of detection. The operator should listen closely to the audio output, as it responds faster than the instrument reading.

28.2.7 Surveying

When surveying, any response above background should be investigated by holding the instrument still for one minute to verify the above-background reading. If an above-background reading is confirmed, slow the scanning speed. Attempt to locate the source by moving the probe in different directions and by scanning in the directions yielding the highest above-background readings.

When the highest reading is located, perform a one-minute scaler count, and record the results of the count and the location the reading was taken.

28.2.8 Battery Check

Periodically during use, perform a battery check to ensure the batteries are still good.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 29.0
PERFORMANCE OF PERSONNEL CONTAMINATION MONITORING

Purpose and Scope: This procedure defines the use of instruments for personnel contamination monitoring, criteria for personnel contamination, control of contaminated personnel, and documentation of contamination occurrences. This procedure is intended for use by Dames & Moore Radiation Protection Technicians.

Equipment: Ludlum Model 12 or equivalent Survey Scope.
Ludlum Model 3 or 31 Count Rate Meter

Documentation: Field Memorandum.

29.1 GENERAL

29.1.1 Radiological Occurrence Response Actions

If a radiological occurrence involves a combination of conditions, response actions will be taken in the following priority:

- Critical injury or illness;
- Skin contamination;
- Noncritical injury or illness; and
- Possible inhalation of radioactive material.

29.1.2 Emergency Medical Care

Emergency medical care of critically injured or ill personnel will take precedence over radiological actions.

29.1.3 Transporting Contaminated Personnel

Care will be exercised in transporting contaminated personnel to minimize the spread of contamination in Uncontrolled Areas. A contractor-owned or leased vehicle will

normally be used for transportation. However, a personal vehicle may be used if a critical injury is involved. The transporting vehicle will be controlled until released by the Dames & Moore Radiation Protection Technician (RPT).

29.2 INSTRUCTIONS

29.2.1 Monitoring Personnel for Contamination

Monitoring of personnel for contamination will be performed in the following situations, however, other requirements may exist in upper-tier documents (e.g., Work Plans or Site-Specific Health and Safety Plans [SSHSPs]) and should also be followed:

- Whenever leaving a Radiologically Controlled Area;
- Whenever exiting a Contaminated Area;
- During and after work where a potential exists for release of radioactive material;
- Whenever passing through a Controlled Area; and
- Following personnel decontamination.

Personnel monitoring will consist of a whole-body survey except for precautionary surveys. The whole-body survey will be conducted front and back, over the following areas or articles:

- head (pause at mouth and nose);
- neck and shoulders;
- arms (pause at each elbow);
- hands (pause at palms and back of hands);
- respirator (exterior, interior, cartridge, and straps);
- chest and abdomen;
- back, hips, and seat of pants;
- legs (pause at each knee);
- pant cuffs (pause at cuff);

- shoe-cover bottoms;
- shoe tops; and
- shoe bottoms (pause at sole and heel).

Alpha contamination monitoring will be performed as follows:

- The Ludlum Model 12 Survey Meter probe type (or equivalent) will be used. Dames & Moore's Senior Health Physicists will determine if a given instrument is equivalent.
    - The detector will be held within 1/4 inch of the body or clothing surface and moved slowly, (i.e., about 2 inches per second);
    - To the extent practical, clothing wrinkles will be smoothed prior to monitoring;
- The instrument scale selector control will be set to the range appropriate for measuring levels of contamination;
- Visual or audible instrument response will be used to determine the presence of contamination;
- Clothing will be considered contaminated if the detectable radioactivity is greater than background; and
- Skin will be considered contaminated if any level of radioactivity above background is detected.

Beta/gamma contamination monitoring will be performed as follows:

- The Ludlum Model 3 or 31 Count Rate Meter or equivalent equipped with a pancake detector will be used. Equivalent instrumentation release limits will be established by Dames & Moore's Senior Health Physicists, taking into consideration the minimum detectable activity (MDA) of the instrument;
- If the background count rate exceeds 150 counts per minute (cpm), consideration will be given to moving the monitoring station;
- The detector will be held within 1/2 inch of the body or clothing surface and moved slowly (i.e., about 2 inches per second);

- Visual or audible instrument response will be used to determine the presence of contamination;
- Clothing will be considered contaminated if 100 cpm above background are indicated; and
- Skin will be considered contaminated if any level of radioactivity is detected.

When skin contamination is detected, the contamination will be appropriately covered and contained. The RPT will escort the contaminated employee to the decontamination area. Field decontamination may be performed provided adequate decontamination equipment is available.

- For wound contamination or for contamination observed around the nose or mouth, Dames & Moore's Senior Health Physicists will be notified immediately.

Area controls will be established for personnel contamination occurrences.

- Stop traffic through the area where contamination occurred;
- Perform contamination surveys to determine the extent of the contamination;
- Isolate the affected area by posting and barricading it;
- Identify the travel routes and other personnel that are potentially contaminated; and
- Perform area and personnel contamination monitoring as required.

Reports required for contamination occurrences will be completed, approved by the SSO, and forwarded to Dames & Moore's Health Physicists as soon as possible.

29.3 CALIBRATION

The Ludlum survey scope will be calibrated every six months, or at the manufacturer's recommendations, by the manufacturer. The instrument will also be source checked on a daily or as-needed basis to verify proper working condition.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 30.0
AIRBORNE RADIOACTIVITY MONITORING

Purpose and Scope: This procedure covers airborne radioactivity monitoring by the filtration method and includes corrections for radon daughters. Equivalent instruments to the ones listed in this procedure may be used. Dames & Moore's Senior Health Physicists will determine if a given instrument is equivalent. This procedure is intended for use by Dames & Moore Radiation Protection Technicians.

Equipment: Air Sampling Pump: Such as the Eberline RAS-1 capable of maintaining a flow rate of up to 100 liters per minute or greater through the selected filter is required. The flow rate should not vary significantly during the sampling period. A calibrated air flow measurement device is also required.

Filters and Filter Holder Assembly: Membrane type filters are recommended with a pore size not to exceed 0.8 microns and a filter holder assembly suitable for the type of filter being used. Adapters for the attachment of the filter holder to the pump are also required.

Counting System: A detector and scaler setup, maintained, operated, and performance tested in accordance with Dames & Moore Radiological Operating Procedures (D&MROP) 30.2.1 and 30.2.2.

Documentation: Field Memorandum; and
Air Sampling Data Record.

30.1 GENERAL

30.1.1 Airborne Radioactivity

Certain activities performed in the field pose the potential for airborne radiological contamination. These include the use of drilling equipment in contaminated soil, driving vehicles over contaminated ground, and decontamination. It is necessary to determine the presence and amount of airborne radiological contaminants to assess the adequacy of implemented levels of protection to the workers.

30.2 INSTRUCTIONS

30.2.1 Sample Collection

- Install the filter in the filter holder assembly and attach to the pump. Place the pump in the appropriate location as determined by indoor air flow measurements or, if outdoors, downwind of the proposed working area and as close to the breathing zone as possible; and

- Operate the pump for the time interval required, pulling air through the filter. Record the start time, the stop time, and the air flow rate on Field Memorandum.

30.2.2 Sample Counting

- Store the sample filter for radon daughter decay, approximately 48 to 72 hours. The sample should be stored in a separate glassine or smear envelope;

- Carefully transfer the filter from the storage envelope to the detector. Orient the collection side of the filter towards the face of the detector; and

- Count the sample for 10 minutes. Record the total counts for the sample, the counting time and date, and the countrate (cpm).

30.2.3 Analysis

Calculate the activity as follows:

$$\text{Activity} = \frac{\text{Sample cpm} - \text{Background cpm}}{V \times E}$$

Where:

V - Volume of Air Sampled in Liters - flow rate (liters per minute) · sampling time (minutes) · 1000 ml/l

E = Counter Efficiency, the fraction $E = \frac{\text{source count rate in cpm}}{\text{source activity in dpm}}$

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 31.0
CHANGE IN STANDARD OPERATING PROCEDURES

Purpose and Scope: The Purpose for this procedure is to allow project personnel, with appropriate approvals, to make minor changes to the SOPs based on unanticipated or unforeseen changes in the field conditions. The change may be requested by any member of the project staff and documented using the Interim Change Notice Form.

Documentation: Field Memorandum
Interim Change Notice
Record of Telephone Conversation

Interim Change Notices (ICN) will be used to identify significant changes to the SOPs where a revision of that SOP is not appropriate at that time. The interim change may be requested by any member of the project staff. The staff requesting the ICN should carefully document the series of events leading to the request for a change in SOPs. The request for change is made to the Field Manager who reviews the need for the change of procedure. The Field Manager documents the change using the ICN form and notifies the Task Manager. The Task Manager will submit the ICN to ESO for review and approval. The ICNs will not be incorporated until approval from ESO has been received. Minor changes in procedures will be documented within the Field Memorandum only.

When documenting the reasons for the change, the Field Manager will include.

- The SOP affected;
- The portion of the SOP being changed;
- The series of events that lead to the need for the change;
- A description of the new procedure; and
- Specific details on when and where the new procedure will be used.

All ICNs are numbered and distributed by Dames & Moore QA/QC personnel.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 32.0
VEGETATION SAMPLING

Purpose and Scope: Samples will be collected to characterize contaminant concentrations in vegetation compartments at the LEHR site. Terrestrial foodstuffs will be sampled to provide verification that hazardous materials traceable to the site are not present in the environment above expected background levels. The primary concern in sampling vegetation is to assure that site-generated radioactive materials and hazardous chemicals have not been introduced into the local food chain where they could be further distributed. Documented vegetation concentrations will therefore help to support subsequent ecological risk assessment calculations. This SOP describes the techniques to be implemented for vegetation sampling. In addition, equipment and documentation requirements necessary for sampling are described.

Equipment:

Maps (described above)
Calculator with random number generator
2 ten-meter ropes marked in meter units
Step ladder
Grass shears, trowel, pruner and pruner with extended handle
Wooden frame that measures one square meter
Mechanical balance with a minimum of 5 kilogram capacity
Necessary weights for mechanical balance
Measuring tape
Kneeling pad
Zippered plastic bags for sample collection
Sample labels (4" x 2" white, self-adhesive labels)
UCD Sample Custody Seals
Waterproof pen
Stainless steel bowl and spoon
Coolers, blue ice and thermometers
Safety equipment (see Section 6.0 of Heath & Safety)
Cleaning and decontamination equipment (Non-phosphate cleaning solution, four 5-gallon buckets, bottle brushes, distilled water, potable water and paper towels)

Documentation: Field Memorandum;
Vegetation Sampling Record (Figure 1);
Environmental Sampling Log (Figure 2);
Sample Chain of Custody (COC; Figure 3).

32.1 RESPONSIBILITIES AND QUALIFICATIONS

Personnel executing the protocols described in this SOP should be instructed in the use of the sampling apparatus and proper identification of species likely to be encountered. At least one person on each field crew should have a minimum of a Master's degree in biology and two years of field experience in conducting vegetation studies. Personnel must also have met OSHA training requirements (40 CFR 1910.120). Periodic performance audits of field personnel will be conducted according to established procedures.

32.2 GENERAL PROCEDURES

Reconnaissance surveys will be performed to provide a consistent and encompassing view of area habitats and to provide qualitative observation for relative comparisons among vegetation/land use types. The principal vegetation components to be considered in the risk assessment are the native and disturbed vegetation at the site and, possibly nearby agricultural fields. Sample sites will be selected after additional site information is collected and terrestrial ecological receptors are selected.

32.3 SAMPLING PREPARATION

Field sampling will be preceded by completing and incorporating preparatory procedures. These procedures include mapping sampling locations, selecting site for quality assurance/quality control (QA/QC) samples, preparing sampling labels, acquiring and donning appropriate personal protective equipment (PPE) and reviewing and becoming knowledgeable of the necessary safety precautions.

32.3.1 Sample Locations

Prior to sample collection, a detailed map or drawing of the sampling locations will be prepared. This map will define the location in terms of area landmarks (e.g. trees, fences, walkways, etc.), so that consistent layout of the sampling grid will be established for current and future sampling. Draw map Block 10 of the Vegetation Sampling Record (Figure 1).

32.3.2 Select Sites for Quality Assurance/Quality Control (QA/QC) Samples

In order to provide essential comparison data, it is necessary to prepare both split and duplicate samples for analysis. Sampling locations for split samples and duplicate samples will be selected from the set of sample locations. This will be accomplished through the use of a random number table or generator (see section 5.2.5). The total percentage for QA/QC samples will be at least 10% of the total number of samples. If the randomly selected sample site is not collectable or has been destroyed, random sites will continue to be generated until a collectable site is identified. The duplicate and split samples will receive full analysis.

32.3.3 Preparation of Sample Labels

In order to save time and assure correct sample identification, sample labels will be prepared before going into the field. Unique sampling numbers will include the sample ID designation defined in the Environmental Monitoring Plan, Table 3.3. The complete number will begin with the project identifier (LEHR), followed by the year and then the Environmental Monitoring Plan location designation: i.e., LEHR93-VS-AS-1. A duplicate (D) or split (S) sample will end in the appropriate letter (D or S). Do not attach the labels to the sample container (bag) before going into the field.

Information to be included on the sample label:

-Sample ID (as above)
-UC Davis EH&S

-Analysis required (list all analyses requirements for the sample
-EPA method(s)
-Date and time sampled
-Initials of person collecting sample

Sample labels will be attached to the sample container immediately after collection.

32.3.4 Personal Protective Equipment (PPE)

The following items will be worn during sampling activities: disposable leather gloves, long pants, long sleeve shirt, sturdy shoes with non-slip soles. Refer to the Health and Safety section 6.0 for information on PPE requirements.

32.3.5 Buddy System

All sampling which requires the use of ladders to collect samples will employ the buddy system. Whenever ladders are used on ground that is not perfectly flat, an individual on the ground must hold the ladder. Refer to section 6.2.3 (Health and Safety) for ladder safety instructions.

32.4 DECONTAMINATION OF EQUIPMENT

Equipment will be decontaminated before use at sampling site. Prior to use and after each sample is collected all sampling equipment will be washed twice in a non-phosphate (Alconox or equivalent) solution, rinsed with potable water and rinsed again with distilled water to prevent cross-contamination. Hard bristle bottle brushes may be used in the first two wash buckets to remove debris. Equipment should be allowed to drain dry after the final distilled water rinse.

32.5 SELECTION OF SAMPLING LAYOUT

The sampling locations defined within the Environmental Monitoring Plan for the LEHR site offer different sampling environments. Depending on the vegetation available at

each sampling location, it is necessary to select from two sampling grid layouts; quadrant formation or transect formation. If the sampling location contains an area of mixed herbaceous and/or perennial vegetation (grasses, weeds, bushes, etc.) of approximately 10 meter square or larger, then the square quadrant formation will be applied. Although a 10 meter square area is ideal, a slightly smaller area may be adapted (eight square meters for example), when area boundaries (creek, road, etc.) do not allow the full 10 meters on each side. If, however, the location has little or no ground cover type of vegetation, but rather a row of trees, plants or bushes, then a transect formation will be applied to that location.

32.5.1 Quadrant Formation Sample Collection

(1) Go to sampling location designated in the Environmental Monitoring Plan. Complete block 5 of the Vegetation Sampling Record, to indicate that quadrant formation has been selected for this sample site. Determine approximately where to position the 10 meter square sample grid.

(2) Place one of the 10 meter long ropes along one side of the grid location. Mark on the prepared map to show where the rope was placed to begin the grid pattern. Draw in the complete grip formation on the map as situated. Use the random number generator (see section 32.5.3) to indicate where to place the second rope so that it is perpendicular to the first, going into the grid. This is the first coordinate of the grid location.

(3) The next number on the random number generator will designate the second coordinate to show exactly where the sample is to be taken within the plotted area. Place the square meter frame over the grid location portion, with the appropriate mark on the rope defining the bottom left corner of the frame. Mark this sample area on the map with a number (1, 2, 3 etc.) to show the order in which was

selected, and write the coordinates on the Vegetation Sampling Record, Block 7.

(4) Use the grass shears and/or pruners to cut all vegetation within the square frame dimensions. Cut the vegetation to approximately 1 cm above ground. Place the sample into the plastic bag as it is cut. Leaves collected for analysis should be clipped at the petiole and allowed to drop directly into the collecting bag. Do not allow sample to come in contact with soil after cutting. Dispose of the leather gloves used in collecting the sample to avoid cross-contamination.

(5) When finished, weigh the amount of sample collected at that grid location, using the mechanical balance. Record on the Vegetation Sampling Record (Figure 1), the grid location and weight of sample collected. If the particular grid location has no vegetation, the weight will be zero.

(6) Continue repeating steps (3) through (5) until at least 1500 grams of sample have been collected at this location. If this location has been randomly selected as a split or duplicate sample location, a second 1500 grams will need to be collected. Duplicate samples will be kept separate from the original sample and coded as a separate sample.

(7) When the sample bag contains 1500 grams wet weight, attach the prepared label to the sample bag, and include the time sample was collected and your initials. Double bag the sample and place immediately in a cooler with sufficient dry ice to maintain the sample at 40 degrees F. Check the thermometer each time the cooler is opened. If it reads above 40 degrees, take the samples in for refrigeration or add more dry ice.

(8) Decon sampling equipment as stated in Section 32.4 after each sample is collected.

32.5.2 Transect Formation Sample Collection

(1) Go to sampling location designated in the Environmental Monitoring Plan. Complete Block 5 of the Vegetation Sampling Record (Figure 1), to indicate that transect formation has been selected for sample site. Determine the approximate dimensions of the transect rectangle. For shrubs, side ratios of 1:5 or 1:10, plots of 50 or 100 square meters are sufficient. For trees, plots of 200 or more meters square, with side ratios of 1:5 or 1:10 are commonly used. Sparser vegetation will require larger sampling areas than denser vegetation. Mark the transect dimensions and situation on the map for that sampling location.

(2) When sampling trees or bushes, prepare the transect grid format so that each bush or tree has its own square. This will make sampling much more logical and allow the tree or bush to be sampled from each direction.

(3) Now use the random number generator to determine which tree or bush to sample. Samples shall be collected from all sides of the tree or bush, from the lowest branch to the highest branch that can be safely reached from the ladder with the extended pruners. Care should be taken to collect vegetation from open, unshaded areas where radionuclide deposition would not be atypical.

CAUTION: Remember not to use the top of a step ladder as a step! The buddy system shall be employed whenever sampling requires a ladder. Refer to section 6.2.3 (Health and Safety) for ladder safety.

(4) Leaves collected for analysis should be clipped at the petiole and allowed to drop directly into the collecting bag. Do not allow sample material to fall on the ground after being cut. This can cause contamination from the soil, as well as the loss of particulate matter from the leaves, which would be significant for the analysis. Additionally, disposable leather gloves are to be changed between each sample.

(5) When finished, weigh the amount of sample collected at that grid location, using the mechanical balance. Record the grid location and the weight collected on the Vegetation Sampling Record (Figure 1).

(6) Continue repeating steps (3) through (5) until at least 1500 grams wet weight of sample have been collected at this location. If this location has been randomly selected as a split or duplicate sample location (see 32.3.2), a second 1500 grams wet weight will need to be collected. Duplicate samples will be kept separate from the original sample taken at a location, and coded as a separate sample.

(7) When 1500 grams of sample have been collected, attach the prepared sample label to the sample bag, along with the time the sample was collected and your initials. Double bag the sample and place in a cooler with sufficient dry ice to keep the sample cooled to 40 degrees F. Check the thermometer each time the cooler is opened. If it reads above 40 degrees F, take the samples in for refrigeration or add additional dry ice.

(8) Decon sampling equipment according to Section 32.4 after each sample is collected.

32.5.3 Sample Selection Using Random Numbers

Calculator with Random Number Generator: Follow directions in the instruction book for that calculator. Normally a nine-digit number is generated. Decimal points shall be disregarded. Digits may be selected from either the right side for the number, or the left (i.e. if the lot is less than 100, use the first 2 digits or the last 2 digits). When the next sample is to be selected, clear the calculator and generate a second random number.

32.6 SAMPLE HANDLING AND STORAGE

Once samples have been collected, special care must be taken to ensure integrity of sample identity and condition. Information is included in Chapter 8 of the Work Plan, with additional details as defined above. The vegetation samples must be maintained at 40 degrees F, which is essential for analysis of tritium. Assure there is sufficient dry ice to maintain this temperature. Additional coolers may be necessary to allow room for both samples and blue ice.

When coolers return from the field after collection, check temperature, assure labels are complete and correct, and that a Vegetation Sample Record (Figure 1) is available for each sample. Complete Vegetation Sampling Log (Figure 2) to provide record of sample and analysis.

32.7 SPLIT SAMPLE PREPARATION

Carefully put contents of sample bag to be split into a stainless steel bowl. Assure that all of sample goes into bowl without spilling. Then, with a spoon, slowly stir ingredients until completely mixed. Then, with gloves physically divide the sample into equal portions and place each half into separate sample bags. Weigh bags to verify that they are of equal weight. Adjust sample amount if needed to achieve balanced weight. Assure labels are attached to bags for correct sample identification. Split samples are to

be prepared for shipment to separate laboratories for comparison analysis. Both randomly selected background and site samples should be included in the lot to be sent to the comparison laboratory.

32.8 SAMPLE PACKAGING AND SHIPPING

Section 12 of the Work Element Quality Assurance Plan provides detailed instruction for packaging and shipping of samples. Assure each sample is placed in a second plastic bag, to protect the label from external moisture and assist in sample containment and integrity. Attach UCD custody seal to each bag and cover with clear tape to prevent tampering with contents prior to receipt of laboratory.

Samples will be shipped to the laboratory for analysis on the same day they were collected. If samples are held for any time before shipping, they will be stored at 40 degrees F in a designated secure area. Care must be taken to minimize handling, potential for sample contamination, or degradation of sample information on labels or documents.

All samples will be shipped by certified mail or its equivalent in order to maintain a chain of legal accountability or custody. Overnight or one day service may be necessary in order to meet holding times. Federal Express or another private carrier may be used if timing and custody requirements are met. A Custody Security Seal should be placed on the cooler and covered with clear tape after the Chain of Custody has been placed inside (see next section).

32.9 CHAIN OF CUSTODY RECORD

To establish the integrity of samples, it is necessary to demonstrate that the samples were maintain under custody from the time they were collected in the field to the time they were analyzed in the laboratory. If samples are held for any time before shipping, they shall be maintained under custody.

A sample is under custody if:

- It is in your possession
- It is in your view, after being in your possession
- It was in your possession and you locked it up, and
- It is in a designated secure area

All samples sent to the lab must be accompanied by a Chain of Custody Record (Figure 3). Instructions for completing this document are found in the procedure OPS QAPP - 3.03, Chain of Custody. Assure that the Chain of Custody includes all analyses required in the Environmental Monitoring Plan, Table 3.4. For analyses to be preformed on QA/QC samples, refer to section 5.1.3 of this procedure. These specifications are included on the Chain of Custody. The original Chain of Custody shall be placed in a plastic bag inside the cooler with the samples and a copy shall be kept on file.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 33.0
DOWN-HOLE RADIATION MONITORING

Purpose and Scope: The purpose of this procedure is to describe the method for measuring the radiation in soil surrounding a borehole. These measurements can be used to determine the presence of radioactive material above natural background, and the approximate spatial limits of the contamination. This procedure is intended for use by Dames & Moore Radiation Protection Technicians.

Equipment: Calibrated instrument capable of scaler and count rate modes (for example, ESP-2/HP-270 or equivalent)
Protective plastic tubing or wrap

Documentation: Field Memorandum
Instrument background and source check data sheet
Survey Record

33.1 GENERAL

The Radiation Protection Technician (RPT) will be familiar with the radiological conditions expected in the borehole area by reviewing the area's historical information and results of surveys conducted on boring equipment.

Instruments used will be calibrated within six months prior to the start of down-hole radiation monitoring.

Instruments used in potentially contaminated bore holes shall be protected from contamination and surveyed for contamination after use.

On each day of use, a source check and background check will be performed and recorded in accordance with SOP 23.

A handling line will be attached to the detector probe and marked at 10 (20) centimeter intervals.

33.2 OPERATION

Prior to performing down-hole measurements, the probe and cabling will be protected from becoming contaminated (PVC pipe lining the hole will serve to protect the cable and side of the probe from being contaminated). Additionally, the probe will be protected from moisture that may accumulate in the bore hole.

With the operating instrument in the count rate mode, slowly lower the probe down the bore hole. Observe the instrument response and note any large (greater than five times background) changes in the count rate. Record the initial results.

Change the operating mode of the instrument to count rate and, starting at the bottom of the hole, perform a 30-second count and record the results.

Raise the probe 10 (20) centimeters and repeat the count and record the results.

As the probe is being raised, survey the protective covering on the cable(s) for contamination and remove and/or contain any contamination found.

Repeat the operation until the probe is out of the suspected area or out of the hole.

Survey all materials not previously surveyed that may have come in contact with or placed down the hole.

Review data and resurvey suspect readings if deemed necessary by the Dames & Moore On-Site Manager.

APPENDIX A
ATTACHMENT 2

FIELD DOCUMENTATION FORMS

This attachment presents full-sized reproducible copies of 20 Field Documentation forms that are referenced in Attachment 1 (Standard Operation Procedures). The forms are presented in the order that they are referenced and include:

Field Memorandum
Water Supply Tracking Form
Field Record of Water Sampling Form
Sample Chain of Custody
Instrument Calibration Form
Soil Boring Log
Well Construction Summary
Well Development Form
Field Record of Soil Sampling
Test Pit Excavation Log
Double-Ring Infiltration Test Data Sheet
Certificate of Calibration for Air Monitor Dry Gas Meter
Certificate of Calibration for Air Monitor Rotameter
Certificate of Vacuum Leak Testing
Area or Equipment Drawing Form
Contamination Survey Form
Instrument Daily Source Check Log
Sealer Instrument Performance Test Log
Gamma Survey Instrument Calibration Log
Gamma Radiation Survey Form
Air Sampling Data Record Form
Interim Change Notice
Vegetation Sampling Record
Vegetation Sample Tracking Form

FIELD MEMORANDUM

ACTION	INFO	
To:		File:
		X-Ref:
		Date:

From: Reply Required By:

Subject:

Reference(s):

ROUTING

114.8 (REV. 3-68)

WATER SAMPLE TRACKING FORM

PROJECT: _____

JOB NUMBER: _____

Sample ID	Groundwater	Surface Water	Storm Water	Field Blank	Date	Time	QA Dupli-cate

FIELD RECORD OF WATER SAMPLING

Well No. _____ Date: _____

Depth of Well: _____ Sampling Event: _____

.asing Type/Diameter: _____ Location: _____

Sampled by: _____

PURGING PRIOR TO SAMPLING

Purging Method: _____

Pump Flow Rate: _____ One Casing Volume (CV), gallons: _____

Initial Water Level: _____ Purge Volume (3 CVs), gallons: _____

Date	Time	Temp	Spec. Cond.	pH	Turbidity	Eh	Gallons Removed	Comments (appearance of water, odor, etc.)

RECORD OF SAMPLING

Sampling Method: _____

Date of Sample: _____ Time: _____ Depth of Sample: _____

Sample No.	Container Types	Analysis

Temp: _____

Spec.

Cond: _____

pH: _____

Eh: _____

Comments: _____

SOP_FORMS\FIELDREC.H20

CHAIN OF CUSTODY

Project # _____

Client:
Dames & Moore
8801 Folsom Blvd., Suite 200
Sacramento, CA 95826
(916) 387-8800
Attention: _____

Signatures
Dames & Moore _____ Date: _____

Sampler: _____

!! IMPORTANT!!
UPON RECEIPT OF THIS FORM:
1. INSPECT ALL SAMPLES.
2. NOTE ANY DAMAGED CONTAINERS
3. SIGN AND DATE THIS FORM.
4. SEND A FAX OF THIS FORM TO:
   DAMES & MOORE
   FAX # (916) 387-0802
5. *DO NOT BEGIN WORK* UNTIL AUTHORIZATION IS RECEIVED FROM DAMES & MOORE BY TELEPHONE.

Sample No.	Soil	Water	Date	Time	# of Containers	Laboratory Number

Analysis Requested for *ALL* Samples Listed

Relinquished by: _____ Date: _____ Time: _____ Rec'd by: _____ Date: _____ Time: _____
Relinquished by: _____ Date: _____ Time: _____ Rec'd by: _____ Date: _____ Time: _____
Relinquished by: _____ Date: _____ Time: _____ Rec'd by: _____ Date: _____ Time: _____

For Lab Use Only

Cooler Radiologic Survey Pass/Fail

Condition of Sample Containers: ☐ Good ☐ Other: _____

SOP_FORMS CHAIN

CHAIN OF CUSTODY FORM

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

FIELD INSTRUMENT CALIBRATION LOG

Parameter:_____
Instrument:_____ Serial No.:_____
Manufacturer:_____ Date Placed in Service:_____
Calibration Procedure:_____

Required Calibration Frequency:_____

Date	Time	Results	Comments*	Calibrated by:

*Note: Include information on Standard Manufacturer, Lot Number, and/or Serial Number in Comments as appropriate.

Reviewed by: _____

SOIL BORING LOG

LOCATION OF BORING

JOB NUMBER | CLIENT | LOCATION

DRILLING METHOD:

BORING NUMBER

SHEET OF

SAMPLING METHOD:

DRILLING

START TIME | FINISH TIME

SURFACE CONDITIONS:

DATE | DATE

DATUM

ELEVATION

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	TIME	SAMPLE NUMBER / SAMPLE DEPTH	BLOWS/FT. SAMPLER	OVA AUGER	OVA SAMPLE	OVA CUTTINGS	DEPTH IN FEET	SOIL GRAPH
								0	
								1	
								2	
								3	
								4	
								5	
								6	
								7	
								8	
								9	
								0	
								1	
								2	
								3	
								4	
								5	
								6	
								7	
								8	
								9	
								0	
								1	

DRILLING CONTRACTOR

BY

DATE

CHECKED BY

45525

Job Name _____ Well No. _____
Job Number _____ Boring No. X-Ref _____

MONITORING WELL CONSTRUCTION SUMMARY

Survey Coordinates _____ Elevation Ground Level _____
_____ Elevation Top of Casing _____

Drilling Summary

Total Depth Drilled _____
Borehole Diameter _____
Driller _____
_____
Rig _____
Bit(s) _____
_____
Drilling Fluid _____
_____
Total Depth of Well _____
Casing Stick-up Height _____
Surface Completion _____

Construction Time Log

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling				
Geophys.Logging				
Casing				
Filter Placement				
Pre-Development				
Cementing				

Well Development

	Date	Time	Date	Time
Well Development				

_____
_____
_____
Initial Water Level _____
Final Water Level _____

Well Design & Specifications

Basis: Geologic Log _____ Geophysical Log _____
Casing String(s): CC=Conductor Casing C=Casing
S=Screen ST=Sediment Trap

Depth	String(s)	Elevation
_____ – _____	_____	_____ – _____
_____ – _____	_____	_____ – _____
_____ – _____	_____	_____ – _____
_____ – _____	_____	_____ – _____
_____ – _____	_____	_____ – _____

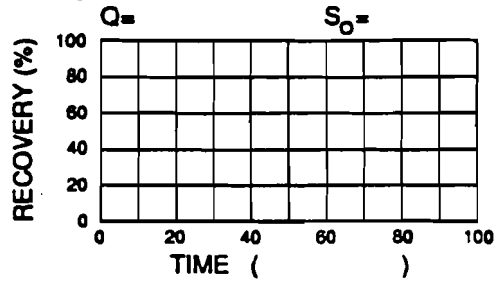
Conductor CC1 _____
Casing CC2 _____
Casing C1 _____
C2 _____
Screen S1 _____
S2 _____
Sed. Trap ST _____
Grout Seal _____
_____
Bentonite Seal _____
_____
Filter Pack _____
_____
Centralizers _____
_____

Stabalization Test Data

Time	pH	Spec. Cond.	Temp (C)	Turbidity

Recovery Data

Q= S_o=



Comments: _____
_____
_____
_____

T.D. =

Observed by: _____ Client: _____ Location: _____

DAMES & MOORE

WELL DEVELOPMENT FORM

Well Number: _____

Depth of Well: _____ TOC bgs

Casing Diameter/Type: _____

Screened Interval: _____ to _____

Initial Water Level: _____

One Casing Volume (CV): _____

Job Number: _____

Client: _____

Location: _____

Page _____ of _____

Date	Time	Gallons Removed	Cumulative Gallons Removed	Water Level	Turbidity	Comments to Purge Method

FIELD RECORD

SOIL SAMPLES

Sampling Method: _____

_____

Job Number: _____

Client: _____

Location: _____

Sampled By: _____ Page ___ of ___

Boring/Test Pit No.	Sample No./I.D.	Depth	Sample Location	Date/Time	Description/ Classification	pH	Sample Container	Lab Submitted to/Date	Comments

Date Completed: 10/28/92
Water Level: Dry
Orientation of Test Pit: -
Logged By: - Checked By: -
Subcontractor: -
Equipment: -
Weather: -

See Figure for Test Pit Location Map

EXPLANATION
- ● Drive Sample
- □ Grab Sample for Chemical Analysis
- ■ Grab Sample for Physical Analysis
- — Sharp Contact
- ····· Gradational Contact

Scale in Feet
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Depth in Feet	USCS	DESCRIPTION
	-	Surface Conditions -
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Subsurface: -

TEST PIT CROSS SECTION

TEST PIT LOG-

Job Name
Client
Location

Job Numb

DOUBLE-RING INFILTRATION TEST DATA SHEET

File: _____

Subject: _____

Test Location: _____

Liquid Used: _____

Tested by: _____

Depth to Water Table: _____

Testing by Double Ring

Constants	Area (cm^2)	Depth of Liquid (cm)
Inner Ring	_____	_____
Annular Space	_____	_____

Penetration of Rings:

Inner: _____

Outer: _____

Trial No.	Date	Time hr:m	Elapsed Time Δ/(total) (min.)	Flow Readings: Inner Ring Reading (cm)	Flow Readings: Inner Ring Flow (cm^3)	Flow Readings: Annular Space Reading (cm)	Flow Readings: Annular Space Flow (cm^3)	Liquid Temp	Incremental Infiltration Rate (cm/s): Inner	Incremental Infiltration Rate (cm/s): Annular	Soil Temp = ____ at depth of ____ Remarks
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Page ___ of ____

CERTIFICATE OF CALIBRATION FOR AIR MONITOR DRY GAS METER

Location _____ Stationary Sampler I.D. _____

Meter Manufacturer _____ Model _____ Serial Number: _____

Calibrator mFr _____ Model _____ Serial Number: _____

Barometer (Uncompensated) _____ Source _____ Time _____ Source _____

Temperature _____ Source _____ Time _____ Source _____

Flow Rate	20%	50%	80%
Time Start	___	___	___
Calibrator Flow Rate/Start/Stop	___	___	___
Total Test Time Minutes/Seconds	___	___	___
Proving Circle Total Revolutions	___	___	___
Indicated Volume - Dry Gas Meter	___	___	___
Manometer Vacuum at Meter	___	___	___
Time Stop	___	___	___
Pressure/Temperature Correction Factor to STP	___	___	___
Corrected Volume - Dry Gas Meter (STP)	___	___	___
Total Volume - Calibrator	___	___	___
Correction Factor	___	___	___

Error Factor: Calibrator _____% Scale (Proving Circle) _____%

. Test Time _____% Volume (Corrected) _____%

Calculations

Calibration Sticker Attached _____ Correction Factor Posted _____

Date _____ Calibrator's Signature _____

Calculations:

CERTIFICATE OF CALIBRATION FOR AIR MONITOR ROTAMETER

Location _____ Stationary Sampler I.D. _____

Meter Manufacturer _____ Model _____ Serial Number: _____

Calibrator mFr _____ Model _____ Serial Number: _____

Sampling train Schematic (Actual):

Rotameter Reading	Calibrator Reading	Error Factor	
_____	_____	Calibrator	____%
_____	_____	Meter Scale	____%
_____	_____		
_____	_____	Total Volume	_____%
_____	_____	Other	_____%

Correction Factor at _____ lpm = _____

Cumulative Error Factor at _____ lpm = _____

Comments:

_____

_____

_____

_____

Calibration Sticker Attached _____ Correction Factor Poster _____

Date _____ Calibrator's Signature _____

Calculations:

CERTIFICATE OF VACUUM LEAK-TESTING

Location _____ Stationary Sampler I.D. _____

Sampling Train Schematic (Actual):

Temperature _____ Source _____

Manometer Reading During Test: _____

Air Particular Train (PASS/FAIL)

Tritium Sampling Train (PASS/FAIL)

Corrective Action Taken (Describe fully):

Calibrator's Signature/Date: _____

Note: The maximum acceptable leak rate for the Air Particulate Sampling Train is 500 cc/min.

The maximum acceptable leak rate for the Tritium Sampling Train is 8 cc/min.

AREA OR EQUIPMENT DRAWING

X-X-X-X = Boundaries of Posted Areas = Direct Frisk Locations = Smear Locations

Comments: _____

_____

_____

_____

Reviewed By: _____ Date: _____

CONTAMINATION SURVEY FORM

Location: _____ Date/Time: _____ Page _____ of _____

Technician: _____ Meter Background: _____ Scaler Model/Serial: _____

Meter Model/Serial: _____ Scaler Background: _____ Calibration Due: _____

Calibration Due: _____ Survey Type: ☐ Alpha α ☐ Beta/Gamma β/γ Signature: _____

Smear Number	Item Surveyed	Location Surveyed	Direct Survey						Smear Survey					
			Gross Count Rate (cpm)		Net Count Rate (cpm)[1]		Total Activity (dpm)[2]		Gross Count Rate (cpm)		Net Count Rate (cpm)[1]		Total Activity (dpm)[2]	
			α	β/γ	α	β/γ	α	β/γ	α	β/γ	α	β/γ	α	β/γ

Note[1] Net Count Rate = Gross Count Rate - Background Count Rate.
Note[2] Total Activity = Net Count Rate ÷ Instrument Efficiency.

INSTRUMENT DAI. SOURCE CHECK LOG

Instrument
Type: _____
Serial #: _____
Calibration Due: _____

Source
Isotope: _____
Activity (DPM): _____
ID #: _____

Acceptance Criteria ± 20%
Upper Limit (DPM: _____
Lower Limit (DPM: _____

Date	Time	Battery Check	High Voltage Check	Efficiency (cpm/dpm) Note(1)	Source Count Rate (cpm)	Background Count Rate (cpm)	Net Count Rate (cpm)(2)	Observed Activity (dpm)(3)	Acceptance (Yes/No)	RPT Initials

Note(1) Efficiency is determined during the instrument calibration.
Note(2) Net Count Rate - Source Count Rate - Background Count Rate.
Note(3) Observed Activity - Net Count Rate ÷ Efficiency.

SCALER PERFORMANCE CHECK LOG

Instrument
Type: _____
Serial #: _____
Calibration Due: _____

Source
Isotope: _____
Activity (DPM): _____
ID #: _____

Acceptance Criteria
Percent Error ≤ 20%

Date	Time	Efficiency (cpm/dpm) Note[1]	Source Count Rate (cpm)	Background Count Rate (cpm)	Net Count Rate (cpm)[2]	Observed Activity (dmp)[3]	$ Error (≤ 20%?)	Acceptance (Yes/No)	RPT Initials

Note[1] Efficiency is determined during the instrument calibration.
Note[2] Net Count Rate - Source Count Rate - Background Count Rate.
Note[3] Observed Activity - Net Count Rate ÷ Efficiency.

GAMMA CALIBRATION CHECK LOG

Instrument
Type: _____
Serial #: _____
Calibration Due: _____

Source
Isotope: _____
Activity (μCi): _____
ID #: _____

Acceptance Criteria
Gamma Reading Within 20% of Initial Reading After Calibration
Initial Reading (μR/hr): _____

Date	Time	Source Reading (μR/hr)	Background Reading (μR/hr)	Net Reading (μR/hr)[1]	% Difference (± 20%?)	Acceptance (Yes/No)	RPT Initials

Note[1] Net Reading = Source Reading - Background Reading.

GAMMA SURVEY FORM

Location: _____ Date/Time: _____ Page _____ of _____

Technician: _____ Meter Background: _____

Meter Model/Serial: _____ Calibration Due: _____ Signature: _____

X-X-X-X = Boundaries of Posted Areas = Gamma Radiation Levels (μR/hr)

Comments: _____

Reviewed By: _____ Date: _____

AIR SAMPLING
DATA RECORD FORM

DATE:_____ SITE:_____

PLACEMENT LOCATION:_____

AIR SAMPLER SERIAL #:_____

FLOWRATE (1pm):_____

PUMP START:_____ PUMP STOP:_____ ELAPSED (MIN:):_____

PUMP START:_____ PUMP STOP:_____ ELAPSED (MIN:):_____

PUMP START:_____ PUMP STOP:_____ ELAPSED (MIN:):_____

TOTAL ELAPSED TIME (MIN):_____

VOLUME COLLECTED (l):_____ =_____ (ml)

ALPHA SAMPLE COUNTER SN#:_____ BACKGROUND (cpm):_____

GROSS ALPHA COUNTS:_____ TIME (min.):_____

NET COUNT RATE (cpm):_____ EFFICIENCY (cpm dpm):_____

TOTAL ACTIVITY (μCi):_____

CONCENTRATION (μCi/Ml):_____

TECHNICIAN:_____

REVIEWED BY:_____

DATE:_____

Special Counting C_1:_____ C_2:_____

STANDARD OPERATING PROCEDURES
INTERIM CHANGE NOTICE

Date: _____

SOP Affected: _____

Revision Affected: _____ Dated: _____

Old procedure to be changed *(describe):* _____

_____

_____

Page number of old procedure: _____ of _____

Modified procedure to be implemented *(describe)* and reason for change: _____

_____

_____

List attached documentation *(i.e., telecons, field logs, field memos, etc.)*

_____

_____

Prepared by: _____ Date: _____
(Project Staff)

Approved by: _____ Date: _____
(Field Manager)

Approved by: _____ Date: _____
(Task Manager)

_____
Coordinator of Quality Assurance

Retain this until further notice ☐

This notice will be incorporated into the next revision to the controlled document referenced ☐

Other ☐

File the notice with your copy of the referenced document. The notice must be destroyed when the next revision of this plan/procedure is received.

Sample Record Number (from log) _____

VEGETATION SAMPLING RECORD

1. Date:	2. Sample Identification Number
3. Performed by:	4. Location:
5. Plot Formation Type (Quadrant or Transect):	
6. If Sample is QA/QC, Identify Type (Split, Duplicate, etc.):	
7. Record of Grid Locations Sampled (Continue on back if necessary):	

Grid Coordinates	Weight Collected	Grid Coordinates	Weight Collected
a.		f.	
b.		g.	
.		h.	
c.		i.	
e.		j.	

8. Total Weight of Sample Collected	9. Time Sample Collected:

10. Map of Sample Location:
    a. Show primary trees, roads, fences, walkways, etc.
    b. Draw in sampling grid with x and y axis numbered.

11. QA Verification and Date.

VEGETATION SAMPLE TRACKING FORM

Sampling Record Number	Sample Date	Sample ID	Sampler	Analytical Lab	Date Results Retrned (attach to record)	QA _____	Comments

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN
RI/FS WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN
RI/FS WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

TABLE OF CONTENTS

Section — Page

1.0 INTRODUCTION 1.1
1.1 PROJECT DESCRIPTION 1.1
1.2 BACKGROUND INFORMATION 1.3
1.3 DISCUSSION OF ACTIVITIES 1.5
1.3.1 Soil Investigation 1.5
1.3.2 Groundwater and Surface Water Investigation 1.6
1.3.3 Baseline Air Monitoring Investigation 1.7
1.3.4 Biota Investigation 1.8
1.3.5 Environmental and Human Resources Characterization 1.9
1.3.6 Target Compounds 1.10
1.3.7 Data Use 1.10
1.3.8 Sampling Locations 1.14

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES 2.1
2.1 QUALITY ASSURANCE RESPONSIBILITIES 2.1
2.1.1 Training 2.3
2.1.2 Documentation 2.3
2.1.3 Qualifications of Suppliers/Subcontractors 2.3
2.1.4 Surveillances and Audits 2.3
2.2 TECHNICAL LEAD RESPONSIBILITIES 2.4
2.2.1 Technical Training 2.4
2.2.2 Selection of Subcontractors 2.4
2.2.3 Selection of Suppliers 2.4

3.0 QUALITY ASSURANCE OBJECTIVES 3.1
3.1 GLOSSARY OF TERMS 3.1
3.2 SPECIFIC QA OBJECTIVES FOR MEASUREMENT DATA 3.3
3.2.1 Precision 3.9
3.2.2 Accuracy 3.9
3.2.3 Completeness 3.10
3.2.4 Representativeness and Comparability 3.10
3.3 DATA USES 3.11

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN
RI/FS WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

TABLE OF CONTENTS (continued)

Section — Page

4.0 SAMPLING PROCEDURES 4.1
4.1 SOIL INVESTIGATION 4.1
4.2 GROUNDWATER AND SURFACE WATER INVESTIGATION 4.1
4.3 BASELINE AIR MONITORING INVESTIGATION 4.1
4.4 GENERAL FIELD PROCEDURES 4.2

5.0 SAMPLE CUSTODY 5.1
5.1 FIELD CUSTODY PROCEDURES 5.1
5.2 LABORATORY CUSTODY PROCEDURES 5.3

6.0 CALIBRATION PROCEDURES 6.1
6.1 FIELD EQUIPMENT 6.1
6.2 LABORATORY EQUIPMENT 6.1

7.0 ANALYTICAL METHODS 7.1

8.0 DATA REDUCTION, VALIDATION, AND REPORTING 8.1
8.1 DATA REDUCTION 8.1
8.1.1 Field 8.1
8.1.2 Office 8.1
8.1.3 Laboratory 8.2
8.2 DATA VALIDATION 8.2
8.3 DATA REPORTING 8.3
8.3.1 Level IV 8.3
8.3.2 Non-Level IV Analyses 8.3
8.4 DATA HANDLING 8.5
8.5 FINAL REVIEW BY TECHNICAL LEAD 8.5

9.0 INTERNAL QUALITY CONTROL 9.1
9.1 PROJECT CONTROLLING DOCUMENTS 9.1
9.1.1 Preparation 9.1
9.1.2 Review and Control 9.2

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN
RI/FS WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

TABLE OF CONTENTS (continued)

Section Page

9.2 FIELD QC CHECKS 9.2
9.2.1 Calibration 9.2
9.2.2 Blanks 9.2
9.2.2.1 Trip blanks 9.2
9.2.2.2 Equipment blanks 9.3
9.2.3 Duplicates and replicates 9.4
9.2.4 Spike samples 9.4
9.3 LABORATORY CHECKS 9.5
9.4 TECHNICAL REVIEW 9.5
9.4.1 Preparation and Review of Reports 9.5
9.4.2 Technical Review of Calculations 9.5
9.4.3 Computer Program Certification 9.7
9.4.4 Preparation of Drawings 9.7

10.0 AUDITS AND SURVEILLANCES 10.1
10.1 AUDITS 10.1
10.2 SURVEILLANCES 10.1

11.0 PREVENTIVE MAINTENANCE 11.1

12.0 ASSESSING DATA PRECISION, ACCURACY AND COMPLETENESS 12.1
12.1 PRECISION 12.1
12.1.1 Water Level 12.2
12.1.2 Temperature, pH, Conductivity, Turbidity, and Redox Potential . . 12.2
12.1.3 Laboratory Analytical Measurements 12.2
12.2 ACCURACY 12.2
12.2.1 Water Level 12.3
12.2.2 Temperature, pH, Conductivity, Turbidity, and Redox Potential . . 12.3
12.2.3 Laboratory Analytical Measurements 12.3
12.3 COMPLETENESS 12.3
12.3.1 Water level 12.4
12.3.2 Temperature, pH, Conductivity, Turbidity, and Redox Potential . . 12.4

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN
RI/FS WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

TABLE OF CONTENTS (continued)

Section Page

12.3.3 Laboratory Analytical Measurements 12.4

13.0 CORRECTIVE ACTION 13.1

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT 14.1

15.0 REFERENCES 15.1

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN
RI/FS WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

TABLES, FIGURES AND ATTACHMENTS

LIST OF TABLES

Page

TABLE 1.1 SUMMARY OF ANALYSES 1.12
TABLE 1.2 SUMMARY OF DATA QUALITY OBJECTIVES 1.13
TABLE 3.1a QUALITY ASSURANCE OBJECTIVES FOR SOIL SAMPLES 3.4
TABLE 3.1b QUALITY ASSURANCE OBJECTIVES FOR WATER SAMPLES 3.6
TABLE 3.1c QUALITY ASSURANCE OBJECTIVES FOR AIR SAMPLES 3.8
TABLE 7.1 SAMPLE ANALYSES - SOIL 7.2
TABLE 7.2 SAMPLE ANALYSES - WATER 7.21
TABLE 7.3 SAMPLE ANALYSES - AIR 7.38

LIST OF FIGURES

FIGURE 2.1 PROJECT ORGANIZATION CHART 2.2
FIGURE 5.1 CHAIN-OF-CUSTODY FORM 5.2
FIGURE 6.1 FIELD INSTRUMENT CALIBRATION LOG 6.2
FIGURE 9.1 COVER SIGNATURE SHEET 9.6

LIST OF ATTACHMENTS

ATTACHMENT 1 STANDARD OPERATING PROCEDURE, DATA VALIDATION

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN
RI/FS WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

1.0 INTRODUCTION

The purpose of this Quality Assurance Project Plan (QAPjP) is to designate and document the specifications and methods that will be employed to establish technical accuracy and precision, statistical validity, and documentary compliance of data generated during the characterization of soil, groundwater, surface water, and air at the LEHR facility. This QAPjP has been included as Appendix B of the RI/FS Work Plan (Work Plan).

The controlling quality assurance document for this work is the "Dames & Moore Quality Assurance Program Plan for Battelle Pacific Northwest Laboratories (Revision 2, September 1994, referred to hereafter as the "QA Program Plan"). This QAPjP will describe project-specific quality assurance procedures and will reference the QA Program Plan when appropriate. Procedure 5 from the QA Program Plan was used in the preparation of this QAPjP, and will be employed for any and all revisions.

1.1 PROJECT DESCRIPTION

The Work Plan presents a description of the LEHR facility operations, a summary of previous investigations, rationale, approach and scope of the proposed characterization, and a schedule for completion. A Field Sampling Plan (FSP) - (Appendix A), this QAPjP, and a Health and Safety Plan (HSP) - (Appendix C) are included as Appendices to this Work Plan.

The Work Plan identifies investigation units and describes the procedures that will be used to characterize the nature and extent of site impacts noted during previous investigations. Additionally, the Work Plan describes procedures for the performance of a Risk Assessment and Feasibility Study (FS) as required by CERCLA. It is also intended that the information developed through this characterization will be used to support the

Environmental Assessment (EA) as required by the National Environmental Policy Act (NEPA) for remediation and the appropriate California Environmental Quality Act (CEQA) documentation. Specifically, the units to be investigated during the RI include:

- The DOE burial areas and trenches in the southwest corner of LEHR and the disposal unit known as the "DOE Disposal Box";
- The radium-226 and strontium-90 treatment tanks and associated leach systems;
- The seven domestic septic tanks and associated leach systems;
- The outdoor dog pen areas, including the area currently occupied by the Cellular Biology Lab;
- The UC Davis trenches between landfill units number 1 and 2, and along the south side of the dog pens;
- The UC Davis landfill units (numbers 1, 2, and 3); and
- Groundwater, surface water, and air.

The investigation of these units has been divided into a number of tasks addressing soil and water. Soil investigation tasks include the following:

- Conducting a background study;
- Locating and sampling of burial areas, trenches, and the DOE Disposal Box;
- Locating and sampling the radium-226 treatment tank and leach system;
- Locating and sampling the strontium-90 treatment tank and leach system;
- Locating and sampling the domestic septic tanks and leach fields;
- Characterizing western set of dog pens and the north chemical dispensing area;
- Locating and sampling the UC Davis burial trenches;
- Locating and sampling the UC Davis Landfill Units; and
- Evaluating the collected data.

Specific water investigation tasks include:

- Quarterly groundwater and surface water monitoring;
- Conducting a CPT/Hydropunch™ investigation;
- Installing monitoring wells;
- In situ groundwater sampling;
- Investigating surface water; and
- Evaluating collected data.

It should be noted that the quarterly groundwater and surface water monitoring (Task 1) will be conducted as described in the Water Monitoring Plan currently being prepared for the LEHR facility as part on the Environmental Monitoring and Surveillance Program specified in DOE 5400.1. The monitoring task is described in this Work Plan (Chapter 6) for completeness.

1.2 BACKGROUND INFORMATION

This section provides a brief description of the site history and previous investigations conducted at the LEHR facility. A more detailed description of this information is provided in Chapters 2 and 3 of the Work Plan.

The DOE-funded research on laboratory animals at the LEHR facility began in the late 1950s. As a result of these studies, a variety of laboratory wastes, including radioactive, organic and inorganic materials, were generated and disposed of on-site. The LEHR environmental restoration activities were initiated in 1989 when the DOE began to investigate previous waste disposal practices and soil and water quality of the LEHR facility as part of an environmental surveillance program at the site.

Full-scale experimental use of radioactive materials began at the LEHR facility in 1960. Early experimentation included the use of radium-226 and strontium-90. In the early 1970s, an outdoor Cobalt-60 Irradiator Field was constructed at the facility to study the effects of chronic exposure to penetrating gamma-ray irradiation on bone marrow cells of beagles. The study was terminated in 1985 and all DOE-sponsored research at the LEHR facility ended in 1989.

Portions of the LEHR facility were previously used as the UC Davis campus landfill. The landfill consisted of two separate disposal units. Disposal in the oldest unit (Inactive Disposal Unit No. 1) began in the 1940s and ceased in the late 1950s to early 1960s. The area is now covered by the Cobalt-60 Irradiator Field at the LEHR facility. The next oldest disposal area (Inactive Disposal Unit No. 2) received wastes from 1956 to 1967. This disposal area is partially covered with the easternmost of two sets of dog pens used for animal research at the LEHR facility. A third landfill disposal unit, located approximately 600 feet east of the LEHR facility (Inactive Disposal Unit No. 3), was used from 1963 to 1967.

Detailed descriptions of known waste-generating and disposal processes are described in the Environmental Survey Preliminary Report, (DOE, 1988). A more detailed discussion of waste-generating processes or potential environmental impacts at the LEHR facility area is presented in Chapter 2 of the Phase II Site Characterization Report (Dames & Moore, 1993).

The DOE and UC Davis have sponsored 14 limited environmental evaluations at the LEHR facility and adjacent landfills. Two surveys, the Initial Assessment Survey (Rockwell, 1984), and the Environmental Survey Preliminary Report (DOE, 1988), present documentation of potential environmental impacts from past operations at the LEHR facility. The Phase I Investigation (Wahler, 1988 and 1989) was an initial investigation of environmental impacts from past LEHR activities.

Two studies, the SWAT investigation (Dames & Moore, 1990b), and the Old UC Davis Landfill Additional Characterization (Dames & Moore, 1991a) address impacts from the former UC Davis landfill. A Contaminant Pathway Analysis (Dames & Moore, 1990c) was conducted to assess health risk exposure from the LEHR facility area. Other environmental studies include an Evaluation of Potential Nitrate and Hexavalent Chromium Sources (Dames & Moore, 1990d), a Waste Burial Trench Investigation (Dames & Moore, 1991b), sediment and surface water sampling in Putah Creek (Dames & Moore, 1990e) and a CEQA Preliminary Study for Characterization Activities (Dames & Moore, 1991c). The Phase II Site Characterization (Dames & Moore, 1993) provides a summary of the previous investigations and presents results of additional soil and groundwater investigations at the LEHR facility.

1.3 DISCUSSION OF ACTIVITIES

This section presents information concerning the proposed sampling activities, selected analytical parameters, data quality objectives, and sampling locations.

1.3.1 Soil Investigation

Chapter 5 of the Work Plan presents a breakdown of the tasks to be conducted for characterization of the soils in the areas of investigation identified at LEHR. Specific activities and sample collection techniques that will be performed during the completion of each task are also described. Additionally, the rationale for sample locations and the number of sampling points are also presented. It is anticipated that a variety of sampling techniques, including backhoe exploration, soil borings and wipe sampling techniques, will be used. Table 5.1 of the Work Plan presents the anticipated sampling techniques and approximate number of samples that will be collected. Details of field sampling activities are presented in the FSP (Appendix A). The soil investigation tasks described in Chapter 5 of the Work Plan are presented below:

- Background study;
- Locate and sample the DOE burial areas, trenches, and the DOE Disposal Box;
- Locate and sample the radium-226 treatment tank and leach system;
- Locate and sample the strontium-90 treatment tank and leach system;
- Locate and sample the domestic septic tanks and leach fields;
- Characterize western set of dog pens and the north chemical dispensing area;
- Locate and sample the UC Davis burial trenches;
- Locate and sample the UC Davis Landfill Cells; and
- Data evaluation.

Prior to initiating investigation activities in the field, a site walk with UC Davis Physical Plant personnel will be conducted to assess the work areas associated with each area of interest. Information sought will include location of overhead and underground utilities, potential access difficulties, type of work area pavements (if any), and potential disruptions to current site activities/operations. UC Davis Physical Plant personnel will be asked to locate all underground utilities and clear all designated underground work areas at

LEHR prior to investigation. Underground Service Alert (USA) will be notified prior to intrusive investigations conducted off of the LEHR site to locate any public utilities.

1.3.2 Groundwater and Surface Water Investigation

Chapter 6 of the Work Plan presents a breakdown of the tasks to be conducted for characterization of groundwater and surface water at LEHR. Specific activities and sample collection techniques that will be performed during the completion of each task are also described. Additionally, the rationale for sampling locations and the number of samples are presented. Details of field tasks proposed for the groundwater and surface water investigation are presented in the FSP (Appendix A).

DOE operations at the LEHR facility ceased in 1989; therefore, water monitoring activities focus primarily on environmental surveillance activities for non-operational facilities as defined in DOE 5400.1. The groundwater and surface water investigation tasks described in Chapter 6 of the Work Plan are intended to supplement the Water Monitoring Plan (currently in progress) submitted as part of the site-wide environmental monitoring program also defined in DOE 5400.1. Quarterly monitoring of groundwater and surface water, which constitutes a surveillance activity, has been conducted since November 1990 as a portion of the Phase II Site Characterization (Dames & Moore, 1993).

The objective of groundwater and surface water investigation task is to: (1) characterize baseline surface water and groundwater conditions at the LEHR facility; (2) further identify surface water or groundwater which may have been impacted by LEHR facility operations; (3) provide data to support future site activities including but not limited to an RI/FS, remedial actions, and decontamination and decommissioning of the site; and (4) comply with applicable federal, state, and local regulations.

To meet the objectives for the groundwater and surface water investigation task at LEHR, the following activities will be conducted.

- Quarterly monitoring of surface water and the existing groundwater monitoring network will continue;

- CPT/Hydropunch™ investigations will be conducted in the areas downgradient of LEHR to optimize monitoring well locations;
- Sixteen new groundwater monitoring wells will be installed to evaluate lateral and vertical extent of impacts identified during the Phase II Site Characterization;
- Slug tests will be completed on all new monitoring wells installed and an aquifer pumping test will be conducted; and
- A surface water study will be conducted to evaluate potential upstream sources and leakage from Putah Creek to the first HSU.

It is anticipated that quarterly monitoring will be continued through the RI/FS process. Monitoring will be conducted under the Water Monitoring Plan currently being prepared for the LEHR facility. The procedures used to collect the water samples and the requested analyses are presented in Chapter 6 of the Work Plan and detailed in the FSP (Appendix A).

1.3.3 Baseline Air Monitoring Investigation

Chapter 7 of the Work Plan describes the local meteorology, air sampling locations, rationale, and sampling/analysis methodologies to be incorporated in the air monitoring program. The air monitoring program has been developed to fulfill a number of individual program objectives, including:

- Assess compliance with applicable federal, state, and local regulations and DOE Orders;
- Document existing off-site background air concentrations for selected potential contaminants of concern;
- Support a quantitative risk assessment by measuring air intake concentrations;
- Detect, characterize, and report unplanned releases and evaluate effectiveness of any effluent treatment and control programs;
- Identify potential environmental problems and evaluate the need for remedial actions, if necessary;

- Allow assessment of airborne impacts during subsequent remedial actions and post-remedial reductions in releases; and
- Evaluate local meteorological conditions at the site.

1.3.4 Biota Investigation

Chapter 8 of the Work Plan presents a description of the biotic sampling and analysis which could be performed at the LEHR site. Vegetation sampling will conducted after assessment of the Stage 1 soil sampling programs. A detailed, appropriately scaled, vegetation sampling program will be developed and incorporated into the Work Plan after assessment of the Stage 1 soil sampling programs discussed in Chapter 5. Other sampling programs which could be performed include sampling of mammals and fish. Performance of these investigations are contingent upon the results of the Stage 1 soil sampling programs and the vegetation sampling program. If contaminants are identified that could be taken up by the LEHR site animals, a detailed and appropriately scaled biological assessment will be developed and incorporated into this Work Plan. This section has been developed to provide a general concept of the investigation that will and could be conducted. ~~The sampling and analysis as well as sample collection techniques for biota will be described in this section.~~

The objectives of the vegetation and biota sampling program will be to: (1) characterize relevant aspects of the local ecosystem; (2) determine if exposure to chemicals at the site could pose a hazard to ecological receptors including, threatened and endangered (T&E) species and/or critical habitats and populations, and (3) determine the spatial and temporal extent of potential ecological effects in selected species that could occur on the site. The biota investigation can be used to determine if site-related chemicals are migrating through the food chain or have affected terrestrial or aquatic ecosystems. ~~If biota data is collected,~~ Sampling collection points will be selected to represent major terrestrial and aquatic habitats at the site. ~~The three major types of sampling which could be performed are:~~

- ~~Vegetation;~~
- ~~Mammals; and~~
- ~~Fish.~~

Collection of site-specific analytical data for vegetation and possibly biota will ~~may~~ be necessary for the development of realistic site-specific parameters for the risk assessment and to identify the extent of chemical impacts on the ecosystem. Assessing the magnitude of human and environmental exposure to contaminants through the food chain depends largely on being able to assess the uptake and bioaccumulation of contaminants in the aquatic and terrestrial food chains. For most contaminants, estimating exposure to chemicals present in the food chain is accomplished through the use of various predictive equations which may overestimate actual exposures. By obtaining site-specific measured data for vegetation and biota, the level of uncertainty associated with these predictive equations can be reduced. ~~If soil, groundwater, surface water and sediment indicate the potential for food chain transfer of chemicals or if chemical specific data (e.g., root uptake factors) are not available, then biotic sampling may be necessary~~.

1.3.5 Environmental and Human Resources Characterization

Chapter 9 of the Work Plan describes the scope of environmental characterization efforts to assess the adequacy of the RI/FS for adoption as an EA under NEPA. This requirement is specified by DOE 5400.4 and subsequent guidance memoranda. Additionally, information will be used to assess compliance with CEQA. The majority of characterization information needed to adequately evaluate all remedial alternatives will be generated through the characterization efforts described elsewhere in the Work Plan. Specifically, Chapters 5, 6, 7, and 8 address the data to be acquired to characterize soil, water, air, and biota impacts, and support evaluation of migration and release pathways and ultimately impact analyses of existing conditions and future remediations.

The scope of Chapter 9 is limited to the additional elements of environmental characterization which will be conducted to meet specific requirements of NEPA and CEQA compliance, but which may not be explicit requirements of a CERCLA RI/FS. These activities will include:

- Baseline characterization of the existing flora and fauna on and adjacent to the site, including threatened or endangered species assessment and their critical habitat;

- Wetland and floodplain characterization;
- Characterization of cultural, historical, or archaeological resources;
- Land use; and
- Socioeconomic, infrastructure, and demographic characterization.

Baseline characterization of the potentially affected environment on and around the LEHR facility will be necessary to support the evaluation of impacts that could result from the implementation of remedial alternatives evaluated in the FS.

1.3.6 Target Compounds

A summary of the analyses for the RI/FS program is provided in Table 1.1. A rationale for selection of these parameters is provided in Chapters 5, 6, 7, and 8 of the Work Plan.

1.3.7 Data Use

It is intended that data collected through implementation of this Work Plan will satisfy federal, state, and local data quality requirements. These data will be used to characterize the nature and extent of contamination, support the risk assessment, support the evaluation of corrective/remedial action, and assist in the development and evaluation of remedial alternatives.

Data Quality Objectives (DQOs) have been specified for each data collection activity, and the work will be conducted and documented in a manner whereby data collected are sufficient and of adequate quality for their intended uses (EPA, 1987 & 1993). DQOs are qualitative and quantitative descriptions of the data required to support decisions made during remedial response activities. The DQOs have been developed and are incorporated into the data collection activities presented in the Work Plan.

A wide variety of measurements will be made during on-going monitoring at the site. Five levels of data quality are established below which address all of the various

measurements. All of the measurements to be taken, the data quality level associated with each type of measurement, and the quantity of samples to be taken for each type of measurement are summarized in Table 1.2, Summary of Data Quality Objectives.

The five levels of data quality established for this monitoring program include:

Level V - Level V is similar to Level IV with respect to a rigorous documentation regimen and data quality requirements. This level applies to non-standard analytical methods or method modifications that may be required for specific constituents or detection limits.

Level IV - Level IV is defined as data which will be used for legal proceedings. It is essentially Level III (see below) data quality with a more rigorous documentation regimen. Gathering data to be presented in court or in response to a court order are examples of tasks which may require Level IV data quality.

Level III - Level III is defined as data which will be used for risk assessment and assessing the nature and extent of contamination present, and for use in support of engineering judgements. This level can accurately identify and quantify contamination present and can be relied upon to make assessments which may affect human health. Data are normally generated in an analytical laboratory setting. Contamination assessments (RI/FS) and groundwater monitoring programs may employ Level III data quality.

Level II - Level II is defined as data which will be used for the general evaluation of alternatives. This level of data can tentatively identify contaminants and usually reports concentrations within a range. Soil gas surveys and monitoring programs utilizing field screening methods are typical examples of tasks which may require Level II data quality.

Level I - Level I is defined as data which will be used for site characterization and health and safety monitoring. This level of data can provide indications of contamination when present, but cannot quantify any contamination detected. Field measurements for reference and for health and safety purposes are examples of tasks which may require Level I data quality.

TABLE 1.1 SUMMARY OF ANALYSES

Volatiles (VOCs)	Semivolatiles (SVOCs)	Pesticides and PCBs
Target Compound List[a]	Target Compound List[a]	Target Compound List[a]
Miscellaneous Organics	**Metals**	**Miscellaneous Inorganics**
Formaldehyde Total Organic Carbon Methane Kerosene	Antimony Arsenic Barium Beryllium Cadmium Chromium (total) Chromium (hexavalent) Cobalt Copper Iron Lead Manganese Mercury Molybdenum Nickel Selenium Silver Thallium Vanadium Zinc	Alkalinity Ammonia Chloride Nitrate (as Nitrogen) Phosphorous Sulfate Sulfide Calcium Magnesium Sodium Potassium Chemical Oxygen Demand Total Dissolved Solids Total Kjeldahl Nitrogen Turbidity pH Electrical Conductivity Oxygen Carbon Dioxide
Radiological	**Soil Physical Tests**	**Field Properties**
Tritium Strontium-90 Gamma Emitters Gross Alpha Gross Beta Carbon-14 Radium-226 Plutonium-241 Americium-241 Isotopic Uranium Isotopic Thorium Cobalt-60 Cesium-137	Hydrometer Grain Size Permeability Moisture Release Moisture Content Mineralogy Specific Gravity Atterberg Limits Bulk Density	pH Turbidity Temperature Electrical Conductivity Redox Potential Water Level Surveying Down-hole Permeability Double-ring Infiltrometer

[a] Refer to Section 7.0 for list of analytes.

TABLE 1.2 SUMMARY OF DATA QUALITY OBJECTIVES

Task	Data Quality Level	Field Samples	Trip Blanks	Equipment Blanks[a]	Dupli-cates	Total Samples[b]
Soil Sampling	IV & V	403	30	16	27	476
Soil Physical Testing[c]	II	10-75	NA	NA	NA	10-75
Soil Gas & Radiologic Surveying	II & III	336	NA	NA	17/17[d]	370
Wipe Sampling	I & II	39	NA	NA	2	41
Down-hole Permeability / Double-ring Infiltrometer Testing	II	10/6	NA	NA	NA	10/6
Surveying	I	NA	NA	NA	NA	NA
Water Level	I	NA	NA	NA	NA	NA
Temperature, pH, Redox Potential, Turbidity, Conductivity	I	NA	NA	NA	NA	NA
Groundwater Sampling	IV & V	72	36	NA	4	112
CPT Hydropunch Sampling	III	19	4	NA	1	24
Monitoring Well Installation Soil Samples	IV & V	22	10	NA	1	33
Monitoring Well Installation Soil Physical Testing	II	22	NA	NA	NA	22
Aquifer Testing	II	NA	NA	NA	NA	NA
Surface Water Sampling	IV & V	12	4	NA	2	18
Storm Water Sampling	IV & V	4	2	NA	2	8
Meteorological Sampling	II	NA	NA	NA	NA	NA
Radiological Sampling - Air	IV & V	96	NA	NA	5	101
Non-radiological Sampling - Air	IV & V	96	NA	NA	5	101

[a] Analyte list provided in Field Sampling Plan (Appendix A).
[b] Total number may vary if new monitoring points are added.
[c] Number of samples may vary for specific physical tests.
[d] Field duplicates will be collected and analyzed by the mobile field laboratory. An equal number of confirmatory samples will be collected and sent to a second laboratory.

1.3.8 Sampling Locations

Sampling locations are identified in specific sections of Chapter 5 (Soil Investigation), Chapter 6 (Groundwater and Surface Water Investigation), Chapter 7 (Baseline Air Monitoring Investigation), and Chapter 8 (Biota Investigation) of the Work Plan.

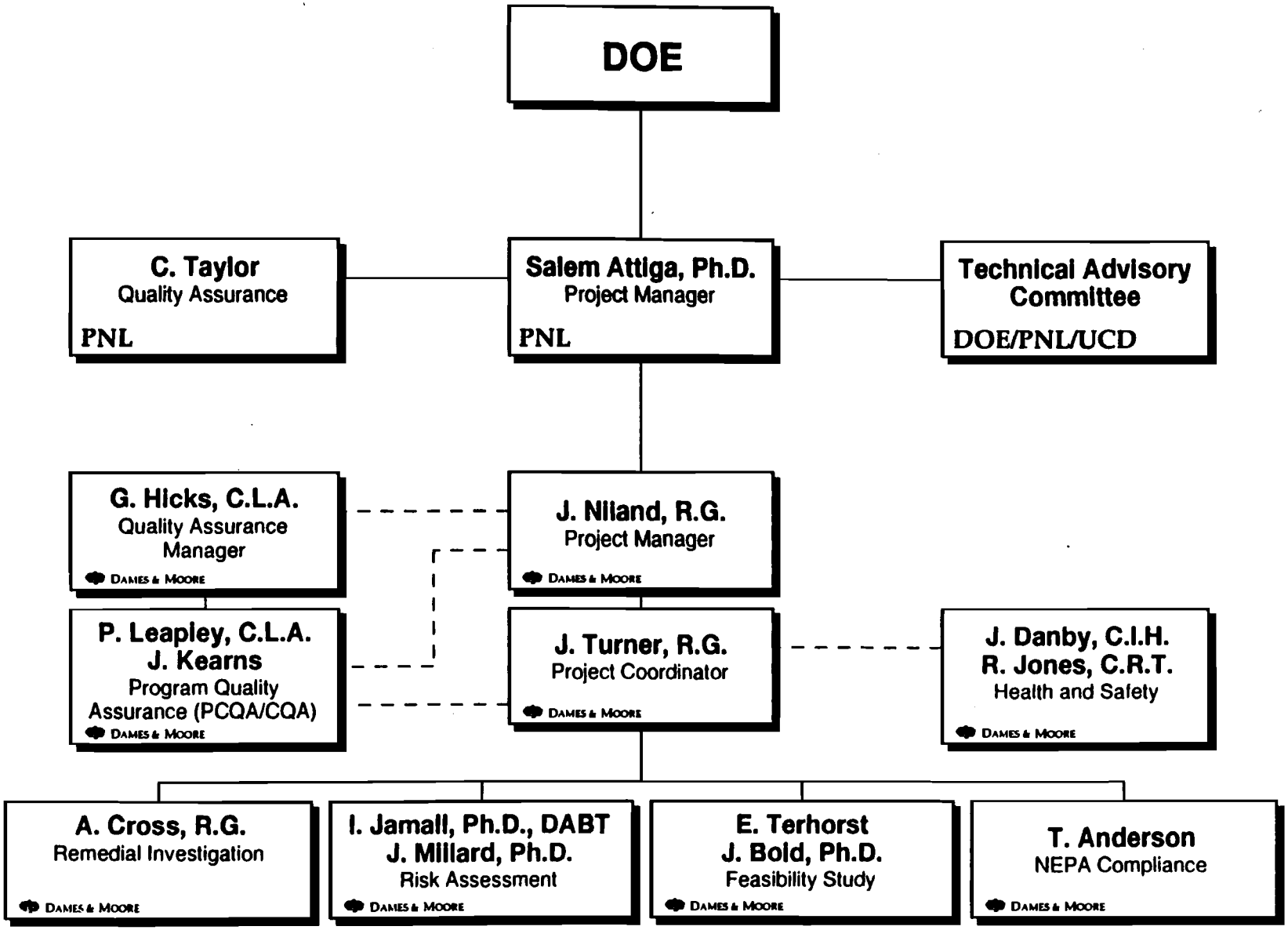
2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents quality assurance and technical lead responsibilities during implementation of the Work Plan, including: organizational reporting structure, training requirements, documentation control, qualification of suppliers/subcontractors, and surveillance/audit activities. The organization described below is specific to Dames & Moore and reflects a structure that has been put in place to implement the QA Program Plan.

2.1 QUALITY ASSURANCE RESPONSIBILITIES

A detailed project organization chart and description of responsibilities is provided in Chapter 13 of the RI/FS Work Plan. Organization of the Quality Assurance (QA) staff to be used during implementation of the Work Plan is illustrated in Figure 2.1. The Coordinator of Quality Assurance (CQA) is independent and reports to the Dames & Moore Program Coordinator of Quality Assurance (PCQA) and indirectly to the Project Manager and/or Project Coordinator. The PCQA reports directly to the Manager of Quality Assurance (MQA) who is appointed by the Dames & Moore Chief Executive Officer (CEO). The MQA is responsible for the management and effective functioning of the QA Program and organization. Quality assurance responsibilities for each of these individuals is detailed in the QA Program Plan.

The QA staff has responsibility for effective planning, verification, and management of QA activities associated with the assigned project. Actual technical judgments are made by the project management team (Program Manager, Project Manager, Task Leaders) and/or by independent Technical Reviewers assigned to the project. In the case of a significant condition adverse to quality, the cause of the condition must be determined and corrective action taken to preclude recurrence. If a deficiency is identified and not corrected, the QA staff has responsibility to implement Procedure 18 of the QA Program Plan (Nonconformances and Corrective Action). In addition, the QA staff will evaluate and document the performance of the technical staff. The QA staff will maintain records and control of project-controlling documents, surveillances, audits, corrective action, and quality assurance training of the technical staff.



PROJECT ORGANIZATION CHART

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

2.1.1 Training

The CQA has been trained in the overall objectives of Dames & Moore's quality assurance program. Quality assurance training of the QA staff, the CQA, and the PCQA will be documented according to Procedures 1 and 2 of the QA Program Plan. Procedure 3 of the QA Program Plan will be used to document QA training sessions held with the technical staff. Procedure 4 of the QA Program Plan will be used to document training of technical staff specific to this document. The CQA will prepare the course materials for each training session. They will be reviewed and modified by the PCQA as appropriate. Quality assurance training sessions held with the technical staff can be conducted by the CQA with the consent of the PCQA.

2.1.2 Documentation

The CQA will maintain project files pertaining to quality assurance aspects of the LEHR Environmental Restoration work. Procedure 19 of the QA Program Plan will be implemented for the control and retention of Quality Assurance Records. The types of documents are discussed in more detail in Chapters 8, 9, 10, 13, and 14 of this QAPjP.

2.1.3 Qualifications of Suppliers/Subcontractors

The PCQA will select qualified individuals to evaluate suppliers or subcontractors whose services affect the quality of the data (analytical laboratories in particular). The pre-award evaluation team will document potential subcontractors according to Procedure 12 of the QA Program Plan. Chemical analyses completed during water monitoring will be conducted under an agreement between an approved laboratory and the investigation contractor.

2.1.4 Surveillances and Audits

Surveillances will be conducted by the CQA and/or by members of the technical staff who are not responsible for the task being reviewed. Audits will be conducted by a

Certified Lead Auditor selected by the PCQA. Surveillance and audit procedures are described in Chapter 10 of this QAPjP.

2.2 TECHNICAL LEAD RESPONSIBILITIES

The investigation contractor has primary responsibility for all phases of investigation and reporting. The Technical Lead will conduct technical training sessions, and select subcontractors and suppliers as discussed in Sections 2.1.1 to 2.1.3.

2.2.1 Technical Training

The Technical Lead/Project Manager, with advice from each Field Operation Lead, is responsible for evaluating the qualifications of the technical staff. The Field Operations Lead is responsible for staff preparation and any "on-the-job" training necessary for the completion of each task. Procedure 4 of the QA Program Plan will be implemented for technical training of the project staff.

2.2.2 Selection of Subcontractors

The Technical Lead/Project Manager has the final responsibility for selecting qualified subcontractors and suppliers. Subcontractors will be selected based on past experience on similar projects, past experience with the investigation contractor, size of firm, ability to complete the job, their health and safety program, their quality assurance program plan, and cost of services compared to other contractors. Laboratory subcontractors will be appropriately certified by the State of California Department of Health Services.

2.2.3 Selection of Suppliers

The Technical Lead/Project Manager will be responsible for purchasing all materials for the RI/FS Program. Selection of the suppliers and control of purchased materials which affect quality will be consistent with Procedure 11 and Procedure 12 of the QA Program Plan.

3.0 QUALITY ASSURANCE OBJECTIVES

The overall quality assurance objective is to sample and analyze water, soil, and air from the LEHR site in a manner that establishes technical data generated during the investigation are accurate and representative, are able to withstand scientific and legal scrutiny, and are useful for evaluating waste disposal alternatives. The following sections present a glossary of terms, specific QA objectives for measurement data, and expected data uses.

3.1 GLOSSARY OF TERMS

The following terms are commonly used in discussions of QA objectives. A detailed explanation of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters is provided in Section 3.2

Accuracy: The degree of agreement of a measurement with an accepted reference or true value. The difference is usually expressed as a percentage. Accuracy is a measure of the bias in a system.

Audits: A documented evaluation of objective evidence that demonstrates quality of sampling and analysis in compliance with stated requirements.

Blank: A solution which is similar in composition to the sample solution but does not contain the species being measured. A blank is run to detect systematic error caused by background or contamination of reagents.

Comparability: A measure of the confidence with which one data set can be compared to another.

Completeness: A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions.

Confidence Level: The probability that the true value will fall within the range given.

Duplicate: A repeat sample collected under the same conditions used to determine the overall precision of field sampling and analytical procedures.

Equipment Blank: A blank used in the field to determine the cleanliness of sampling equipment and containers.

Lab Blank: A blank subjected to the usual analytical processes to establish background data for the compounds of interest during the laboratory process.

Lab Duplicate: Analyses of two aliquots from the same sample, treated as individual samples, used to determine analytical precision.

Precision: A measure of reproducibility of a method when multiple measurements are made on the same sample under the same conditions. (The measured values may differ from the true values without affecting the precision.)

Preventive Maintenance: Maintenance done at prescribed times to minimize down time and loss of data.

Quality Assurance: The total integrated program for assuring the reliability of monitoring and measurement data. The quality assurance elements used to do this are: description of objectives; sampling procedures; training staff; internal quality control checks; audits (performance and system); preventive maintenance; calibration and control of measuring equipment; procedures to assess precision; and quality assurance reports to management.

Quality Control: The routine application of a procedure for obtaining a prescribed standard of performance in the monitoring and measurements process.

Reference Sample: A sample of known concentration used as a performance audit; however, the concentration is unknown to the analyst.

Replicates: See duplicates.

Representativeness: Expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variation, or environmental condition.

Spiking: Addition of a known amount of the substance being measured to a sample in order to determine the original sample concentration by the known addition technique or to determine the accuracy of a direct measurement technique.

Standard Solution: A solution of accurately known strength, used as a reagent for the purposes of calibration.

Standardization: The steps necessary to bring an instrument or solution to an established or known quality. The preparation and/or adjustment of a standard solution and/or an instrument.

Surveillance: Program established and directed by the quality assurance staff to evaluate if field and laboratory activities are performed in compliance with project-controlling documents. A surveillance consists of direct observation of the work being performed.

System Audit: A systematic on-site qualitative review of facilities, equipment, training, procedures, record-keeping, validation, and reporting aspects of a total quality assurance system, to arrive at a measure of the capability and ability of the system.

Trip Blank: A blank that travels from the laboratory to a sampling site and is returned to the laboratory unopened. It is generally used to measure volatile organic compound (VOC) contamination of the samples during transport, handling, and storage.

3.2 SPECIFIC QA OBJECTIVES FOR MEASUREMENT DATA

The criteria commonly used to specify QA goals are precision, accuracy, representativeness, completeness, and comparability (PARCC). Precision is determined by analyzing duplicate samples. Accuracy is determined by analyzing spiked samples. The equations used to calculate values for precision, accuracy, and completeness are discussed in Chapter 12 of this QAPjP. The frequency of duplicates and other QC samples such as field or trip blanks is discussed in Section 9.2.

The QA objectives for this project are described below. A summary of the QA objective acceptance criteria is provided in Table 3.1a: Quality Assurance Objectives For Soil Samples, Table 3.1b: Quality Assurance Objectives For Aqueous Samples, and Table 3.1c: Quality Assurance Objectives For Air Samples. These criteria were based on documented analytical method performance and expected confidence levels appropriate for use of the data. QA objectives for the Biota Investigation will be method specific. If the investigation is conducted, they will be established after a laboratory is selected and the analytical methods are selected.

TABLE 3.1a QUALITY ASSURANCE OBJECTIVES FOR SOIL SAMPLES

Fraction	Parameter	Reference	Precision / Accuracy[a]	Completeness[b]
VOCs:	Target Compound List	CLP SOW OLM 01.8	Exhibit D - VOA	95%
SVOCs:	Target Compound List	CLP SOW OLM 01.8	Exhibit D - SV	95%
Pesticides/PCBs:	Target Compound List	CLP SOW OLM 01.8	Exhibit D - PEST	95%
Metals	Antimony	CLP SOW ILM 02.1	±25/±20%	95%
	Arsenic	CLP SOW ILM 02.1	±25/±20%	95%
	Barium	CLP SOW ILM 02.1	±25/±20%	95%
	Beryllium	CLP SOW ILM 02.1	±25/±20%	95%
	Cadmium	CLP SOW ILM 02.1	±25/±20%	95%
	Chromium (total)	CLP SOW ILM 02.1	±25/±20%	95%
	Chromium^{6+}	7196	±25/±20%	95%
	Cobalt	CLP SOW ILM 02.1	±25/±20%	95%
	Copper	CLP SOW ILM 02.1	±25/±20%	95%
	Iron	CLP SOW ILM 02.1	±25/±20%	95%
	Lead	CLP SOW ILM 02.1	±25/±20%	95%
	Manganese	CLP SOW ILM 02.1	±25/±20%	95%
	Mercury	CLP SOW ILM 02.1	±25/±20%	95%
	Molybdenum	CLP SOW ILM 02.1	±25/±20%	95%
	Nickel	CLP SOW ILM 02.1	±25/±20%	95%
	Selenium	CLP SOW ILM 02.1	±25/±20%	95%
	Silver	CLP SOW ILM 02.1	±25/±20%	95%
	Thallium	CLP SOW ILM 02.1	±25/±20%	95%
	Vanadium	CLP SOW ILM 02.1	±25/±20%	95%
	Zinc	CLP SOW ILM 02.1	±25/±20%	95%
Radiological	Tritium	906.0	±25/±20%	95%
	Strontium 90	905.0	±25/±25%	95%
	Gamma Spectral Analysis	901.1	±25/±20%	95%
	Gross Alpha	9310	±30/±30%	95%
	Gross Beta	9310	±30/±30%	95%
	Carbon-14	LSC	±25/±25%	95%
	Radium-226	903.1(M)	±25/±20%	95%
	Thorium-Isotopic	LAS 0108	±25/±20%	95%
	Uranium-Isotopic	LAS 0108	±25/±20%	95%
	Americium-241	LAS 0108	±25/±20%	95%
	Plutonium-241	LAS 0108	±25/±20%	95%

[a] Refers to Laboratory Check Sample (LCS) or QC check sample.
[b] See discussion regarding completeness for exceptions to 95% (Section 3.2.3).

TABLE 3.1a

QUALITY ASSURANCE OBJECTIVES FOR SOIL SAMPLES (continued)

Fraction	Parameter	Reference	Precision / Accuracy[a]	Completeness[b]
Miscellaneous Organics	Formaldehyde	Modified NIOSH	±25 / ±20%	95%
	Total Organic Carbon	9060(M)	±25 / ±25%	95%
	Kerosene	8015(M)	±25 / ±20%	95%
Miscellaneous Inorganics	Alkalinity	310.1	±25 / ±20%	95%
	Ammonia	350.1	±25 / ±20%	95%
	Nitrate (as Nitrogen)	300.0	±25 / ±20%	95%
	Total Kjeldahl Nitrogen	351.1	±25 / ±20%	95%
	Sulfide	9030A	±25 / ±20%	95%
	Water Soluble Anions	300.0	±25 / ±20%	95%
Soil Vapor - Mobile Lab	VOCs			95%
	Oxygen			95%
	Carbon Dioxide			95%
	Methane			95%
	Gross Beta			95%
	Gross Gamma			95%
Soil Vapor - Stationary Lab	VOCs			95%
	Oxygen			95%
	Carbon Dioxide			95%
	Methane			95%

[a] Refers to Laboratory Check Sample (LCS) or QC check sample.
[b] See discussion regarding completeness for exceptions to 95% (Section 3.2.3).

TABLE 3.1b QUALITY ASSURANCE OBJECTIVES FOR WATER SAMPLES

Fraction	Parameter	Reference	Precision / Accuracy[a]	Completeness[b]
VOCs:	Target Compound List	CLP SOW OLC02.0	Exhibit D - VOA	95%
SVOCs:	Target Compound List	CLP SOW OLM01.8	Exhibit D - SV	95%
Pesticides/PCBs:	Target Compound List	CLP SOW OLM01.8[c]	Exhibit D - PEST	95%
Metals	Antimony	CLP SOW ILC 02.0	±25/±20%	95%
	Arsenic	CLP SOW ILC 02.0	±25/±20%	95%
	Barium	CLP SOW ILC 02.0	±25/±20%	95%
	Beryllium	CLP SOW ILC 02.0	±25/±20%	95%
	Cadmium	CLP SOW ILC 02.0	±25/±20%	95%
	Chromium (total)	CLP SOW ILC 02.0	±25/±20%	95%
	Chromium^{6+}	7196	±25/±20%	95%
	Cobalt	CLP SOW ILC 02.0	±25/±20%	95%
	Copper	CLP SOW ILC 02.0	±25/±20%	95%
	Iron	CLP SOW ILC 02.0	±25/±20%	95%
	Lead	CLP SOW ILC 02.0	±25/±20%	95%
	Mercury	CLP SOW ILC 02.0	±25/±20%	95%
	Molybdenum	CLP SOW ILC 02.0	±25/±20%	95%
	Nickel	CLP SOW ILC 02.0	±25/±20%	95%
	Selenium	CLP SOW ILC 02.0	±25/±20%	95%
	Silver	CLP SOW ILC 02.0	±25/±20%	95%
	Thallium	CLP SOW ILC 02.0	±25/±20%	95%
	Vanadium	CLP SOW ILC 02.0	±25/±20%	95%
	Zinc	CLP SOW ILC 02.0	±25/±20%	95%
Radiological	Tritium	906.0	±25/±20%	95%
	Strontium 90	905.0(M)	±25/±25%	95%
	Gamma Spectral Analysis	901.1	±25/±20%	95%
	Gross Alpha	9310	±30/±30%	95%
	Gross Beta	9310	±30/±30%	95%
	Carbon-14	LSC	±25/±25%	95%
	Radium-226	903.1(M)	±25/±20%	95%
	Americium-241	LAS 0108	±25/±20%	95%
	Plutonium-241	LAS 0108	±25/±20%	95%

[a] Refers to Laboratory Check Sample (LCS) or QC check sample.
[b] See discussion regarding completeness for exceptions to 95% (Section 3.2.3).
[c] CRQLs reported at OLC 02.0 levels.

TABLE 3.1b

QUALITY ASSURANCE OBJECTIVES FOR WATER SAMPLES (continued)

Fraction	Parameter	Reference	Precision / Accuracy[a]	Completeness[b]
Miscellaneous Organics	Formaldehyde	Modified NIOSH	±25/±20%	95%
	Total Organic Carbon	415.2 (9060)	±25/±25%	95%
Miscellaneous Inorganics	Alkalinity	310.1	±25/±20%	95%
	Ammonia	350.1	±25/±20%	95%
	Chloride	300.0	±25/±20%	95%
	Nitrate (as Nitrogen)	300.0	±25/±20%	95%
	Phosphorous	365.2	±25/±20%	95%
	Sulfate	300.0	±25/±20%	95%
	Calcium	6010	±25/±20%	95%
	Magnesium	6010	±25/±20%	95%
	Sodium	6010	±25/±20%	95%
	Potassium	6010	±25/±20%	95%
	Chemical Oxygen Demand	410.1	±25/±20%	95%
	Total Dissolved Solids	160.1	±25/±20%	95%
	Total Kjeldahl Nitrogen	351.2	±25/±20%	95%
	Turbidity	180.1	±25/±20%	95%
	Biochemical Oxygen Demand	405.1	±25/±20%	95%
Field Parameters	pH	SOP 2.0	±25/±20%	100%
	Turbidity	SOP 2.0	±25/±20%	100%
	Temperature	SOP 2.0	±25/±20%	100%
	Electrical Conductivity	SOP 2.0	±25/±20%	100%
	Redox Potential	SOP 2.0	±25/±20%	100%

[a] Refers to Laboratory Check Sample (LCS) or QC check sample.
[b] See discussion regarding completeness for exceptions to 95% (Section 3.2.3).
[c] CRQLs reported at OLC 02.0 levels.

TABLE 3.1c QUALITY ASSURANCE OBJECTIVES FOR AIR SAMPLES

Fraction	Parameter	Reference	Precision / Accuracy[a]	Completeness[b]
VOCs:	Chloroform	TO-14	±25/±20%	95%
	Methylene Chloride	TO-14	±25/±20%	95%
Pesticides/PCBs:	Chlordane	TO-4	±25/±20%	95%
Metals	Antimony	40 CFR 50 Appendix J, Appendix G	±25/±20%	95%
	Beryllium	40 CFR 50 Appendix J, Appendix G	±25/±20%	95%
	Chromium	40 CFR 50 Appendix J, Appendix G	±25/±20%	95%
	Copper	40 CFR 50 Appendix J, Appendix G	±25/±20%	95%
	Molybdenum	40 CFR 50 Appendix J, Appendix G	±25/±20%	95%
	Selenium	40 CFR 50 Appendix J, Appendix G	±25/±20%	95%
Radiological	Tritium	7500-^{3}H[c]	±25/±20%	95%
	Strontium-90	7500-Sr[c]	±25/±20%	95%
	Gamma Emitters	40 CFR 61	±25/±20%	95%
	Gross Alpha	7110[c]	±25/±20%	95%
	Gross Beta	7110[c]	±25/±20%	95%
	Cobalt-60	40 CFR 61	±25/±20%	95%
	Cesium-137	40 CFR 61	±25/±20%	95%
	Radium-226	7500-Ra[c]	±25/±20%	95%
	Isotopic Uranium-234, 235, 238	7500-UC[c]	±25/±20%	95%
	Isotopic Thorium-228, 230, 232	HASL-300	±25/±20%	95%
	Radon-222	N/A	±25/±20%	95%

[a] Refers to Laboratory Check Sample (LCS) or QC check sample.
[b] See discussion regarding completeness for exceptions to 95% (Section 3.2.3).
[c] Standard Methods for the Analysis of Water and Waste Water (1985).

3.2.1 Precision

Precision will be evaluated for the following parameters:

- Water level - Precision for such measurements is expected to be achievable at plus or minus the sensitivity of the measuring instrument. Duplicate measures that agree to ± 0.01 foot will be acceptable.

- Temperature, pH, conductivity, turbidity, and redox potential - Duplicate measurements of these parameters will be required at each station for each reading. Duplicate measurements must agree to within plus or minus the sensitivity of the instrument.

- Laboratory analytical measurements - Precision objectives for all laboratory analytical measurements will be defined in the laboratory Quality Assurance Plan (laboratory QA Plan) which will be attached to this document following the laboratory selection process.

3.2.2 Accuracy

Accuracy will be evaluated for the following parameters:

- Water level - The accuracy of water level measurements is limited by the sensitivity of the measuring instrument. The electric tape to be used must have a sensitivity of ± 0.01 foot.

- Temperature, pH, conductivity, turbidity, and redox potential - The accuracy of these indicator measurements will be limited to the sensitivity of the measuring device, as follows:

  Temperature ± 1°C,
  pH ± 1.0 standard unit,
  Conductivity ± 2 μmhos,
  Turbidity ± 0.10 NTU, and
  Redox potential ± 1 millivolt

- Laboratory analytical measurements - Accuracy objectives for all laboratory analytical measurements will be defined in the laboratory QA Plan obtained from selected contract laboratories.

3.2.3 Completeness

Completeness will be evaluated for the following parameters:

- Water level - The objective for completeness is 100 percent.

- Temperature, pH, conductivity, turbidity, and redox potential - The completeness objective is 100 percent.

- Laboratory analytical measurements - The completeness objective is routinely 95 percent. However, for highly contaminated samples or matrices which present severe interferences a lower completeness objective may be appropriate. Unusual analyses for which approved methods do not exist and field conditions which render sampling impossible are both examples of situations which necessitate a lower completeness objective. The minimum acceptable completeness objective is 90 percent.

3.2.4 Representativeness and Comparability

Representativeness and comparability will be evaluated for the following parameters:

- Water level - Use of Standard Operating Procedures (SOPs) as provided in Attachment 1 of Appendix A and appropriate selection of sample locations as identified in Chapter 3 of the Work Plan will be used to control the representativeness and comparability of water level measurements.

- Temperature, pH, conductivity, turbidity, and redox potential - Use of SOPs as provided in Attachment 1 of Appendix A and appropriate selection of sample locations as identified in Chapter 3 of the Work Plan will be used to control the representativeness and comparability of the temperature, pH and conductivity, turbidity, and redox potential measurements.

- Laboratory analytical measurements - Representativeness is established through the appropriate selection of sample locations and sampling techniques as defined in Section 1.4.3 and the Work Plan SOPs. Field replicate or duplicate sample results will be reviewed in order to assess the representativeness of the sampling technique. It is expected that results of field replicate analysis will match to within

±20 percent for groundwater samples and ±20 percent for surface water samples.

Comparability of lab measurements is maintained through the use of standard sampling methods, analytical methods, and the consistent application of measurement units.

3.3 DATA USES

The Work Plan involves the acquisition of two types of data: field screening data and laboratory data. The quality objectives of screening data is commensurate with qualitative assessments, whereas laboratory data is intended to be quantitative to the degree defined by the EPA (SW-846 and CLP) and in ASTM.

The data can then be used reliably for the following purposes:

- Evaluate levels of chemical and radiological constituents;
- Identify types of contaminants;
- Defend data in a court of law;
- Perform a risk assessment; and
- Evaluate remedial alternatives.

4.0 SAMPLING PROCEDURES

Details of the sample types, locations, analytes and detailed procedures of sample collection are described in the Work Plan, FSP, and SOPs (Attachment A of the FSP). A brief description of these activities follows to identify the location of the applicable procedures.

4.1 SOIL INVESTIGATION

The soil investigation sampling and analysis activities are generally described in Chapter 5 of the Work Plan. SOPs for field activities include:

6.0 - Soil Borings
7.0 - Logging of Soil Borings
9.0 - Borehole Geophysical Logging
10.0 - Soil Sampling
11.0 - Test Pit Excavation
14.0 - Field Measurements - Soil
20.0 - Shallow Subsurface Geophysical Methods
21.0 - Soil Vapor Survey

4.2 GROUNDWATER AND SURFACE WATER INVESTIGATION

The groundwater and surface water investigation sampling and analysis activities are generally described in Chapter 6 of the Work Plan. SOPs for field activities include:

1.0 - Water Sampling
2.0 - Field Measurements - Water
4.0 - Soil Water and Waste Disposal
8.0 - Installation and Construction - Groundwater Monitoring Wells
13.0 - Aquifer Testing
19.0 - Cone Penetrometer Test and Hydropunch Sampling

4.3 BASELINE AIR MONITORING INVESTIGATION

The baseline air monitoring investigation sampling and analysis activities are generally described in Chapter 7 of the Work Plan. SOPs for field activities include:

15.0 - Field Measurements - Air
16.0 - Air Sampling - Ratameters and Mass Flow
17.0 - Air Sampling - Radionuclides in Ambient Air
26.0 - Radon Working Level Monitoring - Grab Sample Technique
27.0 - Performance of the Gamma Radiation Survey
30.0 - Airborne Radioactivity Monitoring

4.4 GENERAL FIELD PROCEDURES

Before starting work, field personnel will attend a field health and safety meeting. The meeting time, place, attendees, and subjects discussed will be documented in the field log book. All field personnel will read the Health and Safety Plan (Appendix C) and sign a release, acknowledging their understanding of this plan. Before any operations take place, the investigation contractor Field Operations Lead will confirm the sampling locations.

5.0 SAMPLE CUSTODY

Samples collected during the field investigation must be traceable at all times to legally-responsible parties. The Chain-of-Custody (COC) form (Figure 5.1) records possession of the samples from the time of collection, until disposal or archival of the sample. This section describes the procedures that will be used on this project. These procedures are slightly different than those detailed in Procedure 14 of the QA Program Plan, but achieve the same goals.

5.1 FIELD CUSTODY PROCEDURES

At the time of sample collection, the following field activities are documented by the site personnel on the field memorandum or COC:

- All procedures and supplies used in sample collection and sample preservation;
- Sample quantity, type (soil, water, or air), and sample locations;
- Information on the sample labels, including sample type (soil, water, or air), sample identification numbers, time, date, proposed laboratory analyses, and name of sampler; and
- Sample identification, sample type (soil, water, or air), date, time, number of containers.

Samples collected by field personnel are the responsibility of each sampler until the samples are delivered to a courier. The investigation contractor field technician signs and dates the COC, retaining a copy. Presentation of the sample to the courier terminates the field technician's responsibility for the sample. However, a copy of the air bill or other bill of lading will be retained as a part of the chain-of-custody. Procedures for sample handling and maintenance of field records are detailed in the SOPs (Attachment 1 of Appendix A to the RI/FS Work Plan).

CHAIN OF CUSTODY

Project # _____

Client:
Dames & Moore
8801 Folsom Blvd., Suite 200
Sacramento, CA 95826
(916) 387-8800
Attention: _____

Signatures
Dames & Moore _____ Date: _____

Sampler: _____

!! IMPORTANT!!
UPON RECEIPT OF THIS FORM:
1. INSPECT ALL SAMPLES.
2. NOTE ANY DAMAGED CONTAINERS
3. SIGN AND DATE THIS FORM.
4. SEND A FAX OF THIS FORM TO:
   RICK MOREN / DAMES & MOORE
   FAX # (916) 387-0802
5. *DO NOT BEGIN WORK* UNTIL AUTHORIZATION IS RECEIVED FROM DAMES & MOORE BY TELEPHONE.

Sample No.	Soil	Water	Date	Time	# of Containers	Laboratory Number

Analysis Requested for *ALL* Samples Listed

Relinquished by: _____ Date: _____ Time: _____ Rec'd by: _____ Date: _____ Time: _____
Relinquished by: _____ Date: _____ Time: _____ Rec'd by: _____ Date: _____ Time: _____
Relinquished by: _____ Date: _____ Time: _____ Rec'd by: _____ Date: _____ Time: _____

For Lab Use Only

Cooler Radiologic Survey Pass/Fail

Condition of Sample Containers: ☐ Good ☐ Other: _____

SOP_FORMS\CHAIN

CHAIN OF CUSTODY FORM

RI/FS Work Plan
LEHR Environmental Restoration
Davis, California

FIGURE 5.1

Prior to presentation to the courier, the sample shipping carton (cooler, box, etc.) is sealed with the signed chain-of-custody forms inside. The authorized laboratory custodian receives the samples and follows the procedures listed in Section 5.2.

5.2 LABORATORY CUSTODY PROCEDURES

Sample custody must be maintained by the laboratory following signing of the COC by the laboratory recipient. The following steps will be taken at all times to assure proper maintenance and custody of the samples:

- The sample custodian receives the samples, inspects sample containers, and cross-references sample labels against the COC;
- The COC form is signed by the sample custodian with date and time received. A photocopy of the COC is made, noting deficiencies in the sample shipment (broken or missing containers). A facsimile copy of the COC and laboratory log-in sheet are then sent to the investigation contractor immediately, and analysis of samples is authorized by the Project Manager. The original COC is retained in the laboratory case file.
- Samples are locked in a refrigerator or cabinet depending on storage requirements.
- When analyses are performed, the technicians must obtain the samples from the sample custodian and sign an in-house COC form.
- When analyses have been completed and the final report has been approved, the samples are disposed of properly, and the photocopied COC form is returned to the investigation contractor with analytical data.

6.0 CALIBRATION PROCEDURES

Calibration is the process of establishing a relationship between standard materials and the output of a measuring device. Calibration also provides a point of reference to which other sample analyses can be correlated. Calibration of field equipment will be based on the manufacturer's suggestions with regard to procedure and frequency. Documentation of field equipment calibration will be kept in the field memoranda and later compiled on separate forms according to Procedure 13 of the QA Program Plan. This section presents general information on equipment calibration procedures for field and laboratory equipment.

6.1 FIELD EQUIPMENT

Equipment calibration procedures for the soil investigation, groundwater and surface water monitoring, and baseline air monitoring are provided in the sampling SOPs (Appendix A). Specific details include equipment operation, performance checking, inventory procedures, out-of-service requirements, corrective action, and maintenance. Standards purchased for the field measurement instruments will be traceable to NIST standards.

The calibration operation should be documented in the daily field memoranda kept by field staff and retained by the Technical Lead/Project Manager. Calibration information, including equipment name, type, and serial number, date and time of calibration, name of person, standards used (lot number), and results of calibration, will be recorded on the Field Instrument Calibration Log (Figure 6.1). The project staff will transcribe calibration information from the Field Instrument Calibration Log onto a cumulative instrument calibration log form similar to Exhibit A from Procedure 13 of the QA Program Plan.

6.2 LABORATORY EQUIPMENT

Each analytical method has a specific set of equipment calibration procedures and verification requirements. Calibration procedures will comply with the analytical laboratory QA Plan.

FIGURE 6.1 FIELD INSTRUMENT CALIBRATION LOG

Page ___ of ___

FIELD INSTRUMENT CALIBRATION LOG

Parameter: _____
Instrument: _____ Serial No.: _____
Manufacturer: _____ Date Placed in Service: _____
Calibration Procedure: _____

Required Calibration Frequency: _____

Date	Time	Results	Comments*	Calibrated by:

*Note: Include information on Standard Manufacturer, Lot Number, and/or Serial Number in Comments as appropriate.

Reviewed by: _____

7.0 ANALYTICAL METHODS

The analytical methods used for this project are primarily EPA (CLP and SW-846) and ASTM methods and are listed in Tables 7.1 (Sample Analyses - Soil), 7.2 (Sample Analyses - Water), and 7.3 (Sample Analyses - Air). Specific analytical method procedures will be detailed in the laboratory QA Plan obtained from selected contract laboratories.

TABLE 7.1 SAMPLE ANALYSES - SOIL

Organic Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRQL	HOLDING TIME
Volatile Organic Compounds	CLP SOW OLM 01.8	2½ inch diameter Stainless Steel Ring	4°C	Page C-2 of SOW OLM 01.8[a]	7 days
Semivolatile Organic Compounds	CLP SOW OLM 01.8	2½ inch diameter Stainless Steel Ring	4°C	Page C-4 & C-5 of SOW OLM 01.8[a]	14 days to extraction, 40 days to analysis
Organochlorine Pesticides	CLP SOW OLM 01.8	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	Page C-8 of SOW OLM 01.8[a]	14 days to extraction, 40 days to analysis

[a] Table 7.1a is attached for reference.

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Radiologic Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Gross Alpha	9310	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	5 pCi/g	180 days
Gross Beta	9310	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	10 pCi/g	180 days
Tritium	906.0	500 ml Glass Jar	None	300 pCi/L[b]	180 days
Radium-226	903.1(M)	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	1 pCi/g	180 days
Carbon-14	LSC	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	50 pCi/g	180 days
Strontium-90	905.0	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	1 pCi/g	180 days
Thorium - Isotopic	LAS 0108[c]	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	1.0 pCi/g	180 days

[b] Extracted water is tested.
[c] Laboratory Standard Operating Procedure.

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Radiologic Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Uranium - Isotopic	LAS 0108[c]	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	0.6 pCi/g	180 days
Americium-241	LAS 0108[c]	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	0.1 pCi/g	180 days
Plutonium-241	LAS 0108[c]	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None	1.0 pCi/g	180 days

[b] Extracted water is tested.
[c] Laboratory Standard Operating Procedure.

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Radiologic Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Gamma Spectral Analysis	901.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	None		180 days
TH-234				130 pCi/g	
PB-214				10 pCi/g	
BI-214				10 pCi/g	
PB-210				250 pCi/g	
U-235				5 pCi/g	
U-238				1 pCi/g	
NA-22				1 pCi/g	
AC-228				15 pCi/g	
PB-212				10 pCi/g	
BI-212				60 pCi/g	
TL-208				5 pCi/g	
K-40				50 pCi/g	
CO-60				4 pCi/g	
CS-137				6 pCi/g	

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Metals Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL[4]	HOLDING TIME
Hexavalent Chromium	7196	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.5 mg/Kg	24 hours
Total Chromium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days
Antimony	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	12 mg/Kg	180 days
Arsenic	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days
Barium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	40 mg/Kg	180 days
Beryllium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg	180 days
Cadmium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg	180 days

[4] Values calculated using formula in CLP SOW ILM02.1 (Section G, Page D-8) and applied to water CRDL values identified on Page C-1.

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Metals Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL[d]	HOLDING TIME
Cobalt	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	10 mg/Kg	180 days
Copper	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	5 mg/Kg	180 days
Iron	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	20 mg/Kg	180 days
Lead	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.6 mg/Kg	180 days
Manganese	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	3 mg/Kg	180 days
Mercury	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.1 mg/Kg	28 days
Molybdenum	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days

[d] Values calculated using formula in CLP SOW ILM02.1 (Section G, Page D-8) and applied to water CRDL values identified on Page C-1.

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Metals Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL[d]	HOLDING TIME
Nickel	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	8 mg/Kg	180 days
Selenium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg	180 days
Silver	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days
Thallium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	2 mg/Kg	180 days
Vanadium	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	10 mg/Kg	180 days
Zinc	CLP SOW ILM 02.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	4 mg/Kg	180 days

[d] Values calculated using formula in CLP SOW ILM02.1 (Section G, Page D-8) and applied to water CRDL values identified on Page C-1.

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

General Chemical Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Alkalinity	310.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	300 mg/Kg	14 days
Nitrate (as Nitrogen)	300.0	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.2 mg/Kg	48 hours
Total Kjeldahl Nitrogen	351.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg*	7 days
Water Soluble Anions	300.0	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	0.1 - 1.0 mg/Kg	48 hours
Formaldehyde	3500 Modified NIOSH	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1 mg/Kg	7 days to extraction, 30 days to analysis
Total Organic Carbon	9060(M)	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	10 mg/Kg*	28 days
Ammonia (as N)	350.1	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	1.5 mg/Kg	28 days

* Reporting Limit based on advisory method detection limit.

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

General Chemical Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Sulfide	9030A	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	50 mg/Kg	7 days
Kerosene	8015(M)	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	10 mg/Kg	14 days to extraction, 40 days to analysis
pH	ASTM 4972	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	None	Upon Receipt
EC	ASTM G-57	2½ inch diameter Stainless Steel Ring or 500 ml Glass Jar	4°C	None	Upon Receipt

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

General Physical Tests:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Hydrometer	D-422	Ring or plastic bag	N/A	N/A	None
Grain Size	C-136	Ring or plastic bag	N/A	N/A	None
Permeability	D-2434	Sealed ring	N/A	N/A	None
Moisture Release	D-3152 and D-2325	Sealed 6" ring	N/A	N/A	None
Moisture Content	D-2216	Sealed ring or plastic bag	N/A	N/A	None
Mineralogy	XRD	Ring or plastic bag	N/A	N/A	None
Specific Gravity	D-854	Ring or plastic bag	N/A	N/A	None
Atterberg Limits	D-4318	Ring or plastic bag	N/A	N/A	None
Bulk Density	D-4531	Sealed ring	N/A	N/A	None

TABLE 7.1 SAMPLE ANALYSES - SOIL (CONTINUED)

Soil Vapor Analyses - Mobile Field Laboratory:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Volatile Organic Compounds[1]	TBD	TBD	TBD	TBD	N/A
Oxygen	TBD	TBD	TBD	TBD	N/A
Carbon Dioxide	TBD	TBD	TBD	TBD	N/A
Methane	TBD	TBD	TBD	TBD	N/A
Gross Beta	SOP 33	TBD	TBD	TBD	N/A
Gross Gamma	SOP 33	TBD	TBD	TBD	N/A

Soil Vapor Analyses - Stationary Laboratory:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Volatile Organic Compounds	TO-14	Stainless Steel Canister	TBD	TBD	TBD
Oxygen	TBD	Stainless Steel Canister	TBD	TBD	TBD
Carbon Dioxide	TBD	Stainless Steel Canister	TBD	TBD	TBD
Methane	TBD	Stainless Steel Canister	TBD	TBD	TBD

[1] Field laboratory analyses of VOCs will be conducted for a limited analyte list: chloroform; 1,1 dichloroethane; 1,1 dichloroethene; 1,2 dichloroethane; trichloroethene; and methylene chloride.

TABLE 7.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[9]
Volatiles (Method CLP SOW OLM 01.8):			
1.	Chloromethane	74-87-3	10
2.	Bromomethane	74-83-9	10
3.	Vinyl Chloride	75-01-4	10
4.	Chloroethane	75-00-3	10
5.	Methylene Chloride	75-09-2	10
6.	Acetone	67-64-1	10
7.	Carbon Disulfide	75-15-0	10
8.	1,1-Dichloroethene	75-35-4	10
9.	1,1 Dichloroethane	75-34-3	10
10.	1,2-Dichloroethene (total)	540-59-10	10
11.	Chloroform	67-66-3	10
12.	1,2 Dichloroethane	107-06-2	10
13.	2-Butanone	78-93-3	10
14.	1,1,1-Trichloroethane	71-55-6	10
15.	Carbon Tetrachloride	56-23-5	10
16.	Bromodichloromethane	75-27-4	10
17.	1,2-Dichloropropane	78-87-5	10

[9] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE 7.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[9]
Volatiles (Method CLP SOW OLM 01.8) - continued:			
18.	cis 1,3 Dichloropropene	10061-01-5	10
19.	Trichloroethene	79-01-6	10
20.	Dibromochloromethane	24-48-1	10
21.	1,1,2-Trichloroethane	79-00-5	10
22.	Benzene	71-43-2	10
23.	trans-1,3-Dichloropropene	10061-02-6	10
24.	Bromoform	75-25-2	10
25.	4-Methyl-2-pentanone	108-10-1	10
26.	2-Hexanone	591-78-6	10
27.	Tetrachloroethene	127-18-4	10
28.	Toluene	108-88-3	10
29.	1,1,2,2-Tetrachloroethane	79-34-5	10
30.	Chlorobenzene	108-90-7	10
31.	Ethyl Benzene	100-41-4	10
32.	Styrene	100-42-5	10
33.	Xylenes (Total)	1330-20-7	10

[9] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE 7.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[9]
Semivolatiles (Method CLP SOW OLM 01.8)			
34.	Phenol	108-95-2	330
35.	bis(2-Chloroethyl) ether	111-44-4	330
36.	2 - Chlorophenol	95-57-8	330
37.	1,3 Dichlorobenzene	541-73-1	330
38.	1,4 Dichlorobenzene	106-46-7	330
39.	1,2-Dichlorobenzene	95-50-1	330
40.	2-Methylphenol	95-48-7	330
41.	2, 2'-oxybis (1-Chloropropane)	108-60-l	330
42.	4-Methylphenol	106-44-5	333
43.	N-Nitroso-di-n-propylamine	621-64-7330	330
44.	Hexachloroethane	67-72-1	330
45.	Nitrobenzene	98-95-3	330
46.	Isophorone	78-59-1	330
47.	2-Nitrophenol	88-75-5	330
48.	2,4-Dimethylphenol	105-67-9	330
49.	bis(2-Chloroethoxy) methane	111-91-1	330
50.	2,4-Dichlorophenol	120-83-2	330

[9] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE 7.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Semivolatiles (Method CLP SOW OLM 01.8) - continued:			
51.	1,2,4-Trichlorobenene	120-82-1	330
52.	Naphthalene	91-20-3	330
53.	4-Chloroaniline	106-47-8	330
54.	Hexachlorobutadiene	87-68-3	330
55.	4-chloro-3-methylphenol	59-50-7	330
56.	2- Methylnaphthalene	91-57-6	330
57.	Hexachlorocyclopentadiene	77-47-4	330
58.	2,4,6-Trichlorophenol	88-06-2	330
59.	2,4,5-Trichlorophenol	95-95-4	800
60.	2-Cloronaphthalene	91-58-7	330
61.	2-Nitroaniline	88-74-4	800
62.	Dimethylphthalate	131-11-3	330
63.	Acenaphthylene	208-96-8	330
64.	2,6-Dinitrotoluene	606-20-2	330
65.	3-Nitroaniline	99-09-2	800
66.	Acenaphthene	83-32-9	330
67.	2,4-Dinitrophenol	51-28-5	800

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE 7.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[a]
Semivolatiles (Method CLP SOW LOM 01.8) - continued:			
68.	4-Nitrophenol	100-02-7	800
69.	Dibenzofuran	132 64 9	330
70.	2,4-Dinitrotoluene	121 14	330
71.	Diethylphthalate	84-66-2	330
72.	4-Chlorophenyl-phenyl ether	7005-72-3	330
73.	Fluorene	86-73-7	330
74.	4-Nitroaniline	100-01 6800	800
75.	4,6-Dinitro-2-methylphenol	534-52-1	800
76.	N-nitrosodiphenylamine	86-30-6	330
77.	4-Bromophenyl-phenylether	01-55 3	330
78.	Hexachlorobenzene	118-74-1	330
79.	Pentachlorophenol	87-86-5	800
80.	Phenanthrene	85-01-8	330
81.	Anthracene	120-12-7	330
82.	Carbazole	86-74-8	330
83.	Di-n-butylphthalate	84-74-2	330
84.	Fluoranthene	206-44-0	330

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE 7.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[9]
Semivolatiles (Method CLP SOW OLM 01.8) - continued:			
85.	Pyrene	129-00-0	330
86.	Butylbenzylphthalate	85-68-7	330
87.	3,3'-Dichlorobenzidine	91-94-1	330
88.	Benzo(a)anthracene	56-55-3	330
89.	Chrysene	218-01-9	330
90.	bis(2-Ethylhexyl)phthalate	117-81-71	330
91.	Di-n-octylphthalate	117-84-0	330
92.	Benzo(b)fluoranthene	205-99-2	330
93.	Benzo(k)fluoranthene	207-08-9	330
94.	Benzo(a)pyrene	50-32-8	330
95.	Indeno(1,2,3-cd)pyrene	193 395	330
96.	Dibenz(a,h)anthracene	53-70-3	330
97.	Benzo(g,h,i)perylene	191-24-2	330

[9] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE 7.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[9]
Pesticides/PCBs (Method CLP SOW OLM 01.8)			
98.	alpha-BHC	319-84-6	1.7
99.	beta-BHC	319-85-7	1.7
100.	delta-BHC	319-86-8	1.7
101.	gamma-BHC (lindane)	58-89-9	1.7
102.	Heptachlor	76-44-8	1.7
103.	Aldrin	309-00-2	1.7
104.	Heptachlor epoxide	1024-57-3	1.7
105.	B-Endosulfan I	959-98-8	1.7
106.	Dieldrin	60-57-1	3.3
107.	4,4'-DDE	72-55-9	3.3
108.	Endrin	72-20-8	3.3
109.	Endosulfan II	33213-65-9	3.3
110.	4,4'-DDD	72-54-8	3.3
111.	Endosulfan sulfate	1031-07-8	3.3
112.	4,4'-DDT	50-29-3	3.3
113.	Methoxychlor	72-43-5	17.0
114.	Endrin ketone	53494-70-5	3.3

[9] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE 7.1a SOIL SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/Kg)[9]
Pesticides/PCBs (Method CLP SOW OLM 01.8) - continued:			
115.	Endrin aldehyde	7421-36-3	3.3
116.	alpha-Chlordane	5103-71-9	1.7
117.	gamma-ChLordane	5103-74-2	1.7
118.	Toxaphene	8001-35-2	170.0
119.	Arochlor-1016	12674-11-2	33.0
120.	Arochlor-1221	11104-28-2	67.0
121.	Arochlor-1232	11141-16-5	33.0
122.	Arochlor-1242	53469-21-9	33.0
123.	Arochlor-1248	12672-29-6	33.0
124.	Arochlor-1254	11097-69-1	33.0
125.	Arochlor-1260	11096-82-5	33.0

[9] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

TABLE 7.2 SAMPLE ANALYSES - WATER

Field Parameters:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
pH	SOP	NA	NA	NA	NA
EC	SOP	NA	NA	NA	NA
Temperature	SOP	NA	NA	NA	NA
Turbidity	SOP	NA	NA	NA	NA
Eh	SOP	NA	NA	NA	NA

TABLE 7.2 SAMPLE ANALYSES - WATER (CONTINUED)

Organic Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRQL	HOLDING TIME
Volatile Organic Compounds	CLP SOW OLC 02.0	2, 40 ml, G	4°C HCl, pH<2	Page C-2 & 3 of SOW OLC 02.0[a]	14 days
Semivolatile Organic Compounds	CLP SOW OLM 01.8	2 Liter, Amber G	4°C	Page C-4 & 5 of SOW OLM 01.8[a]	7 days to extraction, 40 days to analysis
Organochlorine Pesticides	CLP SOW OLM 01.8(M)[b]	2 Liter, Amber G	4°C	Page C-6 of SOW OLC 02.0[a]	7 days to extraction, 40 days to analysis

[a] Table 7.2a is attached for reference.
[b] CRQLs reported at OLC 02.0 levels.

TABLE 7.2 SAMPLE ANALYSES - WATER (CONTINUED)

Radiologic Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA[d]	HOLDING TIME
Gross Alpha	9310	1 Liter P,G	Filter HNO3, pH<2	2 pCi/L	180 days
Gross Beta	9310	1 Liter P,G	Filter HNO3, pH<2	3 pCi/L	180 days
Tritium	906.0	1 Liter G	None	300 pCi/L	180 days
Carbon-14	LSC	1 Liter P,G	None	20 pCi/L	180 days
Strontium-90	905.0(M)[c]	2 Liter P,G	Filter HNO3, pH<2	1 pCi/L	180 days
Radium-226	903.1	1 Liter, G	Filter HNO3, pH<2	1 pCi/L	180 days
Americium-241	LAS 0108[e]	1 Liter, G	Filter HNO3, pH<2	0.1 pCi/L	180 days
Plutonium-241	LAS 0178[e]	1 Liter, G	Filter HNO3, pH<2	1 pCi/L	180 days

[c] Modified procedure specified in laboratory SOP.
[d] Minimum Detectable Activity (MDA) may vary from sample to sample, depending on possilbe matrix interferences such as dissolved solids.
[e] Laboratory Standard Operating Procedure.

TABLE 7.2 SAMPLE ANALYSES - WATER (CONTINUED)

Radiologic Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA[d]	HOLDING TIME
Gamma Spectral Analysis	901.1	4 Liter P,G	Filter		180 days
TH-234			HNO3, pH<2	170 pCi/L	
PB-214				10 pCi/L	
BI-214				10 pCi/L	
PB-210				380 pCi/L	
U-235				5 pCi/L	
U-238				10 pCi/L	
NA-22				1 pCi/L	
AC-228				20 pCi/L	
PB-212				10 pCi/L	
BI-212				70 pCi/L	
TL-208				5 pCi/L	
K-40				55 pCi/L	
CO-60				4 pCi/L	
CS-137				4 pCi/L	

TABLE 7.2 SAMPLE ANALYSES - WATER (CONTINUED)

Metals Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL	HOLDING TIME
Hexavalent Chromium	7196	1 Liter, P	Filter, 4°C	20 µg/L	24 hours
Total Chromium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Antimony	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	5 µg/L	180 days
Arsenic	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	2 µg/L	180 days
Barium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	20 µg/L	180 days
Beryllium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	1 µg/L	180 days
Cadmium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	1 µg/L	180 days
Cobalt	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Copper	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days

TABLE 7.2 SAMPLE ANALYSES - WATER (CONTINUED)

Metals Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL	HOLDING TIME
Iron	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	100 µg/L	180 days
Lead	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	2 µg/L	180 days
Mercury	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	0.2 µg/L	28 days
Molybdenum	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Nickel	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	20 µg/L	180 days
Selenium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	3 µg/L	180 days
Silver	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Thallium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days

TABLE 7.2 SAMPLE ANALYSES - WATER (CONTINUED)

Metals Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT CRDL	HOLDING TIME
Vanadium	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	10 µg/L	180 days
Zinc	CLP SOW ILC 02.0	1 Liter, P	Filter, 4°C HNO3, pH<2	20 µg/L	180 days

TABLE 7.2 SAMPLE ANALYSES - WATER (CONTINUED)

General Chemical Analyses:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Alkalinity	310.1	1 Liter P	Filter, 4°C	10 mg/L	14 days
Sodium	6010	1 Liter, P	Filter, 4°C HNO3, pH<2	2 mg/L	180 days
Potassium			Filter, 4°C HNO3, pH<2	2 mg/L	180 days
Calcium			Filter, 4°C HNO3, pH<2	2 mg/L	180 days
Magnesium			Filter, 4°C HNO3, pH<2	2 mg/L	180 days
Chloride	300.0	1 Liter P,G	Filter, 4°C	1 mg/L	28 days
Sulfate				1 mg/L	28 days

TABLE 7.2 SAMPLE ANALYSES - WATER (CONTINUED)

General Chemical Analyses (continued):					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Phosphorous, all forms	365.2	1 Liter P,G	Filter, 4°C H2SO4, pH<2	1 mg/L	28 days
Nitrate (as Nitrogen)	300.0	1 Liter P,G	Filter, 4°C	0.1 mg/L	48 hours
Total Kjeldahl Nitrogen	351.2	500 ml P,G	Filter, 4°C H2SO4,pH<2	0.5 mg/L	28 days
Total Dissolved Solids	160.1	1 Liter P,G	Filter, 4°C	20 mg/L	7 days
Formaldehyde	3500 Modified NIOSH	2, 40 ml G	4°C H2SO4, pH<2	1 mg/L	30 days
Total Organic Carbon	415.2	1 Liter G	Filter, 4°C H2SO4, pH<2	1 mg/L	28 days
Ammonia	350.1	500 ml P,G	Filter, 4°C H2SO4, pH<2	0.05 mg/L	28 days
Turbidity	180.1	500 ml P,G	4°C	0.1 NTU	48 hours
Chemical Oxygen Demand	410	125 ml P	4°C H2SO4, pH<2	50 mg/L*	28 days
Biochemical Oxygen Demand	405.1	1 Liter P	4°C	5 mg/L*	48 hours

* Reporting limit is based on advisory method detection limit.

TABLE 7.2a WATER SAMPLE ANALYSES
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR ORGANIC ANALYSES

		CAS Number	CRQL (µg/L)
Volatiles (Method CLP SOW OLC 02.0):			
1.	Chloromethane	74-87-3	1
2.	Bromomethane	74-83-9	1
3.	Vinyl chloride	75-01-4	1
4.	Chloroethane	75-00-3	1
5.	Methylene chloride	75-09-2	2
6.	Acetone	67-64-1	5
7.	Carbon disulfide	75-15-0	1
8.	1,1-Dichloroethene	75-35-4	1
9.	1,1-Dichloroethane	75-34-3	1
10.	cis-1,2-Dichloroethene	156-59-4	1
11.	trans-1,2-Dichloroethene	156-60-5	1
12.	Chloroform	67-66-3	1
13.	1,2-Dichloroethane	107-06-2	1
14.	1-Butanone	78-93-3	5
15.	Bromochloromethane	74-97-5	1
16.	1,1,1-Trichloroethane	71.55-6	1
17.	Carbon Tetrachloride	56-23-5	1
18.	Bromodichloromethane	75-27-4	1
19.	1,2-Dichloropropane	78-87-5	1
20.	cis-1,3-Dichloropropene	10061-01-5	1

TABLE 7.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Volatiles (Method CLP SOW OLC 2.0) - continued:			
21.	Trichloroethene	79-01-6	1
22.	Dibromochloromethane	124-48-1	1
23.	1,1,2-Trichloroethane	79-00-5	1
24.	Benzene	71-43-2	1
25.	trans-1,3-Dichloropropene	10061-02-6	1
26.	Bromoform	75-25-2	1
27.	4-Methyl-2-pentanone	108-100-1	5
28.	2-Hexanone	591-78-6	5
29.	Tetrachloroethene	127-18-4	1
30.	1,1,2,2-Tetrachloroethane	79-34-5	1
31.	1,2-Dibromoethane	106-93-4	1
32.	Toluene	108-88-3	1
33.	Chlorobenzene	108-90-7	1
34.	Ethylbenzene	100-41-4	1
35.	Styrene	100-42-5	1
36.	Xylenes (total)	1330-20-7	1
37.	1,3-Dichlorobenzene	541-73-1	1
38.	1,4-Dichlorobenzene	106-46-7	1
39.	1,2-Dichlorobenzene	95-50-1	1
40.	1,2-Dibromo-3-chloropropane	96-12-8	1

TABLE 7.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Semivolatiles (Method CLP SOW OLC 01.8):			
41.	Phenol	108-95-2	10
42.	bis(2-chloroethyl)ether	111-44-4	10
43.	2-Chlorophenol	95-57-8	10
44.	1,3-Dichlorobenzene	541-73-1	10
45.	1,4-Dichlorobenzene	106-46-7	10
46.	1,2-Dichlorobenzene	95-50-1	10
47.	2-Methylphenol	95-48-7	10
48.	2,2'-oxybis (1-Chloropropane)#	108-60-1	10
49.	4-Methylphenol	106-44-5	10
50.	N-Nitroso-di-n-propylamine	621-64-7	10
51.	Hexachloroethane	67-72-1	10
52.	Nitrobenzene	98-95-3	10
53.	Isophorone	78-59-1	10
54.	2-Nitrophenol	88-75-5	10
55.	2,4-Dimethylphenol	105-67-9	10
56.	bis(2-Chloroethoxy)methane	111-91-1	10
57.	2,4-Dichlorophenol	120-83-2	10
58.	1,2,4-Trichlorobenzene	120-82-1	10
59.	Naphthalene	91-20-3	10
60.	4-Chloroaniline	106-47-8	10

TABLE 7.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Semivolatiles (Method CLP SOW OLC 01.8) - continued:			
61.	Hexachlorobutadiene	87-68-3	10
62.	4-Chloro-3-methylphenol	59-50-7	10
63.	2-Methylnaphthalene	91-57-6	10
64.	Hexachlorocyclopentadiene	77-47-4	10
65.	2,4,6-Trichlorophenol	88-06-2	10
66.	2,4,5-Trichlorophenol	95-95-4	25
67.	2-Chloronaphthalene	91-58-7	10
68.	2-Nitroaniline	88-74-4	25
69.	Dimethylphthalate	131-11-3	10
70.	Acenaphthylene	208-96-8	10
71.	2,6-Dinitrotoluene	606-20-2	10
72.	3-Nitroaniline	99-09-2	25
73.	Acenaphthene	83-32-9	10
74.	2,4-Dinitrophenol	51-28-5	25
75.	4-Nitrophenol	100-02-7	25
76.	Dibenzofuran	132-64-9	10
77.	2,4-Dinitrotoluene	121-14-2	10
78.	Diethylphthalate	84-66-2	10
79.	4-Chlorophenyl-phenylether	7005-72-3	10
80.	Fluorene	86-73-7	10

TABLE 7.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Semivolatiles (Method CLP SOW OLC 01.8) - continued:			
81.	4-Nitroaniline	100-01-6	25
82.	4,6-Dinitro-2-methylphenol	534-52-1	25
83.	N-nitrosodiphenylamine	86-30-6	10
84.	4-Bromophenyl-phenylether	101-55-3	10
85.	Hexachlorobenzene	118-74-1	10
86.	Pentachlorophenol	87-86-5	25
87.	Phenanthrene	85-01-8	10
88.	Anthracene	120-12-7	10
89.	Carbazole	86-74-8	10
90.	Di-n-butylphthalate	84-74-2	10
91.	Fluoranthene	206-44-0	10
92.	Pyrene	129-00-0	10
93.	Butylbenzylphthalate	85-68-7	10
94.	3,3'-Dichlorobenzidine	91-94-1	10
95.	Benzo(a)anthracene	56-55-3	10
96.	Chrysene	218-01-9	10
97.	bis-2-Ethylhexyl)phthalate	117-81-7	10
98.	Di-n-ocytlphthalate	117-84-0	10
99.	Benzo(b)fluoranthene	205-99-2	10
100.	Benzo(k)fluoranthene	207-08-9	10

TABLE 7.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Semivolatiles (Method CLP SOW OLC 01.8) - continued:			
101.	Benzo(a)pyrene	50-32-8	10
102.	Indeno(1,2,3-cd)pyrene	193-39-5	10
103.	Dibenz(a,h)anthracene	53-70-3	10
104.	Benzo(g,h,i)perylene)	191-24-2	10

TABLE 7.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Pesticides/PCBs (Method CLP SOW OLM 01.8 [modified to report CRQLs at OLC 02.0 levels]):			
105.	alpha-BHC	319-84-6	0.01
106.	beta-BHC	319-85-7	0.01
107.	delta-BHC	58-89-9	0.01
108.	Gamma-BHC (Lindane)	58-89-9	0.01
109.	Heptachlor	76-44-8	0.01
110.	Aldrin	309-00-2	0.01
111.	Heptachlor epoxide	1024-57-3	0.01
112.	Endosulfan I	959-98-8	0.01
113.	Dieldrin	60-57-1	0.02
114.	4,4'-DDT	72-54-8	0.02
115.	Methoxychlor	72-43-5	0.10
116.	Endrin ketone	53494-70-55	0.02
117.	Endrin aldehyde	7421-36-3	0.02
118.	Alpha-chlordane	5103-71-9	0.01
119.	Gamma-chlordane	5103-74-2	0.01
120.	Toxaphene	8001-35-2	1.0
121.	Aroclor-1016	12674-11-2	0.20
122.	Aroclor-1221	11104-28-2	0.40
123.	Aroclor-1232	11141-16-5	0.20
124.	Aroclor-1242	53469-21-9	0.20

TABLE 7.2a WATER SAMPLE ANALYSES (continued)
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL) FOR WATER SAMPLE ANALYSES

		CAS Number	CRQL (µg/L)
Pesticides/PCBs (Method CLP SOW OLM 01.8 [modified to report CRQLs at OLC 02.0 levels]):			
125.	Aroclor-1248	12672-29-6	0.20
126.	Aroclor-1254	11097-69-1	0.20

Note: Except for methylene chloride, the quantitation limits in this table are set at the concentrations in the sample equivalent to the concentration of the lowest calibration standard analyzed for each analyte. In the case of methylene chloride, the CRQL value in this table is based on the lowest level of contamination of samples with this common laboratory solvent that can be achieved by reasonable means in a production laboratory.

TABLE 7.3 SAMPLE ANALYSES - AIR

Radiologic Analyses:				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Gross Alpha	7110[a]	Store filter in individual glassine envelope	3×10^{-6} µCi/sample	None
Gross Beta	7110[a]	Store filter in individual glassine envelope	3×10^{-6} µCi/sample	None
Gamma Emitters	40 CFR 61	Store filter in individual glassine envelope	Dependent on Compound	None
Tritium	7500-^{3}H[a]	Store filter in individual glassine envelope	2×10^{-4} µCi/sample	48 hours
Cobalt-60	40 CFR 61	Store filter in individual glassine envelope	5×10^{-6} µCi/sample	None
Strontium-90	7500-Sr[a]	Store filter in individual glassine envelope	3×10^{-7} µCi/sample	None
Cesium-137	40 CFR 61	Store filter in individual glassine envelope	3×10^{-6} µCi/sample	None
Radium-226	7500-Ra[a]	Store filter in individual glassine envelope	1×10^{-6} µCi/sample	None

[a] Standard Methods for the Analysis of Water and Waste Water (1985).

TABLE 7.3 SAMPLE ANALYSES - AIR (CONTINUED)

Radiologic Analyses (continued):				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Isotopic Uranium (-238, 234, 235)	7500-UC[a]	Store filter in individual glassine envelope	3×10^{-7} μCi/sample	None
Isotopic Thorium (-232, 230, 228)	HASL 300 and Method A-1, A-3 Alpha spectrometry	Store filter in individual glassine envelope	4×10^{-8} μCi/sample	None
Radon-222	N/A	N/A	Requires either a gas sample or charcoal absorbent	N/A

[a] Standard Methods for the Analysis of Water and Waste Water (1985).

TABLE 7.3 SAMPLE ANALYSES - AIR (CONTINUED)

Metals Analyses:				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Antimony	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.05 $\mu g/m^3$	None
Beryllium	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.004 $\mu g/m^3$	None
Chromium	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.1 $\mu g/m^3$	None
Copper	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.002 $\mu g/m^3$	None
Molybdenum	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.04 $\mu g/m^3$	None
Selenium	40 CFR 50 Appendix J, Appendix G	Store filter in individual glassine envelope	0.04 $\mu g/m^3$	None

TABLE 7.3 SAMPLE ANALYSES - AIR (CONTINUED)

Organochlorine Pesticide Analyses:				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
Chlordane	TO-4	1 Liter Stainless Steel Canister	TBD	None

Volatile Organic Compound Analyses:				
ANALYTE	METHOD	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
Chloroform	TO-14	1 Liter Stainless Steel Canister	0.11 $\mu g/m^3$	None
Methylene Chloride	TO-14	1 Liter Stainless Steel Canister	1.7 $\mu g/m^3$	None

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

Analytical data will be used to evaluate the presence of chemical and radiologic constituents in water samples collected during the RI/FS Program. Validation of field data is accomplished by proper sampling and measurement techniques and by using calibrated equipment. It is the responsibility of the Technical Lead/Project Manager to provide adequate technical training to the Field Operations Lead and the field staff for the collection of valid field data. The Technical Lead/Project Manager will review all field memoranda to verify that proper techniques were employed, and will document this review by initialing and dating the original documents before these data are accepted, and are put into the project file.

Data generated from laboratory analyses will be validated as described in Section 8.2. Calculations will be performed, checked, and documented according to Procedure 8 and Procedure 10 of the QA Program Plan. This chapter presents information on data reduction, validation, reporting, handling, and technical review procedures.

8.1 DATA REDUCTION

This section describes data reduction procedures that will be used in the field, office, and laboratory.

8.1.1 Field

Data recording will occur for the field measurements at the point of sampling. Data measured by field instruments will be recorded in field notebooks and on required forms. Units of measure for field analyses are identified on the field record forms located in Appendix A.

8.1.2 Office

After the field event, the data may be further reduced to data tables, contour maps or trend analysis tables or graphs. Upon receipt of the analytical results from the laboratory and after data validation, the data will be further reduced to data tables. A

detailed Data Management Plan is provided in Chapter 11 of the Work Plan. The data tables will contain the following information:

- Information identifying the samples represented on the tables (e.g. sample location, matrix, depth, etc.);
- The compounds for which the samples were tested;
- The results for each compound; and
- The data flags as applied by the laboratory and the data validators.

8.1.3 Laboratory

The details of laboratory data reduction are covered in the laboratory QA Plans, which will be obtained following selection of the contract laboratories.

8.2 DATA VALIDATION

Data validation will be performed on analytical results received from the laboratory for groundwater, surface water, and storm water runoff, soil, and air. The purpose of data validation will be to identify data that meet the quality required for the RI/FS program and Risk Assessment, and to identify data that does not meet data quality objectives or quality assurance criteria that are set forth in this document and agreed on by the laboratory. Data received from the laboratory will be reviewed with respect to the PARCC parameters.

A USEPA Contract Laboratory Program (CLP) equivalent data package will be obtained from the laboratory for groundwater, surface water, and storm water runoff, soil, and air laboratory results. When received, the investigation contractor will perform a detailed validation of 10 percent of the analytical data, based on the *U.S. Environmental Protection Agency National Functional Guidelines for Laboratory Data Review*. This level of validation consists of a detailed review of sample data, including verification of data calculations for calibration and quality control samples. The remaining 90 percent of the data will be reviewed using a subset of the National Functional Guidelines validation criteria. This review includes an assessment of holding times, method blank performance,

instrument calibration, precision of duplicate measurements, and matrix-specific biases. The SOP to validate 90 percent of the data is provided in Attachment 1.

8.3 DATA REPORTING

This section describes the contents of an analytical data package obtained from the laboratory. Any proposed equivalents to CLP forms required below will be closely scrutinized. The use of equivalents must be justified by the laboratory and approved in advance by the investigation contractor. To be considered equivalent, the proposed forms must include all of the information included in the CLP deliverable formats specified in the CLP Statements of Work for Organics and Inorganics (see Tables 7.1, 7.2, and 7.3 for designated methods).

8.3.1 Level IV

All USEPA CLP forms or their equivalent and raw data deliverable requirements will apply. The deliverable requirements for Level IV are specified in Document Number OLMO1.0 (including revisions OLMO1.1 through OLMO1.8 (August 1991)) for organic parameters and Document Number ILMO2.0 for inorganic parameters.

8.3.2 Non-Level IV Analyses

The following data and summary forms will be submitted by the laboratory for inorganic non-metals analyses or other analyses not covered above:

- Narrative, cross reference, chain-of-custody, method summaries and references, and chronicle as in organics above;
- Calibration summaries;
- Blank results summary;
- Sample spike recovery (when possible);
- Duplicate sample results (when possible);
- Analytical results;
- QA/QC summary.

An example of an acceptable QA/QC summary is presented below:

QA/QC SUMMARY

Batch ID: _____

Matrix: _____ Fraction: _____

Related Samples:

Parameter	Passed	Failed	Narrative Note
Holding time	☐	☐	
Surrogates	☐	☐	
Spikes	☐	☐	
Duplicate	☐	☐	
Blanks	☐	☐	
Calibration	☐	☐	
LCS	☐	☐	

Narrative Notes: _____

_____

_____

_____

Signature: _____

Date: _____

8.4 DATA HANDLING

As stated in Chapter 8 of the QAPjP, the validity (Section 8.2) of the data will be evaluated before raw data or data packages can be further reduced. Original data sheets will be photocopied, and the originals retained in the project file. Valid data is then entered into the investigation contractor's database, which utilizes personal computers and licensed software. After data entry, mathematical manipulations of the data will be checked and checks will be documented as described in Procedure 8 of the QA Program Plan. Software used in the process of data manipulation and presentation will be validated in accordance with Procedure 7 of the QA Program Plan.

During data screening, data verification, and data review activities of field- and laboratory-generated data, unacceptable or suspect data will be evaluated to assess the cause. The results of this investigation will be documented, distributed to the CQA and the Technical Lead/Project Manager, and placed in the permanent project files. If the evaluation indicates that the cause was noncompliance with an established procedure or requirement, a recommendation for corrective action will be documented in accordance with Chapter 13 of the QAPjP and Procedure 18 of the QA Program Plan. If the suspect data have been included in the database, the data will be flagged to indicate their suspect status. Protocols for flagging the database are discussed in Chapter 11 of the RI/FS Work Plan.

8.5 FINAL REVIEW BY TECHNICAL LEAD

All validation reports and supporting analytical data packages shall be subjected to a final technical review by a qualified reviewer at the direction of the Technical Lead/Project Manager prior to submittal to the regulatory agencies or inclusion in reports or technical memoranda. All chemistry data packages and the QA/QC Summary will be reviewed by the Technical Lead who signs the Summary QA/QC Summary. Only then will the data be placed in the project file.

9.0 INTERNAL QUALITY CONTROL

This chapter presents internal quality control information concerning preparation, review, and control of project controlling documents; field QC checks for equipment calibration, sample blanks, duplicates, replicates, and spikes; laboratory checks; and technical review procedures for reports, calculations, drawings, and computer software programs.

9.1 PROJECT CONTROLLING DOCUMENTS

This section describes the procedures that will be used to prepare, review, and control project documents.

9.1.1 Preparation

The format for the Work Plan contains the elements specified in Exhibits A, B, and D of Procedure 5 of the QA Program Plan. All technical memoranda will be prepared using Exhibit F (Procedure 5) as the guide.

Minor changes to the Work Plan or QAPjP will be documented and distributed according to Exhibit G in Procedure 5 of the QA Program Plan. Major changes will be issued as official revisions by the Technical Lead/Project Manager, with acknowledgement receipts which must be returned to the Technical Lead/Project Manager in a timely manner.

Controlled copies of the Work Plan and QAPjP will be retained by the Technical Lead/Project Manager, Field Operations Lead, the PCQA, and CQA. Receipt of these copies will be acknowledged and any modifications to the Work Plan or QAPjP will be distributed to these individuals. Controlled copies of the Work Plan and QAPjP must be returned to the CQA when an individual terminates involvement with the project, or wishes to transfer a controlled copy to another person. The CQA will document return of the copy in the distribution log, the CQA will then check the copy for completeness and reissue the copy as appropriate.

9.1.2 Review and Control

The review of the Work Plan has been completed by independent reviewers whose comments have been incorporated directly by the Technical Lead/Project Manager. For documents other than the Work Plan, Procedure 6 of the QA Program Plan will be implemented for other project controlling documents drafted subsequent to the approval of the Work Plan.

9.2 FIELD QC CHECKS

This section describes procedures that will be used to conduct quality control checks on field activities including, equipment calibration and collection of sample blanks, duplicates, and laboratory spikes.

9.2.1 Calibration

Field measurements of temperature, pH, conductivity, turbidity, and redox potential will be obtained from groundwater samples. Calibration of the instruments used to obtain these measurements is discussed in Chapter 6 of this QAPjP.

Calibration records for each field instrument used on this project will be maintained and a copy will be kept in the project QA files.

9.2.2 Blanks

This section describes the type and collection frequency of sample blanks that will be utilized during the sampling program.

9.2.2.1 Trip blanks

The primary purpose of this type of blank is to detect potential additional sources of contamination that could potentially influence contaminant values reported in actual samples, both quantitatively and qualitatively. Trip blanks serve as a mechanism of control for sample bottle preparation, blank water quality and sample handling. They are

generally submitted to the laboratory for analysis of volatile organic compounds (VOCs). The trip blank travels to the site with the empty sample bottles and returns from the site with the collected samples in an effort to simulate sample handling conditions. One per daily sample shipment will be submitted for analysis. Contaminated trip blanks may indicate inadequate bottle cleaning or blank water of questionable quality. The following have been identified as potential sources of contamination:

- Laboratory reagent water;
- Sample container;
- Cross-contamination during shipment;
- Ambient air or contact with analytical instrumentation during preparation and analysis at the laboratory; and
- Laboratory reagents used in analytical procedures.

Other issues affecting the use and integrity of trip (travel) blanks include the following:

- **Handling:** Trip blanks may be held on site for a maximum of one week. They must be shipped back to the lab at the end of the seventh calendar day. The temperature of the trip blanks must be maintained at 4°C while on site and during shipment.
- **Holding Time:** The holding-time clock for analysis of VOCs begins at the time of sample collection of the oldest sample in the shuttle.

9.2.2.2 Equipment blanks

The primary purpose of this type of blank is to provide an additional check on possible sources of contamination related to field sampling instruments. Laboratory-supplied water is passed through cleaning sample equipment and placed in the empty sample container for analysis. Equipment blanks should be handled, transported, and analyzed in the same manner as the samples acquired that day. Equipment blanks must return to the lab with the same set of sample bottles they accompanied into the field.

Equipment must be packaged with their associated matrix. One equipment blank will be collected for each investigation activity, in each investigation area. For example, three equipment blanks would be collected in an investigation area during sampling activities that include a backhoe exploration, stage 1 soil boring, and stage 2 soil boring. The equipment blanks will be tested for volatile organic compounds (VOCs), ~~semi-volatile organic compounds (SVOCs),~~ metals, hexavalent chromium, nitrate, gross alpha, gross beta, tritium, radium-226, strontium-90, carbon-14, and gamma spectral analysis.

9.2.3 Duplicates and replicates

The collection of duplicate or replicate samples provides for evaluation of the laboratory's performance by comparing analytical results of two samples of the same matrix from the same location. One duplicate or replicate sample will be collected for each analytical batch for each sample matrix sampled. If more than 20 samples of a single matrix are collected, then a frequency of one duplicate or replicate sample per 20 samples should be collected. Table 1.2, Summary of Data Quality Objectives, lists the expected number of duplicate or replicate samples to be collected based on the proposed number of samples. The duplicate or replicate samples will be assigned unique identification numbers so that they exist as blind samples to the laboratory.

Duplicates or replicates will be obtained by collecting a second sample from the sampling device for each parameter. Duplicates and replicates will be collected, preserved, and handled in a similar fashion to primary samples.

9.2.4 Spike samples

Where it is appropriate to the method, matrix spike and matrix duplicate samples will be collected and analyzed at a rate of one every 20 samples for each matrix. The matrix spike and spike duplicate will consist of a field sample spiked in the laboratory with a range of compounds according to the method to be employed. Analyses of these samples may or may not necessitate the collection of additional sample volume in the field. The contracted laboratory will include additional sample containers if they require additional sample volume.

9.3 LABORATORY CHECKS

Analytical activities used by the laboratory as QC checks include:

- Sample integrity check;
- Method blank;
- Standards;
- Calibration check samples;
- Replicate analysis; and
- Matrix spike samples.

The laboratory subcontractor selected will conform to their QA Plan with regard to sample frequency checks, handling, preparation, and analytical procedures.

9.4 TECHNICAL REVIEW

In addition to preparing and implementing work plans, selecting and training staff and subcontractors, the Technical Lead/Project Manager will prepare calculations, computer programs, and prepare drawings needed for reports to clients. The Technical Lead/Project Manager will assign an independent, qualified geologist, engineer, or geochemist to review all geologic analysis, calculations, models, and analytical data for completeness, accuracy, and assumptions. The procedures for conducting and documenting these reviews will be described in Sections 9.4.1 to 9.4.4.

9.4.1 Preparation and Review of Reports

Procedure 20 of the QA Program Plan will be applied to all external reports prior to their release. Quarterly Data Transmittals will be reviewed and approved prior to release. A modified version of the Cover Signature Sheet (Figure 9.1) provided in the QA Program Plan will be used to document review of the Quarterly Data Transmittals.

9.4.2 Technical Review of Calculations

All calculations will be checked by qualified personnel, selected by the Technical Lead/Project Manager and documented using Procedure 8 for the QA Program Plan.

FIGURE 9.1 COVER SIGNATURE SHEET — QUARTERLY DATA TRANSMITTALS

LEHR ENVIRONMENTAL RESTORATION
UNIVERSITY OF CALIFORNIA, DAVIS

DAMES & MOORE
8801 Folsom Boulevard, Suite 200
Sacramento, California 95826

PREPARED BY:	_____	_____	_____
	(Name)	(Signature)	(Date)
APPROVED BY:	_____	_____	_____
(Peer Review)	(Name)	(Signature)	(Date)
APPROVED BY:	_____	_____	_____
(CQA)	(Name)	(Signature)	(Date)

9.4.3 Computer Program Certification

Procedure 7 of the QA Program Plan will be implemented and applied to computer software programs used in the RI/FS Program. This will include software developed internally and/or supplied by qualified vendors.

9.4.4 Preparation of Drawings

Procedure 9 of the QA Program Plan will be applied to drawings obtained from external sources or those internally prepared. The Procedure outlines responsibilities and methods used to provide accountability and covers receipt, distribution, control, checking, and approval.

10.0 AUDITS AND SURVEILLANCES

10.1 AUDITS

The purpose of an audit is to evaluate the effectiveness of a quality assurance program for a project and to verify compliance with objectives stated in the project plans. One annual audit of LEHR Environmental Restoration activities is conducted by a Certified Lead Auditor. Procedure 16 of the QA Program Plan will be applied to the completion of this audit. Responses to any external audits will be prepared according to Procedure 17 of the QA Program Plan. An audit schedule will be maintained in the project QA files.

10.2 SURVEILLANCES

Surveillance programs are conducted by the quality assurance staff to evaluate whether field activities comply with the project controlling documents. Surveillances of the investigation contractor's field staff will be performed as described in Procedure 15 of the QA Program Plan. A surveillance of each ~~significant~~ new or unique field sample collection activity will be performed at least once during the project. These surveillances will be conducted at the beginning of a sampling activity and again at a later date if discrepancies were identified during the first visit. The overall frequency of surveillances conducted for ongoing field activities will be based on importance, duration, and significant changes in project scope or personnel. A surveillance schedule will be maintained in the project QA files.

11.0 PREVENTIVE MAINTENANCE

The investigation contractor is responsible for documenting the maintenance of all field equipment under the procedures described in Chapter 6 of this QAPjP. Laboratories are responsible for all analytical equipment calibration and maintenance as described in their laboratory QA Plan. Subcontractors are responsible for maintenance of all equipment needed to carry out subcontracted duties.

12.0 ASSESSING DATA PRECISION, ACCURACY AND COMPLETENESS

This chapter describes the procedures and mathematical formulas that will be used to assess data precision, accuracy, and completeness.

12.1 PRECISION

"Precision" is defined as the degree of agreement among individual measurements of the same property under similar conditions, and is expressed as relative percent difference (RPD).

The RPD is calculated in percent for duplicate measurements as follows:

$$\%RPD = \frac{X_1 - X_2}{(X_1 + X_2) / 2} \times 100$$

where X_1 is the first sample result, and X_2 is the duplicate sample result.

For radionuclide determinations, replicate measurements must agree within the 95-percent confidence level based on the summed error of the analysis, or within 3σ of the weighted average, as required by the client-specific protocol.

The replicate error ratio (RER) for radionuclide determination is calculated as follows:

$$RER = DER = \frac{R_1 - R_2}{(\sigma_1 + \sigma_2)}$$

Where:

R	=	Result
σ	=	95% confidence level

The precision objectives are noted in Chapter 3 of this QAPjP. The Project Manager will be responsible for monitoring the precision objectives. Should any of the data fail the

precision criteria, corrective action will be taken in accordance with Chapter 13 of this QAPjP.

12.1.1 Water Level

Each water level measurement will be performed in duplicate to verify precision. If duplicate measures fail to agree to within ± 0.01 foot, two additional measures will be taken until acceptable precision is obtained.

12.1.2 Temperature, pH, Conductivity, Turbidity, and Redox Potential

If duplicate measurements fail to meet precision objectives, additional sets of two measurements will be taken until acceptable precision is obtained.

12.1.3 Laboratory Analytical Measurements

The mechanisms for internal review of data for conformance to those specifications, and corrective actions required in cases of failure to meet precision specifications will be provided in the laboratory QA Plan. Independent data validation will also be provided as a further check on laboratory performance (see Chapter 8 for more information on the data validation procedures).

12.2 ACCURACY

"Accuracy" is defined as the degree of agreement between a known value and a measured value.

$$ACCURACY = \frac{MEASURED\ VALUE}{KNOWN\ VALUE} \times 100$$

The accuracy objectives are noted in Chapter 3 of this QAPjP. The Project Manager will be responsible for monitoring the accuracy objectives. Should any of the data fail the

accuracy criteria, corrective action will be taken in accordance with Chapter 13 of this QAPjP.

12.2.1 Water Level

The manufacturer's specifications for the tape used will be noted and a measurement against a known length taken by the principal investigator responsible for field activities. A failure of accuracy will result in the return of the tape to the manufacturer and the acquisition of an accurate instrument.

12.2.2 Temperature, pH, Conductivity, Turbidity, and Redox Potential

The principle investigator in charge of field activities will check one set of results from each instrument against a known value. Accuracy failures will result in the re-calibration of the instrument when possible, or the return of the instrument to the manufacturer when re-calibration is not possible. Additional measurements will be taken until acceptable accuracy is achieved.

12.2.3 Laboratory Analytical Measurements

The mechanisms for internal review of data for conformance to those specifications and corrective actions required in cases of failure to meet the accuracy specifications will be provided in the laboratory QA Plan. Independent data validation will also be provided as a further check on laboratory performance (see Chapter 8 for more information on the data validation procedures).

12.3 COMPLETENESS

"Completeness" is a measure of the amount of valid data obtained compared to the ideally expected amount of data to be obtained.

$$COMPLETENESS = \frac{QUANTITY\ OF\ RELIABLE\ DATA}{TOTAL\ QUANTITY\ OF\ DATA} \times 100$$

The completeness objectives are noted in Chapter 3 of this QAPjP. The Project Manager will be responsible for monitoring the completeness objectives. Should any of the data fail the completeness criteria, corrective action will be taken in accordance with Chapter 13 of this QAPjP.

12.3.1 Water level

All wells to be sampled will be measured for this parameter.

12.3.2 Temperature, pH, Conductivity, Turbidity, and Redox Potential

All applicable samples will be measured for these parameters.

12.3.3 Laboratory Analytical Measurements

The objective for completeness is 95 percent. Certain highly contaminated samples and certain media historically do not yield normal precision and accuracy, or may require established protocols to achieve meaningful results. It is necessary, however, that these problem samples/analyses be identified and discussed with the laboratory QA Officer while they are in the analytical process and that corrective actions taken or deficiencies accepted are deliberately arrived at and carefully documented.

13.0 CORRECTIVE ACTION

Procedure 18 of the QA Program Plan will be implemented for the identification, documentation, and correction of nonconformances. Nonconformances with regard to analytical or field data, sampling or field techniques, equipment calibration, results of surveillances and audits will be reported by the CQA to the Technical Lead/Project Manager.

If the Work Plan requires modification in the field for any reason, the Field Operations Lead will document the change and then attempt to contact the Project Manager or the Lead Consultant. If these individuals are not available, the LEHR ER Project Manager will be informed of the situation and field work will continue as directed by the LEHR ER Project Manager. The Field Operations Lead will document the situation in their daily field memoranda. The Field Operations Lead will notify the Project Manager immediately upon returning from the field, and the Project Manager will then review and distribute copies of the memoranda to the CQA, if corrective action was taken.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Pertinent QA/QC information is periodically reported by the CQA to the Technical Lead/Project Manager to allow assessment of the overall effectiveness of the Quality Assurance Program. These reports provide a summary of key QA activities during the period. At a minimum, these reports will include:

- Results of performance and systems audits;
- Results of surveillances;
- Reports on QA organizational changes;
- Description of significant quality problems and corrective actions taken; and
- Distribution notice of original and revised documents controlled by the quality assurance department.

15.0 REFERENCES

ASTM, 1987, "Annual Book of ASTM Standards," American Society for Testing and Materials, Philadelphia, Pennsylvania

Dames & Moore, August 1990, Work Plan, Phase II Site Characterization LEHR Environmental Restoration, University of California, Davis.

Environmental Protection Agency (EPA), 1979, "Handbook for Analytical Quality Control in Water and Wastewater Laboratories" U.S. Environmental Protection Agency, Washington, DC.

Environmental Protection Agency (EPA), 1986, "Test Methods for Evaluating Solid Waste," SW-846, Third Edition, Office of Solid Waste and Emergency Response, U. S. Environmental Protection Agency, Washington, DC.

Environmental Protection Agency (EPA), 1987, "Data Quality Objectives for Remedial Response Activities: Development Process." EPA/540/G-87/003 (NTIS 9B88-131370).

Environmental Protection Agency (EPA), 1989, "Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis," Office of Emergency and Remedial Response.

Environmental Protection Agency (EPA), 1991, "Laboratory Data Validation Functional Guidelines for Evaluating Organics Analysis," Office of Emergency and Remedial Response.

Environmental Protection Agency (EPA), 1991, "Contract Laboratory Program Statement of Work for Organic Analysis: Multi-media, Multi-concentration," Office of Emergency and Remedial Response.

Environmental Protection Agency (EPA), 1991, "Contract Laboratory Program Statement of Work for Inorganic Analysis: Multi-media, Multi-concentration," Office of Emergency and Remedial Response.

Environmental Protection Agency (EPA), 1993, "Planning for Data Collection in Support of Environmental Decision Making Using the Data Quality Objectives Process.

Leapley, P., 1994, "Quality Assurance Program Plan for Battelle Pacific Northwest Laboratories," Revision 2, September 1994, Sacramento, California.

ATTACHMENT 1

STANDARD OPERATING PROCEDURE
DATA VALIDATION

DATA VALIDATION QUALIFIER DEFINITIONS

The following definitions provide brief explanations of the data validation qualifiers assigned to results in the data review process.

Flag	Data Qualifier Explanation
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

YES NO N/A

HOLDING TIMES

Have all BNA samples been extracted within holding times? . . . . . .

ACTION: If any sample fails this criterion, apply flags to all results in the sample according to the following guidelines:

Condition	Positives	Non-Detects
15 Days ≤ Soil Sampling→Extraction ≤ 28 Days	"J"	"UJ"
Soil Sampling→Extraction > 28 Days	"J"	"R"
8 Days ≤ Water Sampling→Extraction ≤ 14 Days	"J"	"UJ"
Water Sampling→Extraction > 14 Days	"J"	"R"

Have all samples been analyzed within holding times? . . . . . .

ACTION: If any sample fails this criteria for the VOC fraction, apply flags to all results in the sample according to the following guidelines:

Condition	Positives	Non-Detects
15 Days ≤ VOC Sampling→Analysis ≤ 28 Days	"J"	"UJ"
VOC Sampling→Analysis > 28 Days	"J"	"R"

If any sample fails this criteria for the BNA fraction, apply flags to all results in the sample according to the following guidelines:

Condition	Positives	Non-Detects
41 Days ≤ BNA Extraction→Analysis ≤ 80 Days	"J"	"UJ"
BNA Extraction→Analysis > 80 Days	"J"	"R"

SYSTEM MONITORING COMPOUNDS (SURROGATES)

Are all surrogate recoveries in all samples within QC limits? . . . . . .

ACTION: If any surrogate failures are observed in a sample for the VOC fraction, apply flags to all results in the sample, according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper Limit	"J"	No Flags
10 ≤ %R < Lower Limit	"J"	"UJ"
%R < 10	"J"	"R"

If any surrogate failures are observed in a sample for either the Base/Neutral or Acid fractions, apply flags to all results in the sample, for that fraction, according to the following guidelines:

Condition	Positives	Non-Detects
1 %R out & > 10	No Flags	No Flags
2 or more %R out, all > Upper Limit	"J"	No Flags
2 or more %R out, all > 10, some < Lower Limit	"J"	"UJ"
1 or more %R < 10	"J"	"R"

YES NO N/A

QC CHECK SAMPLE (LCS)

Are all LCS recoveries within QC limits? . . . . . .

ACTION: If any LCS compound fails this criterion, apply flags to the failed compound in all samples associated with that LCS, according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper QC Limit	"J"	No Flags
30 ≤ %R < Lower QC Limit	"J"	"UJ"
%R < 30	"J"	"R"

If failures are widespread and consistent in the direction of the failure, then an overall analytical bias can be determined for this fraction. The final report should note the magnitude and direction of the bias.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

Are all MS/MSD recoveries within QC limits? . . . . . .

ACTION: MS/MSD data are used in conjunction with LCS data to identify and describe interferences. If failures are widespread and consistent in direction of failure, then an overall bias can be determined for this fraction. If LCS recoveries indicate a similar bias, then the bias can be determined to be analytical in nature. If LCS recoveries are in control, then the bias can be identified as a matrix effect. The final report should note the nature, direction and magnitude of the bias.

BLANKS

Are the following free of contamination:
Method Blanks? . . . . . .
Trip Blanks? (If present) . . . . . .
Field Blanks? (If present) . . . . . .

ACTION: Use the following steps when qualifying data based on blank contamination.

- Identify all individual data points that are associated with a blank contaminant.
- For any data point associated with contamination from more than one blank, select the blank with the highest concentration of the contaminant. The sample data point will be compared to this contaminant for flagging purposes.
- Convert the concentration of the selected contaminant to the actual contamination level. Divide the contamination concentration by the blank detection limit and multiply by the sample detection limit.

YES NO N/A

- Qualify all data points associated with a common laboratory contaminant (acetone, 2-butanone, methylene chloride, or common phthalates) according to the following guidelines:

Condition	Flag
No Positive Sample Result	None
Positive Sample Result < 10X Contamination Level	"U"
Positive Sample Result > 10X Contamination Level	None

- Qualify all data points associated with any other laboratory contaminant according to the following guidelines:

Condition	Flag
No Positive Sample Result	None
Positive Sample Result < 5X Contamination Level	"U"
Positive Sample Result > 5X Contamination Level	None

GC/MS INSTRUMENT PERFORMANCE CHECKS (TUNES)

Are all ion abundances within QC limits for each tune? . . . . . .

ACTION: If any ion abundances do not fall within QC limits, qualify all results in all related samples "R".

INITIAL CALIBRATIONS (ICs)

Are all RRFs greater than 0.05? . . . . . .

ACTION: If any compound fails this criterion, flag positive results for the failed compound "J" and non-detects for the failed compound "R" in all samples associated with that IC.

Are all %RSDs less than 30? . . . . . .

ACTION: If any compound fails this criteria, apply flags to that compound in all samples associated with that IC, according to the following guidelines:

Condition	Positives	Non-Detects
30 < %RSD < 50	"J"	No Flags
50 < %RSD < 80	"J"	"UJ"
%RSD > 80	"J"	"R"

YES NO N/A

CONTINUING CALIBRATIONS (CCs)

Are all RRFs greater than 0.05? . . . . . .

ACTION: If any compound fails this criterion, qualify the failed compound in all samples associated with that CC. For the affected data points, flag positive results "J" and non-detects "R"

Are all %Ds less than 25? . . . . . .

ACTION: If any compound fails this criteria, apply flags to that compound in all samples associated with that CC, according to the following guidelines:

Condition	Positives	Non-Detects
25 < %D < 50	"J"	No Flags
50 < %D < 80	"J"	"UJ"
%D > 80 and the RF from CC > RRF from IC	"J"	"UJ"
%D > 80 and the RF from CC < RRF from IC	"J"	"R"

INTERNAL STANDARDS (ISs)

Are all IS retention times within 30 seconds of the retention times for the ISs in the associated CCs? . . . . . .

ACTION: If any IS in a sample fails this criterion, qualify all compounds that are quantitated with that IS in that sample. For the affected data points, flag all positive results "J" and all non-detects "R".

Are all IS area counts > 50% and < 200% of the area count for the ISs in the associated CCs? . . . . . .

ACTION: If any IS in a sample fails this criterion, qualify all compounds that are quantitated with that IS in that sample, according to the following guidelines:

Condition	Positives	Non-Detects
Sample Count >200%	"J"	No flags
25% < Sample Count < 50%	"J"	"UJ"
Sample Count < 25%	"J"	"R"

FIELD DUPLICATES (IF APPLICABLE)

Are all compounds present in either the sample or duplicate also present in the other? . .

ACTION: Data are not qualified based on field duplicate precision; rather, an overall assessment of whether or not the data is representative of field conditions is made. This assessment should be discussed in the final report. If several compounds are present in either the sample or the duplicate but not in the other, then data may be qualitatively questionable. Some guidelines for evaluation:

YES NO N/A

- Any sample or duplicate data point that is below the DL is considered to be a positive result if the other data point in the pair is a positive result

- Any sample or duplicate data point that is below the DL is considered to be a non-detect if the other data point in the pair is a non-detect.

- If several discrepancies are noted, check to see if they are consistent (i.e. always present in the sample, but not detected in the duplicate).

- If discrepancies are consistent, compare DLs to see if there may be a large dilution factor for whichever sample consistently shows the non-detects.

Are all RPDs between sample and duplicate acceptable? . . . . . .

ACTION: Make an overall assessment of the quantitative precision of the sample-duplicate data. All RPDs should be generally within 100%. Calculate RPDs according to the following guidelines:

- If both data points for a compound are not detected, or found below the DL, no calculation is necessary.

- Any data point that is found, but below the DL, can be considered a positive result at the DL for calculation purposes.

- The RPD for two data points is (Difference/Mean)*100

YES NO N/A

HOLDING TIMES

Have all SVOC samples been extracted within holding times? . . . . . .

ACTION: If any sample fails this criterion for any SVOC fraction, apply flags to all results in the sample, for that fraction, according to the following guidelines:

Condition	Positives	Non-Detects
15 Days ≤ Soil Sampling→Extraction ≤ 28 Days	"J"	"UJ"
Soil Sampling→Extraction > 28 Days	"J"	"R"
8 Days ≤ Water Sampling→Extraction ≤ 14 Days	"J"	"UJ"
Water Sampling→Extraction > 14 Days	"J"	"R"

Have all samples been analyzed within holding times? . . . . . .

ACTION: If any sample fails this criterion for the VOC fraction, apply flags to all results in the sample according to the following guidelines:

Condition	Positives	Non-Detects
15 Days ≤ VOC Sampling→Analysis ≤ 28 Days	"J"	"UJ"
VOC Sampling→Analysis > 28 Days	"J"	"R"

If any sample fails this criterion for the either the BNA, Pesticide/PCB, or Herbicide fraction, apply flags to all results in the sample, for that fraction, according to the following guidelines:

Condition	Positives	Non-Detects
41 Days ≤ Extraction→Analysis ≤ 80 Days	"J"	"UJ"
Extraction→Analysis > 80 Days	"J"	"R"

SYSTEM MONITORING COMPOUNDS (SURROGATES)

Are all surrogate recoveries in all samples within QC limits? . . . . . .

ACTION: If any surrogate failures are observed in a sample for either the VOC, Pesticide/PCB, or Herbicide fraction, apply flags to all results in the sample, for that fraction, according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper Limit	"J"	No Flags
10 ≤ %R < Lower Limit	"J"	"UJ"
%R < 10	"J"	"R"

If any surrogate failures are observed in a sample for either the Base/Neutral or Acid fractions, apply flags to all results in the sample, for that fraction, according to the following guidelines:

YES NO N/A

Condition	Positives	Non-Detects
1 %R out & > 10	No Flags	No Flags
2 or more %R out, all > Upper Limit	"J"	No Flags
2 or more %R out, all > 10, some < Lower Limit	"J"	"UJ"
1 or more %R < 10	"J"	"R"

QC CHECK SAMPLE (LCS)

Are all LCS recoveries within QC limits? . . . . . .

ACTION: If any LCS compound fails this criterion, apply flags to the failed compound in all samples associated with that LCS, according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper QC Limit	"J"	No Flags
30 ≤ %R < Lower QC Limit	"J"	"UJ"
%R < 30	"J"	"R"

If failures are widespread and consistent in the direction of the failure, then an overall analytical bias can be determined for this fraction. The final report should note the magnitude and direction of the bias.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

Are all MS/MSD recoveries within QC limits? . . . . . .

ACTION: MS/MSD data are used in conjunction with LCS data to identify and describe interferences. If failures are widespread and consistent in direction of failure, then an overall bias can be determined for this fraction. If LCS recoveries indicate a similar bias, then the bias can be determined to be analytical in nature. If LCS recoveries are in control, then the bias can be identified as a matrix effect. The final report should note the nature, direction, and magnitude of the bias.

BLANKS

Are the following free of contamination:
Method Blanks? . . . . . .
Trip Blanks? (If present) . . . . . .
Field Blanks? (If present) . . . . . .

ACTION: Use the following steps when qualifying data based on blank contamination.

- Identify all individual data points that are associated with a blank contaminant.

YES NO N/A

- For any data point associated with contamination from more than one blank, select the blank with the highest concentration of the contaminant. The sample data point will be compared to this contaminant for flagging purposes.

- Convert the concentration of the selected contaminant to the actual contamination level. Divide the contamination concentration by the blank detection limit and multiply by the sample detection limit.

- Qualify all data points associated with a common laboratory contaminant (acetone, 2-butanone, methylene chloride, or common phthalates) according to the following guidelines:

Condition	Flag
No Positive Sample Result	None
Positive Sample Result < 10X Contamination Level	"U"
Positive Sample Result > 10X Contamination Level	None

- Qualify all data points associated with any other laboratory contaminant according to the following guidelines:

Condition	Flag
No Positive Sample Result	None
Positive Sample Result < 5X Contamination Level	"U"
Positive Sample Result > 5X Contamination Level	None

INITIAL CALIBRATIONS (ICs)

Are all %RSDs within QC limits for the quantitation column? . . . . . .

ACTION: If any compound fails this criterion, apply flags to that compound in all samples associated with that IC, according to the following guidelines:

Condition	Positives	Non-Detects
QC Limit < %RSD < 50	"J"	No Flags
50 < %RSD < 80	"J"	"UJ"
%RSD > 80	"J"	"R"

CONTINUING CALIBRATIONS (CCs)

Are all %Ds within QC limits for the quantitation and confirmation columns? . . . . . .

ACTION: If any compound fails this criterion, apply flags to that compound in all samples associated with that CC, according to the following guidelines:

Condition	Positives	Non-Detects
QC Limit < %D < 50	"J"	No Flags
50 < %D < 80	"J"	"UJ"
%D > 80 and the RF from CC > RRF from IC	"J"	"UJ"
%D > 80 and the RF from CC < RRF from IC	"J"	"R"

YES NO N/A

FIELD DUPLICATES (IF APPLICABLE)

Are all compounds present in either the sample or duplicate also present in the other? . .

ACTION: Data are not qualified based on field duplicate precision; rather, an overall assessment of whether or not the data is representative of field conditions is made. This assessment should be discussed in the final report. If several compounds are present in either the sample or the duplicate but not in the other, then data may be qualitatively questionable. Some guidelines for evaluation:

- Any sample or duplicate data point that is below the DL is considered to be a positive result if the other data point in the pair is a positive result
- Any sample or duplicate data point that is below the DL is considered to be a non-detect if the other data point in the pair is a non-detect.
- If several discrepancies are noted, check to see if they are consistent (i.e. always present in the sample, but not detected in the duplicate).
- If discrepancies are consistent, compare DLs to see if there may be a large dilution factor for whichever sample consistently shows the non-detects.

Are all RPDs between sample and duplicate acceptable? . . . . . .

ACTION: Make an overall assessment of the quantitative precision of the sample-duplicate data. All RPDs should be generally within 100%. Calculate RPDs according to the following guidelines:

- If both data points for a compound are not detected, or found below the DL, no calculation is necessary.
- Any data point that is found, but below the DL, can be considered a positive result at the DL for calculation purposes.
- The RPD for two data points is (Difference/Mean)*100

YES NO N/A

HOLDING TIMES

Have all samples been analyzed within holding times:
28 Days for Mercury? . . . . . .
180 Days for all other metals? . . . . . .

ACTION: If any sample fails this criteria, apply flags to all sample results according to the following guidelines:

Condition	Positives	Non-Detects
29 Days ≤ Mercury Analysis ≤ 56 Days	"J"	"UJ"
Mercury Analysis > 56 Days	"J"	"R"
181 Days ≤ Other Analysis ≤ 360 Days	"J"	"UJ"
Other Analysis > 360 Days	"J"	"R"

LABORATORY CONTROL SAMPLE (LCS)

Are all LCS recoveries within QC limits? . . . . . .

ACTION: If any LCS compound fails this criterion, apply flags to the failed compound in all samples associated with that LCS, according to the following guidelines:

Condition	Positives	Non-Detects
Water %R > 120	"J"	No Flags
50 ≤ Water %R < 80	"J"	"UJ"
Water %R < 50	"J"	"R"
Soil %R > Upper QC Limit	"J"	No Flags
30 ≤ Soil %R < Lower QC Limit	"J"	"UJ"
Soil %R < 30	"J"	"R"

If failures are widespread and consistent in the direction of the failure, then an overall analytical bias can be determined for this fraction. The final report should note the magnitude and direction of the bias.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

Are all MS/MSD recoveries within 75-125 QC range? . . . . . .

ACTION: MS/MSD data are used in conjunction with LCS data to identify and describe interferences. If failures are widespread and consistent in direction of failure, then an overall bias can be determined for this fraction. If LCS recoveries indicate a similar bias, then the bias can be determined to be analytical in nature. If LCS recoveries are in control, then the bias can be identified as a matrix effect. The final report should note the nature, direction, and magnitude of the bias.

YES NO N/A

BLANKS

Are the following free of contamination:
Preparation Blanks? . . . . . .
Initial Calibration Blanks? . . . . . .
Continuing Calibration Blanks? . . . . . .
Field Blanks? (If present) . . . . . .

ACTION: Use the following steps when qualifying data based on blank contamination.

- Identify all individual data points that are associated with a blank contaminant.
- For any data point associated with contamination from more than one blank, select the blank with the highest concentration of the contaminant. The sample data point will be compared to this contaminant for flagging purposes.
- Convert the concentration of the selected contaminant to the actual contamination level. Divide the contamination concentration by the blank detection limit and multiply by the sample detection limit.
- Qualify all data points associated with a laboratory contaminant according to the following guidelines:

Condition	Flag
No Positive Sample Result	None
Positive Sample Result <5X Contamination Level	"U"
Positive Sample Result >5X Contamination Level	None

CALIBRATIONS

Are all ICV recoveries within QC limits:
80-120 for Mercury? . . . . . .
90-110 for all other metals? . . . . . .

ACTION: If any compound fails this criterion, flag positive results for the failed compound "J" and non-detects for the failed compound "UJ" in all samples associated with that ICV.

Are all CCV recoveries within QC limits:
80-120 for Mercury? . . . . . .
90-110 for all other metals? . . . . . .

ACTION: If any compound fails this criterion, flag positive results for the failed compound "J" and non-detects for the failed compound "UJ" in all samples associated with that CCV.

YES NO N/A

FIELD DUPLICATES (IF APPLICABLE)

Are all compounds present in either the sample or duplicate also present in the other? . .

ACTION: Data are not qualified based on field duplicate precision; rather, an overall assessment of whether or not the data is representative of field conditions is made. This assessment should be discussed in the final report. If several compounds are present in either the sample or the duplicate but not in the other, then data may be qualitatively questionable. Some guidelines for evaluation:

- Any sample or duplicate data point that is below the DL is considered to be a positive result if the other data point in the pair is a positive result
- Any sample or duplicate data point that is below the DL is considered to be a non-detect if the other data point in the pair is a non-detect.
- If several discrepancies are noted, check to see if they are consistent (i.e. always present in the sample, but not detected in the duplicate).
- If discrepancies are consistent, compare DLs to see if there may be a large dilution factor for whichever sample consistently shows the non-detects.

Are all RPDs between sample and duplicate acceptable? . . . . . .

ACTION: Make an overall assessment of the quantitative precision of the sample-duplicate data. All RPDs should be generally within 100%. Calculate RPDs according to the following guidelines:

- If both data points for a compound are not detected, or found below the DL, no calculation is necessary.
- Any data point that is found, but below the DL, can be considered a positive result at the DL for calculation purposes.
- The RPD for two data points is (Difference/Mean)*100

YES NO N/A

HOLDING TIMES

Have all samples been analyzed for all compounds within holding times? . . . . . .

ACTION: If any sample fails this criteria for a compound, flags that compound in that sample according to the following guidelines:

Condition	Positives	Non-Detects
HT + 1 ≤ Analysis ≤ 2 x HT	"J"	"UJ"
Analysis > 2 x HT	"J"	"R"

LABORATORY CONTROL SAMPLE (LCS)

Are all LCS recoveries within QC limits? . . . . . .

ACTION: If any compound fails this criterion, flag the failed compound in all samples associated with that LCS, according to the following guidelines:

Condition	Positives	Non-Detects
%R > Upper QC Limit	"J"	No Flags
30 ≤ %R < Lower QC Limit	"J"	"UJ"
%R < 30	"J"	"R"

If failures are widespread and consistent in the direction of the failure, then an overall analytical bias can be determined for this fraction. The final report should note the magnitude and direction of the bias.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)

Are all MS/MSD recoveries within QC limits? . . . . . .

ACTION: MS/MSD data are used in conjunction with LCS data to identify and describe interferences. If LCS recoveries indicate a similar bias, then the bias can be determined to be analytical in nature. If LCS recoveries are in control, then the bias can be identified as a matrix effect. The final report should note the nature, direction, and magnitude of any significant bias observed for a compound.

BLANKS

Are the following free of contamination:
Laboratory Blanks? . . . . . .
Trip Blanks? (If present) . . . . . .
Field Blanks? (If present) . . . . . .

ACTION: Use the following steps when qualifying data based on blank contamination.

- Identify all individual data points that are associated with a blank contaminant.

YES NO N/A

- For any data point associated with contamination from more than one blank, select the blank with the highest concentration of the contaminant. The sample data point will be compared to this contaminant for flagging purposes.

- Convert the concentration of the selected contaminant to the actual contamination level. Divide the contamination concentration by the blank detection limit and multiply by the sample detection limit.

- Qualify all data points associated with a laboratory contaminant according to the following guidelines:

Condition	Flag
No Positive Sample Result	None
Positive Sample Result <5X Contamination Level	"U"
Positive Sample Result >5X Contamination Level	None

CALIBRATIONS

Are all initial calibrations acceptable:
%RSDs within QC limits? (If applicable) . . . . . .
Correlation coefficients > 0.995? (If applicable) . . . . . .
ICV recoveries within QC limits? (If applicable) . . . . . .

ACTION: If any compound fails applicable criteria, as specified in the QAPjP and/or the method, flag positive results for the failed compound "J" and non-detects for the failed compound "UJ" in all samples associated with the failure.

Are all continuing calibrations acceptable:
%Ds within QC limits? (If applicable) . . . . . .
CCV recoveries within QC limits? (If applicable) . . . . . .

ACTION: If any compound fails applicable criteria, as specified in the QAPjP and/or the method, flag positive results for the failed compound "J" and non-detects for the failed compound "UJ" in all samples associated with the failure.

FIELD DUPLICATES (IF APPLICABLE)

Are all compounds present in either the sample or duplicate also present in the other? . .

ACTION: Data are not qualified based on field duplicate precision; rather, an overall assessment of whether or not the data is representative of field conditions is made. This assessment should be discussed in the final report. If several compounds are present in either the sample or the duplicate but not in the other, then data may be qualitatively questionable. Some guidelines for evaluation:

- Any sample or duplicate data point that is below the DL is considered to be a positive result if the other data point in the pair is a positive result

YES NO N/A

- Any sample or duplicate data point that is below the DL is considered to be a non-detect if the other data point in the pair is a non-detect.

- If several discrepancies are noted, check to see if they are consistent (i.e. always present in the sample, but not detected in the duplicate).

- If discrepancies are consistent, compare DLs to see if there may be a large dilution factor for whichever sample consistently shows the non-detects.

Are all RPDs between sample and duplicate acceptable? . . . . . .

ACTION: Make an overall assessment of the quantitative precision of the sample-duplicate data. All RPDs should be generally within 100%. Calculate RPDs according to the following guidelines:

- If both data points for a compound are not detected, or found below the DL, no calculation is necessary.

- Any data point that is found, but below the DL, can be considered a positive result at the DL for calculation purposes.

- The RPD for two data points is (Difference/Mean)*100

APPENDIX C
HEALTH AND SAFETY PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
UNIVERSITY OF CALIFORNIA, DAVIS

Job No. 10805-720-044
Preparation Date: August 1994

HEALTH AND SAFETY PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
UNIVERSITY OF CALIFORNIA, DAVIS

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Preparation Date:	August 31, 1994	

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Project Manager:

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Joseph J. Niland, R.G. (R.G. 5545) (DATE)

Project Health Physicist:

_____

Fred L. W. Duncan, CIH, CHP (DATE)

Radiological Control Technician:

_____

TBD (DATE)

This Health and Safety Plan is valid only for this specific project as described in Chapter 4 of the LEHR RI/FS Work Plan. It is not to be used for other projects or subsequent phases of this project without the written approval of the Division Health and Safety Manager.

HEALTH AND SAFETY PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
UNIVERSITY OF CALIFORNIA, DAVIS

TABLE OF CONTENTS

Chapter		Page
1.0	SUMMARY	1
2.0	APPLICABILITY	1
3.0	SITE BACKGROUND AND SETTING	1
3.1	HISTORY OF OPERATIONS	1
3.2	PREVIOUS INVESTIGATIONS	3
3.2.1	Initial Assessment Survey	3
3.2.2	Phase I Investigation	3
3.2.3	Solid Waste Assessment Test	4
3.2.4	Waste Burial Trench Investigation	5
3.2.5	Old UC Davis Landfill Additional Characterization	5
3.2.6	Phase II Site Characterization	6
4.0	SUMMARY OF WORK	1
4.1	BACKGROUND STUDY	1
4.2	DOE BURIAL AREAS, TRENCHES, AND THE DISPOSAL BOX	2
4.3	RADIUM-226 TREATMENT TANK AND LEACH SYSTEM	2
4.4	STRONTIUM-90 LEACH SYSTEM	3
4.5	DOMESTIC SEPTIC TANKS	4
4.6	WESTERN DOG PEN AND NORTH CHEMICAL DISPENSING AREAS	4
4.7	UC DAVIS BURIAL TRENCHES	5
4.8	UC DAVIS LANDFILL UNITS	6
4.9	GROUNDWATER AND SURFACE WATER INVESTIGATION	6
4.10	VEGETATION SAMPLING	7
4.11	MAMMAL INVESTIGATION	7
4.12	AQUATIC COLLECTION	8
5.0	RESPONSIBILITIES	1
5.1	PROJECT MANAGER	1
5.2	SITE SAFETY OFFICER	3
5.3	RADIOLOGICAL CONTROL TECHNICIAN	5
5.4	PROJECT HEALTH PHYSICIST	6
5.5	PROJECT HEALTH AND SAFETY MANAGER	7
5.6	SITE SAFETY AUDITOR	8
5.7	PROJECT PERSONNEL	8
5.8	SUBCONTRACTOR'S SAFETY REPRESENTATIVE	10

TABLE OF CONTENTS
(Continued)

6.0 JOB HAZARD ANALYSIS 1
6.1 HEAT STRESS AND COLD STRESS RECOGNITION AND CONTROL 2
6.1.1 Signs, Symptoms and First Aid 3
6.1.2 Heat Stress Prevention 5
6.1.3 Determination of the Initial Work/Rest Cycle 6
6.1.4 Heart Rate Monitoring 7
6.1.5 Cold Stress 8
6.2 CHEMICAL HAZARDS 9
6.3 RADIOLOGICAL HEALTH HAZARDS 12
6.3.1 Biological Effects of Ionizing Radiation 12
6.3.2 Radioactive Materials at LEHR 13
6.3.3 Radiation Protection Regulations and Guidelines 18
6.3.4 LEHR ALARA Plan 23
6.4 HAZARD COMMUNICATION 24
6.5 UNDERGROUND UTILITIES AND ELECTRICAL HAZARDS 25
6.6 WORK AREA PROTECTION 27
6.7 NOISE HAZARDS 27
6.8 HEAVY EQUIPMENT SAFETY 27
6.8.1 General Heavy Equipment Safety 28
6.8.2 Drilling Safety Guidelines 31
6.9 TRENCHING AND EXCAVATION GUIDELINES 38
6.9.1 Excavation Activities in the DOE Burial Trenches 38
6.10 CONFINED SPACE ENTRY 39
6.11 EQUIPMENT INSPECTIONS 39
6.12 LIFTING SAFETY 40
6.13 POTENTIAL CONTACT WITH INFECTIOUS/LABORATORY WASTE . . . 41

7.0 EXPOSURE MONITORING PLAN 1
7.1 CHEMICAL EXPOSURE MONITORING 1
7.2 PERSONAL MONITORING 4
7.2.1 Chloroform 4
7.3 EXPLOSIVE ATMOSPHERES 5
7.4 RADIOLOGICAL MONITORING 5
7.4.1 Direct Exposure Controls 8
7.4.1.1 Personnel Dosimetry 8
7.4.1.2 Monitoring During Soil and Solid Waste Handling Activities 8
7.4.2 Area Radiation Survey 10
7.4.2.1 Background Readings 10
7.4.2.2 Low-Level Gamma Radiation Surveys 10
7.4.3 Ambient Air Monitoring 10
7.4.4 Bioassay Program 11
7.5 BACKGROUND READINGS 12
7.6 DATA LOGGING 13
7.7 ACCESS TO RADIOLOGICAL MONITORING RECORDS 13
7.8 DUST CONTROL 13

TABLE OF CONTENTS
(Continued)

8.0 PERSONAL PROTECTIVE EQUIPMENT 1
8.1 INTRODUCTION 1
8.2 PERSONAL PROTECTIVE EQUIPMENT STANDARDS 1
8.2.1 Eye Protection 1
8.2.2 Hearing Protection 2
8.2.3 Foot Protection 3
8.2.4 Hand Protection 3
8.2.5 Taping of Joints 3
8.2.6 Head Protection 4
8.3 RESPIRATORY PROTECTION 4
8.3.1 Medical Condition 4
8.3.2 Respirator Fit Testing 5
8.3.3 Training 6
8.4 SELECTION OF PERSONAL PROTECTIVE EQUIPMENT 7
8.5 LIMITATIONS OF PROTECTIVE CLOTHING 9
8.6 DURATION OF WORK TASKS 10

9.0 SITE CONTROL 1
9.1 WORK ZONES 1
9.2 POSTING REQUIREMENTS 2
9.2.1 Posting Controlled Areas 4
9.2.2 Posting Radiological Buffer Areas 4
9.2.3 Posting Radiation Areas 5
9.2.4 Posting Non-Radiological Hazards 5
9.2.5 Labeling 5
9.3 GENERAL SITE CONTROL REQUIREMENTS 5
9.4 CONTROL PROCEDURES FOR PERFORMANCE OF GAMMA SURVEYS . . 6

10.0 DECONTAMINATION PROCEDURES 1
10.1 CONTAMINATION PREVENTION 1
10.2 DECONTAMINATION AREA 2
10.3 PERSONNEL DECONTAMINATION 3
10.4 SANITATION 4
10.5 DECONTAMINATION-MEDICAL EMERGENCIES 4
10.6 EQUIPMENT DECONTAMINATION 5
10.6.1 Decontamination of Vehicles and Heavy Equipment 5
10.6.2 Decontamination of Tools 7
10.6.3 Equipment Release Surveys and Criteria 8

11.0 SAFE WORK PRACTICES 1
11.1 GENERAL CONDITIONS 1
11.2 SAMPLING PRACTICES 2
11.3 HEALTH AND SAFETY EQUIPMENT LIST 3

TABLE OF CONTENTS
(Continued)

12.0 EMERGENCY RESPONSE PLAN 1
12.1 PLACES OF REFUGE 3
12.2 COMMUNICATION 4
12.3 EMERGENCY RESPONSE TEAM PROCEDURES 5
12.4 MEDICAL EMERGENCY RESPONSE PLAN 6
12.4.1 First Aid Kit/Required Contents 7
12.4.2 First Aid for Poisonous Bites and Stings 8
12.5 FIRE 10
12.6 ACCIDENT INVESTIGATION 11
12.6.1 Program Responsibilities 11
12.6.2 Accident and Illness Investigation 12
12.6.3 Responsibilities For An Accident or Illness Investigation 13
12.6.4 Accident Reporting 14
12.8 OPERATION SHUTDOWN 15

13.0 TRAINING 1
13.1 HEALTH AND SAFETY TRAINING FOR SITE WORKERS 1
13.2 FIRST AID/CPR TRAINING 1
13.3 BLOODBORNE PATHOGENS TRAINING 1
13.4 RADIOLOGICAL TRAINING FOR SITE WORKERS 2
13.4.1 Radiological Worker Training (Level I) 2
13.4.2 Radiological Worker Training (Level II) 3
13.5 RADIOLOGICAL CONTROL TECHNICIAN TRAINING 4
13.6 SPECIALIZED RADIOLOGICAL WORKER TRAINING 4
13.6.1 Technical Support Personnel Training 4
13.6.2 Management Training 5
13.7 VISITOR TRAINING 5
13.8 HAZARDOUS MATERIALS HANDLING 6
13.9 PRE-JOB AND SITE SAFETY BRIEFINGS 6
13.10 HAZARDOUS WORK PERMIT 8
13.11 RECORDKEEPING 9

14.0 MEDICAL SURVEILLANCE 1
14.1 SCHEDULING OF EXAMINATIONS 1
14.2 MEDICAL RECORDKEEPING 2
14.3 SPECIFIC COMPONENTS OF EXAMS 3

15.0 SPILL CONTROL 1
15.1 NOTIFICATION OF SPILLS AND DISCHARGES 1
15.2 REQUIRED EQUIPMENT 1
15.3 SPILL CONTROL 2
15.4 DECONTAMINATION 3

16.0 INJURY AND ILLNESS PREVENTION PROGRAM 1

17.0 RECORDKEEPING 1
17.1 OSHA RECORDKEEPING 2
17.2 RADIOLOGICAL RECORDKEEPING REQUIREMENTS 3

TABLE OF CONTENTS
(Concluded)

ATTACHMENTS

ATTACHMENT A - SAFETY PLAN COMPLIANCE AGREEMENT
ATTACHMENT B - HOSPITAL ROUTE MAP
ATTACHMENT C - ACCIDENT REPORT FORM
ATTACHMENT D - PERSONNEL DECONTAMINATION STATION LAYOUT
ATTACHMENT E - EMERGENCY DECONTAMINATION CHART
ATTACHMENT F - EMERGENCY RESPONSE PROCEDURES
ATTACHMENT G - SITE SAFETY BRIEFINGS
ATTACHMENT H - HAZARDOUS WORK PERMIT
ATTACHMENT I - DAILY PID OR OVA INSTRUMENT CALIBRATION CHECK SHEET
ATTACHMENT J - OVA AND PID OPERATING INSTRUCTIONS
ATTACHMENT K - WORK AREA PROTECTION GUIDANCE
ATTACHMENT L - MATERIAL SAFETY DATA SHEETS
ATTACHMENT M - RESPIRATOR INSPECTION PROCEDURES
ATTACHMENT N - INJURY AND ILLNESS PREVENTION PROGRAM SUMMARY AND HAZARDOUS CONDITION REPORT FORM
ATTACHMENT O - NIOSH METHOD 1003 AND METHOD 1501
ATTACHMENT P - ROUTINE BIOASSAY MONITORING PROGRAM FOR LEHR
ATTACHMENT Q - BLOODBORNE PATHOGENS PROGRAM SUMMARY
ATTACHMENT R - U.S. DOE OCCURRENCE REPORT

LIST OF TABLES

TABLE 6-1 RADIOACTIVE MATERIALS AT LEHR

TABLE 6-2 SUMMARY OF ANNUAL FEDERAL DOSE LIMITS WITH THE CONTRACTOR'S DOSE LIMITS IN PARENTHESES

TABLE 6-3 SUMMARY OF CONTAMINATION LIMITS

TABLE 6-4 DERIVED AIR CONCENTRATIONS (DAC) FOR CONTROLLING RADIATION EXPOSURES TO WORKERS AT DOE FACILITIES

TABLE 7-1 OVA/PID MONITORING ACTION LEVELS

HEALTH AND SAFETY PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN
LEHR ENVIRONMENTAL RESTORATION
UNIVERSITY OF CALIFORNIA, DAVIS

1.0 SUMMARY

The Laboratory for Energy-Related Health Research (LEHR) facility, which occupies approximately 15 acres, was operated by UC Davis for the Department of Energy (DOE) for more than 30 years to conduct research on the long-term biological effects of low-level radiation exposure on laboratory animals. More than 1,000 beagles were used in this research, which primarily involved the use of bone-seeking radionuclides strontium-90 (Sr-90) and radium-226 (Ra-226). External irradiation of dogs using a cobalt-60 gamma source was also performed. This was primarily conducted outdoors in an irradiation field area.

Radiological and chemical wastes generated from these studies were disposed of in a variety of ways. Effluent from indoor dog cages, after being processed for radiological materials, was routed to a leach field. Excrement from dogs housed in metabolic cages was discharged to cobble-filled seepage pits. In addition, low-level radioactive waste may have been buried in trenches in the southwest corner of the LEHR site and between the outdoor dog pen areas.

Other portions of the LEHR site have previously been used as the UC Davis campus landfill. The landfill consists of three separate disposal units. Disposal in the oldest unit (Inactive Disposal Unit No. 1) began in the 1940s and ceased in the late 1950s to early 1960s. The area is now covered by the Cobalt-60 field. The next oldest disposal area (Inactive Disposal Unit No. 2) received wastes from 1956 to 1967. This disposal area is partially covered by the two easternmost set of dog pens used for animal research. A third landfill disposal unit located approximately 600 feet east of LEHR (Inactive Disposal Unit No. 3), was used from 1963 to 1967. The combined total acreage for the three disposal areas is estimated at approximately six acres.

During the Remedial Investigation, a combination of drilling, excavation, and soil and water sampling activities will be performed in the following areas of the site: the DOE Disposal Box; the former DOE and UC Davis waste disposal trenches; the former dog pen area; the UC Davis Landfill areas; the Radium-226 Treatment Tank and Leach System; the Strontium-90 Leach System, and the Domestic Septic Tanks. During investigation activities, confined space entry will not be performed. In addition, trenches that are deeper than five feet or trenches constructed in Type C soil will not be entered during this project; soil samples will be collected from these locations using remote sampling techniques.

Skin contact with soil or water that is potentially contaminated with hazardous chemicals and radioactive materials will be minimized by wearing personal protective clothing (as described in Section 8.4). Inhalation of vapors and particulates during drilling, excavation, and soil and water sampling will be minimized by air monitoring and the use of engineering controls, and respiratory protection will be used if action levels (see 6.1) are exceeded, or if entering areas with unknown potential contamination. Ingestion of contaminated materials will be minimized by good personal hygiene during decontamination (i.e., thoroughly washing face and hands with soap and water before eating or drinking).

During all invasive site activities, an Organic Vapor Analyzer (OVA), or a Photoionization Detector (PID) with a minimum lamp energy of 11.45 eV, will be used to monitor for organic vapors. Monitoring for organic vapors will be performed as outlined in Section 7.1 and personal protective clothing will be worn as described in Section 8.4.

Project personnel working in areas where radiological contamination is known or suspected will be protected by a combination of radiation monitoring, engineering controls, personal protective equipment, and other controls (i.e., ALARA principles). Radiation monitoring will be conducted as outlined in Section 7.4.

2.0 APPLICABILITY

The purpose of this plan, which was developed specifically for operations at the LEHR site located in Davis, California, is to assign responsibilities, establish personal protection standards and mandatory safety procedures, and provide for contingencies that may arise while operations are being conducted at the site. This plan complies with, but does not replace:

1. Federal Health and Safety Regulations as set forth in 29 CFR 1910 and 1926;

2. California Health and Safety Regulations as set forth in Title 8, California Code of Regulations, and guidance established by the California Environmental Protection Agency;

3. DOE Orders 1324.2A, 5000.3B, 5400.1, 5400.5, 5480.1B, 5480.4, 5480.6, 5480.7. 5480.8, 5480.9, 5480.10, 5480.11, 5480.19, 5483.1A and 5484.1;

4. Nuclear Regulatory Commission (NRC) regulation 10 CFR Part 20, Standards for Protection Against Ionizing Radiation;

5. NRC Regulatory Guide 8.15 and NUREG-0041, Respiratory Protection Program; and American National Standards Institute (ANSI) 88.2, Respiratory Protection Equipment Use;

6. NRC Regulatory Guide 8.22, Uranium Bioassay Program;

7. NRC Regulatory Guide 8.10, Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable;

8. LEHR Radiological Control Committee's ALARA goals; and

9. LEHR Radiological Control Manual, July 1993, DOE/LEHR 17523.

Applicable portions of these standards and guidelines are incorporated into this HSP by reference, as noted. This plan is to be used by the Investigation Contractor and subcontractor personnel as a supplement to such rules, regulations, and guidance.

Changing and/or unanticipated site conditions, changes in regulatory requirements, or changes in site specific guidance documents may require modification of this site health and safety plan in order to maintain a safe and healthful work environment. Any proposed changes to this plan shall be reviewed with the Project Health and Safety Manager (PHSM), or his designee, and the PNL Radiological Control Manager, prior to their implementation. If this is not feasible, the site/project manager may modify the plan and record all changes in the field log book; under no circumstances will modifications to this plan conflict with Federal, state, and local health and safety or radiological control regulations.

The Investigation Contractor is providing a copy of this Health and Safety Plan to each site subcontractor in order to fulfill its obligation under 8 CCR 5192(b) to inform subcontractors of site hazards.

3.0 SITE BACKGROUND AND SETTING

The information found in this chapter is derived from Chapter 2 of the project work plan; please reference the work plan for more detailed information.

The LEHR site is located in the southeast quarter of Section 21, Township 8 North, Range 2 East, Mount Diablo Base and Meridian. The site is approximately 1.5 miles south of the main UC Davis campus and the town of Davis, and approximately three-quarters of a mile south of Interstate 80 on County Road 79 (Old Davis Road) in Solano County, California.

The site encompasses approximately 15 acres and consists of one- and two-story laboratory and office buildings, and animal-handling facilities. The land is owned by the Regents of the University of California and leased to the Department of Energy (DOE).

3.1 HISTORY OF OPERATIONS

UC Davis has conducted radiological studies on laboratory animals for the DOE since the 1950s. The initial studies, conducted for the U.S. Atomic Energy Commission (AEC, now DOE), involved the irradiation of beagles at the UC Davis main campus. Eventually, irradiation experiments were discontinued at this site which was then used to house the breeding colony that supplied beagles for future studies at LEHR.

Full-scale experimental use of radioactive materials, including strontium-90 and radium-226, began at LEHR in 1960. In the initial stages of operation at the LEHR site, waste was handled through a central handling facility on the main campus. However, due to safety concerns, waste handling for LEHR-generated waste was returned to the LEHR site in the early 1960s.

Portions of the LEHR site have previously been used as the UC Davis campus landfill. The landfill consists of three separate disposal units. Disposal in the oldest unit (Inactive Disposal Unit No. 1) began in the 1940s and ceased in the late 1950s to early 1960s. The area is now covered by the Cobalt-60 field. The next oldest disposal area (Inactive Disposal Unit No. 2) received wastes from 1956 to 1967. This disposal area is partially covered by the two easternmost set of dog pens used for animal research. A third landfill disposal unit located approximately 600 feet east of LEHR (Inactive Disposal Unit No. 3), was used from 1963 to 1967. The combined total acreage for the three disposal areas is estimated at approximately six acres.

In the early 1970s, an outdoor Cobalt-60 Field was constructed at the LEHR site to study the effects of chronic exposure to penetrating gamma ray irradiation on bone marrow cells of beagles. In January 1993, the Cobalt-60 source was removed from the LEHR site and transported to General Electric's Hot Cell in Pleasanton, California.

In 1975, a program in basic aerosol science was initiated at the LEHR site to link the evaluation of airborne materials and the laboratory study of these materials utilizing cellular and animal models. The DOE reported that research activities in this program focused on the potential health effects associated with combustion products released to the atmosphere from fossil fuel power plants.

In 1983, construction of the Toxic Pollutant Health Research Laboratory (TPHRL) was completed at LEHR. This facility was designed for the study of highly toxic and carcinogenic agents including both radioactive and chemical materials. Research at the TPHRL included studies of the behavior of plutonium-241 and americium-241 in beagles and monkeys; radioactive and toxic gas-particle mechanistic aerosol studies; monodisperse aerosol inhalation deposition; intratracheal applications of carcinogen-coated particles; and an organic vapor uptake utilizing beagles.

3.2 PREVIOUS INVESTIGATIONS

A number of environmental studies have been conducted at the LEHR site since 1984. The studies have been performed for both UC Davis and DOE. A summary of the environmental studies conducted to date is presented below. Additional information on results from previous investigations can be found in the reports for each investigation and in the work plan for this project.

3.2.1 Initial Assessment Survey

Rockwell International conducted an Initial Assessment Survey of the LEHR site in October 1984 for DOE. During this survey, a total of 22 soil samples were collected and analyzed for the Initial Assessment Survey. Results of these analyses indicated radium-226 and strontium-90 activity up to 0.204 pCi/g and 0.07 pCi/g, respectively, in the Radium-226 Dry Well area. Strontium-90, radium-226 and carbon-14 activity were reported at levels of 3.94 pCi/g, 17.3 pCi/g and 1.160 pCi/g, respectively, in the Southwest Chemical Dispensing area. The highest reported measurement of tritium activity was from the sample in the southeast corner of the eastern dog pens at 208 pCi/g. An intact vessel of concentrated pesticide that contained 68% heptachlor, 4.1% Carbophenothion and 0.38% Dieldrin was unearthed in an exploratory trench. Soil samples from the same vicinity reported very low concentrations of these same pesticides. ~~The pesticides heptachlor, aldrin, and dieldrin were found in almost pure concentrations in samples collected from exploratory trenches.~~

3.2.2 Phase I Investigation

Wahler Associates performed a Phase I Investigation for both DOE and UC Davis. The Phase I Investigation consisted of 43 soil borings, the installation and sampling (two rounds) of nine groundwater monitoring wells (UCD-1 through UCD-9), and the excavation of 16 backhoe trenches. Sample analysis results reported

that groundwater wells UCD-8 and UCD-9 contained several volatile organic compounds including chloroform at concentrations up to 41.9 mg/L. Reported concentrations of chromium in groundwater were elevated compared to background; however, it is not known if groundwater samples analyzed for metals were filtered. Strontium-90 and radium-226 activity were reported in soil samples from the Radium-226 Dry Well area at measurements up to 1.6 pCi/g and 1.23 pCi/g, respectively, and strontium-90 activity was reported in samples from soil in the Strontium-90 Leach Field area at measurements up to 0.02 pCi/g. Tritium activity was reported in one sample from UCD-1 in the northwest corner of the site at 102 pCi/g, and one exploratory trench in the Southwest Disposal Area contained measurable activity of radiation up to 2,500 cpm using a hand-held survey meter.

3.2.3 Solid Waste Assessment Test

The Solid Waste Water Quality Assessment Test (SWAT) Report was prepared for UC Davis to assess the possibility of leakage from the three Old UC Davis Landfill disposal units located on and adjacent to the LEHR site and the potential impacts to groundwater, surface water, vadose-zone water and soil. Analytical results of the SWAT reported that groundwater downgradient of Landfill Units 1 and 2 contain several VOCs including chloroform up to 17 mg/L, and elevated levels of general water quality parameters. Hexavalent chromium was also elevated (up to 0.38 mg/L) in UCD-11. Groundwater samples from UCD-8 and UCD-13 have measured tritium and carbon-14 activity up to 36,269 pCi/L, and 2,702 pCi/L, respectively.

Analytical results for the water and sediment samples collected from Putah Creek found hexavalent chromium in water samples ranging from 0.01 to 0.03 mg/L and in sediment samples from less than 0.1 to 0.3 mg/Kg. Xylenes were reported in water samples ranging from 0.28 to 0.58 μg/L. Bromodichloromethane and chloroform were reported in water samples up to 0.54 and 2.50 μg/L

respectively. Gross alpha activity was reported up to 6.0 pCi/L in water and 1.5 pCi/g in sediment samples. Gross Beta activity was reported up to 23 pCi/L in water and 2.9 pCi/g in sediment. Strontium-90 activity was reported up to 4.1 pCi/L in water and was not reported in sediment samples. No tritium activity was reported in water or sediment samples.

3.2.4 Waste Burial Trench Investigation

During this investigation, eighteen exploratory trenches were excavated and Ground Penetrating Radar (GPR) surveys were conducted in the vicinity of the burial trenches. During trenching activities, UC Davis personnel collected and analyzed three grab soil samples to better assess impacts from waste burial trenches used by UC Davis. Results of soil samples collected from trenches located just north of UCD-12 reported measurements of radium-226 and thorium activity at 0.44 pCi/g and 0.51 pCi/g, respectively. Chlordane and tritium were reported in soil samples analyzed from this same area at 688 μg/kg and 0.61 pCi/g, respectively.

3.2.5 Old UC Davis Landfill Additional Characterization

As part of the Old UC Davis Landfill Additional Characterization, two CPT and Hydropunch™ investigations were performed in April 1991 and September 1991 to address comments and recommendations by the RWQCB on the SWAT report for the Old UC Davis Landfill.

Results of analysis of Hydropunch™ samples reported chloroform, nitrate, hexavalent chromium, and tritium at elevated concentrations up to 59.0 mg/L, 68.4 mg/L, 0.34 mg/L, and 2,220 pCi/L, respectively, downgradient of Landfill Units 1 and 2 in the first hydrostratigraphic unit (HSU).

3.2.6 Phase II Site Characterization

During the Phase II Site characterization of LEHR, 10 groundwater monitoring wells were installed, and 10 soil borings (10 to 30 feet deep) and 28 shallow soil borings (less the two feet deep) were drilled to further characterize the site. Over 200 soil samples were collected and analyzed for various chemical and radiological parameters. The objective of the investigation was to further assess potential sources and to evaluate the geologic and hydrogeologic relationships at the site in order to present a conceptual model to explain interrelationships between site sources and environmental impacts. Results of the investigation are presented in the Phase II Site Characterization Report. The results indicate that there has been impact to the environment that may be from the source areas identified during the investigation.

The results of samples collected in the southwest area reported the highest detections of gross alpha, gross beta and tritium activity. No volatile organic compounds (VOCs) were reported. Mercury was reported in all soil samples collected from this area at levels greater than the highest levels reported for samples collected from off-site.

In the soil samples collected from the radium-226 area, the highest detection of nitrate was reported. Reported detections of radium-226 activity were lower than the highest reported detection from samples collected off-site. Strontium-90 activity and hexavalent chromium were reported at levels higher than the maximum levels reported from off-site samples.

In the soil samples from the strontium-90 area, no strontium-90 or tritium activity was reported an radium-226 activity was reported at levels less than the maximum activity levels reported from off-site samples. Hexavalent chromium was reported at levels higher than the maximum levels reported from off-site samples.

Nitrate and chlordane were reported at elevated levels in the dog pen areas. The highest reported activity of radium-226 or strontium-90 was at or below the highest activity levels reported off-site, and in the north chemical dispensing area, chlordane, nitrate and mercury were reported at levels higher that the highest reported detection in samples from off-site.

During the quarterly groundwater monitoring, several metals, VOCs, pesticides, nitrate, and tritium have been reported at levels above drinking water standards. The metals, and nitrate have been reported above drinking water standards in wells both upgradient and downgradient of the LEHR site. Pesticides have only been reported in three wells along the upgradient border of the LEHR site. VOCs and tritium are typically above drinking water standards in wells downgradient of the UC Davis landfill units and trenches.

4.0 SUMMARY OF WORK

The types of activities to be conducted during the Remedial Investigation/Feasibility Study are briefly presented below. Specific details regarding this investigation are presented in the LEHR RI/FS Work Plan and Sampling and Analysis Plan.

4.1 BACKGROUND STUDY

A background study will be conducted to evaluate regional background concentrations of metals, chemicals and radiological constituents of concern found in soils at the LEHR site. During this background study, soil borings will be drilled in various offsite locations around the LEHR site. During drilling activities, soil samples will be collected and shipped to an analytical laboratory for radiological and chemical testing.

Prior to conducting work in off-site locations, the Investigation Contractor will contact UC Davis personnel to identify if experimental pesticides or other potential contaminants of concern are located in areas where contractor personnel will be conducting the drilling program. If experimental pesticides are located in the work area, UC Davis will provide the contractor with information concerning the physical and chemical properties and health hazards associated with each pesticide. The PHSM will then evaluate the information and issue an addendum to this HSP, if conditions warrant special considerations, prior to work being conducted in any offsite location. In addition, the Investigation Contractor will maintain control of all gates used to enter an offsite work location to prevent inadvertent lock-ins or lock-outs.

4.2 DOE BURIAL AREAS, TRENCHES, AND THE DISPOSAL BOX

A surface geophysical survey will be conducted to locate the DOE disposal box and the DOE disposal trenches. Once located, a soil gas and radiological survey will be conducted to assess general levels of VOCs and radionuclides in the subsurface.

Exploration trenches will then be excavated to a depth of one to two feet below the disposal trench-natural soil interface to obtain information on the depth and contents of the disposal trenches and the disposal box. While the exploration trenches are open, soil samples will be collected from the trench sidewalls for chemical and radiological analysis. Soil samples will be collected using remote sampling techniques (i.e., collecting samples from the backhoe bucket); site personnel will not enter trenches or excavations that are deeper than five feet or that are constructed in Type C soil during this investigation.

In addition, two stages of soil borings will be drilled in the area of the disposal trenches and the disposal box. The first stage borings will be drilled to collect additional samples of potential source materials and of the underlying soil to obtain data on source strengths and constituent types. Based on first stage sample analytical results, second stage borings will be drilled to further evaluate lateral and vertical extent of identified constituents and to obtain data on the physical characteristics of soils beneath the sources. Surface soil samples will also be collected in the locations of selected borings.

4.3 RADIUM-226 TREATMENT TANK AND LEACH SYSTEM

A surface geophysical survey will be conducted to locate the seepage trench associated with the radium-226 treatment system. Several backhoe trenches will then be excavated to confirm the location of the seepage trench. While these trenches are open, soil samples will be collected from the trench sidewalls for chemical and radiological analysis. Soil samples will be collected using remote sampling techniques (i.e., collecting samples from the backhoe bucket); site personnel will not enter trenches or excavations that are deeper than five feet or that are constructed in Type C soil during this investigation.

Soil borings will then be drilled immediately adjacent to the radium-226 treatment tank, the three dry wells, and the seepage trench. Soil samples will be collected from the borings to evaluate the vertical and lateral extent of chemical and radiological constituents.

To evaluate residual radiological constituents that may be present in leach lines, distribution boxes, and dry well access areas, wipe samples will be collected from these structures. The wipe samples will be collected using cotton swipes soaked in high grade alcohol.

4.4 STRONTIUM-90 LEACH SYSTEM

A surface geophysical survey will be conducted to locate the two leach fields associated with the strontium-90 treatment system. Backhoe trenches will then be excavated to confirm the location of the leach fields. While these trenches are open, soil samples will be collected from the sidewalls for chemical and radiological analysis. Soil samples will be collected using remote sampling techniques (i.e., collecting samples from the backhoe bucket); site personnel will not enter trenches or excavations that are deeper than five feet or that are constructed in Type C soil during this investigation.

Soil borings will then be drilled adjacent to the leachfields and the strontium-90 treatment tank. Soil samples will be collected from these borings for chemical and radiological analysis.

Wipe samples will be collected to evaluate the chemical and radiological constituents that may be present in the leach lines and distribution boxes. Wipe samples will be collected from the interior surfaces of the structures using cotton wipes soaked in high grade alcohol.

4.5 DOMESTIC SEPTIC TANKS

This task involves locating the seven abandoned domestic septic tanks and associated leach fields at the LEHR site. Three of the septic tanks at LEHR were observed by partial excavation during the Phase II Site Characterization. The location of one tank was also tentatively confirmed. Relatively non-invasive exploration methods, such as surface geophysical surveys and hand probing, will be used in initial attempts to locate the other five tanks. If a tank cannot be positively located using these methods, then backhoe or hand excavation will be used to explore for the septic tanks.

After the location of a tank is confirmed, a backhoe will be used to remove pavement and soil overlying the tank for purposes of evaluating the tank's condition. A sample of the contents of the tank will then be collected via remote sampling techniques. The septic tanks will not be entered at any time during the RI/FS, thus confined space entry techniques are not covered in this HSP. In addition, site personnel will not enter trenches or excavations that are deeper than five feet or that are constructed in Type C soil during this investigation.

After the material at the bottom of the tanks has been sampled, the tank will be backfilled so that a truck-mounted drill rig can be set up over the tank for additional subsurface sampling. Soil borings will be drilled so that samples can be collected from soil beneath the leach field distribution lines. Wipe samples will also be collected from an inside surface of the effluent leach lines.

4.6 WESTERN DOG PEN AND NORTH CHEMICAL DISPENSING AREAS

In 1975, 64 outdoor dog pens were removed to allow for construction of the Cellular Biology Laboratory. Construction of the laboratory building is such that the southern half of the building covers the area originally occupied by the former dog pens. This area was not assessed during the Phase II Site Characterization.

During this investigation, soil samples will be collected from borings drilled in the vicinity of the previously existing dog pens and the north chemical dispensing area. Soil samples will be collected from depths of five to twenty feet in the existing western dog pen area to further assess the extent of contamination. Soil samples will be analyzed for chemical and radiological parameters.

4.7 UC DAVIS BURIAL TRENCHES

This task will be performed to locate the UC Davis trenches along the southern boundary of LEHR and between UC Davis landfill units number one and two. Trenches will be located by conducting a surface geophysical survey. A soil gas and radiological survey will then be conducted to assess general levels of VOCs and radionuclides in the subsurface.

Based upon the results of the soil gas and radiological survey, backhoe trenches will be excavated to a depth of approximately one to two feet below the disposal trench-natural soil interface to obtain information on the contents and depth of the disposal trenches. While the exploration trenches are open, soil samples will be collected from the trench sidewalls for chemical and radiological analysis. Soil samples will be collected using remote sampling techniques (i.e., collecting samples from the backhoe bucket); site personnel will not enter trenches or excavations that are deeper than five feet or that are constructed in Type C soil during this investigation.

Two stages of soil borings will then be drilled in the areas of the UC Davis trenches to evaluate lateral and vertical extent of identified site constituents and obtain data on the physical characteristics of soils beneath the trenches. Soil samples will be collected during drilling activities and analyzed for chemical and radiological parameters. In-situ groundwater samples will also be collected from selected borings and analyzed for chemical and radiological parameters.

4.8 UC DAVIS LANDFILL UNITS

The UC Davis landfill units will be located using surface geophysical techniques. A landfill gas and radiological survey will then be conducted to obtain screening information concerning the contents of the landfill units. This information will be used to identify "hot spots" and to optimize locations for confirmation soil borings.

Two stages of soil borings will then be drilled. The first stage soil borings will be drilled to collect samples of refuse from within the disposal units, samples of soil directly beneath the refuse, and to evaluate for the presence of leachate. Based on first stage sample analytical results, the second stage borings will be drilled to evaluate lateral and vertical extent of identified constituents of concern and obtain data on the physical characteristics of soils beneath the landfills. In-situ groundwater samples will be collected and analyzed from selected second stage soil borings.

If additional information is required to evaluate the contents of the landfill units, backhoe trenching may be conducted.

4.9 GROUNDWATER AND SURFACE WATER INVESTIGATION

To further characterize the groundwater and surface water at LEHR, the following investigative tasks will be conducted:

- Quarterly monitoring of surface water and the existing groundwater monitoring network will continue;

- A CPT/Hydropunch investigation will be conducted in the areas to the east of LEHR to optimize monitoring well locations;

- New groundwater monitoring wells will be installed to evaluate lateral and vertical extent of impacts;

- Slug tests will be completed on all new monitoring wells installed, and a pumping test will be conducted at or near LEHR;

- A surface water study will be conducted to evaluate potential upstream water sources and leakage from Putah Creek to the first hydrostratigraphic unit; and

- Stormwater samples will be collected from stormwater collection areas during two storm events.

4.10 VEGETATION SAMPLING

Reconnaissance surveys will be performed to provide a consistent and encompassing view of area habitats and to provide qualitative observations for relative comparisons among vegetation/land use types. After performing the reconnaissance surveys, vegetation samples will be collected from agricultural areas, if possible, and from adjoining land parcels. Vegetation samples will mainly consist of grasses, flowers, twigs, forbs, shrubs, and various types of vegetation that are indigenous to the area.

4.11 MAMMAL INVESTIGATION

If chemical analytical data in soil or vegetation indicate the potential for adverse impacts to terrestrial receptors, mammals may be collected for chemical tissue analyses.

At each area of concern, a short small-mammal trapline or grid will be established consisting of Sherman live traps and museum special snap traps. The traps will be set out for a maximum of six days. All mammals caught will be retained, observed and tested if conditions warrant analytical testing.

4.12 AQUATIC COLLECTION

The purpose of the aquatic sampling program is to: (1) collect tissue for analysis, and (2) characterize fish inhabiting nearby surface water bodies. Putah Creek is expected to be the only potentially impacted aquatic system.

Fish sampling may be used to document fish species occurrence, relative abundance and to determine bioaccumulation levels of compounds in muscle tissue and surface water sampling locations. The creek sampling locations will be selected based on the occurrence of fish.

Fish may be collected at each sample location using a variety of methods including gill netting, seining, minnow trapping, and electroshocking, depending upon creek conditions at the time of sampling. The collected fish will be identified, weighed and measured, and samples of fish bodies and filets (from edible species) will be analyzed if conditions warrant.

5.0 RESPONSIBILITIES

The Investigation Contractor will have site safety and health oversight and coordination responsibilities for contractor personnel; each subcontractor will be held accountable for the safe and healthful performance of work by each of their employees, subcontractor, or support personnel who may enter the site.

5.1 PROJECT MANAGER

The Project Manager (PM) shall direct onsite operations. The PM may delegate all or part of these duties to a properly-qualified employee who is designated as the Site Manager. At the site the PM, assisted by the Site Safety Officer (SSO), has primary responsibility for:

1. Seeing that appropriate personal protective equipment and monitoring equipment is available and properly utilized by all onsite personnel;

2. Documenting that site personnel are aware of the provisions of this plan, are aware of the provisions of the LEHR Radiological Control Manual, are instructed in the work practices necessary to ensure safety, and are familiar with planned procedures for dealing with emergencies;

3. Documenting that all onsite personnel have completed a minimum of 40 hours of health and safety training and have appropriate medical clearance as required by 8 CFR 5192 (f), and have been fit tested for the appropriate respirators;

4. Documenting that all onsite personnel who will be working in areas that are known to contain or are suspected of containing radioactive material or contamination are Radiation Worker Level I or II qualified, as stipulated in DOE Order N5480.6, the LEHR Rad Con Manual, and Section 13.4 of this HSP;

5. Seeing that site personnel are aware of the potential hazards associated with site operations;

6. Monitoring the safety performance of all site personnel to see that the required work practices are employed;

7. Correcting any work practices or conditions that may result in injury or exposure to hazardous chemicals or radioactive materials;

8. Preparing and submitting to the PNL Project Manager and the PHSM any accident/incident reports for site activities (see Section 12.6.4), and any unusual Radiological Occurrence Reports as described in Section 12.7;

9. Seeing to the completion of the Safety Plan Compliance Agreement forms by all site personnel (See Attachment A);

10. Halting site operations, if necessary, in the event of an emergency or to correct unsafe work practices;

11. Reviewing and approving this project Health and Safety Plan;

12. Seeing that the Investigation Contractor's Injury and Illness Prevention Program is effectively implemented during site activities;

13. Seeing that the Investigation Contractor's Bloodborne Pathogen Program is effectively implemented during site activities; and

14. Notifying the PNL Project Manager in the event of any loss of radioactive material.

5.2 SITE SAFETY OFFICER

With the approval of the PHSM, the Site Safety Officer's (SSO) duties may be carried out by the PM, the site manager, or other appropriately qualified personnel. The SSO:

1. Implements this project Health and Safety Plan and the LEHR Radiological Control Manual (LEHR Rad Con Manual) and reports any deviations from the anticipated conditions described in these documents to the PM, and, if necessary, the PHSM.

2. Sees that a copy of this HSP and LEHR Rad Con Manual are located onsite at all times.

3. Sees that monitoring equipment is used properly by project personnel and is performance checked and utilized in accordance to the Investigation Contractor's Radiological Operating Procedures (located in Appendix A of the Work Plan) and the manufacturer's instructions, and that results are properly recorded and filed. (See Attachment I for Daily Calibration Check Sheet).

4. Verifies that project personnel have current Fit-For-Duty medical and training authorizations.

5. Maintains training certificates and Fit-For-Duty Medical authorizations at the site for possible agency review.

6. Assumes any other duties as directed by the PM or PHSM.

7. Coordinates with the PHSM and the Occupational Physician to identify personnel for whom specific PPE or exposure monitoring may be required or desirable.

8. Conducts daily safety meetings as outlined in Section 13.9 and completes the Site Safety Briefing Report located in Attachment G.

9. Completes and posts a Hazardous Work Permit prior to the start of field operations as described in section 13.10.

10. Provides ongoing review of the protection level needs as project work is performed, and informs the PM of the need to upgrade/downgrade protection levels as appropriate.

11. Maintains a daily record of personnel activities, monitoring activities, exposure results, radiological exposure results, exposure symptoms, and incidents.

12. Sees that decontamination procedures listed in Chapter 10 are followed by project personnel.

13. Halting site operations, if necessary, in the event of an emergency or to correct unsafe work practices.

14. Reviews and approves this project Health and Safety Plan.

15. Maintains a daily log of personal entry and exit.

16. Maintains a chemical inventory list and material safety data sheets (MSDSs) for all hazardous chemicals brought onsite by contractor and subcontractor personnel.

17. Implements the Investigation Contractor's Injury and Illness Prevention Program as described in Chapter 16.0; and

18. Implements the Investigation Contractor's Bloodborne Pathogens Program (See Attachment Q).

19. Coordinates activities with RCT to minimize overlap/redundancy of duties.

5.3 RADIOLOGICAL CONTROL TECHNICIAN

The Radiological Control Technician (RCT) shall be qualified per the Rad Con Tech course of study, or shall have equivalent certification (e.g., NNRPT) as outlined in the LEHR Radiation Control Manual. The RCT is responsible for monitoring for radioactive contamination during all invasive work activities. In addition, the RCT shall:

1. Conduct radiation monitoring as outlined in Section 7.4.

2. See that all radiological equipment is calibrated in accordance with the manufacturers' instructions.

3. Coordinate personal dosimeter monitoring with UC Davis Health and Safety personnel.

4. Complete a Hazardous Work Permit form (located in Attachment H) prior to the start of work in each work area where radioactive materials are present or presumed to be present.

5. Record results of all radiological monitoring.

6. See that all site personnel are using TLD badges correctly and maintain accountability for all assigned devices and records generated from use.

7. Along with the SSO, see that the proper personal protective equipment is worn by site personnel, as indicated by instrument readings and site conditions.

8. Conduct radiological monitoring for skin contamination after site personnel have undergone decontamination procedures.

9. Implement engineering controls and ALARA principles as directed by the Project Health Physicist.

10. Document the occurrence of unusual radiological events or occurrences as described in Section 12.7.

11. Maintain all radioactive sources used to conduct performance checks for instruments, etc., and notify the PM and the PNL Project Manager or the Radiation Control Manager in the event of any loss of radioactive material as described in Article 411 of the LEHR Rad Con Manual.

12. Maintain all radiological records as described in Section 17.2.

5.4 PROJECT HEALTH PHYSICIST

The Project Health Physicist shall:

1. Direct the activities of the RCT.

2. Review unusual radiological monitoring results and assist with the preparation of unusual occurrence reports.

3. Review radiological survey results prior to the initiation of soil handling activities.

4. Implement, in conjunction with the RCT, time, distance, and shielding techniques or contamination control procedures at the site if radiological monitoring activities indicate results above the action limits/exposure limits.

5. Evaluate all radiological exposure results above their respective action limits, and evaluate the need for increases in personal protective equipment associated with previous and current exposure results.

6. Calculate sampling intervals, sampling equipment to be used, and measurement protocols for all radiological monitoring equipment.

7. Assist the RCT in preparing Hazardous Work Permits as described in Section 13.10.

5.5 PROJECT HEALTH AND SAFETY MANAGER

The Project Health and Safety Manager (PHSM) shall:

1. Oversee the activities of the Site Safety Auditor (SSA) in conducting weekly audits of the operation to evaluate compliance with this plan.

2. Provide health and safety support as requested by the SSA, SSO and PM.

3. Assign appropriately trained personnel to function as SSOs.

4. Evaluate suggested changes or modifications to this HSP.

5. Maintain the project OSHA Form 200, "Log and Summary of Occupational Injuries and Illnesses".

5.6 SITE SAFETY AUDITOR

The Site Safety Auditor (SSA) is a Certified Industrial Hygienist who functions as the PHSM's and PHP's health and safety liaison for this project. The SSA shall:

1. Conduct the opening site safety briefing.

2. Visit the site on a weekly basis and conduct and document weekly site audits during all invasive activities at the LEHR site to evaluate compliance with the requirements of this HSP .

3. Provide on-call health and safety support to the SSO and RCT.

4. Conduct industrial hygiene and noise monitoring as directed by the PHSM.

5.7 PROJECT PERSONNEL

Project personnel involved in onsite investigations and operations are responsible for:

1. Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.

2. Performing only those tasks they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the SSO or PM.

3. Implementing the procedures set forth in this Health and Safety Plan and the LEHR Radiological Control Manual, and reporting any deviations from these procedures to the SSO or PM for action.

4. Notifying the Occupational Physician of any special medical problems (i.e., allergies).

5. Attending all required site safety briefings and adhering to the procedures specified in the site safety briefing, this HSP, and the LEHR Rad Con Manual.

6. Reviewing this project Health and Safety Plan and the LEHR Rad Con Manual and signing the acceptance form.

Personnel responsible for work on this site and for conducting work on this site include:

Project Manager/ Project Coordinator	Joseph Niland, R.G. Dames & Moore	916-387-7513 (w) 916-391-1272 (h)
Site Safety Officer	Gary Dickenson Dames & Moore	916-387-8800 (w)
Project Site Safety Auditor	Patricia L. Facino, CIH Dames & Moore	916-387-7567 (w) 916-858-1368 (h)
Project Health Physicist	Fred L. W. Duncan, CIH, CHP Dames & Moore	303-299-7923 (w) 303-666-8217 (h)
Radiological Control Technician	TBD Dames & Moore	
Project Health and Safety Manager	John G. Danby, CIH Dames & Moore	916-387-7554 (w) 916-351-1526 (h)

5.8 SUBCONTRACTOR'S SAFETY REPRESENTATIVE

Each subcontractor is requested to designate a Subcontractor's Safety Representative (SSR), who is the subcontractor supervisor. The SSR is responsible for the safe and healthful performance of work by his work force and subcontractors in full compliance with this health and safety plan, the LEHR Radiological Control Manual and applicable federal, state, and local regulations. During the subcontractor's activities onsite, the SSR will perform continuing work area inspections, and conduct safety meetings and safety orientations for all new employees. The SSR will attend periodic safety meetings with the SSO. The SSR will also investigate accidents and overexposures involving subcontractor personnel. Each SSR is responsible for:

1. Seeing that appropriate personal protective equipment and monitoring equipment is available and properly utilized by their onsite personnel;

2. Establishing that their onsite personnel are aware of the provisions of this plan, the provisions of the LEHR Rad Con Manual, are instructed in the work practices necessary to ensure safety, and are familiar with planned procedures for dealing with emergencies;

3. Establishing that their onsite personnel have completed a minimum of 40 hours of health and safety training and have appropriate medical clearance as required by 8 CCR 5192 (f), and have been fit tested for the appropriate respirators (all certificates are to be available on site);

4. Establishing that their onsite personnel who will be working in areas that are known to have or suspected of containing radioactive material or contamination are radiation worker (Level II) qualified as stipulated in DOE Order N5480.6, Chapter 6, Part 3;

5. Seeing that their onsite personnel are aware of the potential hazards associated with site operations;

6. Monitoring the safety performance of their onsite personnel to see that the required work practices are employed;

7. Correcting any work practices or conditions that may result in injury or exposure to hazardous substances;

8. Preparing any accident/incident reports for their activities;

9. Seeing to the completion of the Safety Plan Compliance Agreement form by their onsite personnel (See Attachment A);

10. Implementing their firm's Injury and Illness Prevention Program, which includes having a copy available onsite for agency review;

11. Halting their site operations, if necessary, in the event of an emergency or to correct unsafe work practices; and

12. Reviewing and approving this project health and safety plan.

6.0 JOB HAZARD ANALYSIS

Previous investigations have indicated the presence of very low levels (mostly below drinking water standards) of radiological contamination in groundwater, and similarly low levels of strontium-90, radium-226, and cesium-137 in the soil. Higher levels of tritium (<4500 pCi/g) have been found in waste disposal trench grab samples and in some soil boring samples.

Chemical hazards that may be present at the site include laboratory reagents and chlordane insecticide (0.69 ppm), which was used for flea control. One existing well (UCD-12) has shown elevated levels of chloroform (24 ppm). Methylene chloride (0.01 ppm) has also been found sporadically in groundwater, and hexavalent chromium has been found in both soil and groundwater at the LEHR site ranging up to 0.34 ppm. An intact vessel of concentrated pesticide that contained 68% heptachlor, 4.1% Carbophenothion and 0.38% Dieldrin was unearthed in an exploratory trench.

Invasive operations, including drilling and test pit excavating, will be conducted into and/or in the immediate vicinity of landfills and burial trenches. These areas have not yet been characterized, and it is reasonable to assume that broken or intact containers of chemicals may be encountered during these activities. Exposures to chemical and radiological contaminants may occur during sampling activities. Potential routes of exposure are: dermal contact or absorption of organic compounds; ingestion of contaminants, especially if good decontamination and personal hygiene practices are not followed; and inhalation of volatile organic solvent compounds from exposed soils as well as chemical or radiological contaminants from resuspended dusts.

Potential physical hazards at this work site include those associated with:

- heat stress and cold stress;
- slip-trip-fall type of accidents;

- sharp objects such as broken laboratory glassware, needles, and scalpels disposed of in burial areas and disposal trenches;
- excessive noise from heavy equipment;
- drilling hazards;
- fire or explosion associated with uncovering of containers of unstable or flammable chemicals;
- trenching and excavation hazards;
- insect bites and stings;
- back injuries due to improper lifting;
- being caught in or struck by moving equipment; and
- electrocution or explosion hazards associated with drilling or excavation activities, such as contact with overhead or underground power lines or pipelines.

6.1 HEAT STRESS AND COLD STRESS RECOGNITION AND CONTROL

The wearing of Personal Protective Equipment (PPE) can place a hazardous waste worker at considerable risk of developing heat stress. This can result in health effects ranging from transient heat fatigue to serious illness or death. Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, work load, and the individual characteristics of the worker. Because heat stress is probably one of the most common (and potentially serious) illnesses at hazardous waste sites, the SSO will

conduct regular monitoring and see that site personnel observe other preventive heat stress measures.

Heat stress monitoring should commence when personnel are wearing PPE, including Tyvek®-type coveralls, and the ambient temperature exceeds 70°F. If standard work garments (cotton coveralls) are worn, monitoring should commence at 85°F. (NIOSH Publication "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities", October 1985).

6.1.1 Signs, Symptoms and First Aid

Heat rash - (prickly heat) may result from continuous exposure to heat or humid air. It appears as red papules (elevated skin lesion), usually in areas where the clothing is restrictive, and gives rise to a prickly sensation, particularly as sweating increases. It occurs in skin that is persistently wetted by unevaporated sweat. The papules may become infected unless treated.

First Aid for Heat Rash - to prevent heat rash: shower after work, dry off thoroughly, and put on clean, dry underwear and clothes. Try to stay in a cool place after work. If, in spite of this, heat rash develops, a physician should be consulted.

Heat Cramps - are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include:

- muscle spasms
- pain in the hands, feet and abdomen

First Aid for Heat Cramps - The worker is to leave the work area, and rest in a cool, shaded place. Provide one or two glasses of electrolyte replacement

drink, and encourage the worker to gently massage the cramped muscle. Once the spasms disappear, the worker may return to work. Taking adequate breaks and drinking electrolyte replacement drink should prevent the cramps from returning.

Heat exhaustion - occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:

- pale, cool, moist skin
- heavy sweating
- dizziness
- nausea
- fainting

The key here is that the victim is still sweating, so the cooling system is still working; it's just under severe stress. The body core temperature should still be near normal. It is important to recognize and treat these symptoms as soon as possible, as the transition from heat exhaustion to the very hazardous heat stroke can be quite rapid.

First Aid for Heat Exhaustion - The individual is to leave the work area immediately, go through decon and remove all chemical protective clothing. The victim is to rest in a cool, shaded place with clothing open to allow air circulation; victim is to lay flat except when taking fluids. Provide cooled electrolyte replacement drinks. The victim is not to return to work until cleared by a physician. Medical assistance should be summoned.

Heat stroke - is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate

action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are:

- red, hot, usually dry skin
- lack of or reduced perspiration
- nausea
- dizziness and confusion
- strong, rapid pulse
- coma

First Aid for Heat Stroke - THIS IS A MEDICAL EMERGENCY! SUMMON MEDICAL ASSISTANCE IMMEDIATELY! Remove the victim from the work area, perform a gross decon, and remove all PPE. Have the victim lie down in a cool, shady area. Attempt to bring the victim's temperature down by increasing air movement (electric fan) or placing wetted sheets or towels on them. Place an ice bag on the victim's head. The victim must not be sent home or left unattended without a physician's specific order.

6.1.2 Heat Stress Prevention

The best approach to avoiding heat-related illnesses is through preventative heat stress management. The SSO, with the assistance of the SSA, is responsible for implementing this program.

Rest areas - a relatively cool, shaded area must be provided for breaks when ambient temperatures exceed 70°F and workers are wearing chemical protective clothing (including uncoated Tyvek), or if temperatures exceed 85°F and workers are wearing "Level D" coveralls or work clothes. A car or van is an oven, not a rest area. The rest area should be *located in the support zone adjacent to the contamination reduction zone*, situated so that part of it is in the decon area; this will permit workers to take breaks without

going through full decon. If shade is not available, build some: use a plastic "dining canopy", which can be obtained at sporting goods stores. This same type of canopy can be set up to shade personnel performing hand auguring in hot weather.

Liquids - encourage employees to drink cool water and electrolyte replacement drinks, such as Gatorade, Squench or Quik-kick (drink), frequently. Replacement drinks are preferred to plain water. OSHA prohibits a "community cup"; use paper cups. Have workers drink 16 ounces of drink before beginning work, such as in the morning and after lunch. At each break, workers should take 8-16 ounces of drink. Don't wait until you are thirsty to drink.

Discourage the use of alcohol during non-working hours, and discourage the intake of coffee during work hours, as these make heat stress control more difficult.

Acclimatization - this is the process by which the body "gets used to" hot work environments. This is achieved by slowly increasing workloads. One should start at 50 percent capacity on day one, and increase by 10 percent per day; on day six, 100 percent will be achieved. Acclimatization will fade slightly over a weekend, but it'll start to decrease significantly after three to four days. If one does not perform hot work for a week, it is gone. Full shift hot work is not required to achieve or retain acclimatization; a minimum of 100 minutes of continuous hot work exposure per day is adequate.

6.1.3 Determination of the Initial Work/Rest Cycle

Measure the air temperature with a standard thermometer with the bulb shielded from radiant heat; this yields T (actual). Estimate the fraction of sunshine by judging what percent time the sun is not shielded by clouds that are thick

enough to produce a shadow. 100 percent sunshine - no cloud cover = 1.0; 50 percent sunshine - 50 percent cloud cover = 0.5; 0 percent sunshine - full cloud cover = 0.0.

Plug these variables into the following equation to determine the adjusted temperature:

T°F (adjusted temp.) = T°F (actual temp.) + (13 x % sunshine)

Use the chart below to determine the length of the first work shift. At the first break, initiate the heart rate monitoring as described in the next section.

INITIAL WORK/MONITORING CYCLES

ADJUSTED TEMPERATURE	NORMAL WORK CLOTHES	PROTECTIVE CLOTHING
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°-90°F (30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F (28.1°-30.8°)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5°F (25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

6.1.4 Heart Rate Monitoring

Heart rate (HR) should be measured by radial pulse for 30 seconds as early as possible in the resting period, preferably immediately after decon has been completed. The HR at the beginning of the rest period should not exceed 110 beats/minute. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 110 beats/minute at the beginning of the next rest period, the following work period should be further shortened by 33 percent, while the length of the rest period stays the same. Normal rest periods can range from 15 to 60 minutes and even longer, depending upon the ambient temperature, protective clothing, and

work load. Rest periods will continue until site personnel's pulse rates reach normal range.

6.1.5 Cold Stress

Exposure to cold working conditions can result in cold stress (hypothermia) and/or injury (frostbite) to hands, feet, and head. Hypothermia can result when the core body temperature drops below 36°C (96.8°F). Lower body temperature will very likely result in dizziness, drowsiness, disorientation, slurred speech, or loss of consciousness, with possible fatal consequences. Pain in the extremities may be the first warning of danger to cold stress. Shivering develops when the body temperature has fallen to 35°C (95°F).

Hypothermia can be brought on by exposure to cold air, immersion in cold water, or a combination of both. Wind chill factor, the cooling power of moving air, is a critical factor in cold stress.

Adequate insulating clothing must be worn by workers if work is performed in temperatures below 4°C (40°F). At temperatures of 2°C (35.6°F or less), workers whose clothing becomes wet should be immediately provided with a change of clothing and if necessary, treated for hypothermia. Treatment includes warming the victim with skin-to-skin contact, or by providing warm blankets or other coverings, and drinking warm liquids. Skin exposure should not be permitted at temperatures of -32°C (-25°F) or below.

If fine work is to be performed with bare hands for more than 10 to 20 minutes at temperatures below 16°C (60°F), provisions should be made for keeping the workers' hands warm. If temperatures fall below 40°F and fine manual dexterity is not required, then gloves should be worn. Metal handles of tools should be covered with insulating material at air temperatures below -1°C (30°F).

6.2 CHEMICAL HAZARDS

Previous investigations conducted at the LEHR site indicate that low levels of chlorinated hydrocarbons including chloroform and methylene chloride, pesticides including chlordane and chlordane's carrier solvent kerosene, and hexavalent chromium metal are the chemical contaminants of concern at the project site. The levels of these contaminants found to date do not represent a significant concern; however, the site is not fully characterized, so the potential for exposure to elevated levels of these contaminants may exist. Overviews of the hazards associated with exposure to the chemicals found onsite to date are presented below in terms of:

PEL - Permissible Exposure Limit
C - Ceiling
TLV - Threshold Limit Value
REL - Recommended Exposure Limit

Cal/OSHA Permissible Exposure Limits (PELs), ACGIH Threshold Limit Values (TLVs), Time-Weighted Averages (TWAs), and NIOSH Recommended Exposure Limits (RELs) are defined as concentrations for an 8-hour work day, 40-hour work week to which almost all workers can be repeatedly exposed without suffering adverse health effects.

A ceiling value (c) is a concentration that should not be exceeded at any time in any work day.

<u>Chloroform (Trichloromethane; CHCL3)</u>

Cal/OSHA PEL = 2 ppm TLV = 10 ppm REL = Lowest Feasible Concentration

Several organ systems can be effected by elevated chloroform exposures: central nervous system, heart, liver, and kidney. CNS effects (lassitude, digestive

disturbances) are noted at exposures exceeding 80 ppm. Long term exposure to concentrations somewhat lower may cause heart and kidney damage. Chloroform is considered to be a suspected human carcinogen. Chloroform is known to the State of California to cause cancer under the criteria of Proposition 65. Its mean odor threshold is reported to be above 130 ppm, which means its warning properties are inadequate for exposure prevention. Chloroform's ionization potential (IP) is 11.42 eV, and its vapor pressure is 160 torr.

Methylene Chloride (Dichloromethane)

Cal/OSHA PEL = 100 ppm TLV = 50 ppm C = 1,000 ppm
REL = Lowest Feasible Concentration

Methylene chloride is an eye and skin irritant. At very high levels, slight narcosis can occur. Long term exposures above the TLV can cause liver injury. Methylene chloride is considered a suspected human carcinogen. Methylene chloride is known to the State of California to cause cancer under the criteria of Proposition 65. The mean odor threshold is 250 ppm, which means its warning properties are inadequate for exposure prevention. Methylene chloride's ionization potential (IP) is 11.35 eV, and its vapor pressure is 350 torr.

Chlordane

Cal/OSHA PEL = 0.5 mg/m^3 "Skin" TLV/REL = 0.5 mg/m^3

Chlordane exhibits typical effects of organochlorine pesticides: central nervous system effects at elevated levels of exposure. Test groups exposed at ten times the PEL showed none of the classic CNS symptoms of headache, nausea, fatigue, and disturbances of vision and respiration. Some aspects of the toxic effects of chlordane can be attributed to the carrier solvent used in application of the pesticide. Some animal tests indicate the potential for liver damage at higher long-

term exposures. The literature does not indicate an odor threshold for chlordane itself; any predominant odor would likely be from the carrier solvent. Chlordane is readily absorbed by the skin, producing systemic effects. Chlordane is known to the State of California to cause cancer under the criteria of Proposition 65. There is no reported ionization potential for chlordane, and its vapor pressure is 0.00001 torr.

Kerosene

REL = 100 mg/m^3 (~ 14 ppm)

Inhalation produces effects typical of other lower molecular weight hydrocarbons, namely dizziness and nausea. Narcosis may occur at high exposure levels due to central nervous system depression.

When ingested, kerosene is moderately toxic (toxic dose low = 3570 mg/kg), producing distorted perceptions, coughing, nausea or vomiting, and fever. Aspiration of vomitus can cause serious pneumonitis.

Kerosene vapors are moderately explosive when exposed to heat or flame. Because kerosene is a mixture of varying proportions, a mean odor threshold has not been determined.

Hexavalent Chromium

Cal/OSHA PEL = 0.05 mg/m^3 TLV = 0.05 mg/m^3 REL = 0.001 mg/m^3

Hexavalent chromium compounds are irritating and corrosive compounds that can enter the body by ingestion, inhalation, and through the skin. Acute exposures to Cr^{6+} dust or mist may cause coughing and wheezing, nasal irritation, headache, dyspnea, painful breathing, fever, and loss of

weight. Hexavalent chromium compounds have shown to increase the risk of lung cancer in U.S. chromate workers. Hexavalent chromium is known to the State of California to cause cancer under the criteria of Proposition 65.

6.3 RADIOLOGICAL HEALTH HAZARDS

Minimizing and reducing any ionizing radiation hazard at the LEHR site will be governed by the LEHR Rad Con Manual, and the site ALARA (As Low As Reasonably Achievable) policy and goals. The manual emphasizes that a clear understanding of the characteristics and effects of ionizing radiation must be attained by all project personnel. The following subsections will give explanations of the different types of radiation, their effects, and methods for reducing the hazards. In addition, a summary of the radionuclides that may be encountered during project activities is presented.

6.3.1 Biological Effects of Ionizing Radiation

The harmful consequences of ionizing radiations to a living organism result from the energy absorbed by cells and tissue of the organism. The absorbed energy causes ionization and excitation of atoms within the tissue. This leads to a chemical decomposition of the molecules present in the living cells. If a sufficient amount of chemical decomposition occurs, the living cells will die, thus resulting in tissue damage. If enough tissue is damaged in a short time, physical symptoms such as nausea, vomiting, and malaise could occur (short term effects). However, a large amount of dose would have to be absorbed before these symptoms occurred (over 200 rad). Long term effects of radiation, even at much lower doses, may include either somatic effects (e.g., cancer, cataracts, lifespan shortening), and genetic effects (changes to chromosomes in sex cells) which could affect future generations.

TABLE 6-2 - SUMMARY OF ANNUAL FEDERAL DOSE LIMITS WITH CONTRACTOR DOSE LIMITS IN PARENTHESES

TYPE OF EXPOSURE		ANNUAL LIMIT (a)
Radiological Worker:	Whole Body (internal + external)	5 rem (0.5)
Radiological Worker:	Lens of Eye	15 rem (1.5)
Radiological Worker:	Extremity (hands and arms below the elbow; feet and legs below the knees)	50 rem (5.0)
Radiological Worker:	Any organ or tissue (other than lens of eye) and skin	50 rem(5.0)
Declared Pregnant Worker:	Embryo/Fetus	0.5 rem in 9 months (0.2)
Minors and Students: (under age 18)	Whole Body (internal + external)	0.1 rem (0.1)
Visitors and Public:	Whole Body (internal + external)	0.1 rem (0.1)

(a) All doses listed above are committed effective dose equivalents (CEDE).

Project personnel who will be working in areas in which radiological material or contamination is known or suspected to exist must be Radiation Worker I qualified as specified in the LEHR Rad Con Manual. Project personnel performing An excavation or characterization of this material in the field, or who work in areas of airborne radioactivity, soil or equipment contamination, or high radiation fields, must be Radiation Worker II qualified. Project personnel working as Radiological Control Technicians must be qualified per the DOE Rad Con Tech course of study, or have equivalent certification (e.g., NRRPT) as outlined in the LEHR Rad Con Manual. In all cases of training and qualification, site personnel will conform to the LEHR Radiation Control Manual. Questions regarding the manual or its provisions will be referred to the LEHR Rad Con Manager/PNL Project Manager.

Federal and state guidelines also mandate contamination limits for personnel, equipment, and facilities. Personnel will be monitored for radiological contamination through the use of hand-held radiological detection equipment. The radiological contamination monitoring issues, including, but not limited to, instrument selection, wipe sample frequency, exit monitoring, and buffer zone setup will be decided by either the RCT or the Project Health Physicist on a project or task-specific basis. Table 6-3 summarizes the allowable contamination limits for project personnel. The limits will be adhered to unless superseded by the LEHR Rad Con Manual or by task specific procedures.

Task specific planning will be performed keeping in mind the goals of the ALARA Plan and using the principles of time, distance, shielding, and dress to minimize exposure to radiation and prevent inhalation or skin contact with radioactive materials. Tasks that may result in a deviation from ALARA philosophy or threaten specific ALARA goals must receive approval, in writing, from the Project Health Physicist and the Project Manager before work commences. The LEHR Radiological Control Manager and PNL Project Manager will also be notified so they can take part in the decision making process.

TABLE 6-3 - SUMMARY OF CONTAMINATION LIMITS ALLOWABLE TOTAL RESIDUAL SURFACE CONTAMINATION (dpm/100 cm²)

RADIONUCLIDES[2,8]	AVERAGE[3,4]	MAXIMUM[4,5,10]	REMOVABLE[4,9]
U-natural, U-235, U-238 and associated decay product, alpha emitters	5,000	15,000	1,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100[6]	300[7]	20[7]
Th-natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and other noted above.[7]	5,000	15,000	1,000

1 As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

2 Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha- and beta-gamma-emitting nuclides should apply independently.

3 Measurements of average contamination should not be averaged over an area of more than 1 m². For objects of less surface area the average should be derived for each such subject.

4 The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

5 The maximum contamination level applies to an area of not more than 100 cm².

6 Limits used are U.S. NRC Regulatory Guide 1.86 limits plus ALARA.

7 This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 is enriched.

[8] The values in this table apply to radioactive contamination deposited on, but not incorporated into the interior of the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha and beta-gamma-emitting nuclides apply independently.

[9] The amount of removable material per 100 cm^2 of surface area should be determined by swiping the area with a dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For object with a surface area of less than 100 cm^2, the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, Ra-228, Ac-227, Th-228, Th-230, Pa-231, and alpha-emitters, it is not necessary to use swiping techniques to measure removable contamination.

[10] For fixed contamination only, the levels may be averaged over 1 m^2 provided that the maximum activity in any area of 100 cm^2 is less than three times the values in Table 6-3.

The information contained in Table 6-3 was taken from the LEHR Radiological Control Manual, July 1993.

Airborne radiological material is an issue of concern with sampling activities. Airborne material containing radionuclides could become inhaled during work activities. If deemed necessary by the SSO, RCT or the PHP, airborne dust levels will be monitored using appropriate air sampling equipment. In addition, if airborne dust levels are deemed to be too high (by the RCT or the PHP), appropriate personnel protective equipment (i.e., respirators) and engineering controls will be implemented. Table 6-4 summarizes the Derived Air Concentrations (DAC) which come from DOE Order 5480.11 that are applicable to this project. DACs are the concentrations in air of radionuclides which would result in a dose of 5 rem if inhaled continuously for one year. If airborne levels exceed 10% of an applicable DAC, appropriate personnel protective equipment (i.e.,respirators) and/or engineering controls (i.e., soil wetting) shall be implemented by the SSO and RCT.

TABLE 6-4 - DERIVED AIR CONCENTRATIONS (DAC) FOR CONTROLLING RADIATION EXPOSURES TO WORKERS AT DOE FACILITIES

RADIONUCLIDE	AIR CONCENTRATION (μCi/ml)
Strontium-90	2.E-09
Yttrium-90	3.E-07
Radium-226	3.E-10
Radon-222	3.E-08
Cesium-137/Barium-137m	7.E-08
Cobalt-60	1.E-08
Tritium	2.E-05
Carbon-14	1.E-06
Chlorine-36	1.E-07
Thorium-232	5.E-13
Thorium-228	4.E-12
Plutonium-241	1.E-10
Americium-241	2.E-12

6.3.4 LEHR ALARA Plan

As discussed in the LEHR Rad Con Manual, the development and implementation of the ALARA Program Plan will be accomplished through the LEHR Radiological Control Committee. This committee is composed of senior health physics personnel from each of the contractors operating at the site. This plan will offer sitewide goals applicable to all contractors and implemented through their health and safety plans, work plans, and associated procedures. The committee will have visibility of deviations from the ALARA Plan through its members as well

as through the Occurrence Reporting System at the site. Currently, the Draft LEHR ALARA Policy for Radiation Protection of Workers, the Public and the Environment, Revision 0, is being reviewed by the Rad Con Committee and is awaiting finalization. When finalized, its provisions will be reflected in a future version of this Health and Safety Plan.

6.4 HAZARD COMMUNICATION PROGRAM

Materials which are considered hazardous materials under the Cal/OSHA Hazard Communication Standard may be used during this project for construction, decontamination or equipment calibration purposes. Copies of the MSDSs for such materials are included in Attachment L. The SSO will make copies of these MSDSs available to any subcontractors, including drillers and excavators, on this project. Any additional material brought onsite that may be considered hazardous under the Cal/OSHA regulations must first be cleared through the Site Safety Officer, so appropriate provisions can be made, if necessary, for compliance with the Hazard Communication Standard. A copy of the Investigation Contractor's Hazard Communication Program will be maintained at the site office.

The following chemicals will be used onsite by site personnel:

- TSP or Alconox (decontamination)
- Isobutylene (calibration)
- Nitric acid (water sampling)
- Hydrochloric acid (water sampling)
- High Grade Alcohol (wipe sampling)
- Hexane (decontamination)
- Gasoline (generator and equipment fuel)
- Diesel (equipment fuel)
- Buffer solutions for pH meter
- Portland cement
- Powdered bentonite

All subcontractors are required to provide copies to the SSO of the MSDSs for all chemicals they bring onsite. A complete list of the hazardous chemicals brought onsite will be maintained and updated by the SSO, with assistance from the SSA, whenever chemicals are added or deleted from the inventory.

The SSO is also responsible for providing Hazard Communication training to site personnel to inform them of the hazards and health effects associated with the chemicals brought onsite by all contractors and subcontractors. Training will also be updated when new chemicals are added to the chemical inventory list. Such training will be documented in the health and safety field log book.

At the site, gasoline must be stored in a non-sparking, red container with a flame arrestor in the fill spout. The word "gasoline" must be clearly visible on the container. In addition, all flammable materials will be stored in a flammable materials storage cabinet or other suitable cabinet/container. Each container of hazardous materials must be labeled with the chemical name and an appropriate hazard warning. In addition, a 20 lb. fire extinguisher must be located in the immediate vicinity of all flammable liquids stored on the site.

6.5 UNDERGROUND UTILITIES AND ELECTRICAL HAZARDS

The Investigation Contractor will coordinate with UC Davis Physical Plant personnel to locate all underground utilities prior to the commencement of drilling, excavation, or other invasive activities. Resources include site plans, utility companies, ITEH Site Engineering, and Underground Services Alert (USA). USA must be contacted at least two, but not more than fourteen working days prior to drilling or excavating on public property (i.e., streets, sidewalks, etc). The deactivation of utilities should be certified by the proper utility company personnel, and the certification retained in the permanent log.

In areas where limited or no information is available regarding subsurface lines or obstructions, geophysical technologies will be employed. Four geophysical methods may be used: magnetic; electromagnetic; ground penetrating radar; and, electromagnetic line location.

Drilling operations adjacent to overhead lines shall not be initiated until operations are coordinated with the utility officials. Operations adjacent to overhead lines are prohibited unless one of the following conditions is satisfied.

- Power has been shut off and positive means taken to prevent lines from being energized; or

- Equipment, or any part of the equipment, does not have the capability of coming within the following minimum clearance from energized overhead lines, or the equipment has been positioned and blocked to assure no part, including cables, can come within the following minimum clearances:

POWER LINES NOMINAL SYSTEM (kv)	MINIMUM REQUIRED CLEARANCE
0-50	10 feet
51-100	12 feet
101-200	15 feet
201-300	20 feet
301-500	25 feet
501-750	35 feet
751-1000	45 feet

Ground fault interrupters (GFI) shall be used on all extension cords. All extension cords shall have a non-current carrying grounding conductor. Cords with damaged

insulation shall not be used. Personnel maintaining and repairing electrical or mechanical equipment will follow the appropriate lockout and tagout procedures for the equipment being worked on. All portable tools shall be grounded or of approved, double insulated construction.

6.6 WORK AREA PROTECTION

As the project operations may be undertaken in a roadway or parking lot, motor vehicles may be a hazard. Guidance on properly coning and flagging the work area is located in Attachment K. Consideration should be given to parking a work vehicle within the coned area between the work area and on-coming traffic.

6.7 NOISE HAZARDS/HEARING CONSERVATION PROGRAM

The primary noise hazard at this site is from the drilling and excavating equipment. Previous surveys indicate that such equipment may produce continuous and impact noise at or above the action level of 85 dBA. Noise monitoring using a sound level meter will be conducted by the SSA to evaluate noise exposures from this equipment. Sound level meter readings are to be taken in the areas where personnel are working. Areas where readings may exceed 85 dBA will require the use of hearing protection. The SSA will notify of the SSR of noise-impacted personnel. Each employer working on the site is required to have a Hearing Conservation Program that meets the requirements of 8 CCR 5097 in place for employees whose average 8-hour exposure exceeds 85 dBA. Personnel will wash their hands with soap and water prior to inserting ear plugs to avoid initiating ear infections.

6.8 HEAVY EQUIPMENT SAFETY

The following section provides an overview of safe work practices for reference only. The heavy equipment operator is expected to have superior knowledge of the safe operation of the equipment and its appurtenances, and should perform accordingly. It is

assumed that the health hazards described in the above sections may be encountered at any given time by personnel participating in specific site activities, so these hazards are not addressed here.

6.8.1 General Heavy Equipment Safety

Heavy equipment can represent a substantial hazard to workers. In general, requirements for motor vehicles and material handling equipment are provided in the Cal/OSHA Construction Safety Orders at 8 CCR, Chapter 4, Subchapter 4. The following safe work practices (SWP's) should be followed when heavy equipment is in use (front end/backhoe loaders, grading equipment, and so on):

- Use common sense. Do not assume that the equipment operator is keeping track of your whereabouts. Never walk directly in back of, or to the side of, heavy equipment without the operators knowledge.
- Hard hats, steel toe boots, and safety glasses are to be worn at all times around heavy equipment. Other protective gear as specified in this health and safety plan is also applicable.
- Remain alert at all times.
- Maintain visual contact at all times.
- Establish hand signal communication when verbal communication is difficult. Assign one person per work group to give hand signals to equipment operators.
- Be aware of footing at all times.
- Only qualified/licensed people are to operate heavy equipment.

- Use chains, hoists, straps, and any other equipment to safely aid in moving heavy materials.

- Use proper personal lifting techniques. Use your legs, not your back.

- Never use a piece of equipment unless you are familiar with its operation. This applies to heavy as well as light equipment (i.e., chain saws).

- Pipe sections and other materials to be utilized during this project are extremely heavy. Make sure all precautions have been taken prior to moving heavy materials. Let the equipment, not your body, do the moving.

- Be sure that no underground or overhead power lines, sewer lines, gas lines, or telephone lines, will present a hazard in the work area.

- Keep all non-essential people out of the work area.

- Prohibit loose-fitting clothing or loose long hair around moving machinery.

- Keep cabs free of all non-essential items and secure all loose items.

- Instruct equipment operators to report to their supervisor(s) any abnormalities such as equipment failure, oozing liquids, unusual odors, and so on.

- When an equipment operator must negotiate in tight quarters or where vision is in question, provide a second person to ensure adequate clearance.

- Implement an ongoing maintenance program for all tools and equipment. Inspect all tools and moving equipment regularly to ensure that parts are secured and intact with no evidence of cracks or areas of weakness, that the equipment turns smoothly with no evidence of wobble, and that it is operating according to manufacturer's specifications. Promptly repair or replace any defective items. Keep maintenance and repair logs.

- Store tools in clean, secure areas so that they will not be damaged, lost or stolen.

- Keep all heavy equipment that is used in the exclusion zone in that zone until the job is done. Completely decontaminate such equipment within the designated vehicle decontamination pad.

- Vehicles may not have cracked windshields or windows, and all glass used in windshields or windows shall be safety glass.

- Blades, buckets, dump bodies, and other hydraulic systems must be fully lowered when equipment is not in use.

- Parking brakes shall be engaged when equipment is not in use.

- All vehicles with rollover protective structures (ROPS) will have seat belts; operators will be trained in the use of seat belts, and the seat belts shall be used at all times during vehicle operation.

- Equipment with an obstructed rear view must have an audible alarm that sounds when it is operating in the reverse direction (unless a spotter guides the vehicle operator).

- Material handling equipment that lacks a ROPS must not be operated on a grade, unless the grade can safely accommodate the equipment involved.

- A safety barrier will be used to protect workers whenever a tire is inflated, removed, or installed on split rims.

- Heavy equipment will be inspected by the operator prior to the beginning of each work shift.

6.8.2 Drilling Safety Guidelines

The drill rig operator has superior knowledge regarding, and is responsible for drill rig maintenance and safety. The following information, taken from the National Water Well Association's Manual of Safe Operating Procedures, provides general guidelines for safe practices onsite.

Movement of Drill Rigs

The following safety guidelines relate to offroad movement of drill rigs:

- Before moving a drill rig, first walk the route of travel, inspecting for depressions, slumps, gullies, ruts, and similar obstacles.

- Always check the brakes of a drill rig carrier before traveling, particularly on rough, uneven, or hilly ground.

- Discharge all passengers before moving a drill rig on rough or hilly terrain.

- Engage the front axle of 4x4 or 6x6 vehicles or carriers when traveling off the highway on a hilly terrain.

- Use caution when traveling on a hillside. Conservatively evaluate the hillside capability of drill rigs, because the addition of drilling tools may raise the center of mass. When possible, travel directly uphill or downhill.

- Attempt to cross obstacles such as small logs, small erosion channels or ditches squarely, not at an angle.

- When lateral or overhead clearance is close, use the assistance of someone on the ground as a guide.

Underground utilities are as dangerous as overhead lines. Be aware and always suspect the existence of underground utilities such as electrical power, gas, petroleum, telephone, sewer, and water. Ask for assistance:

- If a sign warning of underground utilities is located on a site boundary. Do not assume that underground utilities are located on or near the boundary or property line under the sign; call the telephone or utility company and have them check it out. The underground utilities may be a considerable distance away from the warning sign.

- Always contact the owners of the utility lines or the nearest underground utility locating service before drilling. The utility personnel should determine the location of underground lines and should mark and flag these locations. Determine, with the utility personnel, what specific precautions must be taken to assure safety.

Housekeeping On and Around The Drill Rig

To complete the first requirement for safe field operations, the safety supervisor of the drilling crew must understand and fulfill his responsibility for maintenance and "housekeeping" on and around the drill rig. Suitable storage locations should be provided for all tools, materials, and supplies. The locations should allow for the convenient handling of tools, materials or supplies without danger that these could fall on or hit a member of the drill crew or a visitor.

Avoid storing or transporting tools, materials, or supplies within or on the mast (derrick) of the drill rig. Pipe, drill rods, bits, casing, augers, and similar drilling tools should be stacked in an orderly manner on racks or sills to prevent spreading, rolling, or sliding.

Penetration hammers or other types of driving hammers should be placed at a safe location on the ground or secured to prevent movement when not in use. Work areas, platforms, walkways, scaffolding, and other access ways should be kept free of materials, obstructions, and substances such as ice, excess grease, or oil that could cause a surface to become slick or otherwise hazardous. Keep all controls, control linkages, and warning and operation lights and lenses free of oil, grease, and/or ice.

Do not store gasoline in any portable container other than a non-sparking, red container with a flame arrestor in the fill spout. The word "gasoline" must be clearly visible on the container.

Use of Hand Tools

There are many kinds of hand tools that can be used on or around a drill rig. The most important rule is "use the tool for its intended purpose." The following are a few specific and general suggestions that apply to the safe use of several hand tools often used on and around drill rigs.

- When a tool becomes damaged, either repair it before using it again or discard it.
- When using a hammer, any kind of hammer, for any purpose, wear safety glasses and require all others around you to do the same.
- When using a chisel, any kind of chisel, for any purpose, wear safety glasses and require all others around you to do the same.
- Keep all tools cleaned and stored in an orderly manner when not in use.
- Replace hook and heel jaws when they become visibly worn.
- When breaking tool joints on the ground or on a drilling platform, position your hands so that your fingers will not be caught between the wrench handle and the ground or the platform, should the wrench slip or the joint suddenly let go.

Use of Augers

The following general procedures should be used when advancing a boring with continuous flight or hollow-stem augers:

- Prepare to start an auger boring with the drill rig level, the clutch or hydraulic rotation control disengaged, the transmission in low gear, and the engine running at a low RPM.

- The operator and tool handler should establish a system of responsibility for the series of various activities required for auger drilling, such as connecting and disconnecting auger sections, and inserting and removing the auger fork. The operator must be sure that the tool handler is well away from the auger column and that the auger fork has been removed before starting rotation.

- Only use the manufacturer's recommended method of securing the auger to the power coupling. Do not touch the coupling or the auger with your hands, a wrench, or any other tool during rotation.

- Whenever possible, use tool hoists to handle auger sections.

- Never place your hands or fingers under the bottom of an auger section when hoisting the auger over the top of the auger section in the ground or other hard surfaces such as the drill rig platform.

- Never allow your feet to get under the auger section that is being hoisted.

- When rotating augers, stay clear of the rotating auger and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason.

- Never use your hands or feet to remove cuttings away from auger.

- Augers should be cleaned only when the drill rig is in neutral, and the augers have stopped rotating.

Start-Up Procedures

All drill rig personnel and visitors should be instructed to "stand clear" of the drill rig immediately prior to and during and starting of an engine. Before starting a drill rig engine, make sure that all of the gear boxes are in neutral, all hoist levers are disengaged, all hydraulic levers are in the correct non-actuating positions, and the cathead rope is not on the cathead.

Drill Rig Operation (Hollow-stem)

Safety requires the attention and cooperation of every worker and site visitor. The following procedures are related to safety during drilling operations:

- Do not drive the drill rig from hole to hole with the mast in the raised position. Before raising the mast, look up to check for overhead obstructions.

- Before raising the mast, clear all drill rig personnel (with the exception of the operator) and visitors from the areas immediately to the rear and the sides of the mast. In addition, inform them that the mast is being raised.

- Before the mast of a drill rig is raised and drilling is commenced, the drill rig must first be leveled and stabilized with leveling jacks and/or solid cribbing. The drill rig should be re-leveled if it settles after the initial set up. Lower the mast only when leveling jacks are down, and do not raise the leveling jack pads until the mast is completely lowered. Before starting drilling operations, secure and/or lock the mast, if required by the drill manufacturer's recommendations.

- The drill rig operator should operate a drill rig only from the position of the controls. The operator should shut down the drill engine before leaving the vicinity of the drill. "Horsing around" within the vicinity of the drill rig and tool and supply storage areas is strictly prohibited, even when the drill rig is shut down. Watch for slippery ground when mounting/dismounting the platform.

- Drilling operations should be terminated during an electrical storm.

- Consuming alcoholic beverages, depressants, stimulants, or any other chemical substance while on the job is strictly prohibited.

- All unattended boreholes must be adequately covered or otherwise protected to prevent drill rig personnel, site visitors or animals from stepping or falling into the hole. When the drilling project has been completed, all open boreholes should be covered, protected or backfilled adequately and according to local or state regulations.

6.9 TRENCHING AND EXCAVATION GUIDELINES

It is anticipated that all samples collected from trenches that are greater than five feet in depth will be collected from the backhoe bucket; entry into trenches that are over 5 feet deep, or those less than five feet deep that are not constructed in Type C soil or that display a hazardous atmosphere will not be entered. Since work will not be conducted in these areas, the hazards associated with trenching and excavation are not discussed in this HSP.

6.9.1 Excavation Activities in the DOE Burial Trenches

Test pits are to be excavated in and/or adjacent to the DOE Burial Trenches and the DOE Disposal Box. As these areas have not been fully characterized, and historical data related to the potential contents of these disposal areas is incomplete, significant potential exposure risks may be associated with this activity.

The Project Manager will consult with the Site Safety Auditor and the Project Health and Safety Manager prior to initiating the construction of the test pits. Data from related geophysical, gas, and radiological surveys will be presented in order to evaluate the risks associated with test pit construction. For those test pits which the data indicate elevated potential hazards, the following steps will be taken:

- The SSA will be onsite for test pit excavation activities.
- The backhoe will be equipped with a minimum one-inch thick plexiglas (or equivalent) blast shield that is securely attached to the Roll-over Protection Structure and configured to protect the backhoe operator in the event of an explosion.

- If practical, the backhoe will be upwind of the excavation, so that any vapor releases move away from the backhoe operator.

- The spotter will move to a safe area while the backhoe makes each cut, then slowly proceed toward the trench to make observations after the cut is completed and only if no smoke, vapors, or other emissions are being released from the pit.

- In the event of a fire or vapor release from the excavation, the backhoe operator will attempt to immediately smother the release with spoils. If the release makes it unsafe to do this, the backhoe operator is to evacuate upwind.

- The backhoe operator and the spotter will wear full-face air purifying respirators with combination organic vapor/acid gas/HEPA cartridges; each will carry a 5-minute escape respirator. No other personnel shall be in the immediate vicinity while the test pit is being excavated.

6.10 CONFINED SPACE ENTRY

During Remedial Investigation activities, confined space entry will not be performed. Site personnel are prohibited from entering confined spaces such as septic tanks and trenches that display hazardous atmospheres. Since these activities are not part of the scope of work, the hazards associated with confined space entry are not covered in this HSP.

6.11 EQUIPMENT INSPECTIONS

All heavy equipment shall be inspected before each shift to see that it is in a safe operating condition. The following parts and equipment should be checked:

1. Brakes, including trailer brake connections
2. Parking and emergency brakes
3. Tires
4. Horns
5. Steering mechanisms
6. Coupling devices
7. Seat belts
8. Operating controls
9. Lights, reflectors, windshield wipers, defrosters, fire extinguishers, back-up alarms, and other safety devices.

Daily equipment inspections are to be recorded on a check sheet or in the equipment operator's log book.

6.12 LIFTING SAFETY

During all hand auguring and lifting episodes, site personnel will observe proper lifting techniques. When heavy objects are required to be lifted, personnel will follow the following lifting techniques:

- Keep the load as close to the body as possible;
- Lift mainly with your legs, not your back;
- Use two person lifts when lifting objects that weigh over 40 pounds or when lifting large bulky objects;
- When using two person lifts, have a spotter call the lift; and
- If you have back problems or a weak back, inform the SSO prior to work activities. Individuals with bad backs will not perform lifting activities.

6.13 POTENTIAL CONTACT WITH INFECTIOUS/LABORATORY WASTE

When working in an area where there is a potential for infectious/laboratory waste to be located, care must be taken to avoid contact with materials such as syringes, scalpels, broken glassware, and any other type of infectious/laboratory waste. During the collection of soil, water, sludge or wipe samples from areas where infectious/laboratory waste is located, personnel will first observe the area where the sample will be collected for suspected waste items. If potentially infectious/laboratory waste is seen, either another sample location will be chosen or care will be taken to move the object away from the work area. If the material must be handled, site personnel will wear heavy work gloves, as selected by the PHSM, over their chemically protective gloves to prevent skin puncturing. If the skin is punctured, personnel will immediately report the incident to the Occupational Physician and seek medical attention as described in the Investigation Contractor's Bloodborne Pathogen Procedure. Information concerning the Bloodborne Pathogen Procedure is located in Attachment Q, and information concerning nearby medical facilities is located in Chapter 12. A full copy of the Bloodborne Pathogens Program is located in the Investigation Contractor's Health and Safety Program Manual which is maintained by the Project Health and Safety Manager and is available upon request.

7.0 EXPOSURE MONITORING PLAN

Heat and cold stress and chemical exposures may be encountered at this site. Heat stress monitoring and prevention is addressed in Section 6.1, and noise monitoring is described in Section 6.7.

7.1 CHEMICAL EXPOSURE MONITORING

A Foxboro Organic Vapor Analyzer (OVA), or a HNu Photoionization Detector (PID) or equivalent with a minimum lamp energy of 11.5 eV, will be used to monitor for chlorinated hydrocarbons, which are the primary non-radiological contaminants of concern, in areas where previous investigations have detected elevated levels of chlorinated hydrocarbons, specifically UCD-9. The instrument used will have sufficient ionization energy (> 11.5 eV) to detect these contaminants. Some representative ionization potentials are listed below.

Chloroform - 11.42 eV Methylene chloride - 11.35 eV

These analyzers typically demonstrate approximately 60% or better response to these contaminants; for example, an OVA has a 90% response to methylene chloride and 65% to chloroform, while a HNu PID has a 96% response to methylene chloride and a 60% response to chloroform.

The OVA/PID will be used on a regular basis, typically every 5 to 10 minutes during drilling, excavation and sampling activities to monitor in the immediate vicinity of the borehole, excavation, cuttings adjacent to the borehole and excavation, and in the general work area. If readings exceed 1 ppm (above background), monitoring in the operator's breathing zone (OBZ) of site personnel working nearest the source of the readings will start immediately. If OBZ readings exceed 1 ppm for more than one minute, a Drager Chloroform 2/A tube will be used to monitor for chloroform. If chloroform is indicated, NIOSH/MSHA-approved half-face respirators with combination organic vapor/HEPA

cartridges will be donned. If the tube does not indicate the presence of chloroform, OBZ monitoring with the OVA/PID will continue as indicated in Table 7-1. If an indication of chloroform is exhibited on the Drager Chloroform 2/A detector tube after 10 strokes of the pump, the SSA will be notified and personal monitoring will be performed as outlined in Section 7.2.

Personal monitoring will be used to assess breathing zone concentrations of chloroform. If chloroform is found to be present in levels exceeding the Permissible Exposure Limit of 2 ppm, then personal monitoring will be performed by the SSA on an as needed basis, determined by the PHSM and through the use of Drager Chloroform tubes, to verify that air-purifying respirators can continue to be used to protect site personnel from exposure to chloroform vapors.

If OVA/PID OBZ readings exceed 5 ppm, on average, for more than one minute then half-face respirators with combination organic vapor/HEPA filter cartridges will be donned by personnel. OBZ readings above 10 ppm, on average, for more than one minute will require the use of full-face respirators with combination organic vapor/HEPA cartridges; in addition, personal monitoring for aromatic and chlorinated hydrocarbons will be initiated by the SSA. If OBZ readings exceed 50 ppm, on average, over one minute, work will stop, an attempt will be made to suppress vapor emission by applying a suppressant foam, and workers will move upwind while the vapors dissipate. If elevated emissions persist, personnel will cover the cuttings with plastic visqueen or clean soil, leave the area in an upwind direction, and contact the PHSM for further guidance.

A summary of the monitoring criteria and action requirements is presented below.

TABLE 7-1 - OVA/PID MONITORING ACTION LEVELS

Analyzer Reading*	Location	Time Period	Action
< 1 ppm	Borehole/ excavation/ sampling location	----------	Continue periodic monitoring. (every 5-10 minutes)
> 1 ppm	Borehole/ excavation/ sampling location	> 1 minute	Monitor OBZ with OVA/PID Commence monitoring with Drager Chloroform 2/A tube.
< 5 ppm or no chloroform indication on tube	OBZ	----------	No respirators required.
> 5 ppm or positive chloroform indication on tube	OBZ	> 1 minute	Half-face respirators with organic vapor/HEPA cartridges. Immediately notify the PHSM and the SSA will be dispatched to perform personal monitoring for chloroform as outlined in Section 7.2.1.
> 10 ppm or personal monitoring indicates chloroform levels above 5 ppm	OBZ	> 1 minute	Full-face respirators with organic vapor/HEPA cartridges. Initiate personal monitoring for aromatic and chlorinated hydrocarbons as described in Section 7.2.2.
> 50 ppm or personal monitoring indicates chloroform levels above 10 ppm	OBZ	> 1 minute	Stop work; foam material; move upwind while vapors dissipate. If elevated levels remain, cover boring, excavation and associated cuttings, evacuate upwind and notify PHSM or PM.

OBZ = Operator's Breathing Zone)

* above background readings

7.2 PERSONAL MONITORING

7.2.1 Chloroform

If measurements taken with the Chloroform 2/A tube indicate that chloroform is present in concentrations greater than 1 ppm, the SSA will be notified to conduct industrial hygiene monitoring (integrated sampling) on personnel working in the exclusion zone. Sampling will be conducted in accordance with NIOSH Analytical Method 1003 (Halogenated hydrocarbons), a copy of which is located in Attachment O. A calibrated personal sampling pump will pull 200 cc/min of air over a 100/50 charcoal sorbent tube for 4 hours, yielding a sample volume of 48 liters, which should provide a limit of detection of ~0.14 ppm chloroform. Samples will be analyzed by a laboratory accredited by the American Industrial Hygiene Association, and results will be made available to affected employees in a manner consistent with OSHA requirements.

7.2.2 Aromatic and Chlorinated Hydrocarbons

If breathing zone measurements exceed 10 ppm for more than one minute, the SSA will be notified to conduct industrial hygiene monitoring (integrated sampling) on personnel working in the exclusion zone. Sampling will be conducted in accordance with NIOSH Analytical Methods 1501 (Aromatic Hydrocarbons) and 1003 (Halogenated hydrocarbons), copies of which are located in Attachment O. A calibrated personal sampling pump will pull 200 cc/min of air over a 100/50 charcoal sorbent tube for 4 hours, yielding a sample volume of 48 liters. If he deems it appropriate, the PHSM may direct the lab to analyze a sample via gas chromatograph/mass spectrometer to semi-quantitatively evaluate the compounds present. Samples will be analyzed by a laboratory accredited by the American Industrial Hygiene Association, and results will be made available to affected employees in a manner consistent with OSHA requirements.

7.3 EXPLOSIVE ATMOSPHERES

The potential exists for explosive atmospheres at the site due to the possible presence of methane gas, which has a low flash point, when drilling or excavating in the landfill and septic tank areas. A Combustible Gas Indicator/O_2 (CGI/O2) meter will be used to monitor ambient conditions at all times during drilling or excavation operations. Oxygen concentrations should be measured prior to taking combustible gas readings to determine that there is sufficient oxygen (>10%) to operate the Combustible Gas Indicator. Decisions will be based on the Lower Explosive Limit (LEL) as determined by the Combustible Gas Indicator as follows:

LEL Reading	Action
<10% LEL	Continue operations
10% - 20% LEL	Continuous Monitoring
>20% LEL	Shutdown Operations and evaluate source, ventilate

For excavation operations, a CGI with a remote sensing head should be used. The sensing head should be attached to the excavator arm near the bucket, and the cable run back along the arm to the CGI located in the excavator cab. This will permit the operator to be alerted to hazardous situations without requiring personnel to stand at the working face to monitor.

Fire suppression equipment (Two 20-pound ABC fire extinguishers or fire hoses) is to be present at all times during operation of drilling or excavation equipment in areas where fire potential exists.

7.4 RADIOLOGICAL MONITORING

Due to the past activities and experiments that have been conducted at the site, and the current environmental restoration activities that will be performed during the RI/FS,

project personnel may be exposed to radioactive materials during invasive activities at the LEHR site. The radionuclides that may pose an internal or external radiation hazard depending upon their type, are discussed in Section 6.3. The Radiological Control Technician in conjunction with the Project Health Physicist will monitor the appropriateness of radiological protection requirements on a project or task-specific basis. Requirements have been defined as follows:

- Levels of protection and types of protective clothing required to minimize radiological hazards as specified in Chapter 8.

- Radiological training and certification as specified in Chapter 13.

- Radiation detection instrumentation as indicated in Section 7.4.

- External radiation dosimetry as specified in Section 7.4.1.1.

- Internal radiation dosimetry or bioassay as specified in Section 7.4.4.

- Surficial contamination monitoring of equipment, personnel, field samples, drums, etc. as specified in Radiological Operating Procedure 22.0 located in Appendix A of the Work Plan.

- External radiation monitoring of work areas, drums, equipment, field samples, etc., using hand-held instrumentation as specified in Section 7.4.1.2.

- Air monitoring to determine the levels of airborne radioactive materials for workers and the public as specified in Section 7.4.3.

- Engineering controls to reduce levels of airborne radioactive materials as discussed in Section 7.4.3.

- Data logging as specified in Section 7.6.

The various radiological protection aspects are defined by applicable provisions of the LEHR Rad Con Manual, which are more restrictive than federal and state radiation protection/control regulations.

All radiological instrumentation and equipment will be source and performance checked daily for proper performance and "wear and tear" prior to the initiation of work activities. These instruments will also be spot checked during the work activities for proper performance. Usage, maintenance, and calibration checks of radiological detection equipment may only be performed by experienced radiological technicians or health physicists. Radiation detection instrumentation must be calibrated every twelve months.

Field logs and records of worker dosage, air monitoring, external radiation surveys, and equipment calibration/calibration checks will be maintained by the RCT. Dosimetry results will be kept for each radiation worker in accordance with Chapter 5, "Radiological Support Operations" of the LEHR Rad Con Manual. Accumulated internal/external exposures will be reported annually to the worker. This activity will be coordinated through the UC Davis Health and Safety Office (HSO).

The Radiological Control Technician with direction from the Project Health Physicist will conduct monitoring for radiological hazards, as required. The monitoring program will consist of four components:

- Direct Exposure Controls
- Area Radiation Surveys
- Ambient Air Monitoring
- Bioassay Program

Each component will be discussed in the following sections.

7.4.1 Direct Exposure Controls

7.4.1.1 Personnel Dosimetry

All personnel participating in ~~prolonged~~ work activities at the site (as determined by the RCT or SSO) will be required to wear dosimetry devices (TLD badges) supplied by a NVLAP-accredited dosimetry service through the University of California-Davis at all times while onsite. These devices will measure radiation exposure to penetrating radiation. The devices shall be worn between the waist and the neck facing forward. If the badge is lost or damaged in any way, the RCT or the SSO and the UC Davis HSO shall be notified immediately.

As personnel exit the work site each day, the dosimeters will be placed in a controlled location to guard against loss, damage, and inadvertent radiation exposure above background. It will be the responsibility of the RCT in conjunction with the SSO to see that all personnel are using their TLD badge properly and to maintain accountability of all assigned devices and records generated as a result of use.

7.4.1.2 Monitoring During Soil and Solid Waste Handling Activities

Results of previously collected gamma survey data and radiological analyses of the work areas shall be reviewed by the PM, RCT, and PHP prior to initiation of any soil handling activities.

Soil Sampling (Subsurface)

The Radiological Control Technician will perform radiation surveys of soil and soil samples as they are removed from the boreholes. As soil is withdrawn, a calibrated Ludlum Model 12s μR meter or equivalent instrument will be used to survey soil. If elevated readings occur (>5

mR/hour at 30 cm) appropriate time, distance, and shielding techniques must be implemented. The area will be posted as a Radiation Area per the LEHR Rad Con Manual. The RCT must also be notified at the earliest convenient time as to the location and description of the soil conditions. The results of each survey shall be recorded on a survey form and identified by borehole location and identifier. If readings are below 5 mR/hour but greater than background where the workers are exposed, which is likely for the majority of sampling, the RCT will perform a surface contamination survey using a calibrated GM-type detector as needed. This technique will also be applied using a "hardwall" GM tube on a three meter cord for down hole radiation screening measurements (indication only). The results of these surveys shall also be documented on the survey form designed for this purpose.

Soil Sampling (Surface)

When surface soil samples are to be collected, a surface scan will be performed using a calibrated survey instrument set in the lowest range. The Bicron Fibler instrument may be utilized following the radiological Standard Operating Procedure (SOP) 22.0 located in Appendix A of the Work Plan. Generally, these measurements will be performed as part of the survey to define sampling locations. The results of this survey shall be documented on the survey form.

Soil Excavation

Soil excavation or movement activities involving heavy equipment will be periodically monitored for external exposure levels at the location of the equipment operator and any ground-based personnel working on this activity. Exposure levels in excess of background will require evaluation, in excess of 5 mR/hr will require posting by the RCT before work continuation.

7.4.2 Area Radiation Survey

7.4.2.1 Background Readings

The normal background for gamma radiation in the California area is approximately 5 to 15 μR/hour on a gamma survey instrument designed to read at that low level. It may be necessary to leave the area in order to obtain a background reading. When a reading greater than 20 μR/hour is encountered, the RCT should notify the PHP, LEHR Rad Con Manager and PM.

7.4.2.2 Low-Level Gamma Radiation Surveys

A gamma radiation survey of the site may be required. This survey will be conducted in accordance with the Investigation Contractor's Standard Operating Procedure 22.0 and 23.0 located in Appendix A of the Work Plan. These procedures specify equipment and measurement protocols to be used during both the radiation survey as well as during sampling activities as determined by the RCT and PHP.

Following the movement of soil piles, or the addition of drummed materials or soils to existing soil piles, an area radiation survey will be performed in the vicinity of the pile to provide a characterization of the radiation levels resulting from the material.

7.4.3 Ambient Air Monitoring

An air sampling program will be conducted during any material movement operations that have the potential for radionuclides to become airborne at concentrations above applicable guidelines and will continue until the operations are completed. High volume grab-air samples will be used for area monitoring downwind of the work area in order to establish the concentration of airborne radioactive particulates and the need for respiratory protection. Concentrations in

excess of 10% of the DAC will require the use of respiratory protection and posting as an Airborne Contamination Area.

In all air sampling operations, it will be necessary to correct for background radon progeny collected during air sampling. Correction will be directed by the RCT or PHP, and may include upwind background sampling, 24 hour sample decay, or shorter sample decay with appropriate correction factor application.

Baseline air monitoring will be audited at the LEHR site as described in Chapter 7 of the RI/FS Work Plan.

Soil Sampling (Subsurface)

During initial drilling and soil sampling activities, high volume air samples will be collected to monitor for the presence of airborne activity. Once a baseline has been established, the need for continuous or additional air monitoring for each investigation area will be under the discretion of the RCT and PHP.

Soil Sampling (Surface)

Air sampling for radioactive materials is not generally required during surface soil sampling activities, unless dusty conditions are encountered. Dusty conditions can be avoided by thoroughly wetting the soil to be collected. Personnel must wear eye protection if dusty conditions are present. The RCT or PHP will determine if respiratory protection is needed based upon air monitoring results.

7.4.4 Bioassay Program

Bioassay monitoring will be performed for employees working at the LEHR site. Routine bioassay monitoring of radiation workers is performed to detect intakes of radioactive materials that may otherwise go undetected through the processes of workplace and personnel contamination monitoring. The data derived

from this program can also be used to verify the integrity of radioactive containments and the effectiveness of contamination control programs.

Routine bioassay monitoring will include:

- Baseline measurements, interim monitoring, and exit monitoring.
- Bioassay, which entails analysis for radionuclides in the excreta (urine and feces) or in the mucus or sputum (nasal/mouth smears).

All site personnel who perform work with materials that are potentially contaminated with radionuclides at the LEHR site will participate in the Investigation Contractor's bioassay program. Specific details regarding this program are included in Attachment P.

7.5 BACKGROUND READINGS

All direct-reading instrument readings for non-radiological instruments will be evaluated relative to background readings, not "meter zero". Prior to the start of work at each shift, and whenever there is a significant shift in wind direction, instrument readings will be obtained upwind of the site work zone in order to determine the level of "background" readings from local vehicle traffic, emissions from nearby operations unrelated to the site, etc. Site readings will be evaluated against these background readings (i.e., if an action level is listed as 20 ppm, it is evaluated as 20 ppm above background).

7.6 DATA LOGGING

All exposure monitoring data, including background readings, will be logged in the field log book. The results of daily instrument calibrations can either be logged on the form provided in Attachment I or in the field log book. All organic vapor monitoring instruments will be calibrated, and all radiological instruments will be source checked in accordance with the manufacturer's instructions, prior to the start of each shift. (Guidance for the proper operation of the organic vapor analyzer and photoionization detector can be found in Attachment J). Calibration should also be performed when inconsistent or erratic readings are obtained. If an instrument cannot be calibrated to specification, or becomes otherwise inoperable, all site work will cease until the instrument is appropriately repaired or replaced; the PM, PHSM or HSP Preparer should be contacted for further guidance.

7.7 ACCESS TO RADIOLOGICAL MONITORING RECORDS

All personal radiological monitoring results associated with the TLD badges issued by UC Davis will be maintained by the UC Davis Environmental Health and Safety (UC Davis EH&S) office as required under DOE 1324.2A and DOE 5480.11. All records will be retained for a minimum of 30 years past the last date of employment. Upon request, personnel will receive a current radiation dose record from the UC Davis EH&S office. Upon termination, employees will receive a report, within 90 days of the last date of employment, that summarizes radiation dose for the total period of employment at the reporting facility. In addition, the UC Davis EH&S office will make all dosimetry records available to the Project Health Physicist for radiation protection program evaluation purposes.

7.8 DUST CONTROL

If site operations generate sustained visible dust, a water mist will be applied to reduce dust generation If the mist is not effective in reducing dust generation, personnel will don respirators (half-face or full-face as appropriate for analyzer readings) with

combination organic vapor-HEPA cartridges (such as MSA's GMC-H cartridges). Foam suppressants can also be used to suppress dust and vapor emissions at the site.

The sand and portland cement which may be used in groundwater monitoring well construction may contain free silica (quartz). Airborne exposure to silica dust may occur during handling of these materials. Half-face respirators with HEPA cartridges should be worn for those sand and cement handling operations where there is a reasonable possibility for exposure to sustained airborne dust from the pouring and mixing of dry sand or cement.

8.0 PERSONAL PROTECTIVE EQUIPMENT

8.1 INTRODUCTION

The purpose of personal protective equipment (PPE) is to shield individuals from the chemical and radiological hazards that may be encountered during site work. This chapter discusses the types of PPE that will be utilized during this investigation.

8.2 PERSONAL PROTECTIVE EQUIPMENT STANDARDS

Some pieces of protective equipment such as hardhats, boots, safety glasses, and respirators have specific standards for manufacture and only those items meeting these standards should be used. However, there are no such standards for much of the chemical protective clothing used for field activities, and selections must be based upon experience, manufacturer's information, and reports in the literature. The following requirements pertain to the more common types of PPE.

8.2.1 Eye Protection

If work tasks are performed that can potentially harm the eyes, operations that may involve splashing, release of projectiles, or release of sufficient vapors or dusts as to cause an eye irritation problem, eye protection shall be worn. In general, eye protection will be worn at all times while working in the exclusion, contamination reduction, and support zones at the LEHR site. When working conditions require the use of a full-face respirator, the respirator provides protection for the eyes and face. However, if respiratory protection is not required, then safety glasses with side shields will be used to provide eye protection. Safety goggles or a combination of safety glasses and faceshield is preferable for liquid hazards.

Common prescription glasses are sometimes called "safety glasses," but they are not the industrial quality glasses required by the current standard, ANSI Z87.1. Non-safety prescription eyeglasses are not permitted for use as eye protection at the LEHR site. Non-safety prescription eyeglasses may be used only if covered with safety goggles or a face shield. Prescription eyeglass inserts may be worn under a full-face respirator. If prescription safety glasses are required, the cost of the frames and lenses should be reimbursable under the employer's health and safety program. The cost of the eye examination is usually borne by the employee or the employee's medical plan. Individuals whose vision is not correctable with prescription eyeglasses are handled on a case-by-case basis. These individuals should contact the PHSM or SSA for further guidance.

Contact lenses shall not be worn: (1) in the exclusion zone or contamination reduction zone; (2) in conjunction with respiratory protection; or, (3) in areas and operations with potential for contact with eye irritants. Contact lenses may be worn for administrative activities in the support zone, providing that the activities preclude contact with site contaminants.

8.2.2 Hearing Protection

Ear plugs or muffs will be worn by personnel who are required to perform tasks around backhoes, tractors, compactors, heavy machinery, compressors, impact tools, and similar equipment which produce high noise levels. The requirements of the Cal/OSHA noise standard must be followed, especially in the case of long-term site activities in high noise areas. Ear protection must comply with Cal/OSHA 8 CCR 5095. Individuals who are required to wear hearing protection will be trained on their proper use, fitting and care. In addition, good personal hygiene will be practiced to avoid initiating ear infections and because of the increased potential of chemical constituents being introduced into the ear.

8.2.3 Foot Protection

Foot protection, including leather work boots and chemical resistant boots, worn during site activities must meet the specifications of ANSI Z41-1983 and Cal/OSHA 8 CCR 3385. The material used to make the boots is not subject to any standards. For field activities at this site, the boots must have steel toes and shanks and be constructed of a chemically protective material.

8.2.4 Hand Protection

Gloves must resist puncturing and tearing as well as provide the necessary chemical resistance. In many instances, particularly when protecting against concentrated source materials, gloves may have to be layered. In this case, gloves are referred to as "inner" gloves, and "outer" gloves. Heavy leather gloves may be worn over chemical protective gloves when doing heavy work which could tear the chemical glove. If they become contaminated, leather gloves should be discarded because leather is difficult to decontaminate.

Gloves are a primary means to prevent radiological skin contaminations, which occur most often on the extremities. Special attention will be paid to proper attire, and dress/undress procedures, as they pertain to gloves, to prevent skin contaminations.

8.2.5 Taping of Joints

Boots and gloves are generally taped to the protective garment in order to reduce the possibility of contaminants flowing into them. Duct tape is used in most instances. However, the taped joint is not a chemical barrier. The rule of taping is that the protective garment is taped over the glove or boot so that contaminants do not flow in. However, if a significant amount of "over the head" work will be done,

consider taping the glove over the garment sleeve. Glove selection for specific tasks will be performed by the SSA or PHSM. Taping is also important for preventing the entry of ticks into clothing.

8.2.6 Head Protection

The hardhat, a basic piece of safety equipment used in many work operations, must meet ANSI Z89.1-1969 and Cal/OSHA 8 CCR 3381 specifications. Manufacturers have adapted hardhats so that ear protection and faceshields may be easily attached. Hardhats are adjustable so that a helmet liner can be worn during cold-weather. A chin strap is advantageous when work involves bending and ducking. It also helps secure the hardhat to the head when full-face respirators are worn.

Faceshields that attach to hardhats provide added protection. A combination that leaves no gap between the shield and the brim of the cap is best because it prevents overhead splashes from running down inside the faceshield. The faceshield must meet ANSI Z89.1-1968 specifications.

Hardhats are to be worn at all times while in the exclusion, contamination reduction, or support zones at the LEHR site, except when indoors.

8.3 RESPIRATORY PROTECTION

8.3.1 Medical Condition

The use of any type of respirator will impose some physiological stress on the user. For example:

- Air-purifying respirators make breathing more difficult because the filter or cartridge impedes the flow of air.

- The special exhalation valve on an open circuit pressure demand respirator requires the wearer to exhale against some resistance.

- The bulk and weight of an SCBA can be a burden.

- If the wearer is using an airline respirator, they might have to drag up to 300 feet of hose around.

All these factors can significantly increase the employee's workload, and wearers shall have medical examinations to determine if they are medically able to wear respiratory protective equipment without aggravating preexisting medical problems.

8.3.2 Respirator Fit Testing

Fit testing is required by OSHA and ANSI. Each respirator user shall undergo a qualitative or quantitative fit test before working at the LEHR site. All subcontractors are required to have a current fit test before proceeding to the LEHR site. The SSO will receive a copy of all fit test records before site personnel are allowed in the exclusion zone.

Fit testing is required for the use of all air-purifying respirators, fit testing is not required for the use of positive-pressure air line respirators. The following policies shall be observed in the fitting and use of all air-purifying respirators:

- Fit tests will be repeated at least annually.

- Personnel shall be allowed to use only the specific make(s), model(s) and size of air purifying respirators for which the person has obtained a satisfactory fit verified through fit testing procedures.

- The Site Safety Officer will keep records of the make, model, size, and type of respirator each onsite employee has been fit tested with. The record must include the date and signature of the person performing the test.

- No facial hair or glasses are allowed that will interfere with the attainment of a good seal. Limited facial hair, such as regulation-military moustaches, that does not interfere with a good facepiece-to-face seal may be permissible. However, beards, even a one day growth of facial hair, are not permitted for personnel who will work in the Exclusion Zone or Contamination Reduction Zone.

- Contractors will provide their personnel requiring glasses with special glasses that mount inside the full face mask. Under no circumstances will contact lenses be worn while using any type of respirator.

- If it is found that an employee cannot obtain a good facepiece-to-face seal because of facial features or medical factors, respirators shall not be used and the employee shall not enter an atmosphere requiring the use of respirators.

- After donning an air-purifying respirator, a positive and negative fit test must be performed.

8.3.3 Training

Although equipment selection is important to the success of a respiratory protection program, the proper use of the equipment is equally important. Proper use can be ensured by carefully training employees in the selection, use, and maintenance c the provided respiratory equipment. Respiratory protection training is a part of the initial and annual refresher training for hazardous waste site workers

required under Cal/OSHA standard 8 CCR 5192 for Hazardous Waste Site Operations.

8.4 SELECTION OF PERSONAL PROTECTIVE EQUIPMENT

The selection of the types of PPE to be used at the LEHR Site are based upon the most current data available concerning the chemical constituents and radioactive materials found at the site, their concentrations, their chemical and physical properties and the site activities. The general levels of protection assigned to task-specific activities have also been selected on best available data. The PPE level may vary with the scheduled activities or from activity to activity within a specific project task, based upon the work involved and any updated information made available during the project. Based upon the information available, the following types of PPE will be used throughout the project.

Minimum protective equipment for site personnel working within the exclusion and/or contamination reduction zones:

- Hardhat
- Safety glasses
- Chemical-resistant steel-toed boots
- Canvas gloves
- Boot covers
- Tyvek® coveralls

Wrists and ankles of coveralls are to be taped.

Where chemical contact can be reasonably expected such as during sampling of suspected chemically contaminated soils, add:

- Nitrile gloves
- Surgical latex or vinyl gloves (inner)

Dosimetry badges shall be worn in all areas until the presence of radiological contaminants has been ruled out.

If OVA readings in OBZ are greater than 5 ppm, on average, for more than one minute, or if the Drager chloroform tube indicates the presence of chloroform, add:

- Half-face respirator with organic vapor/HEPA cartridges
- Poly-coated Tyvek® in place of Tyvek® coveralls

If OVA readings in OBZ greater than 10 ppm, on average, for more than one minute, or personal monitoring indicates chloroform levels above 5 ppm, or measured radionuclides are 10% of a DAC or greater, add:

- Full-face respirator with organic vapor/HEPA cartridges

Full face respirators with organic vapor/acid gas/ HEPA cartridges are required for the excavation operations described in Section 6.9.1; 5-minute escape respirators are also required for this activity.

If there is potential for liquid contact during sampling activities or if airborne radiological contamination in excess of 10% of the DAC is present:

- Use poly-coated Tyvek® coveralls in place of uncoated Tyvek®

8.5 LIMITATIONS OF PROTECTIVE CLOTHING

The protective equipment ensembles selected for this project are anticipated to provide protection against the types and concentrations of hazardous materials that may potentially be encountered during field operations. However, no protective garment, glove or boot is resistant to all chemicals at any concentration; in fact, chemicals may continue to permeate or degrade a garment even after the source of contamination is removed.

In order to obtain optimum usage from PPE, the following procedures are to be followed by all project personnel:

- When using disposable coveralls, don a clean, new garment after each rest break where the worker has left the work area, or at the beginning of each work shift.

- Inspect all clothing, gloves and boots both prior to and during use for:

  - Imperfect seams
  - Non-uniform coatings
  - Tears
  - Poorly functioning closures

- Inspect respirator both prior to and after use as described in Attachment M - Respirator Inspection Procedures.

- Inspect reusable garments, boots and gloves both prior to and during use for:

  - Visible signs of chemical permeation such as swelling, discoloration, stiffness or brittleness

- Cracks or any signs of puncture or abrasion

Any reusable garments exhibiting any such characteristics will be discarded.

8.6 DURATION OF WORK TASKS

The duration of work tasks in which personnel use PPE ensembles that include chemical protective clothing (including uncoated Tyvek®) will be established by the SSO. Variables to be considered include ambient temperature and other weather conditions, the capacity of individual personnel to work in the required level of PPE in heat and cold, and the limitations of specific PPE ensembles. The minimum rest breaks are as follows:

- Fifteen minutes midway between shift startup and lunch
- Lunch break (30 to 60 minutes)
- Fifteen minutes midway between lunch and shift end

Additional rest breaks will be determined through heat or cold stress monitoring as described in Section 6.1.

Rest breaks are to be taken in the support zone or other clean area after personnel have completed the decontamination process, including soap and water wash of hands and face.

9.0 SITE CONTROL

9.1 WORK ZONES

Work zones must be established during all invasive site activities as described below. These work zones will also provide for Controlled Areas for radiation protection should work areas meet any of the following conditions:

- The estimated gamma ray exposure rate to any individual in a work area meets or exceeds 5 mrem in an hour as a result of work activities.

- Airborne concentrations of radionuclides exceed 10% of the DAC identified in DOE order 5480.11.

Controlled areas must be conspicuously marked at points of potential access with appropriate signs according to applicable posting and labeling requirements set forth in 10 CFR 20 and the LEHR Rad Con Manual.

- Exclusion Zone/Contaminated Area - a 25 foot (as practical) circle around the work area will be defined before work starts. Barricades and barricade tape should be used to delineate the exclusion zone. A short piece of barricade tape can be affixed to a secure upright to serve as a wind-direction tell-tale. The encircled area will constitute the "Exclusion Zone". This zone is where potentially hazardous contaminants and physical hazards to the workers will be contained. Personal protective equipment as described in Section 8.4 will be required in this area. Plastic sheeting (visqueen) and/or tarps may be used as necessary to control soil spilled to the ground during drilling and excavation operations. The size of the Exclusion Zone may be altered to accommodate site conditions and to ensure contaminant containment.

- Radiological Buffer Zone (RBZ)/Contamination Reduction Zone (CRZ) - a corridor leading from the Exclusion Zone to the Support Zone will be defined. The corridor shall be located upwind from the work area. All entry to and exit from the Exclusion Zone will be made through this corridor in order to control potential sources of contamination and leave contaminated soil and debris in the work area. All decontamination activities will occur in the RBZ/CRZ. An equipment decontamination area equipped with an equipment decontamination pad will be provided in the RBZ/CRZ as outlined Section 10.6.1. A waste container will be placed at the end of the corridor so contaminated disposal equipment can be placed inside and covered. Surface/soil contamination in this area should be controlled using plastic sheeting. Site personnel will not be permitted into the RBZ/CRZ or Exclusion Zone unless they are in full compliance with the requirements of this Plan.

- Support Zone (SZ) - a Support Zone, the outermost part of the site, must be defined for each field activity. Support equipment is located in this uncontaminated or clean area. Normal work clothes are appropriate within this zone. The location of this zone depends on factors such as accessibility, wind direction (upwind of work area), and resources (i.e., roads, shelter, utilities).

9.2 POSTING REQUIREMENTS

Radiological posting shall be used to alert personnel to the presence of radiation and radioactive materials and to aid them in minimizing exposures and preventing the spread of contamination. The LEHR Rad Con Manual requires the following posting requirements to be followed at the LEHR site:

- Radiological postings shall be displayed to present actual or potential radiological conditions.

- Signs shall be maintained in legible condition and updated based upon results of the most recent surveys.

- If more than one radiological condition exists in the same area, each condition shall be posted.

- In areas of ongoing work activities, the dose rate and contamination level or range of each should be included on or in conjunction with each posting as applicable.

- Entrance points to areas of ongoing work activities controlled for radiological purposes shall state basic entry requirements, such as if dosimetry or respiratory protection is required for entrance into the area.

- Plastic barrier tape will be used to designate the boundaries of posted areas and shall be placed so that they are clearly visible from all directions and at various elevations. These barriers shall have magenta lettering with a yellow background and shall be set up so as to not impede the intended use of emergency exits or evacuation routes.

- Work areas set up for the purpose of obtaining soil samples may require a clear delineation (as determined by the SSO or RCT) with warning signs stating "Authorized Personnel Only." All necessary radiological posting and labeling shall be in accordance with the LEHR Rad Con Manual.

The following signs will be posted at the site as required:

- Controlled Area;
- Underground Radioactive Material;
- Caution, Radioactive Material;
- Contamination Area;

- Radioactive Buffer Zone;
- Radiation Area;
- Caution; and
- Authorized Personnel Only.

All radiological signs will be readable from 25 feet, have magenta lettering with a yellow background, and be metal backed and enamel painted. Additional information and guidance regarding the use of signs at the LEHR site can be found in Part 3, Article 231-238 of the LEHR Radiological Control Manual.

In addition to signs that warn of radioactive material, a sign that describes workers responsibilities at the site will be posted at the entrance of all work areas. Information regarding sign contents is located in Part 2, Article 123 of the LEHR Rad Con Manual.

9.2.1 Posting Controlled Areas

Areas within the site boundary will be clearly posted to alert personnel to the presence of radiation and radioactive materials above natural background levels. These areas shall be designated Controlled Areas. Persons who enter only the Controlled Area without entering Radiation, Contamination, Airborne Radioactivity or Radiological Buffer Areas are not expected to receive an exposure of more than 100 mrem per ~~in a~~ year.

9.2.2 Posting Radiological Buffer Areas

A Radiological Buffer Area shall be established within the Controlled Area to provide a second boundary to minimize the spread of contamination. The Radiological Buffer Area is intended for use where ongoing work activities may create an airborne radioactivity hazard or the spread of contamination.

9.2.3 Posting Radiation Areas

All radiation areas shall be posted to alert personnel of the presence of external radiation in accordance with Table 6-3 and Article 231 of the LEHR Rad Con Manual. Underground radioactive materials shall also be posted as outlined in Article 237 of the LEHR Rad Con Manual. When posting an area along a fence line, signs will be placed every ~~50~~ 40 feet as appropriate.

9.2.4 Posting Non-Radiological Hazards

In addition to posting requirements for radiological hazards, the work area will also be posted with "Hearing Protection Required" signs if noise monitoring indicates that exposures to noise are above the Cal/OSHA Action Level of 85 dB. "Hard Hat Required" signs will also be posted at the entrance to all work areas where overhead hazards are present.

All other appropriate CAL/OSHA and Department of Labor posters will be posted in the job trailer before work activities commence.

9.2.5 Labeling

All drums and containers of soil, water, and waste material generated by contractor personnel will be labeled. All drums and containers will be handled and labelled in accordance with EPA, DOT, and other relevant regulations.

9.3 GENERAL SITE CONTROL REQUIREMENTS

At the end of the shift, all borings/sampling holes and excavations must be covered or otherwise secured. All cuttings and decontamination fluids are to be handled in accordance with relevant regulations and instructions from the PM.

The PM or SSO will determine an upwind evacuation area prior to each shift and any time the wind changes direction, and all personnel will be notified of its location. A horn or other signalling device will be used to signal an evacuation in the event of an emergency. Three blasts of the horn will be the signal to immediately stop work and proceed to the evacuation area.

The SSO will see that all site visitors sign the visitors' log and that all site personnel who enter the exclusion zone/work area do so only after presenting evidence (i.e., medical clearance form, training certificates, etc.) of both their participation in a medical surveillance program, bioassay program, and completion of health and safety training programs that fulfill the requirements of this plan.

The SSO will provide site hazard and emergency action information to all site visitors before they enter the site; this can be done by providing a copy of this HSP to the visitor.

9.4 CONTROL PROCEDURES FOR PERFORMANCE OF GAMMA SURVEYS

- Sampling operations will typically require the use of standard protective clothing and gear, as described in Section 8.2. Dust generated during each sampling operation will be visually evaluated by the RCT to define the need for respiratory protection.

- Personnel performing a surface gamma survey shall wear disposable plastic booties over their normal footwear in all areas which prior site surveys show levels of surface gamma to be above background.

- A single entry/exit (control) point shall be established for each area such that, prior to entry, all work personnel are checked by the SSO or RCT for proper protective clothing. Upon exiting, contaminated or suspected contaminated clothing will be properly labeled, removed, and placed in

proper waste receptacles, and all existing personnel will be surveyed for any possible contaminated material which may be present.

- Persons found to be contaminated shall be decontaminated per the guidance of NCRP Report Number 39 at a permanent station at the site specifically designed and equipped for that purpose. The levels and extent of the contamination will be documented in accordance with Chapter 5 of the LEHR Rad Con Manual. The results of any and all decontamination efforts shall also be documented.

  Decontamination efforts will assure that the whole body committed effective dose equivalent (CEDE) will not exceed 5 rem in any one year; that exposure to the lens of the eye will not exceed 15 rem in any one year; that exposure to the skin or any extremity (hands and arms below the elbow; feet and legs are below the knee) will not exceed 50 rem; and that total exposure for all other organs and/or tissues will not exceed 50 rem.

10.0 DECONTAMINATION PROCEDURES

10.1 CONTAMINATION PREVENTION

- Eating, drinking, smoking, application of cosmetics, and chewing tobacco or chewing gum are prohibited in the work area. These activities are permitted in the support zone only after monitoring and after the employees have removed their protective clothing and respirators and washed their hands and face.

- Disposable clothing, gloves, hard hats and respirators will be removed before leaving the work area, and an exit survey of all personnel will be performed by the Radiological Control Technician.

- Employees will not kneel or sit on the ground or on drums, containers or other potentially contaminated areas.

- Monitoring and sampling instruments will be covered with visqueen or a plastic bag prior to entering the exclusion zone to the maximum extent practical without interfering with the operation of the instrument. This is to protect the instrument from contamination to the maximum extent possible.

- Good housekeeping is of primary importance for an effective decontamination program and is enforced accordingly. Discarded equipment (i.e., gloves, rags, coveralls, etc.) will be disposed of in appropriate containers.

- Employees will not remove any contaminated clothing or equipment from the site.

- Torn or otherwise damaged protective clothing, gloves, rubber boots, safety glasses, and hard hats will be replaced immediately.

10.2 DECONTAMINATION AREA

- The decontamination area in the RBZ/CRZ shall be covered with plastic sheeting which shall be replaced when torn or heavily soiled, and at the end of each shift. A schematic of a "Minimum Layout of Personnel Decontamination Station" is provided in Attachment D.

- All spent decontamination fluids (wash and rinse waters) will be handled as hazardous waste until laboratory results indicate otherwise. Fluids will be placed in proper containers, such as 55 gallon, metal, DOT approved drums, and handled and labelled in accordance with OSHA (or State equivalent), EPA, DTSC, and DOT regulations.

- Disposable clothing, gloves and spent respirator cartridges will be disposed of after each work shift. All personal protective equipment to be disposed of that has been used in areas of suspected or detected radiological contamination will be monitored prior to disposal. Any contaminated PPE will be placed in a separate plastic bag from uncontaminated PPE, properly marked and kept separate from uncontaminated PPE. These items are to be placed in waste receptacles located inside the CRZ. Contaminated clothing will be disposed of in a manner consistent with NRC/State of California regulations for the level of surface contamination. These waste receptacles are to be emptied daily into hazardous waste containers for shipment to an approved landfill.

- Employees will use a clean respirator and fresh cartridges on each work shift. Employees will be responsible for the cleaning and maintaining their respirators as described in Attachment M.

- Used respirators, face shields, hardhats, safety glasses, etc. which have been surveyed as free from radiological contamination are to be cleaned by the employee at the end of each shift. Clean respirators are to be stored in respirator bags.

10.3 PERSONNEL DECONTAMINATION

- Remove all monitoring equipment, sample containers, and notes to the RBZ/CRZ.
- Remove hardhat (place in bin to be surveyed and decontaminated).
- Scrub boots, gloves, and protective suit with a stiff bristle brush and decontamination solution. Rinse with water. Washtubs and chairs will be provided.
- Remove tape from around wrist and ankles.
- Remove boot covers.
- Remove nitrile gloves or canvas gloves.
- Remove disposable coverall taking care not to touch the outside of the garment; discard in provided container.
- Remove eye protection (place in bin to be decontaminated).
- Remove respirator.
- Remove monitor badge and dosimeter.

- Remove inner surgical latex gloves; discard in provided container.

- Wash hands and face in soapy water and rinse with potable water.

- All personnel will then be monitored for radiological contamination by the RCT using a portable beta-gamma monitor. All contamination will be removed before release of the individual. If a skin contamination incident occurs, the RCT shall notify the SSO, PHP, and the PNL PM or LEHR Rad Con Manager as soon as practical. PNL will then notify the DOE Project Manager and the UC Davis Project Manager as soon as practical and report the occurrence in accordance with DOE 5000.3B. If a skin exposure occurs, the requirements outlined in Part 5, Article 541 of the LEHR Rad Con Manual will be implemented.

10.4 SANITATION

Potable water will be made available at the site, either from a pressurized source or commercially-available bottled water. Drinking cups will be supplied so personnel will neither drink directly from the source of water nor have to share drinking cups. Sources of non-potable water shall be clearly labeled as such.

Washing facilities will be provided on site, and will be located in the decontamination area or the support area. Soap, clean water, wash basins and single-use towels will be available for personnel use.

10.5 DECONTAMINATION-MEDICAL EMERGENCIES

In the event of physical injury or other serious medical concerns, immediate first-aid may be administered as needed in lieu of further decontamination efforts.

See Emergency Decontamination Chart in Attachment E for a decision tree for emergency decontamination.

10.6 EQUIPMENT DECONTAMINATION

10.6.1 Decontamination of Vehicles and Heavy Equipment

- Where it is likely that vehicles or heavy equipment has come in contact with contaminated material, such equipment will be decontaminated upon leaving the Exclusion Zone. As much mud, dirt, rocks, and so on, as possible will be mechanically removed from the tires, tracks, or outside of the equipment, prior to leaving the Exclusion Zone.

- Any equipment that is going to leave the site must first be driven to the equipment decontamination pad for a thorough decontamination. This decontamination pad will be constructed in the Cobalt-60 Field. The pad will be constructed in a manner that will permit all wash and rinse fluids to be contained and collected and the pad to be readily washed down to prevent a buildup of contaminated material; heavy gauge plastic sheeting and sandbags or a concrete pad can be used for this purpose, and a suction device used to collect liquids. A high pressure, high temperature steam cleaner may be used to wash down heavy equipment. The decontamination pad will be enclosed by portable/disposable curtains that are 10 meters long, 5 meters wide, and 4 meters high. Radiological calculations indicate that aerosols generated during decontamination procedures will not exceed personal exposure values, nor will this activity generate sufficient radioactive containing aerosols to adversely effect the nearest offsite receptor.

- All equipment will be monitored for fixed and removable radiological contamination. Decontamination will proceed until levels are below those indicated in Table 6-3.

- All swipe samples collected will be analyzed in the field and equipment will not be moved until it is analyzed clean. Swipe sample analysis will not detect tritium; however, equipment cleaned of other contaminants will also be cleaned of tritium. To confirm that tritium has been removed, several swipe samples should be sent to an offsite laboratory for analysis before equipment is removed from the site.

- All spent decontamination fluids or sludges (that is, rinse waters, mud slurries, and so on) will be handled as hazardous waste until laboratory results indicate otherwise. Fluids and sludges will be placed in proper containers (that is, 55 gallon drums, tanks, bins,) and handled and labelled in accordance with CAL/OSHA, NRC, DOE and LEHR Site Specific Radiation Control Manuals, EPA, and DOT regulations.

- Air filters shall be replaced prior to the equipment leaving the site. Spent air filters will be considered potentially contaminated and monitoring will be performed to assure contamination levels are below Table 6-3 values. All air filters will be disposed of as contaminated waste.

- Interiors of the vehicles and equipment will be thoroughly wet-wipe cleaned prior to leaving the site. Cleaning rags will be considered as potentially contaminated and disposed of in the proper manner.

- Following the washing, the equipment will be inspected by the SSO or his designee. Upon SSO approval, the equipment may be driven into

the support zone. Under no circumstances will heavy equipment be allowed to leave the site if it is not decontaminated.

- Heavy equipment will remain onsite until the end of the project. At project completion, equipment that is potentially contaminated with radiological agents will undergo stringent decontamination procedures. The equipment will then be surveyed for residual radioactive materials. If detectable contamination is found, equipment will not be allowed to leave the site until surveyed clean.

10.6.2 Decontamination of Tools

- When all work activities have been completed, contaminated tools (drill augers, hand trowels, shovels, etc.) shall be totally decontaminated. A job is NOT considered complete until the work area has been cleaned and all used material properly discarded and tools cleaned and properly stowed. Clean tools will be surveyed for radiological contamination before storage.

- It is expected that all tools will be constructed of non-porous, non-absorbent materials. This will aid the decontamination process. Any tool, or part of a tool, which is made of a porous/absorbent material (that is, wood or cloth) shall be discarded and disposed of as a hazardous waste if it cannot be properly decontaminated.

- Tools to be decontaminated will be placed on a decontamination pad or into a bucket and thoroughly washed using a soap solution and brushing or high pressure spray, followed by a water rinse. All visible particles should be removed before the tool is considered clean. If contaminants are not easily cleaned with water due to organic nature, a Hexane solution may be used.

10.6.3 Equipment Release Surveys and Criteria

- Prior to release for unrestricted use, all equipment and materials used in the contamination reduction and exclusion zones must be checked for radiological contamination. Equipment and materials are checked for removable contamination by counting 47mm or 1.75" diameter smears which are wiped over 100 cm^2 of the object being monitored. Equipment and materials are checked for fixed plus removable contamination using an alpha scintillation detector (for alpha radiation) and a Geiger-Mueller or organic scintillation detector (for beta and/or gamma radiation). Any detectable contamination that is greater than the limits specified in Table 6-3 must be removed or reduced to levels that are below the limits in Table 6-3. If some areas or surfaces of the equipment or materials are inaccessible, the SSO must approve the equipment or materials release based on the history of its use and the results of the work area monitoring. Surveys of all equipment and materials must be documented and maintained by the RCT.

- Table 6-3, taken from DOE N5480.6 Radiological Control Manual, defines the maximum allowable contamination limits for equipment, materials, and facilities.

11.0 SAFE WORK PRACTICES

11.1 GENERAL CONDITIONS

The following safe work practices will be observed by all personnel:

1. Eating, drinking, chewing gum, or tobacco and smoking are prohibited in the contaminated or potentially contaminated area or where the possibility for the transfer of contamination exists.

2. Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, or mud, etc. Avoid, whenever possible, kneeling on the ground, leaning or sitting on equipment or ground. Do not place monitoring equipment on potentially contaminated surfaces.

3. All field crew members should make use of all their senses to alert them to potentially dangerous situations in which they should not become involved. This includes the presence of strong, irritating or nauseating odors.

4. To the extent possible, prevent spillages of potentially contaminated or contaminated soil, groundwater or other materials onto clean surfaces. In the event that a spillage occurs, contain liquid or solid material, clean up the spill (if appropriate), and notify the SSO, RCT, and LEHR Rad Con Manager as soon as possible.

5. Prevent splashing of the contaminated materials.

6. Field crew members shall be familiar with the physical characteristics of investigations, including:

   - Wind direction in relation to contaminated working area;
   - Accessibility to other personnel, equipment, vehicles;
   - Communications;
   - Areas of known or suspected contamination;
   - Site access; and
   - Nearest water sources.

7. The number of personnel and equipment in the contaminated area should be minimized but only to the extent consistent with workforce requirements of safe site operations.

8. All wastes generated during site activities at the site will be disposed of as directed by the PM, PNL Project Manager, and the UC Davis Project Manager.

9. All personal protective equipment will be used as specified and required in Section 8.4.

11.2 SAMPLING PRACTICES

For all sampling activities, the following standard safety procedures shall be employed:

1. All sampling equipment should be cleaned before proceeding to the site.

2. At the sampling site, sampling equipment should be cleaned after each use.

3. Work in "cleaner" areas should be conducted first where practical.

4. All unauthorized personnel will remain outside exclusion zones at all times.

11.3 HEALTH AND SAFETY EQUIPMENT LIST

The following equipment list reflects the types of equipment that will be used and implemented over the life of the HSP. This list serves as a starting point for the SSO and RCT as they prepare for each phase of the work. The equipment listed below will be available during site activities.

Hardhats
Safety glasses
Ear plugs or muffs
Tyvek® and polycoated Tyvek® coveralls
Chemical resistant steel-toed boots
Work gloves
Canvas gloves
Nitrile gloves
Surgical vinyl inner gloves
Latex rubber gloves
Duct tape
Plastic sheeting (visqueen)
55 gal 17-H drums (for contaminated solids) and 17-E drums (for liquids)
Drum liners
Radiological control signs
Barricade tape and barricades
Wash tubs and scrub brushes
Decon solution (i.e., TSP)
Garden sprayer
Folding chairs
5 or 10 gal (15 minute) portable eyewash
Respirator sanitizing equipment

Compressed gas horn
First Aid kit
Drinking water
Gatorade or similar drink
Type ABC fire extinguishers
Half-face and full-face respirators (NIOSH/MSHA approved)
Organic vapor/HEPA cartridges
Organic vapor/acid gas/HEPA cartridges
5-minute escape respirators
Organic Vapor Analyzer (OVA) (or Photoionization Detector (PID) with > 11.5 eV lamp) and calibration kit
Sound Level Meter
Alpha scintillation detector/instruments (with detection limits ≤ 50 CPM)
Geiger-Mueller detector/instruments (with detection limits ≤ 100 CPM)
Micro-R meters (with detection limits ≤ 0.2 mR/hr)
Alpha sample (≈ 2" diameter) counter/instruments
Wipe smears (1.75" dia)
Thermoluminescent dosimeters or equivalent
High/low volume area air samplers and media
Personal air samplers and 100/50 coconut shell charcoal sampling tubes
Sampling pump calibration equipment
Drager pump and Chloroform 2/A tubes
Site Communication Equipment

12.0 EMERGENCY RESPONSE PLAN

It is the Investigation Contractor's policy to evacuate personnel from areas involved in hazardous material emergencies and to summon outside assistance from agencies with personnel trained to deal with the specific emergency. This chapter outlines the procedures to be followed by contractor personnel in the event of a site emergency. These procedures are to be reviewed prior to the commencement of site work in a site wide safety meeting (including DOE and UC Davis personnel). In addition, emergency procedures will be reviewed during the daily onsite safety briefings conducted by the SSO.

In the event of a fire or medical emergency, the following numbers can be called for assistance:

Fire: 911
Ambulance: 911
Police: 911
Hospital: Sutter-Davis Hospital **(For Non-Radiological Emergencies)**
25665 County Road 99
Davis, California
756-6440

Hospital: U.C. Davis Medical Center **(For Radiological Emergencies)**
2315 Stockton Blvd.
Sacramento, California
453-3096

Directions to Sutter-Davis Hospital from the LEHR Site **(Non-Rad Emergencies)**

To reach Sutter-Davis Hospital from the LEHR site, travel north from on Old Davis Road, under I-80, and turn left on the transition road to Highway 113-North. Proceed

north on 113 to the third off-ramp, which is Covell Boulevard. Turn left (west) on Covell and proceed for one mile to County Road 99. Turn right (north) on County Road 99 and proceed for one block to the hospital, which is located on the right.

Directions to the Sutter-Davis Hospital from Offsite Locations **(Non-Rad Emergencies)**

The hospital route listed above will also apply for work being conducted in the off-site locations. Currently, it is anticipated that all off-site locations are located in the fields that surround the LEHR site.

Directions to U.C. Davis Medical Center from the LEHR Site **(Rad Emergencies)**

To reach U.C. Davis Medical Center for the site, travel north on Old Davis Road to I-80 East. Turn right (east) onto I-80 and proceed toward Sacramento. After passing the Business 80 and 99 interchange, take the 34th Street exit south. Turn right on 34th Street and proceed to "Y" Street. Turn left (east on "Y" Street and proceed to Stockton Blvd. Turn left (north) on Stockton Blvd. and the hospital is located on the right side of the street at 2315 Stockton Blvd.

Directions to U.C. Davis Medical Center from Offsite Locations **(Rad Emergencies)**

The hospital route listed above will also apply for work being conducted in the off-site locations. Currently, it is anticipated that all off-site locations are located in the fields that surround the LEHR site.

Additional contacts in case of site emergency including medical emergencies, radiological emergencies, and spills or releases are as follow:

Joseph Niland, R.G. Dames & Moore Project Manager	(916) 387-7513 (w) (916) 391-1272 (h)
John Danby, CIH Dames & Moore Health and Safety Manager	(916) 387-7554 (w) (916) 351-1526 (h)
Patricia Facino, CIH Dames & Moore Site Safety Auditor	(916) 387-7567 (w) (916) 858-1368 (h)
Fred Duncan, CIH, CHP Dames & Moore Certified Health Physicist	(303) 299-7835 (w) (303) 666-8217 (h)
California Department of Health Services Radiological Health Branch	(916) 445-0931
Dawn Mitchell Radiological Control Manager	(916) 752-4023
Patrice Rodgers U.C. Davis - Environmental Health and Safety Officer	(916) 752-1348

12.1 PLACES OF REFUGE

In the event of a site emergency requiring evacuation, all personnel will evacuate to a pre-designated area located a safe distance from any health or safety hazard and safely away from the area of influence. The SSO will designate a primary assembly area prior to the start of work each day. The daily pre-designated assembly area may have to be re-designated by the SSO in the event of an emergency where the area of influence affects

the primary assembly area. Once assembled, the SSO shall take a head count. The SSO will evaluate the assembly area to determine if the area is outside the influence of the situation; if not, the SSO will redirect the group to a new assembly area where a new head count will be taken.

During any site evacuation, all employees shall be instructed to observe wind direction indicators. During evacuation, employees will be instructed to travel upwind or crosswind of the area of influence. The SSO will provide specific evacuation instructions, via the site emergency radio if necessary, to site personnel regarding the actual site conditions. In the event of an emergency, consult the Emergency Response Procedures chart located in Attachment F for information concerning the preparation, response, and follow-up activities associated with an emergency situation.

12.2 COMMUNICATION

A communication network must be set up to alert site personnel of emergencies and to summon outside emergency assistance. Where voice communication is not feasible an alarm system (i.e., sirens, horns, etc.) should be set up to alert employees of emergencies. Radio communication may also be used to communicate with personnel in the exclusion zone. Where phone service is not readily available, radios or portable phones should be used to communicate with outside agencies. Site personnel shall be trained on the use of the site emergency communication network. Emergency phone numbers should be posted at the phone or radio used for outside communication. The SSO is responsible for establishing the communication network prior to the start of work, and for explaining it to all site personnel during the site safety briefing.

The following hand signals will be used by personnel in the event of an emergency:

Signal	Definition
Hands clutching throat	Out of air/can't breathe
Hands on top of head	Need assistance
Thumbs up	OK/I'm alright/I understand
Thumbs down	No/negative
Arms waving upright	Send backup support
Grip partner's wrist	Exit area immediately

12.3 EMERGENCY RESPONSE TEAM PROCEDURES

The emergency response team will consist of employees who assume the following roles:

- Emergency Care Provider/s

Provide first aid/CPR as needed.

- Communicator

The role of the communicator is to maintain contact with appropriate emergency services, providing as much information as possible, such as the number injured, the type and extent of injuries, and the exact location of the accident scene. The communicator should be located as close to the scene as possible in order to transmit to the emergency care providers any additional instructions that may be given by emergency services personnel in route.

- Site Supervisor

  The site supervisor (usually the SSO) should survey and assess existing and potential hazards, evacuate personnel as needed, and contain the hazard. Follow up responsibilities include replacing or repairing damaged equipment, documenting the incident, and notifying appropriate personnel/agencies described under incident reporting. It also includes reviewing and revising site safety and contingency plans as necessary.

In the event of an emergency, follow the procedure outlined in Attachment F. Notify site personnel of the situation. Survey the scene to determine if the situation is safe, to determine what happened, and to search for other victims.

12.4 MEDICAL EMERGENCY RESPONSE PLAN

At least one employee on site will hold a current certificate in American Red Cross Standard First Aid. This training provides four hours of Adult CPR and four hours of Basic First Aid. If a medical emergency exists consult the emergency phone number list and request an ambulance immediately. Perform First Aid/CPR as necessary, stabilize the injured, decontaminate if necessary, and extricate <u>only</u> if the environment they are in is dangerous or unsafe and ONLY if the rescuers are appropriately protected for potential hazards they may encounter during the rescue. When emergency services personnel arrive, communicate all first aid activities that have occurred. Transfer responsibility for care of the injured/ill to the emergency services personnel.

The following items and emergency response equipment will be located within easy access at all times:

- First Aid Kit (see required contents - Section 12.4.1);
- American Red Cross Standard First Aid Manual;

- Eyewash - A 15-minute eyewash will be available on site for flushing foreign particles or contaminants out of eyes. The SSO will demonstrate the proper operation of the unit(s) prior to the start of work;

- Emergency Phone Numbers List;

- Maps and directions to the hospital;

- Portable radios for emergency communications in remote areas; and

- Copies of the posters on CPR, choking, rescue breathing.

12.4.1 First Aid Kit/Required Contents

The following list has been approved by the Occupational Physician.

Adhesive dressings
Adhesive tape rolls, 1 inch wide
Sterile eye dressing packets
1 inch gauze bandage rolls
2 inch gauze bandage rolls
4 inch gauze bandage rolls
Sterile gauze pads, 2 inch square
Sterile gauze pads, 4 inch square
Sterile surgical pads suitable for pressure dressings
Triangular bandages
Safety pins
Tweezers and scissors
Tape for bandaging
Ace bandages
Latex gloves

Sterile gloves
Pen light
Hydrogen peroxide
Sterile eye irrigating solution
Ammonia inhalants
Glucose packets (for diabetics)
Splints (arm and leg)
Antibiotic ointment
Cotton-tipped applicators
Flashlight
Cold packs
Blankets (2)
CPR Microshields/Clear Mouth Barriers (2)
Face shield

Drugs, inhalants, or medications not listed above shall not be included in the First Aid Kit. Supplies should be re-ordered as they are used. A monthly inventory must be done on the first aid kit contents and supplies re-ordered that have been used and not reported.

12.4.2 First Aid for Poisonous Bites and Stings

Reactions from insect bites and stings are usually not a life threatening issue unless individuals are allergic to the venom introduced into the circulatory system. If individuals are allergic to bee stings or insect bites, the following first aid procedures should be followed before emergency services arrive.

First Aid Procedure: The objective of first aid is to reduce the circulation of blood through the bite area, to delay absorption of venom, to prevent aggravation of the local wound, and to sustain respiration.

The most important step is to get the bite victim to the hospital quickly.

Meanwhile, take the following first aid measures:

1. Keep the victim from moving around.

2. Keep the victim as calm as possible and preferably in a lying position.

3. If the victim has been prescribed a Bee Sting Kit or Anaphylaxis Emergency Treatment Kit for insect bites, quickly administer the antidote injection. The antidote shot is an intramuscular or subcutaneous injection only. Do not inject directly into a vein or artery.

4. Immobilize the bitten extremity and keep it at or below heart level.

5. Get the victim to a hospital immediately.

Several other factors must be considered in cases of allergic insect bites:

- Shock: Keep the victim lying down and comfortable, and maintain his or her body temperature.

- Breathing and heartbeat: If breathing stops, give mouth-to-mouth resuscitation. If breathing stops and there is no pulse, perform cardiopulmonary resuscitation (CPR) if you have been trained to do so.

- Identifying the insect: If you can, capture the insect and bring it to the hospital for identification.

- Cleaning the bitten area: If the stinger is still present, it should be carefully pulled out and the area washed with soap and water. You may apply dressings and bandages, but only for a short period of time.

The above information is presented to assist site personnel in controlling and treating insect bites and stings. Additional information can be obtained from the Certified Occupational Physician.

12.5 FIRE

Prior to performing any hot work activities, the UC Davis Fire Department must be notified of the location and type of activity to be performed. Upon notification, the UC Davis Fire Department will issue a permit to be used during the hot work activities. All requirements of the permit will be followed prior to, and during hot work activities.

To protect against fires, the following special precautions must be taken when performing hot work activities:

- No flame-producing devices or other uncontrolled ignition sources shall be used in the exclusion zone at any time;

- Any hot work outside of the support zone can only be done in an area that has been cleared of brush and other flammable materials for a distance of 15 feet;

- A fire watch will be posted for the duration of any hot work and for a period of approximately 30 minutes after hot work activities have been completed, depending upon the type of chemicals stored in the immediate vicinity and the vegetation surrounding the hot work location. The fire watch will have no other duties while on fire watch;

- Two full 20 pound ABC fire extinguishers must be located at the work area when hot work is being conducted; and

- Upon completion of the hot work activities the area will be inspected for hot metal, slag, hot spots, etc.

Type ABC fire extinguishers will be available onsite to contain and extinguish small fires. The UC Davis fire department shall be summoned (911) in the event of any fire on site. The UC Davis fire department should be notified by UC Davis EH&S of the Investigation Contractor's operations prior to their commencement. A copy of this plan is to be provided to the station commander.

12.6 ACCIDENT INVESTIGATION

The investigation and reporting of occupational injuries, illnesses and dangerous occurrences is essential for project management to be able to take the steps necessary to avoid additional injuries or illnesses. A complete investigation will provide information regarding the elements of the incident and the process by which they came together to cause the injury, illness, or dangerous occurrence. By identifying the elements and processes, further incidents can be avoided. Timely reporting also permits project contractors to remain in compliance with Cal/OSHA recordkeeping regulations.

12.6.1 Program Responsibilities

The Project Health and Safety Manager will:

- Determine if an incident warrants a formal investigation, and conduct incident investigations as required.

- Provide reports of formal investigations to the PM and the PNL Project Manager and the UC Davis Project Manager.

- Review all accident reports.

- Maintain the project OSHA Form 200.

The Site Manager, or his designee, will:

- Investigate all incidents on his projects.

- Complete and submit reports in accordance with this Procedure.

Site personnel are responsible for reporting ALL incidents involving injuries or illnesses, including near-misses, to their supervisor immediately.

12.6.2 Accident and Illness Investigation

Sometimes the investigation of an accident or illness is necessary to prevent similar occurrences. An investigation should not attempt to prove guilt or innocence; rather its purpose should be to ascertain the existence of hazards by identifying the elements and sources which caused the accident or illness. Additionally, a proper investigation should result in the identification of any corrective measures which may be required.

The objectives of an accident or illness investigation are to:

- Determine the existence of any hazards or contributing factors involved.

- Make recommendations for eliminating the hazards.

- Determine if any unsafe or unhealthful behavior or condition was involved.

- Make recommendations for eliminating the unsafe or unhealthful condition or behavior involved.

12.6.3 Responsibilities For An Accident or Illness Investigation

Accident or illness investigations require a search for all factors involved in the accident or illness. Every factor must be found, evaluated and considered in order to determine what actually occurred and why. Failure to gather and consider all factors could allow recurrent accidents or illnesses from the same cause.

When a Supervisor is advised that an accident or illness has occurred, he should:

- Immediately notify the PHSM and the PNL Project Manager.

- Complete the appropriate Accident Report Forms (Attachment C).

- Investigate promptly.

- Determine what happened and how it happened.

- Determine the results.

- Determine what immediate corrective action to take.

12.6.4 Accident Reporting

In the event of an injury or illness, work is to be stopped until the cause of the incident has been determined and appropriate action has been taken. Any injury or illness, regardless of the severity, is to be reported on an Accident Report form located in Attachment C. The Project Manager, or his designee, is responsible for reporting all accidents or incidents to the PHSM and PNL Project Manager.

12.7 UNUSUAL EVENT REPORT

After the occurrence of a new or unusual radiological event, the RCT will document the occurrence of the event by establishing facts in chronological order and reporting the events and facts on a U.S. DOE Occurrence Report located in Attachment R. The purpose of this report is to identify the underlying reasons or causes for the success or failure of the event so the facts are well understood. This report will be completed within two days of the occurrence and a copies of the report will be given to the PNL PM or the LEHR Rad Con Manager, UC Davis PM, PHP, and PM. This report will be used to evaluate and describe lessons learned as described in Article 353 of the LEHR Rad Con Manual.

Anytime new or unusual radiological events occur at the site, the RCT will immediately notify the PHP, the PM and the PNL Project Manager. After notification the RCT will investigate the event by determine if a formal investigation is required. If a formal investigation is required, the RCT will:

- Determine the existence of any hazards or contributing factors involved.
- Make recommendations for eliminating the hazards.
- Determine if any unsafe or unhealthful behavior or condition was involved.
- Make recommendations for eliminating the unsafe or unhealthful condition or behavior involved.

Results of the investigation will be reported on the Occurrence Report form located in Attachment R.

12.8 OPERATION SHUTDOWN

Under certain extreme hazardous situations the site manager, RCT, SSO or SSR may request that site operations be temporarily suspended while the underlying hazard is corrected or controlled. During site activities, work will cease when any of the following conditions are present:

- Inadequate radiological or chemical exposure controls;
- Radiological and chemical exposure controls not being implemented;
- Radiological control hold point not being satisfied; or
- Any hazardous work condition that is not properly controlled.

During operation shutdown, all personnel will be required to stand upwind to prevent exposure to fugitive emissions. Radiological work will not resume until proper radiological control has been established. Resumption of radiological work required the approval of the SSO, RCT, SSR and the PNL PM.

13.0 TRAINING

13.1 HEALTH AND SAFETY TRAINING FOR SITE WORKERS

All site personnel will have met the requirements of 8 CCR 5192 (e), including:

- Forty hours or initial off-site training or its recognized equivalent;
- Eight hours of annual refresher training as required for all personnel;
- Eight hours of supervisor training for personnel serving as Site Safety Officers; and
- Three days of work activity under the supervision of a trained and experienced supervisor.

13.2 FIRST AID/CPR TRAINING

The RCT, SSO and each subcontractor safety representative shall maintain current certification in American Red Cross First Aid and CPR training or the equivalent. All other onsite personnel who are responsible for responding to site emergencies and incidents shall also maintain current certification in American Red Cross First Aid and CPR training or the equivalent. In addition, all first aid responders must receive Bloodborne Pathogens training as described below.

13.3 BLOODBORNE PATHOGENS TRAINING

Site personnel who are required to work in areas where laboratory waste could potentially be located including the landfill units and the septic tanks, and anyone who will be performing first aid/emergency response activities will be trained in accordance with the Bloodborne Pathogens Standard located at 29 CFR 1030. Bloodborne Pathogens training

will include an overview of the standard, an explanation of the types of bloodborne pathogens, their modes of transmission and corresponding health effects, an overview of the Soil Contractor's Exposure Control Plan (see Attachment Q for a Summary of this program) and vaccination program, universal precautions and how the will be implemented during field activities, and all other pertinent requirements outlined in the standard. Training will be refreshed on an annual basis and whenever tasks change that will effect occupational exposure.

13.4 RADIOLOGICAL TRAINING FOR SITE WORKERS

13.4.1 Radiological Worker Training (Level I)

All individuals whose job assignments require access to Radiological Buffer Areas and Radiological Control Areas must successfully complete Radiological Worker I training and site-specific Radiological Worker I training before being permitted to enter these areas without a qualified escort.

Radiological Worker I training includes the DOE standardized core training course material, site specific training, and ALARA principles and goals. The site specific training shall encompass, at a minimum, the following site-specific practical factors:

- Entering and exiting simulated Radiological Buffer Areas and Radiological Control Areas;
- Performance of frisking for personnel contamination, as applicable;
- Verification of instrument response and source check; and
- Anticipated response to alarm situations.

13.4.2 Radiological Worker Training (Level II)

Workers whose job assignments involve entry into Contamination Areas shall complete Radiological Worker II training. Radiological Worker II training will consist of the DOE standardized core training course materials for Radiological Worker II, site specific training, and ALARA principals and goals.

Radiological Worker II training shall encompass, at a minimum, the following site-specific practical factors:

- Donning of protective clothing;
- Entering a simulated Radiological Buffer Area, and Contamination Area to perform a task;
- Anticipated response to simulated abnormal situations;
- Anticipated response to simulated alarms or faulty radiological control equipment;
- Removing protective clothing and equipment and subsequently exiting the simulated area; and
- Verification of instrument response and source checks.

All contractor personnel who will be involved in intrusive activities at the site will receive Radiological Worker II training as described above before field activities commence.

13.5 RADIOLOGICAL CONTROL TECHNICIAN TRAINING

Training for Radiological Control Technicians (RCTs) consists of successfully completing the standardized core training course,receiving on-the-job training, and passing both a final comprehensive written examination and final oral examination conducted by the Oral Examination Board. Members of the LEHR Radiological Control Committee will participate in the oral examinations.

Training for Radiological Control Technicians will include the above material, and will also include more in-depth training in the fundamentals of radiation physics, radiation protection, radiation detection instrumentation, and site specific radiation protection procedures. On-the-job training and evaluation is required in each of the activities to be performed. Additional information concerning Radiological Control Technician training is located in the LEHR Rad Con Manual Article 641-643.

13.6 SPECIALIZED RADIOLOGICAL WORKER TRAINING

Special radiological worker training shall be completed prior to conducting nonroutine operations, or work in areas with changing radiological conditions or in areas with the potential for high radiological consequences. Work in these types of situations is not expected to be undertaken at the LEHR site. If conditions exist or are found that fit this criteria, then specialized training will be conducted prior to the commencement or continuation of site work.

13.6.1 Technical Support Personnel Training

Appropriate technical support personnel (engineers, schedulers, procedure writers) shall be trained in the principals of ALARA, basic ALARA techniques and dose reduction techniques if they are working in areas that are re: .ted to radiological control.

13.6.2 Management Training

Managers that supervise or provide oversight of Radiological Control Programs shall be trained in the principles of the LEHR Rad Con Manual. Training will include site-specific information and continued training which will include performance indicators, root causes and lessons learned based on operational experience.

13.7 VISITOR TRAINING

All visitors to the site will receive a radiological safety orientation prior to visiting the site. This training will be coordinated through the UC Davis Environmental Health and Safety Office and will include the following topics:

- Basic radiation protection concepts;
- Risk of low-level occupational radiation exposure, including cancer and genetic effects;
- Risk of prenatal radiation exposure;
- Radiological protection policies and procedures;
- Visitor and management responsibilities for radiation safety;
- Adherence to radiological posting and labeling;
- Applicable emergency procedures; and
- Training for issuance of dosimeters, where applicable.

This training will be accomplished using standardized training materials common to all onsite contractors, and visitors will be asked to sign a form stating they have been trained on the items listed in this Section. This training may be communicated by videotape or handout.

The Project Manager must notify the UC Davis EH&S Office 48 hours in advance to coordinate this type of training whenever non-trained personnel will be visiting the site.

13.8 HAZARDOUS MATERIALS HANDLING

All employees who will handle and package hazardous materials for shipment will have received training, specific to their job function, as required under the Department of Transportation (DOT) Hazardous Materials Training-181 (HMT-181) requirements.

13.9 PRE-JOB AND SITE SAFETY BRIEFINGS

Prior to the start of operations at the site, the SSA will conduct a pre-job/site safety briefing, which will include all personnel involved in site operations. At this meeting, the SSA will discuss:

- Contents of this HSP;
- Contents of the LEHR Rad Con Manual;
- Scope of work to be performed;
- Types of hazards at the site and means for minimizing exposure to them;
- Radiological conditions in the workplace;
- Special radiological control requirements;

- Radiological control hold points;
- Communications and coordination with other contractors;
- The type of monitoring that will be performed;
- Action levels for upgrade and downgrade of personal protective equipment;
- Personal protective equipment that will be used;
- Heat stress monitoring and control;
- Decontamination protocol;
- Site control measures, including safe operating practices and communication;
- Provisions for housekeeping and final cleanup;
- Emergency response procedures;
- Location and use of emergency equipment;
- Evacuation signals and procedures;
- Overview of the Hazardous Work Permit;
- Overview of the Investigation Contractor's Injury and Illness Prevention Program and Bloodborne Pathogens Programs located in Attachment N and Attachment Q, respectively;

- Routes of entry, toxicology, and health hazard information for radioactive materials and chlorinated hydrocarbons; and

- Conduct hazard communication training for all chemicals brought onsite. MSDS's for the chemicals brought onsite by the Investigation Contractor are located in Attachment L.

Subsequent site safety briefings will be conducted by the SSO prior to each shift to review pertinent safety issues, discuss any problem and discuss aspects of the shift's tasks.

When additional chemicals are brought onsite by subcontractor personnel, the hazards associated with their use will be included in the next day's site safety briefing, and before the chemicals are used at the site.

For each briefing, the SSO will complete a Site Safety Briefing form (see Attachment G) and submit each on a regular basis to the DHSM.

13.10 HAZARDOUS WORK PERMIT

Prior to the start of work, the SSO or RCT will complete a Hazardous Work Permit (located in Attachment H) which will be posted at the access point to each work area. The Hazardous Work Permit will be used to inform site personnel and visitors of the radiological and safety controls to be followed during site activities. The hazardous work permit will include the following information:

- Description of work;

- Work area radiological conditions;

- Dosimetry requirements;

- Training requirements for entry;
- Protective clothing and respiratory protection requirements;
- Radiological control coverage requirements and stay time controls;
- Limiting radiological conditions that may void the HWP;
- Special dose or contamination reduction considerations;
- Special personnel frisking requirements;
- Date of issue and expiration; and
- Authorizing signatures.

In addition to the above information, Hazardous Work Permits will comply with Section 321 through 323 of the LEHR Rad Con Manual.

13.11 RECORDKEEPING

Copies of all training certificates will be maintained onsite by the SSO. All site safety briefing forms will also be maintained onsite by the SSO and copies will be submitted to the PHSM on a regular basis.

14.0 MEDICAL SURVEILLANCE

This chapter describes the minimum medical screening requirements that will be used to provide a method of identifying those employees whose medical history indicates potentially increased health risk when exposed to the added burden associated with protective equipment and/or toxic chemicals and radioactive materials present at the LEHR site. This chapter also describes the minimum medical screening which will be used to determine if personnel can use positive and negative pressure respirators and to document exposure to specific contaminants.

14.1 SCHEDULING OF EXAMINATIONS

All project personnel performing work in potentially contaminated areas, regardless of length of employment at the site, are required to participate in the medical surveillance program. The following medical surveillance intervals will be provided for all site employees working inside of the exclusion zone:

- Prior to the start of work, all personnel must undergo a baseline medical examination. The results of the examination must be reviewed and approved by an occupational physician prior to being permitted access to the contaminated or potentially contaminated areas of the site.

- All personnel included in the program must obtain at least one medical examination per year during the term of site activity.

- If an employee develops signs or symptoms of illness related to potential workplace exposures, then a medical exam will be performed.

- At termination of employment, a termination exam should be completed.

- When an employee develops a lost time injury or illness during the period of this contract.

When an employee develops a lost time work-related injury or illness during the project, a written statement allowing the employee to return to the work site after the illness must be provided to the employee's supervisor. This written statement must be signed by the Occupational Physician and copies must be submitted to the Radiological Control Manager and the PHSM.

Prior to participating in the medical surveillance program, the following information will be provided to the examining physician:

- Information on the employee's anticipated or measured exposure;
- PPE use;
- A description of the employee's duties;
- A copy of 8 CCR 5192; and
- Information from previous examinations not readily available to the examining physician.

14.2 MEDICAL RECORDKEEPING

All medical and exposure records must be retained for a period of at least 30 years beyond an employee's last day of employment. A written notification of the storage location of all project associated medical/compliance records will be relayed to the LEHR Rad Con Manager at the close of the project.

These records are accessible only by the participants and the consulting physician. Pertinent medical information may be shared with emergency medical facilities adjacent to hazardous work sites.

As required by OSHA standards, records of employee medical history must be made available upon request to the employees, employee representatives, and OSHA. The standard applies to all employers in general industry, construction and maritime operations whose employees are exposed to toxic substances and harmful physical agents. By providing workers with information they can use to detect, treat, and prevent occupational diseases, the policy is intended to increase awareness of workplace hazards and allow workers to play a meaningful role in their own health management.

14.3 SPECIFIC COMPONENTS OF EXAMS

Baseline

The baseline medical exam will consist of the following:

- A medical and occupational history questionnaire with emphasis on the following systems: nervous, skin, lung, blood forming, cardiovascular, gastrointestinal, reproductive, as well as ears, nose, and throat.

- A complete physical exam, including at least the following:

    1. Height, weight, temperature, pulse, respiration, and blood pressure

    2. Head, nose, and throat

    3. Eyes (Snellen)

4. Ears (audiometric testing at 500, 1,000, 2,000, 3,000, 4,000, 6,000, and 8,000 Hz including an otoscopic examination of the ear for wax, and questionnaire)

5. Chest (heart and lungs)

6. Peripheral vascular system

7. Abdomen (liver, spleen, and kidney)

8. Musculoskeletal system

9. Genitourinary system

10. Skin

11. Nervous system

12. Pelvic, breast, and rectal (Guaiac) examination for women

13. Testicular and rectal (Guaiac) examination for men

- Tests

1. Complete blood counts and chemistries including:

   a. White blood cell differential cell and platelet counts
   b. Hemoglobin and/or hematocrit
   c. Albumin, globulin, total protein and total bilirubin
   d. Serum glutamic oxalacetic transminases
   e. Lactic dehydrogenase
   f. Alkaline phosphate and Gamma Glutamine Trans Peptidase
   g. Calcium

h. Phosphorous
i. Uric acid
j. Creatinine
k. Urea nitrogen
l. Cholesterol and triglycerides
m. Glucose
n. RBC Cholinesterase

2. Urinalysis (Clean Catch), including:

a. Color and character
b. Specific gravity
c. pH
d. Protein
e. Acetone
f. Glucose
g. Microscopic examination

3. PA Chest-X-ray (14 x 17 inch P-A performed for the baseline exam)

4. Pulmonary function test to include, at a minimum:

a. Forced vital capacity (FVC)
b. Forced expiratory volume, one second (FEV_1)
c. The FEV_1:FVC ratio

5. Standard 12-lead resting electrocardiogram (EKG).

Annual Medical Exam

The annual medical exam is similar to the baseline, with the following exceptions:

- An annual questionnaire is administered in place of the Comprehensive Medical History Questionnaire.
- Chest x-rays are not performed annually, but less frequently, depending upon age and regulatory requirements.
- The EKG will be performed every 3 years for those under the age of 40, every 2 years for those aged 40 to 50, and annually for those over 50 years of age.

Termination Exams

The termination exam is conducted at the discretion of the Occupational Physician on the basis of an individual's medical and exposure history. All project personnel who worked in the exclusion zone or who may have otherwise been exposed to elevated levels of site contaminants will have a termination exam. The employee's supervisor should contact the Occupational Physician upon notification of termination to determine whether an exit exam is needed.

Baseline Labwork For Hazardous Materials Exams

- Urinalysis (microscopic)
- Complete Blood Count (with differential)
- RBC Cholinesterase (not always necessary; only needed if pesticide work is anticipated)

- 24 Item Blood Chemistry Panel

Calcium	Cholesterol
Phosphorus	Triglycerides
Sodium	T. Protein
Potassium	Globulin
Chloride	Albumin
LDH	A/G Ratio
AST (SGOT)	BUN
T. Bili	Creatinine
GGT	Uric Acid
ALT (SGPT)	Glucose
Alk. Phos.	Iron
HDL	T_4

Special Tests (as required)

- Chest x-ray (14- x 17-inch P-A)
- EKG Stress Test
- RBC Cholinesterase
- Blood Lead
- Zinc Protoporphyrin
- Polychlorinated Biphenyls
- Arsenic, Cadmium, and Mercury; other heavy metals
- Thiocyanate
- Uroporphyrin
- Hexachlorobenzene
- Methemoglobin
- Bioassay tests for exposure to radionuclides will be provided on an as needed basis. Information concerning the bioassay program is located in Section 7.4.4 and Attachment P.

15.0 SPILL CONTROL

15.1 NOTIFICATION OF SPILLS AND DISCHARGES

Prior to commencing site activities, the Project Manager is to contact the chief at the nearest fire station. A copy of this SSHP will be offered to the fire chief, and the PM will explain the operation, the potential risks to the community and facility personnel in the event of a significant release of hazardous materials; evacuation routes, procedures and signals should also be discussed.

If a spill occurs and humans or the environment are threatened, contractor personnel will immediately contact the SSHO or PM who in turn will immediately notify the local fire department, the PNL Project Manager and the UC Davis Environmental Health and Safety Office.

After spill response activities are completed, a Spill Report will be issued to the both the PNL Project Manager and the UC Davis Environmental Health and Safety Office. This spill report will identify the cause and extent of the spill, any resulting contamination danger, and the corrective actions taken by the Investigation Contractor and emergency personnel.

15.2 REQUIRED EQUIPMENT

The following equipment will be kept at the site at all times to provide for the means to clean up an unexpected spill or discharge:

- Spill pillows and socks;
- Sand, clean fill, or other noncombustible absorbent;
- 55 gallon U.S. DOT 17-E and 17-H drum;

- Shovels~~; and~~

Any spill of a quantity that would require the use of Level B PPE will be referred to an emergency response contractor for cleanup. Prior to the start of invasive operations, the PM and PHSM will identify an appropriate emergency response contractor, and contact the contractor's representative to provide information on project activities as well as a copy of this health and safety plan. The contractor's emergency phone number will be posted prominently at the site phones and project office.

15.3 SPILL CONTROL

If a spill occurs at the site, the following actions will be immediately taken by the Investigation Contractor:

- Notify the local fire department;
- Isolate and contain the hazardous spill area;
- Notify the PNL Project Manager and the UC Davis Environmental Health and Safety Office;
- Do not allow anyone to touch or approach the spilled material without wearing the appropriate PPE;
- Direct personnel to stay unwind of the spill location, and to keep out of low areas;
- Keep combustibles away from the spilled material;
- Use water spray to reduce vapors and dust as needed;
- Collect samples for analysis to assess if cleanup activities were adequate; and

- Conduct any other actions as needed.

If hazardous solid material is spilled at the site, the spilled material will be removed and placed into a dry container and labeled for disposal.

If a hazardous liquid material is spilled, the spilled material will be absorbed with sand, clean fill, or noncombustible absorbent material. Once absorbed, the material will be placed into dry containers and labeled for disposal.

15.4 DECONTAMINATION

After the spill area has been controlled, personnel will undergo decontamination procedures as outlined in Chapter 10.

16.0 INJURY AND ILLNESS PREVENTION PROGRAM

The Investigation Contractor is committed to maintaining an injury and illness free workplace and complying with applicable laws and regulations governing workplace safety. To achieve this goal, the Investigation Contractor has developed and implemented an Injury and Illness Prevention Program that meets the requirements of California Senate Bill 198, Statutes of 1989, Chapter 1369, Labor Code 6401.7, and the accompanying General Industry Safety Order at Title 8, California Code of Regulations, Section 3203 (8 CCR 3203) in all California offices and at temporary job site locations.

The Injury and Illness Prevention Program will be implemented during all field operations. The SSO will conduct a safety meeting before the project commences to discuss the provisions of the IIPP and discuss the importance of reporting potentially hazardous conditions before an accident occurs. The SSO will also review the Hazardous Condition Report Form, which will be used to report any potential safety hazards noted at the job site. A summary of the Investigation Contractor's Injury and Illness Prevention Program and a copy of the Hazardous Condition Report Form is located in Attachment N. A full copy of the Injury and Illness Prevention Program is contained in the Investigation Contractor's Health and Safety Program Manual which is maintained by the Project Health and Safety Manager and is available upon request.

17.0 RECORDKEEPING

The PM, SSO, and RCT are responsible for site recordkeeping. Prior to the start of work, they will review this plan; if there are no changes to be made, they will sign the approval form and forward a copy to the PHSM.

All site personnel are required to have available copies of their training records and medical clearance documents at the site. Before site personnel enter the exclusion zone, they must present evidence of medical clearance and training records which meet the criteria described in Chapter 13 and 14, respectively. The PM or SSO will maintain current copies of training certificates and statements of medical program participation for all site personnel.

In addition, all site personnel will review this HSP and sign a copy of the safety plan compliance agreement, which is found in Attachment A. The PM will maintain these agreements at the site, and forward them to the PHSM at the conclusion of the operation.

The SSO will conduct a Site Safety Briefing in accordance with Section 13.9 prior to each shift and have all attendees sign the form in Attachment G; copies will be forwarded to the PHSM.

Any accident or exposure incident will be investigated and the form in Attachment C will be completed and forwarded to the PHSM.

All instrument readings and calibrations, PPE use and changes, health and safety-related issues, and deviations from or problems with this HSP will be recorded in the Field Log. These portions of the Log will be transmitted to the PHSM for review at the completion of field operations.

17.1 OSHA RECORDKEEPING

OSHA Form 200, the Log and Summary of Occupational Injuries and Illnesses, is maintained for the project by the PHSM. This function is centralized to ensure that a uniform procedure is used for the completion and distribution of Form 200.

The PHSM has 5 workdays from the date of the occurrence of the recordable injury or illness to make the appropriate entries in the log. Therefore, the PM or site supervisor must complete the Accident Report Form immediately upon report and initial investigation of the incident and forward a copy to the PHSM.

The PHSM will complete an OSHA Report of Occupational Injury or Illness and will update the site's Form 200 using the information from the OSHA Form 101. The OSHA Form 101 is the employers first report of occupational injury. The PHSM will also need to know how many days the affected individual was off duty and/or on restricted duty in order to complete the update.

At the end of each calendar year, an annual summary of occupational injuries and illnesses for that year will be prepared. The summary must be posted for the entire month of February in the year following the summary year. The posted summary shall not show the names of the personnel whose illnesses or injuries are listed.

The log and summary, Form 200, and the accident reports, Form 101, must be retained at the site for 5 years. All OSHA records will be made available upon request for inspection and copying by authorized Federal and State government officials. Site personnel, former site personnel, and representatives are provided access only to the log, Form 200. Access to these records will be provided in a reasonable manner and at a reasonable time.

17.2 RADIOLOGICAL RECORDKEEPING REQUIREMENTS

All radiological records will be controlled and managed throughout the project. Management of records will include archiving all pertinent paperwork and seeing that all significant radiological events are properly documented. Records that are required to be kept current and in the radiological records filed by the PM, SSO and RCT include the following:

- Radiological policy statement
- Radiological control procedures
- External dosimetry reports
- Internal dosimetry reports
- Individual radiological doses
- Internal and external dosimetry policies and procedures
- Personnel training
- ALARA records
- Radiological instrumentation test, repair and calibration records
- Radiological surveys
- Area monitoring dosimetry results
- Health and safety plans
- Radiological performance indicators and assessments
- Radiological safety analysis and evaluation reports
- Quality assurance records
- Radiological incident and occurrence reports
- Accountability records for sealed sources
- Records for release of material to controlled areas
- Reports of loss of radioactive material.

All other recordkeeping requirements outlined in Chapter 7 of the LEHR Rad Con Manual will be adhered to during the project.

ATTACHMENT A

SAFETY PLAN COMPLIANCE AGREEMENT

ATTACHMENT A

SAFETY PLAN COMPLIANCE AGREEMENT
FOR
LEHR ENVIRONMENTAL RESTORATION
UNIVERSITY OF CALIFORNIA, DAVIS

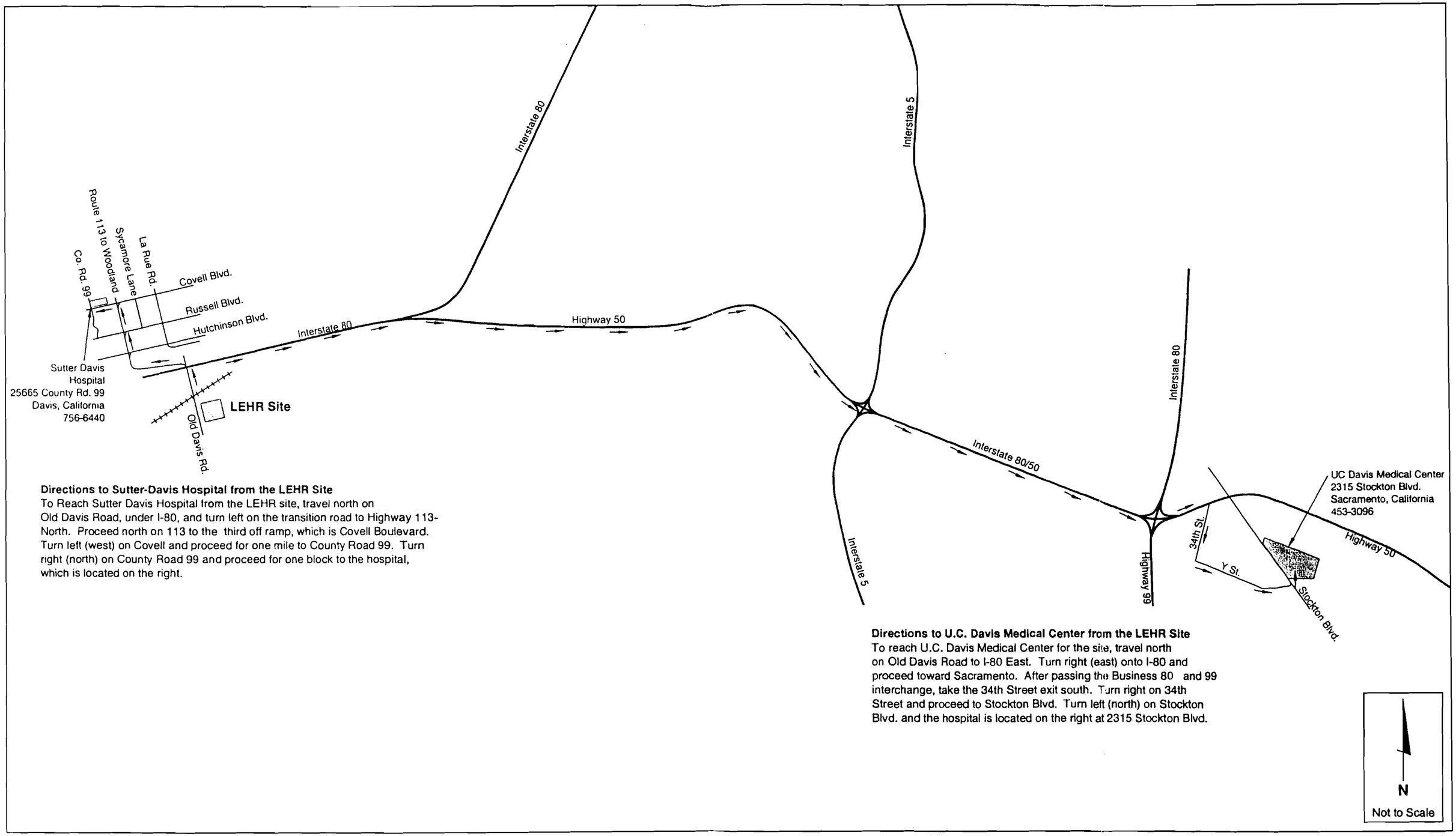
I, _____, have received a copy of the Health and Safety Plan and the LEHR Radiological Control Manual for the Project. I have reviewed these documents, understand them, and agree to comply with all of their provisions. I understand that I could be prohibited from working on the project for violating any of the health and safety requirements specified in these documents.

SIGNED: _____ _____
(Signature) (Date)

Firm: _____

ATTACHMENT B

HOSPITAL ROUTE MAP



Directions to Sutter-Davis Hospital from the LEHR Site
To Reach Sutter Davis Hospital from the LEHR site, travel north on Old Davis Road, under I-80, and turn left on the transition road to Highway 113-North. Proceed north on 113 to the third off ramp, which is Covell Boulevard. Turn left (west) on Covell and proceed for one mile to County Road 99. Turn right (north) on County Road 99 and proceed for one block to the hospital, which is located on the right.

Directions to U.C. Davis Medical Center from the LEHR Site
To reach U.C. Davis Medical Center for the site, travel north on Old Davis Road to I-80 East. Turn right (east) onto I-80 and proceed toward Sacramento. After passing the Business 80 and 99 interchange, take the 34th Street exit south. Turn right on 34th Street and proceed to Stockton Blvd. Turn left (north) on Stockton Blvd. and the hospital is located on the right at 2315 Stockton Blvd.

HOSPITAL ROUTE MAP

Health and Safety Plan
LEHR Environmental Restoration
Davis, California

DAMES & MOORE

12561-099-043 SJR 2/12/93 EW3-RAD

ATTACHMENT C

ACCIDENT REPORT FORM

ACCIDENT/EXPOSURE REPORT

EMPLOYEE NAME_____ DATE OF BIRTH _____

HOME ADDRESS_____ PHONE NO._____

SEX: MALE____ FEMALE____ JOB TITLE_____ SOCIAL SECURITY NO._____

OFFICE NO._____ OFFICE LOCATION_____ DATE OF HIRE _____

HOURS USUALLY WORKED: HOURS PER DAY_____ HOURS PER WEEK_____ TOTAL HOURS WEEKLY_____

WHERE DID ACCIDENT OR EXPOSURE OCCUR? (INCLUDE ADDRESS)_____

_____

COUNTY_____ ON EMPLOYER'S PREMISES? YES_____ NO_____

WHAT WAS EMPLOYEE DOING WHEN INJURED? (BE SPECIFIC)_____

_____

HOW DID THE ACCIDENT OR EXPOSURE OCCUR? (DESCRIBE FULLY)_____

_____

_____

_____

WHAT STEPS COULD BE TAKEN TO PREVENT SUCH AN OCCURRENCE?_____

_____

_____

OBJECT OR SUBSTANCE THAT DIRECTLY INJURED EMPLOYEE_____

_____

DESCRIBE THE INJURY OR ILLNESS_____ PART OF BODY AFFECTED_____

NAME AND ADDRESS OF PHYSICIAN_____

IF HOSPITALIZED, NAME AND ADDRESS OF HOSPITAL_____

DATE OF INJURY/ILLNESS_____ TIME OF DAY_____ LOSS OF ONE OR MORE DAY OF WORK? YES/NO_____

IF YES-DATE LAST WORKED_____

HAS EMPLOYEE RETURNED TO WORK?_____ IF YES-DATE RETURNED_____ DID EMPLOYEE DIE?_____ IF YES-DATE_____

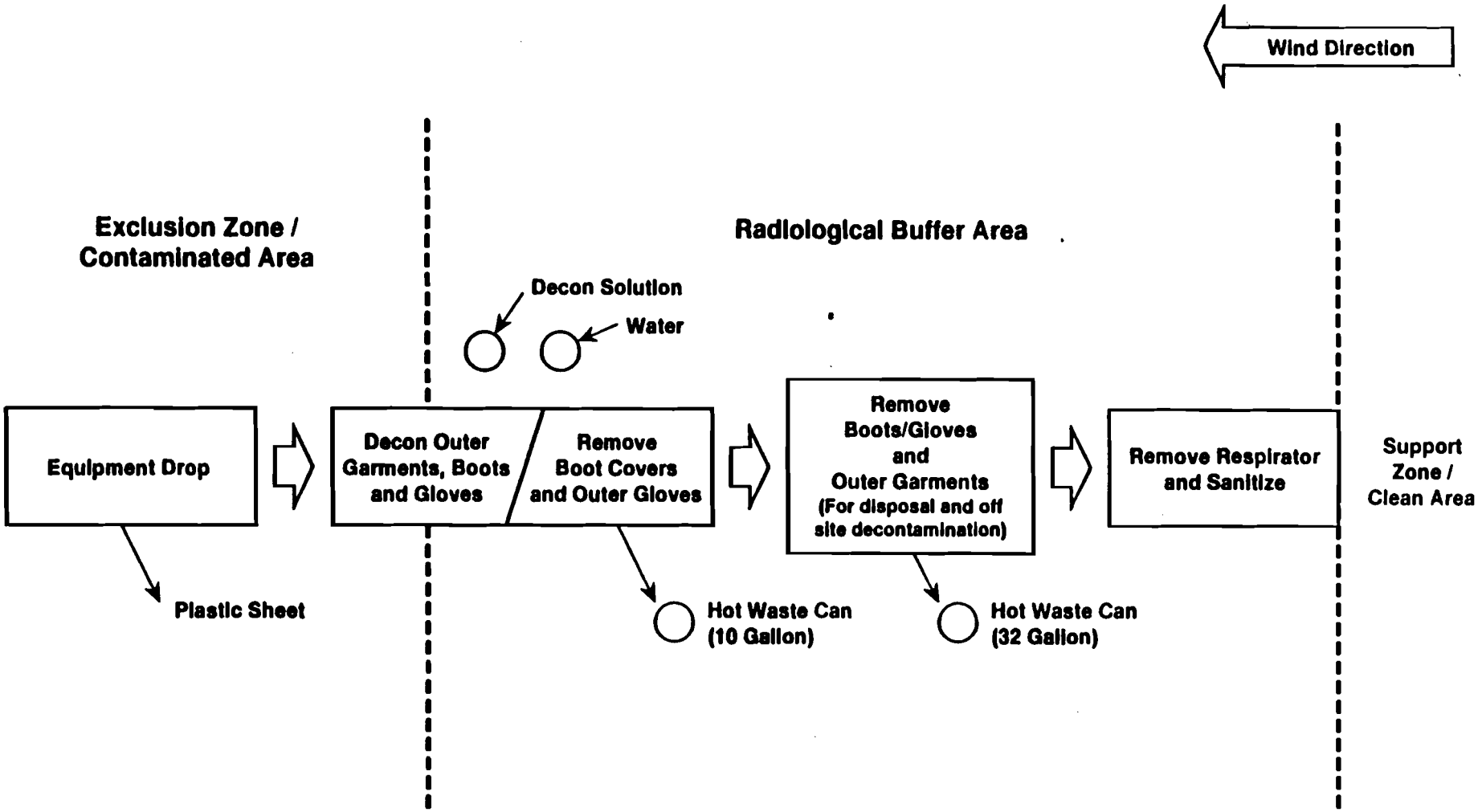
COMPLETED BY (PRINT)_____ SIGNATURE_____

TITLE_____ DATE_____

An accident/exposure report must be completed by the supervisor or site safety officer immediately upon learning of the incident.

ATTACHMENT D

PERSONNEL DECONTAMINATION STATION LAYOUT



MINIMUM LAYOUT OF PERSONNEL DECONTAMINATION STATION

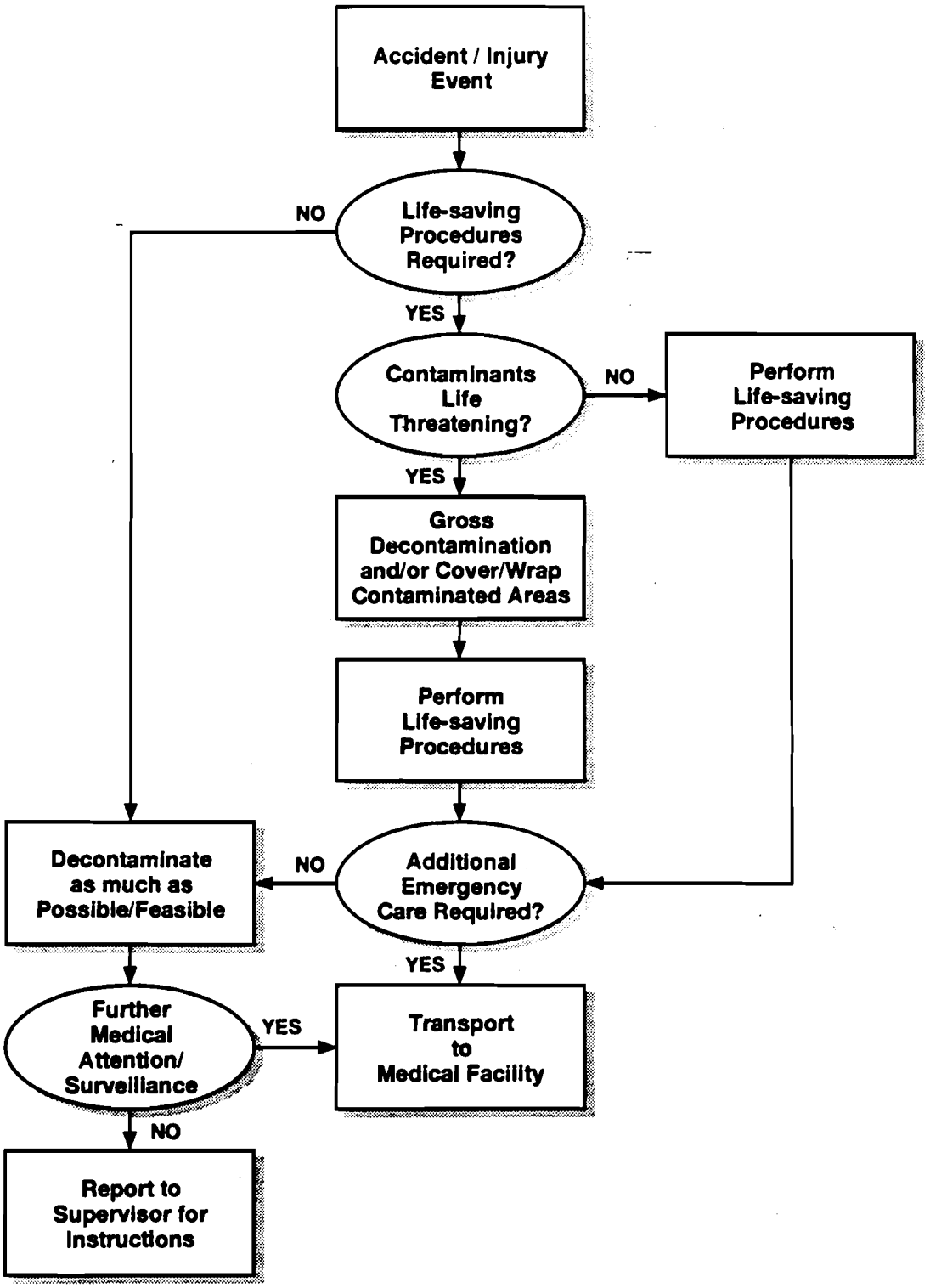
Health and Safety Plan
LEHR Environmental Restoration
Davis, California

DAMES & MOORE

10805-720-044.decon

ATTACHMENT E

EMERGENCY DECONTAMINATION CHART

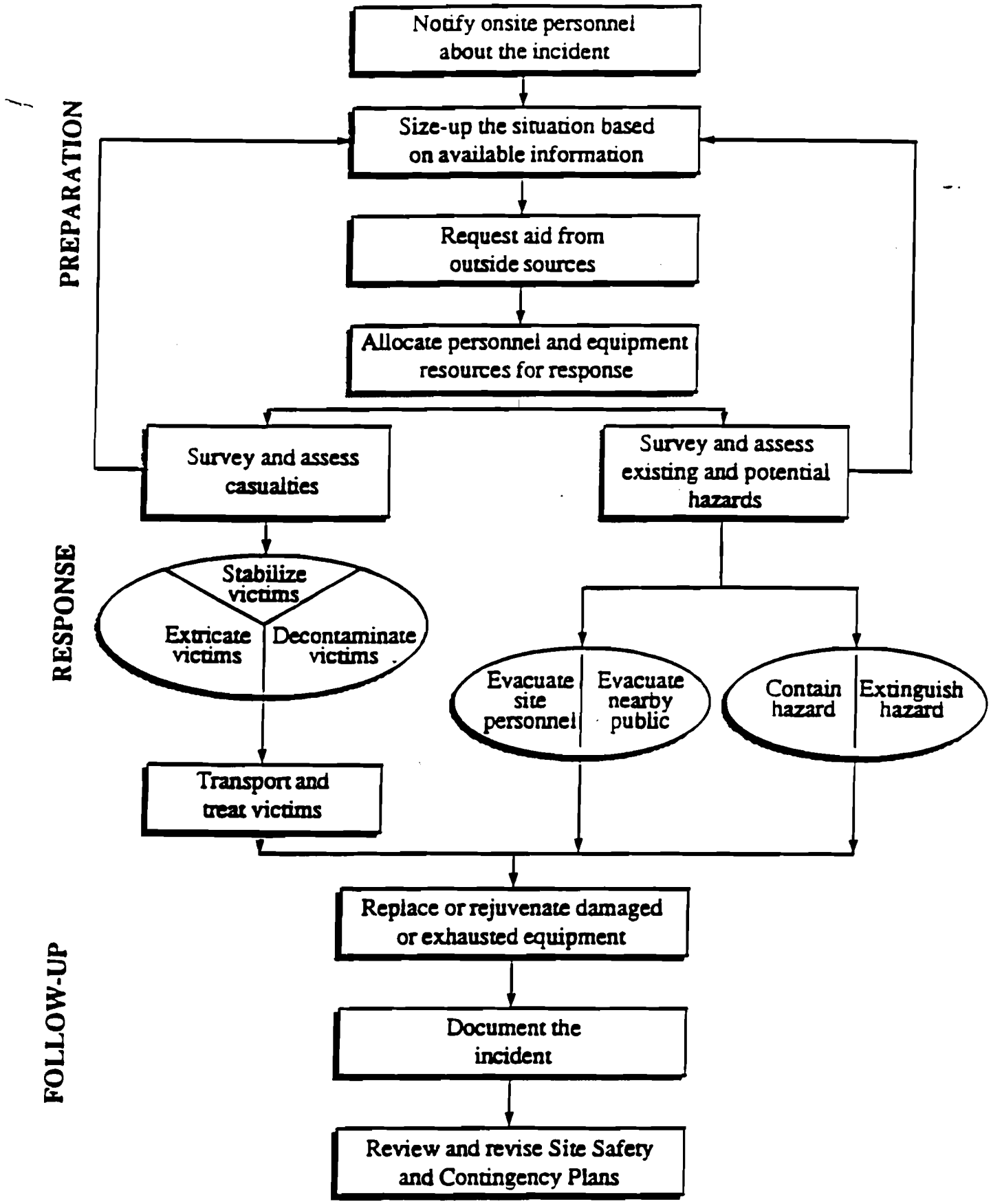


EMERGENCY DECONTAMINATION

ATTACHMENT F

EMERGENCY RESPONSE CHART

Emergency Response Procedures



ATTACHMENT G

SITE SAFETY BRIEFINGS

SITE SAFETY BRIEFINGS

Job Name_____ Number _____
Date_____ Start Time_____ Completed _____
Site Location_____
Type of Work (General)_____
****

SAFETY ISSUES

Tasks (this shift)_____
_____
Protective Clothing/Equipment_____
_____
Chemical Hazards_____
_____
Radiological Hazards_____
_____
Physical Hazards_____
_____
Control Methods including monitoring techniques_____
_____
_____
Special Equipment/Techniques_____
_____
Hazard Communication Overview_____
_____
Nearest Phone_____
Hospital Name/Address_____
Special Topics (incidents, actions taken, etc.)_____
_____
_____
****

ATTENDEES

Print Name	Sign Name

Meeting conducted by: _____

BRIEFSUP.FRM

ATTACHMENT H

HAZARDOUS WORK PERMIT

HAZARDOUS WORK PERMIT	
Job Name:	**Number:**
Date:	**Completed by:**
Location:	
Effective Dates:	
RADIATION TYPES	RADIONUCLIDES
[ ] Alpha [ ] Beta [ ] Gamma [ ] Neutron	

DESCRIPTION OF WORK

WORK AREA RADIOLOGICAL CONDITIONS

DOSIMETRY REQUIREMENTS

TRAINING REQUIREMENTS FOR ENTRY

PROTECTIVE CLOTHING AND RESPIRATORY PROTECTION REQUIREMENTS

RADIOLOGICAL CONDITIONS THAT VOID THIS HWP

SPECIAL DOSE OR CONTAMINATION REDUCTION CONSIDERATIONS

SPECIAL PERSONNEL FRISKING REQUIREMENTS

DATE OF ISSUE AND EXPIRATION

OTHER

AUTHORIZED SIGNATURES

	Print Name	Sign Name
Project Manager		
Site Safety Officer		
Radiological Control Technician		

ATTACHMENT I

DAILY PID OR OVA INSTRUMENT CALIBRATION CHECK SHEET

DAMES & MOORE

HEALTH & SAFETY PROGRAM
DAILY INSTRUMENT CALIBRATION CHECK SHEET

Project Name _____ Instrument _____

Job Number _____ Serial # _____

DATE	INSTRUMENT	BATTERY CHECK OK?	ZERO ADJUST OK?	CALIBRATION GAS (PPM)	READING (PPM)	CALIBRATED BY	COMMENTS

80-310

ATTACHMENT J

OVA AND PID OPERATING INSTRUCTIONS

FOXBORO OVA OPERATING INSTRUCTIONS

A. Move the INSTR switch to ON and allow five minutes to warm up.

B. Battery Check: Move INSTR/BATT Test Switch to the BATT position and ensure battery is charged by reading the indication on the readout meter.

C. Move the CALIBRATE Switch to X10 and adjust the meter reading to zero with the CALIBRATE ADJUST (zero) Knob.

D. Ensure the PUMP Switch is ON and observe the SAMPLE FLOW RATE Indicator. Indication should be approximately two units.

E. Open H2 TANK VALVE one (1) turn and observe the reading on the H2 TANK PRESSURE Indicator. (Approximately 150 psi of pressure is needed for each hour of operation.)

F. Open H2 SUPPLY VALVE 1/2 to 1 turn and observe the reading on the H2 SUPPLY PRESSURE Indicator.

CAUTION

Do not leave H2 SUPPLY VALVE open when the pump is not running, as this will allow hydrogen to accumulate in the detector chamber.

G. Confirm that meter is still reading zero (readjust if required).

H. Depress ignite button. There will be a slight "pop" as the hydrogen ignites and the meter pointer will move upscale of zero. Immediately after ignition, release the igniter button. Do not depress igniter button for more than six seconds. If burner does not ignite, let instrument run for several minutes and try again. After ignition, the meter pointer will indicate the background concentration. This background level is nulled out using the CALIBRATE ADJUST (zero) Knob.

I. Move instrument to an area which is representative of the "lowest ambient background concentration" (cleanest air) to be surveyed. Move the CALIBRATE Switch to X1 and adjust the meter to read 1 ppm with the CALIBRATE ADJUST (zero) Knob.

FOXBORO OVA FIELD CALIBRATION PROCEDURE

1. Start up OVA according to factory procedure; warm it up for ten minutes prior to calibration.

2. Fill a small (2 liter) Tedlar bag with 100 ppm Methane/balance air calibration gas.

3. Set the calibrate switch to X10.

4. Sample the gas from the Tedlar bag. Use the "gas select" potentiometer to adjust the reading on the readout scale to near 100 (10 x 10). The reading should stabilize in 20 to 30 seconds.

5. Lock the knob on the gas select potentiometer; the OVA is now ready to use.

SHUTDOWN PROCEDURE

The following procedure should be followed for shutdown of the instrument:

1. Close H2 SUPPLY VALVE.
2. Close H2 TANK VALVE.
3. Move the INSTR Switch to OFF.
4. Wait five seconds and move PUMP Switch to OFF. INSTRUMENT IS NOW IN A SHUTDOWN CONFIGURATION.

FOXBORO.HSP

HNu PID Operating Instructions

1. Before attaching the probe, check the function switch on the control panel to make sure it is in the off position.

2. Attach the probe by plugging in the 12-pin plug to the inter face on the readout module.

3. Turn the six-position function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scale. If not, recharge the batter. If the red indicator comes on, the battery should be recharged.

4. Turn the function switch to any range setting. Look into the end of the probe briefly to see if the lamp is on. If it is on, it will give a purple glow. Do not stare into the probe for any length of time as UV light can damage your eyes. The instrument is now ready for operation.

5. To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the span pot produces a downscale deflection, while counterclockwise rotation yields an upscale deflection. Note: No zero gas is needed since this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked (and adjusted, if necessary). Wait 15 to 20 seconds to ensure that the zero is stable. If necessary, readjust zero.

6. Turn function switch to the 0-20 position (or to scale to accommodate calibration gas).

7. For calibration of the instrument from the pressurized container, connect the valve (provided with the calibration kit) to the pressurized container of calibration, and convert the valve via Tygon tubing directly to the 8" extension to the photoionization probe. Crack the valve of the pressurized container until a slight flow is indicated on the gauge. The instrument draws in the volume of sample required for detection, and the flow in the rotameter indicates an excess of sample. Now adjust the span pot so that the instrument is reading the exact value of the calibration gas. (If the instrument span setting is changed, the instrument should be turned back to the standby position and the electronic zero should be readjusted, if necessary).

8. Place probe in the atmosphere to be monitored. If the needle moves to the upper limit of the scale, change the function switch to the next position.

ATTACHMENT K

WORK AREA PROTECTION GUIDANCE

WORK AREA PROTECTION GUIDANCE

CORRECT USE OF WORK AREA PROTECTION EQUIPMENT

1. High Level Warning

High Level Warning should be the first protection equipment to be placed in position. This will provide a degree of protection during positioning of the other equipment. Always start with the Advanced Warning and work back to the job site, establishing the guidance pattern and placing signs. The table below should be used only as a guide. Conditions will vary with type of operation and location.

Speed of Traffic	Distance from Work Site (High Level Warning)
25 or below*	-150 feet
35	250 feet
45	500 feet
55	750 feet
60	1500 feet
Expressway	1/2 Mile or More

* In heavily congested traffic areas, with slow moving vehicles, such as a downtown area, it may be advisable to place the high-level warning at the work area.

A good rule of thumb for placing the initial warning sign ahead of the work area is--the further the better the protection. Each situation will differ as in the case of hills and curves. Consideration should always be given, depending on the situation, for the use of Flagman.

2. Traffic Cones

Traffic cones create an excellent guidance path for the motorist when they are correctly positioned. Too many cones, cones in a soiled condition or improperly positioned cones only increase the hazard through confusion. Cones should only be used for guiding and channeling traffic. Keep them clean, visible and in good repair.

From the Advanced High Level Warning Device to the job site, cones should be positioned so as to effect a guidance path similar to that which is accomplished through striping, to direct vehicles into a Left Turn Lane. If cones are SPACED CORRECTLY with relation to speed to traffic, they will produce the same effect as a solid line to the approaching motorist.

The following table gives suggested distances for the spacing of Traffic Cones.

Miles per Hour	Distance in Feet
up to 30 mph	10 - 20 feet
30 - 45 mph	25 - 35 feet
45 - 55 mph	40 - 50 feet
55 and over	55 - 60 feet

3. Barricades

The generally accepted method is to place Barricades at right angles to the direction to the approaching traffic. They should be highly visible in themselves. There are many approved uses for Barricades and there are many variations in shapes and sizes. Refer to "Manual on Uniform Traffic Control Devices."

4. Flasher Warning Lights

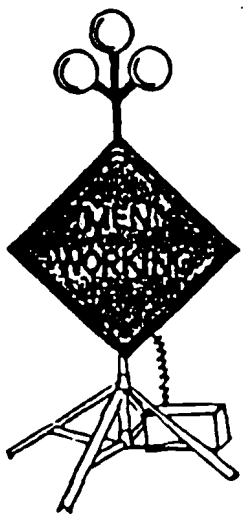
The most EFFECTIVE Flasher Warning Lights are those which incorporate the following:

7" diameter lens
Transistor circuit
Incandescent bulb
Percentage Dwell--22-28%
Flash Rate (approximately 70 fpm)

HIGH LEVEL WARNING PROTECTION

Advanced "High Level Warning" for daytime use

Easily assembled, 3 red flags—with stabilizing weights and wind spilling devices—the standard will withstand high winds without turning or toppling.



Advanced "High Level Warning" for night use

Three 7" diameter flashing amber lights. Battery operated—when positioned properly flasher warning lights create an excellent warning.

TABLE A

SUGGESTED SPACING OF HIGH LEVEL ADVANCED WARNING RELATED TO SPEED OF TRAFFIC

Speed of Traffic	Lane Closure	Low Level Guidance Traffic Cone Spacing	High Level Warning Sign to Work Site	Sign Legend	Sign Size
25 mph or below	No	10'	150'	Men Working	30" x 30"
35 mph	No	35'	250'	Men Working	30" x 30"
45 mph	No	45'	500'	Men Working	30" x 30"
	Yes	45'	1st Sign 500'	Right or Left Lane Closed Ahead	48" x 48"
			2nd Sign 150'	Men Working	30" x 30"
55 mph	No	55'	750'	Men Working	30" x 30"
	Yes	55'	1st Sign 750'	Right or Left Lane Closed Ahead	48" x 48"
			2nd Sign 150'	Men Working	30" x 30"
FREEWAY	No	65'	1st Sign 2500'	Men Working	48" x 48"
			2nd Sign 1500'	Men Working	48" x 48"
			3rd Sign 1000'	Men Working	48" x 48"
			4th Sign 500'	Men Working	48" x 48"
			5th Sign 150'	Men Working	30" x 30"
FREEWAY	Yes	65'	1st Sign 2500'+	Right or Left Lane Closed Ahead	48" x 48"
			2nd Sign 1500'	Right or Left Lane Closed Ahead	48" x 48"
			3rd Sign 1000'	Right or Left Lane Closed Ahead	48" x 48"
			4th Sign 500'	Right or Left Lane Closed Ahead	48" x 48"
			5th Sign 150'	Men Working	30" x 30"

NOTE: Freeway with median — repeat signing on median.
Lane Closure — repeat in opposite direction if guidance path affected.

ATTACHMENT L

MATERIAL SAFETY DATA SHEETS

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

NO. 43

TRISODIUM PHOSPHATE DODECAHYDRATE

Date November 1978

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: TRISODIUM PHOSPHATE DODECAHYDRATE

DESCRIPTION: Crystallizes from water as $Na_3PO_4.12H_2O$ and can exist as several hydrate forms, depending on processing, and as the anhydrous salt.

OTHER DESIGNATIONS: TSP, Trisodium Orthophosphate, Sodium Phosphate, Tribasic, Teriary Sodium Phosphate, GE Material D4K1, ASTM D538, CAS# 007 601 549

MANUFACTURER: Available from several suppliers, including FMC Corporation, Monsanto Co., Stauffer Chemical Co., and Olin Corp.

SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Trisodium Phosphate (as $Na_3PO_4.12H_2O$)	>97	No TLV established*
*Under OSHA inert dust limits it can be assumed that airborne particulate, not otherwise controlled, is limited to a maximum of 5 mg/kg of respirable dust; however, this level may not be adequate to prevent irritation with this material.		($Na_3PO_4.12H_2O$) Rat, Oral LD_{50} 7400 mg/kg

SECTION III. PHYSICAL DATA

Boiling point --------- -11 H_2O at 100 C (decomposes)

Melting point, deg C -- >73.3 (dec)

Solubility, g/100g H_2O:
- at 0 C ---------- 1.5
- at 15 C ---------- 28.3
- at 70 C ---------- 157

Specific gravity (20/4 C) ------- 1.62

pH of 1% water solution at 25 C - ca 12

Molecular weight ---------- 380.1

Appearance & Odor: White or colorless crystalline solid (also as powder flake, granules, etc.). No odor.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
None	None	None		

Extinguishing Media: Use that which is appropriate to the surrounding fire; this material is non-combustible.

In a fire situation at high temperature phosphates can emit highly toxic phosphorus oxide fumes. Firefighters should use self-contained breathing apparatus.

SECTION V. REACTIVITY DATA

This material is a stable alkaline solid at room temperature. It does not undergo hazardous polymerization.

It is incompatible with acidic materials.

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SECTION VI. HEALTH HAZARD INFORMATION

TLV None established (See Sect II)

This alkaline material will cause irritation to the respiratory tract if inhaled as a dust or as a solution mist. Prolonged or repeated skin contact will irritate the skin. Eye contact will irritate and can damage the eyes (alkaline attack). This material is low in toxicity by ingestion, but its alkaline nature will irritate, injure the digestive tract. (Trisodium phosphate is used as a food additive; but it must be reduced in alkalinity before being taken into the body.)

FIRST AID:

Eye contact: Promptly flush with plenty of water for 15 minutes. Get medical help.

Skin contact: Wash well with soap and water; rinse well with water. If irritation persists, get medical help.

Inhalation: Remove to fresh air. Get medical help if irritation persists.

Ingestion: Give 1-2 glasses of water or milk to drink to dilute; then give fruit juice or diluted vinegar to drink. Do not induce vomiting! Immediately contact a physician.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

For large spills, notify safety personnel. Clean-up personnel should use protection against contact or inhalation of dust or mist. Scoop up spill for recovery or disposal and place in a container with a lid. Flush residues to the sewer with plenty of water.

DISPOSAL: Scrap material can be used for neutralizing acidic wastes, or it can be buried in an approved manner in an approved landfill. Small amounts can be flushed to the sewer if regulations permit. Follow Federal, State and local regulations for disposal.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation to the workplace; if dusting conditions occur, local exhaust ventilation will be needed and a NIOSH approved dust respirator may be required.

The use of rubber or plastic gloves and chemical safety glasses with side shields is recommended for handling this material. An apron may also be desirable to prevent contact with clothing, especially where solutions are involved.

Provide eyewash station near to the workplace where this material is used; a safety shower may also be needed where large amounts of solution are prepared or used.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store this material in tightly sealed containers in a clean, dry, ventilated area. Prevent physical damage to containers.

Avoid contact with the body and inhalation of dust.

Note that anhydrous trisodium phosphate and lower hydrates are more alkaline on a weight basis than $Na_3PO_4 \cdot 12H_2O$.

DATA SOURCE(S) CODE: 1,2,4-7,12,15

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Material Safety Data Sheet

from Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 674

ISOBUTYLENE

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: ISOBUTYLENE

Description (Origin/Uses): Obtained from refinery steams by absorption on 65% sulfuric acid (H_2SO_4) at 59°F (15°C). Used primarily to produce diisobutylene, trimers, butyl rubber, and other polymers; also used to produce antioxidants for foods, plastics, and packaging food supplements.

Other Designations: Isobutene; 2-Methylpropene; *gamma*-Butylene; $CH_2=C(CH_3)_2$; CAS No. 0115-11-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 4 / 1 / 0 / -

HMIS			
H	1	R	1
F	4	I	1
R	0	S	1
PPG*		K	4

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

Ingredients and Hazards	%	Exposure Limits
Isobutylene, CAS No. 0115-11-57	Ca 100	OSHA PEL None Established ACGIH TLV, 1988-89 None Established NIOSH REL None Established Toxicity Data* Rat, Inhalation, LC_{50}: 620 g/m³ (4 Hrs) Mouse, Inhalation, LC_{50}: 415 g/m³ (2 Hrs)

*Monitor NIOSH, *RTECS* (UD0890000), for additional data.

SECTION 3. PHYSICAL DATA

Boiling Point: -19.6°F (-6.9°C)
Melting Point: -220°F (-140°C)
Vapor Density (Air = 1): 1.9
Specific Gravity (H_2O = 1): Ca 0.6
Molecular Weight: 56 Grams/Mole
Solubility in Water (%): Insoluble*
% Volatile by Volume: 100

Appearance and Odor: A colorless, extremely flammable gas; odor not listed.

*Isobutylene is very soluble in alcohol, ether, and sulfuric acid.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature: 869°F (465°C)	LEL: 1.8% v/v	UEL: 9.6% v/v

Extinguishing Media: Isobutylene gas is an extremely flammable gas that has a substantial explosive air-gas range. For isobutylene fires, the recommended fire-fighting technique is to stop the flow of gas instead of extinguishing the fire. If the flames are extinguished and the isobutylene gas continues to escape or leak, an explosive air-gas mixture can form quickly and ignite without warning. A resulting explosion could cause greater damage than that which would be caused by allowing the fire to burn itself out. If the fire must be extinguished to allow safe access to shutoff valves, recommended extinguishing agents include CO_2 and dry chemical. **Unusual Fire or Explosion Hazards:** In many cases, the preferred strategy is to allow the flames to continue to burn and to cool the surroundings with water spray to prevent ignition of nearby combustibles. Isobutylene gas is heavier than air and can collect in low-lying, confined spaces. Potentially explosive air-gas mixtures are especially likely to build up in such an area, so enter it with extreme caution whether or not it is presently involved in a fire. Possible sources of ignition must not be brought into any area suspected of containing substantial concentrations of isobutylene gas. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Sax (Genium ref. 6) reports a flash point of -105°F (-76°C) for isobutylene.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Isobutylene is stable in closed, pressurized containers during routine operations at room temperature. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Isobutylene can react dangerously with strong oxidizing materials. **Conditions to Avoid:** Prevent exposing isobutylene to any source of ignition such as an open flame, sparks, lighted tobacco products, or steam lines. **Hazardous Products of Decomposition:** Isobutylene fires can produce toxic gases such as carbon monoxide (CO) or lower-molecular-weight hydrocarbons. **Comments:** The extreme flammability of isobutylene means that any reactions involving this material, including nonhazardous ones, must be performed carefully in order to prevent fires and/or explosions.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Isobutylene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Isobutylene is a simple asphyxiant. As such it will not cause significant physiological responses, but it can displace the minimum required atmospheric oxygen level. Significant displacement by isobutylene results in an oxygen-deficient atmosphere with no adequate warning properties. Asphyxiation fatalities can occur especially in confined, low-lying, poorly ventilated spaces because isobutv-

SECTION 6. HEALTH HAZARD INFORMATION. cont.

lene gas is almost twice as dense as air itself (see sect. 3). **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** None reported. **Primary Entry:** Inhalation. **Acute Effects:** Initial symptoms of the effects of simple asphyxiant gases are rapid respiration and air hunger, diminished mental alertness, and impaired muscular coordination. Continuing lack of oxygen causes faulty judgment, depression of all sensations, rapid fatigue, and emotional instability. As the asphyxia continues, nausea; vomiting; prostration; loss of consciousness; and, finally, convulsions; deep coma; and death can occur. **Chronic Effects:** None reported. **FIRST AID:** Inhalation. Would-be rescuers need to be concerned about their own safety when entering confined, poorly ventilated, oxygen-deficient areas. Self-contained breathing equipment must be readily available for rescuers. Station standby workers outside the immediate area so that they can summon additional help if it is needed. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Comments:** The extreme flammability of isobutylene gas warrants special attention even during rescue operations. Rescue personnel must not smoke. All emergency lamps and floodlights that must be lowered into enclosed areas for rescue operations must be explosion proof. Obtain this equipment before any emergency occurs and make it accessible to emergency-response personnel. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat any isobutylene gas leak as an emergency.* If the leaking gas has not yet ignited, use water spray to direct flammable gas-air mixtures away from sources of ignition. Extinguish all sources of ignition as quickly as possible; however, if the leaking gas is burning, do not attempt to extinguish the flames until the source of the isobutylene gas is located and sealed. Otherwise, flammable isobutylene gas-air mixtures can explode without warning and cause widespread damage that might not have occurred if the original fire had been allowed to burn itself out. If it is necessary to extinguish isobutylene flames in order to gain access to a shutoff valve, use dry chemical or carbon dioxide as extinguishing agents. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z): Not Listed

EPA Designations (40 CFR 302.4): Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres, which lack warning properties; to work in them safely requires that an SCBA be worn. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the lower explosive limit cited in section 4. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale isobutylene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store isobutylene in closed, pressurized containers in a cool, dry, well-ventilated area away from sources of ignition, combustible materials, and strong oxidizers. Protect containers from physical damage. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent static sparks. **Comments:** Isobutylene is an extremely explosive and flammable gas. It must not be exposed to any possible source of ignition in work or storage areas.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Liquefied Petroleum Gas
DOT Hazard Class: Flammable Gas
ID No. UN1055
DOT Label: Flammable Gas
DOT Packaging Requirements: 49 CFR 173.304, .314, .315
DOT Packaging Exceptions: 49 CFR 173.306

IMO Shipping Name: Isobutylene
IMO Hazard Class: 2.1
IMO Label: Flammable Gas

References: 1, 6, 84-94, 116, 117, 120, 122.

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 7

NITRIC ACID
(Revision C)
Issued: October 1980
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: NITRIC ACID

Description (Origin/Uses): Used to dissolve noble metals, for etching and cleaning metals, to make organic nitrates and nitrocompounds, to destroy residues of organic matter, and in explosives.

Other Designations: Red Fuming Nitric Acid; HNO_3; CAS No. 7697-37-2

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 0 / 3 / 0 / oxy

HMIS			
H	3	R	1
F	0	I	4
R	1	S	4
PPG*		K	0

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

Ingredients	%	Exposure Limits
Nitric Acid, CAS No. 7697-37-2	*	**OSHA PEL** 8-Hr TWA: 2 ppm, 5 mg/m³ **ACGIH TLVs, 1987-88** TLV-TWA: 2 ppm, 5 mg/m³ TLV-STEL: 4 ppm, 10 mg/m³ **Toxicity Data**** Mouse, Inhalation, LC_{50}: 67 ppm/4 Hrs

*Contact your supplier to determine the percent by weight of nitric acid in the purchased product. Water is the other component of the product.
**See NIOSH, *RTECS* (QU5775000, QU5900000), for additional data with references to reproductive effects.

SECTION 3. PHYSICAL DATA

Boiling Point: Ca 251°F (122°C)*
Specific Gravity (H_2O = 1): 1.4*
pH: Very Acidic
Water Solubility (%): Complete
Molecular Weight: 63 Grams/Mole
Melting Point: Ca -30°F (-34°C)*

Appearance and Odor: A water white to slightly yellow liquid that darkens to a brownish color on aging and exposure to light; characteristic nitrogen dioxide (NO_2) odor.

*These properties are for the approximately 68%-by-weight nitric acid that is commercially available.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Nitric acid does not burn. Use extinguishing agents that will put out the surrounding fire. Use a water spray to dilute nitric acid during fires and to absorb liberated oxides of nitrogen.

Unusual Fire or Explosion Hazards: Although nitric acid does not burn, it is a strong oxidizing agent that can react with combustible materials to cause fires. Also, it can react with metals to liberate extremely flammable hydrogen gas. If this happens, direct fire-fighting procedures at this evolved hydrogen gas.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Choose protective equipment carefully (see sect. 5, Conditions to Avoid).

SECTION 5. REACTIVITY DATA

Nitric acid is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Nitric acid reacts explosively with metallic powders, carbides, hydrogen sulfide, and turpentine. Contact with organic materials such as wood, paper, sawdust, or alcohol, etc., may cause fires. Combustible materials can attain an increased flammability after being exposed to nitric acid even if they do not immediately catch fire.

Conditions to Avoid: Avoid any contact with incompatible chemicals. Because it is so reactive, always establish another material's compatibility with nitric acid before mixing the two materials. This applies to the selection of safety and handling equipment, because nitric acid can attack some forms of coatings, plastics, and rubber.

Hazardous Products of Decomposition: Various nitrogen oxides, including nitric oxide (NO), nitrogen dioxide (NO_2), nitrous oxide (N_2O), as well as nitric acid mist or vapor, can be produced by the decomposition reactions that can affect the nitric acid during fires.

SECTION 6. HEALTH HAZARD INFORMATION

Nitric acid is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: This material is corrosive to any body tissue it contacts. Dental erosion is also reported.
Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** Skin, eyes, mucous membranes of the respiratory tract, teeth. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Irritation and/or corrosive burns of skin, eyes, and upper respiratory tract (URT), delayed pulmonary edema, pneumonitis, bronchitis, and dental erosion. **Chronic Effects:** None reported.

FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Treat for eye burns. **Skin.** Immediately wash the affected area with soap and water. Watch for chemical skin burns and treat them accordingly. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. If the exposure is severe, hospitilization with careful monitoring by trained medical personnel to detect the delayed onset of severe pulmonary edema (lungs filled with fluid) is recommended for at least 72 hours. **Ingestion.** Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. Do not induce vomiting. If the exposed person is responsive, give him or her one or two glasses of milk or water to drink as quickly as possible after exposure.
GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. NOTE TO PHYSICIAN: Wash affected skin areas with a 5% solution of sodium bicarbonate ($NaHCO_3$). If ingested, the risk versus the benefit of the passage of a naso-gastric tube is debatable. Activated charcoal is of *no* value. Do *not* give the exposed person bicarbonate to neutralize the material.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately in case contact with metals should produce highly flammable hydrogen gas. Cleanup personnel need protection against contact with and inhalation of nitric acid (see sect. 8). Contain large spills and collect waste. Use water sprays to direct nitric acid away from incompatible chemicals (see sect. 5). Neutralize the spilled nitric acid with soda ash or sodium bicarbonate. Use an absorbent such as sand, earth, or vermiculite on the resulting slurry and place the neutralized nitric acid material into containers suitable for eventual disposal, reclamation, or destruction.
Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per Clean Water Act (CWA), Section 311 (b) (4)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of nitric acid solution is possible, wear a full faceshield as a supplementary protective measure. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Consult the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for general recommendations on proper respiratory procedures. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent skin contact with nitric acid. Choose protective equipment carefully (see sect. 5, Conditions to Avoid).
Ventilation: Install and operate both general and local exhaust-ventilation systems powerful enough to maintain airborne concentrations of nitric acid below the OSHA PEL standard cited in section 2. Construct exhaust ducts and systems with material such as fiberglass, which resists attack by nitric acid. **Safety Stations:** Make emergency eyewash stations, washing facilities, and safety/quickdrench showers available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean nitric acid from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Provide preplacement and annual medical exams with emphasis on skin irritation to workers who are regularly exposed to nitric acid. Workers must receive training before handling this material in the workplace; even experienced workers should undergo refresher training periodically.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store nitric acid in a cool, dry, well-ventilated area away from incompatible chemicals (see sect. 5). Consider outside, isolated, or detached storage. Protect containers from direct sunlight.
Special Handling/Storage: Build all storage facilities of nonflammable materials that are resistant to chemical attack by nitric acid. Protect containers from physical damage. Preplan for routine use and emergency response.
Engineering Controls: Proper ventilation is essential in bulk storage areas; consider installing an automatic monitoring system to detect hazardous levels of nitrogen oxides that can develop from this material.
Comments: Separate nitric acid from hydrazine, diethylenetriamine, fluorides, and all other corrosives except sulfuric acid and sulfur trioxide when shipping or transferring it.
Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: (I) Nitric Acid, Fuming or (II) Nitric Acid, Over 40% or (III) Nitric Acid, 40% or Less
(I) Oxidizer and Poison or (II) Oxidizer and Corrosive or (III) Corrosive
DOT Hazard Class: (I) and (II) Oxidizer or (III) Corrosive Material
DOT ID Nos. (I) UN2032; (II) UN2031; (III) NA1760
8 (All Types of Nitric Acid)
DOT Label: (I) Corrosive, Oxidizer, Poison; or (II) and (III) Corrosive
References: 1, 2, 26, 38, 84-94, 100, 112, 113, 114.

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Material Safety Data Sheets Collection:

Sheet No. 30A
Hydrochloric Acid
Issued: 10/77 Revision: C, 9/92 Erratum: 5/93

Section 1. Material Identification

Hydrochloric Acid (HCl) Description: An aqueous solution of hydrogen chloride. Derived by dissolving hydrogen chloride gas in water at various concentrations. Hydrochloric acid is also formed as a byproduct from oxychlorination and/or oxyhydrochlorination of organic materials. Used in metal pickling and cleaning (boiler and heat exchange equipment scale removal), ore reduction, processing (corn syrup, hydrolyzing starch), dye and dye intermediate production, electroplating, leather tanning, in fertilizer, artificial silk, and paint pigment production, refining soaps and edible fats and oils, petroleum extraction, toilet bowl cleaners; as an alcohol denaturant, a chemical intermediate and solvent in organic synthesis, and in the photographic, textile, and rubber industries.

Other Designations: CAS No. 7647-01-0, Caswell No. 486, chlorohydric acid, Muriatic acid, spirits of salt.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Hydrochloric acid is highly corrosive and causes serious skin and eye burns as well as acute and chronic respiratory problems.

R 1
I 4
S 4
K 0

NFPA
0
3 0
-

HMIS
H 2*
F 0
R 0
PPE†
* Chronic effects
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Hydrochloric acid; ~38% (commercial), 20% ("azeotrope"). Trace impurities include ammonia, arsenic, iron, sulfate, free Cl-, and heavy metals.

1991 OSHA PEL
Ceiling: 5 ppm (7 mg/m^3)

1990 IDLH Level
100 ppm

1990 NIOSH REL
Ceiling: 5 ppm (7 mg/m^3)

1992-93 ACGIH TLV
Ceiling: 5 ppm (7.5 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 5 ppm (7 mg/m^3)
Category 1: local irritants
Peak Exposure Limit: 10 ppm,
5 min momentary value/8 per shift

1985-86 Toxicity Data*
Human, inhalation, LC_{Lo}: 1300 ppm/30 min; toxic effects not yet reviewed
Rabbit, oral, LD_{50}: 900 mg/kg; toxic effects not yet reviewed
Rat, inhalation, TC_{Lo}: 450 mg/m^3/1 hr (1 day prior to pregnancy) produced fetotoxicity (except death) & specific developmental abnormalities (homeostasis).
Rabbit, eye: 100 mg rinse caused mild irritation.

*See NIOSH, *RTECS* (MW4025000), for additional irritation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: -120.64 °F (-84.8 °C)*
Vapor Pressure: 4 atm at 64 °F (17.8 °C)
Vapor Density (Air = 1): 1.257
Surface Tension: 23 at 244.68 (118.16 °C)
Molecular Weight: 36.46
Odor Threshold: 0.1 to 5 ppm
Ionization Potential: 12.74 eV

Freezing Point: 1.1 °F (-17.14 °C) for 10.81%, -51.16 °F (-46.2 °C) for 31.24%
Density: 1.194 at -14.8 °F (-26 °C)
Water Solubility: Soluble, 823 g/L at 32 °F (0 °C); 561 g/L at 140 °F (60 °C).
Other Solubilities: Soluble in alcohol, benzene, and ether; insoluble in hydrocarbons
pH: 1N (0.1), 0.1N (1.1), 0.01N (2.02), 0.001N (3.02), 0.0001N (4.01)
Refraction Index (1N solution): 1.34168 at 64.4 °F (18 °C/D)

Appearance and Odor: Colorless liquid that fumes in air and has a strong pungent odor. Can be slightly yellow from traces of iron, chlorine, or organic matter. Forms a constant boiling azeotrope at 20 % HCl, 108.58 °C and 760 mm Hg.

* Decomposes at 3239.6 °F (1782 °C).

Section 4. Fire and Explosion Data

Flash Point: Noncombustible	Autoignition Temperature: None reported	LEL: None reported*	UEL: None reported*

Extinguishing Media: Use extinguishing agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: *Extreme heat or contact with many metals liberates hydrogen gas which has explosion limits of 4 to 75%.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing is *ineffective* for fires involving hydrochloric acid. Stay away from ends of tanks. Cool tanks with water spray until well after fire is out. *Do not* release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Hydrochloric acid has high thermal stability (decomposes at 3239.6 °F/1782 °C). Hazardous polymerization does not occur unless exposed to aldehydes or epoxides.
Chemical Incompatibilities: Polymerizes on contact with aldehydes or epoxides; attacks most metals (except mercury, silver, gold, platinum, tantalum, and some alloys), some plastics, rubber, and coatings; reacts explosively with alcohols + hydrogen cyanide, potassium permanganate, tetraselenium tetranitride; ignites on contact with fluorine, hexalithium disilicide, metal acetylides or carbides (cesium acetylide, rubidium acetylide); and is incompatible with acetic anhydride, 2-amino ethanol, ammonium hydroxide, calcium phosphide, chlorosulfonic acid, 1,1-difluoroethylene, ethylene diamine, ethylene imine, oleum, perchloric acid, ß-propiolacetone, propylene oxide, sodium hydroxide, silver perchlorate + carbon tetrachloride, sulfuric acid, uranium phosphide, acetate, calcium carbide, magnesium bromide, mercuric sulfate, and chlorine + dinitroaniline.
Conditions to Avoid: Avoid contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of HCl produces toxic chloride fumes and explosive hydrogen gas.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list HCl as a carcinogen.
Summary of Risks: HCl is a highly corrosive liquid and depending on concentration and duration of exposure, symptoms range from irritation to ulcerations and permanent injury. **Target Organs:** Eyes, skin, respiratory tract, and liver (in animals). **Primary Entry Routes:** Inhalation, skin and eye contact. **Medical Conditions Aggravated by Long-Term Exposure:** Respiratory disorders.

Section 6. Health Hazard Data, *continued*

Acute Effects: Inhalation of vapors or mists is corrosive to the respiratory tract and can cause tracheal and bronchial epithelium necrosis (tissue death), cough, choking, ulceration. Liquid aspiration can cause pulmonary edema, lung collapse, emphysema and damage to the pulmonary blood vessels. Skin contact with HCl solutions causes burns and ulcerations. Permanent eye damage may result from splashes. Ingestion is unlikely but if it occurs, symptoms include gray tongue color, corrosion of mucous membranes, esophagus, and stomach, nausea, vomiting, intense thirst, diarrhea, difficulty swallowing, circulatory collapse and possible death. **Chronic Effects:** Repeated or prolonged exposure can cause dermatitis, conjunctivitis, gastritis, photosensitization, tooth erosion, and repeated exposure to mists from heated-metal pickling solutions can cause nose and gum bleeds, ulceration of oral or nasal mucosa, and "renders facial skin so tender that shaving is painful."[133]

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Treat skin with a 5% triethanolamine solution. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting!

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Consider a chest x-ray in acute overexposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Neutralize spills with crushed limestone, soda ash, lime, or sodium bicarbonate. After neutralizing, take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for disposal; flush large spills to containment area and reclaim (if possible) or await disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** In soil, HCl will infiltrate moving faster in the presence of moisture. It may dissolve some soil matter, particularly those of a carbonate base will be neutralized to some degree and will be transported to groundwater. **Ecotoxicity Values:** Chronic plant toxicity = 100 ppm; injurious to irrigatable crops at 350 mg/L; trout, LC_{100}, 10 mg/L/24 hr shrimp, LC_{50}, 100 to 330 ppm/starfish, LC_{50}, 100 to 330 mg/L/48 hr; shore crab, LC_{50}, 240 mg/L/48 hr. **Disposal:** Neutralize to between 5.5 & 8.5 before disposal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.23, *0.01N solution or higher*): No. D002, Characteristic of corrosivity
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 5000 lb (2270 kg) [* per CWA, Sec. 311 (b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 50 ppm, use a cartridge respirator with acid gas cartridges, or any supplied-air respirator (SAR) or SCBA. For < 100 ppm, use any chemical cartridge respirator with a full facepiece and cartridge that protects against HCl inhalation, or any SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polycarbonate, butyl rubber, polyvinyl chloride, and chlorinated polyethylene are recommended materials for PPE. Polyvinyl alcohol is not recommended. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area on a cement floor away from direct sunlight and heat sources. Use decanting pumps or pouring frames to minimize spillage during loading and unloading operations.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. HCl should be manufactured in closed systems. Pay close attention to leak detection. Aqueous scrubbers are used to control hydrogen chloride emissions from vent stacks and other sources. Workers shouldn't enter tanks previously containing HCl until they have been cleaned.

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the eyes, skin, and respiratory tract. Pulmonary function tests (FEV, FVC) are useful in determining lung disorders. Conduct difficult operations in fume hoods.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Hydrochloric acid, solution
DOT Hazard Class: 8
ID No.: UN1789
DOT Label: Corrosive
DOT Packing Group: II
Special provisions (172.102): A3, A6, B2, B15, N41, T9, T27

Packaging Authorizations
a) Exceptions: 173.154
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity limitations
a) Passenger, Aircraft, or Railcar: 1 L
b) Cargo Aircraft Only: 30 L

Vessel Stowage Requirements
a) Vessel Stowage: C
b) Other: 8

***MSDS Collection* References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 180
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD

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Material Safety Data Sheets Collection:

Sheet No. 361
Ethyl Alcohol

Issued: 10/77 Revision: C, 9/92

Section 1. Material Identification

39

Ethyl Alcohol (CH_3CH_2OH) Description: Produced from ethylene by direct catalytic hydration or with ethyl sulfate as intermediate; by enzymatic hydrolysis of cellulose; by fermentation of starch, sugar, and other carbohydrates; or by oxidation of methane. Anhydrous ethyl alcohol is manufactured on a large scale by azeotropic distillation. In laboratories and industry ethyl alcohol is used as solvent for resins, fats, fatty acids, oils, and hydrocarbons; in the manufacture of denatured alcohol, synthetic rubber, acetic acid acetaldehyde, ethylene, butadiene, 2-ethyl hexanol, pharmaceuticals (rubbing compounds, lotions, tonics, colognes), cosmetics, detergents, elastomers, cleaning preparations, surface coatings, explosives; as an antifreeze and an octane booster in gasoline. Ethyl alcohol in suitable dilutions is used in alcoholic beverages.
Other Designations: CAS No. 64-17-5, alcohol, Algrain, Anhydrol, cologne spirit, dehydrated alcohol, ethanol, EtOH, ethyl hydrate, ethyl hydroxide, fermentation alcohol, grain alcohol, Jaysol, methylcarbinol, molasses alcohol, NCI-C03134, potato alcohol, spirits of wine, Spirit, Tecsol.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.
Cautions: Ethyl alcohol is an eye and mucous membrane irritant and central nervous system (CNS) depressant. Avoid exposure to high vapor concentrations. It is a dangerous fire and explosion hazard.

R	1
I	1
S	2
K	4

NFPA: 3 / 0 / 0 / -

HMIS
H 1*
F 3
R 0
PPE†
* Chronic Effects
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Ethyl Alcohol, ca 100%

1991 OSHA PEL
8-hr TWA: 1000 ppm (1900 mg/m³)

1992-93 ACGIH TLV
TWA: 1000 ppm (1880 mg/m³)

1990 DFG (Germany) MAK
TWA: 1000 ppm (1900 mg/m³)
Category IV: Substances eliciting very weak effects
Short-term Level, Peak: 2000 ppm, 60 min, momentary value, 3 times/shift

1990 NIOSH REL
TWA: 1000 ppm, (1900 mg/m³)

1985-86 Toxicity Data*
Human, oral, LD_{Lo}: 1400 mg/kg caused sleep, headache, nausea, and vomiting.
Woman, oral, TD_{Lo}: 256 g/kg/12 weeks caused hallucinations and distorted perceptions and effected the menstrual cycle.
Woman, oral, TD_{Lo}: 41 g/kg (41 weeks preg.) produced effects on the newborn (Apgar score; other neonatal measures or effects; drug dependence)
Human, DNA inhibition, lymphocyte: 220 mmol/L
Rat, inhalation, LC_{50}: 20000 ppm/10 hr; toxic effects not yet reviewed.
Rabbit, eye: 100 mg/24 hr caused moderate irritation.

* See NIOSH, *RTECS* (KQ6300000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: 173.3 °F (78.5 °C)
Melting Point: -173.4 °F (-114.1 °C)
Vapor Pressure: 43 mm Hg at 68 °F (20 °C)
Saturated Vapor Density (Air = 1.2 kg/m³, 0.075 lbs/ft³): 1.24 kg/m³, 0.078 lbs/ft³
Surface Tension: 22.75 dyne/cm in contact with vapor at 20 °C
Viscosity: 1.200 cP at 20 °C

Molecular Weight: 46.07
Specific Gravity: 0.7893 at 20 °C/4 °C
Water Solubility: Miscible
Other Solubilities: Chloroform, ether, acetone, methanol
Octanol/Water Partition Coefficient: log K_{ow} = -0.31
% in Saturated Air: 6.58 at 77 °F (25 °C)
Odor Threshold: 84 ppm

Appearance and Odor: Clear, colorless, very mobile, fragrant liquid with a burning taste.

Section 4. Fire and Explosion Data

Flash Point: 55 °F (13 °C) CC	Autoignition Temperature: 685 °F (363 °C)	LEL: 3.3% v/v	UEL: 19% v/v

Extinguishing Media: Do not extinguish fire unless flow can be stopped. Carbon dioxide and alcohol-resistant foam are the most appropriate extinguishers. Use water in flooding quantities as fog. **Unusual Fire or Explosion Hazards:** Vapor may explode if ignited in an enclosed area. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. If feasible and without undue risk, move containers from fire area or apply cooling water to fire-exposed containers until well after fire is out. For massive fires, use unmanned hose holders or monitor nozzles or withdraw from area and let burn. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: EtOH is stable at room temperature in closed containers under normal storage and handling conditions. It absorbs water rapidly from air. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include strong oxidizing agents, perchlorates, calcium hypochlorite, chlorine oxides, mercuric nitrate, hydrogen peroxide, nitric acid, bromine pentafluoride, uranyl perchlorate, nitrosyl perchlorate, chromyl chloride, permanganic acid, uranium hexafluoride, iodine heptafluoride, disulfuryl difluoride, acetyl chloride, acetyl bromide (evolves hydrogen bromide); manganese perchlorate + 2,2-dimethoxypropane; cyanuric acid + water; dichloromethane + sulfuric acid + nitrate or nitrite; tetrachlorisilane + water. Ignites on contact with phosphorous (III) oxide, platinum, disulfuric acid + nitric acid, potassium *tert*-butoxide + acids. EtOH ignites and then explodes on contact with acetic anhydride + sodium hydrogen sulfate. Forms explosive products in reaction with silver nitrate (forms ethyl nitrate); ammonia + silver nitrate (forms silvernitride and silver fulminate); magnesium perchlorate (forms ethyl perchlorate); sodium (evolves hydrogen gas); nitric acid + silver (forms silver fulminate); silver (I) oxide + ammonia or hydrazine (forms silver nitride and silver fulminate). **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of ethyl alcohol can produce oxides of carbon.

Section 6. Health Hazard Data

Carcinogenicity: The IARC lists ethyl alcohol as a confirmed human carcinogen for ingestion of beverage alcohol. Chronic ethanol ingestion is associated with hepatoma (liver cancer).
Summary of Risks: EtOH is an eye and mucous membrane irritant and CNS depressant. Concentrations of 5000 to 10,000 ppm caused transient irritation of the eyes and nose; 15,000 ppm caused continuous lacrimation and cough; and >20,000 ppm was intolerable. Under reasonable conditions of handling and use, the hazards from industrial exposure to EtOH are low. There is no concrete evidence that exposure to EtOH vapor causes cirrhosis of the liver. A tolerance is acquired after repeated exposure to ethyl alcohol and may be a factor in individual response to a given concentration. The well-known effects of alcoholism from the excessive ingestion of alcoholic beverages are not a likely consequence of typical industrial exposure. Most industrial EtOH contains a denaturant, i.e., a substance added to render it undesirable to drink.

Continued on next page

Section 6. Health Hazard Data, *continued*

Denaturants (for ex. gasoline, acetone, formaldehyde, methyl alcohol) may cause other effects. EtOH is not irritating to the skin nor is it absorbed in appreciable amounts. EtOH may act as an adjuvant, increasing the toxicity of other inhaled, absorbed, or ingested chemical agents.
Medical Conditions Aggravated by Long-Term Exposure: Liver disease. **Target Organs:** Mucous membranes, eyes, CNS. **Primary Entry Routes:** Ingestion, inhalation, eye contact. **Acute Effects:** Prolonged exposures to excessive concentrations may produce eye, mucous membrane and upper respiratory irritation, headache, nervousness, dizziness, tremors, fatigue, nausea, and narcosis (stupor or unconsciousness). Liquid splashed in the eye causes immediate burning and stinging sensation with tearing and reflex closure of the lids, transitory injury of the corneal epithelium, and hyperemia (excess of blood in a body part) of the conjunctiva. Although ingestion is not a likely route for industrial exposure, symptoms include sleep disorders, hallucinations, distorted perceptions, convulsions, motor activity changes, ataxia (loss of muscular coordination), coma, headache, pulmonary changes, alteration in gastric secretion, nausea or vomiting, menstrual cycle changes, glandular changes, and body temperature decrease. **Chronic Effects:** Chronic vapor exposure may result in mucous membrane irritation, headache, and CNS depression symptoms including somnolence (prolonged sleepiness) and lack of concentration. Prolonged or repeated skin contact may cause defatting and dermatitis.
FIRST AID
Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. Dispose of contaminated clothing carefully as it may pose a fire hazard.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Position patient with head forward and mouth down to avoid aspiration of vomitus. **After first aid, get appropriate in-plant, paramedic, or community medical support.**
Note to Physicians: Diagnostic tests include alcohol in expired air, urine or blood. Activated charcoal does not reduce ethanol absorption. Because hemodialysis effectively removes ethanol, consider it in those patients who deteriorate despite conventional therapy. With severe toxicity, watch for respiratory depression; intubation support may be needed.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Attempt to stop the leak if without undue risk. Use water spray to disperse vapors and dilute standing pools of liquid. For small spills, take up with sand or other noncombustible absorbent and place into containers for later disposal. For large spills, dike far ahead of spill to contain liquid for later disposal. Keep EtOH out of sewers and water sources. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** EtOH is not expected to bioconcentrate in fish. **Aquatic toxicity:** 250 ppm/6 hr/ (goldfish/lethal/fresh water). **Environmental Degradation:** When released to the atmosphere, EtOH will photodegrade in hours (polluted urban atmosphere) to an estimated range of 4 to 6 days in less polluted areas. When released into water, it will volatilize and probably biodegrade. BOD: (Biochemical Oxygen Demand) 125%, 5 days; 44.2% (theor.), 5 days; 71.2% (theor.), 20 days **Soil Absorption/Mobility:** When spilled on land, it is apt to volatilize, biodegrade, and leach into the ground water. It is not expected to absorb to sediment and its fate in ground water is unknown.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
Listed as a RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4, Unlisted Hazardous Wastes Characteristic of Ignitability): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001]
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged skin contact. Consider natural rubber, neoprene, nitrile, or Viton for PPE as these compounds have breakthrough times of at least one hour or more. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, well-ventilated area away from heat and ignition sources and incompatibles (Sec. 5). Protect containers against physical damage. If large quantities of EtOH are used, underground storage tanks outside the building are preferred.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Provide sills and curbs and design floors to limit the spread of escaping liquid. Prohibit the use of compressed air or oxygen to transport alcohol. To prevent ignition sources in areas where large quantities of EtOH are made or used, provide flameproof electrical installations and equipment (Class I, Group D).

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Ethanol or Ethyl alcohol
DOT Hazard Class: 3
ID No.: UN1170
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: - -

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 175, 176,
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** Dave Wilson, CIH; **Medical Review:** Warren Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 397
n-Hexane

Issued: 8/83 Revision: C, 8/89

Section 1. Material Identification

***n*-Hexane Description:** *n*-Hexane is the chief constituent of petroleum ether or liqroin. Used to determine the refractive index of minerals; and as a mercury replacement in thermometers (usually with blue or red dye).
Other Designations: Normal-hexane; C_6H_{14}; CAS No. 0110-54-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.
Comments: See *MSDS Collection*, No. 397A, for isohexanes.

R 1
I 3
S 2
K 4

NFPA
HMIS
H 1
F 3
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

n-Hexane, ca 100%*

OSHA PEL
8-hr TWA: 50 ppm, 180 mg/m³

ACGIH TLV, 1988-89
TLV-TWA: 50 ppm, 180 mg/m³

Toxicity Data†
Human, inhalation, TC_{Lo}: 5000 ppm/10 min
Rat, oral, LD_{50}: 28,710 mg/kg

* *n*-Hexane is this product's major component; however, possible contaminants are other isomers of hexane, C_5 to C_7 saturated hydrocarbons, C_5 to C_7 olefinic hydrocarbons, and aromatic hydrocarbons.
† See NIOSH, *RTECS* (MN9275000), for additional data with references to reproductive, irritative, and neurological effects.

Section 3. Physical Data

Boiling Point: 156.11 °F (68.95 °C)
Melting Point: ca -139 °F (-95 °C)
Vapor Pressure: 124 torr at 68 °F (20 °C)
Vapor Density (Air = 1): 3.0
Molecular Weight: 86 g/mol
Specific Gravity (H_2O = 1): 0.66 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear, colorless, mobile, volatile, flammable liquid: a mild hydrocarbon odor.

Section 4. Fire and Explosion Data

Flash Point: -22 °F (-30 °C) CC	Autoignition Temperature: 473 °F (223 °C)	LEL: 1.2% v/v	UEL: 8% v/v

Extinguishing Media: Use carbon dioxide (CO_2), foams, or dry chemical to put out *n*-hexane fires. Never direct solid streams of water into burning pools of liquid since this can scatter and spread the fire. Use water sprays to cool fire-exposed containers, prevent dangerous pressure rise and/or rupture, disperse vapors, and flush unignited spills away from sensitive exposures.
Unusual Fire or Explosion Hazards: *n*-Hexane is a very flammable, volatile liquid which burns like gasoline. It represents a dangerous fire and explosion hazard. Since it evaporates quickly, the resulting denser-than-air vapors can flow along surfaces, collect in low-lying or enclosed areas like sumps and utility rooms, reach distant sources of ignition, and flash back to the original liquid.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

Section 5. Reactivity Data

Stability/Polymerization: *n*-Hexane is stable at room temperature during routine operations. Hazardous polymerization cannot occur.
Chemical Incompatibilities: *n*-Hexane can react violently with strong oxidizing agents.
Conditions to Avoid: Never expose this liquid to any ignition source (heat, sparks, open flames, or uninsulated heating elements).
Hazardous Products of Decomposition: Thermal oxidative degradation of *n*-hexane can produce carbon dioxide and toxic carbon monoxide (CO).

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists *n*-hexane as a carcinogen.
Summary of Risks: The metabolic products of *in vivo* partial oxidation of *n*-hexane include 2, 5-hexanedione. This metabolite is the most highly neurotoxic compound formed from *n*-hexane. Occupational exposures to *n*-hexane are associated with chronic neurotoxic damage to the central nervous system (CNS) and the peripheral nervous system (PNS). The effects are not permanent; Genium reference 100 notes that recovery from neuropathy is usually complete within a year after the exposure. Methyl *n*-butyl ketone (MBK) (*MSDS Collection*, No. 425) produces the neurotoxic metabolite 2, 5-hexadione in even greater quantities than the *n*-hexane. Prevent simultaneous exposures to *n*-hexane and MBK. Genium reference 89 notes: "...concurrent exposure to methyl ethyl ketone, and possibly other chemicals or drugs which boost liver oxidative mechanisms, reduces the time for neuropathy to appear as a result of exposure to both *n*-hexane and MBK." **Medical Conditions Aggravated by Long-Term Exposure:** CNS and PNS disorders, vision defects, and memory diminution. **Target Organs:** Skin, eyes, CNS, PNS. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Irritation of eyes, nose, and upper respiratory tract (URT); dermal erythema (abnormally red skin from capillary congestion), edema (abnormal accumulation of clear, watery fluid in body tissue), and vesiculation (blistering). Acute inhalation causes headache, dizziness, nausea, narcosis, and coma. High concentrations may act as asphyxiants. **Chronic Effects:** Anorexia, nausea, weight loss, malaise; muscular weakness, pain, and spasms in extremities; neurotoxic effects like sensorimotor polyneuropathy, generalized polyneuropathy, and other degenerative changes in the peripheral nervous system (PNS).

FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Have a qualified medical personnel adminsister oxygen as required. **Ingestion:** Never induce vomiting! Severe aspiration hazard exists. If vomiting occurs spontaneously, lower victim's head to the knee level. Never give anything by mouth to an unconscious or convulsing person. Administer several ounces of edible oil to drink.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a n-hexane spill control and countermeasure plan (SCCP).* When a spill occurs, notify safety personnel, evacuate unnecessary personnel, eliminate heat and ignition sources, provide maximum explosion-proof ventilation, and implement the SCCP. Cleanup personnel should wear fireproof personal protective equipment (Sec. 8).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Subpart Z)
EPA Designations
Assigned the RCRA Hazardous Waste No. D001 (40 CFR 261.21, Ignitability)
Assigned as a CERCLA Hazardous Substance (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg)
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Where splashing is possible, wear a full face shield. **Respirator:** Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, washing facilities, and properly serviced fire extinguishers. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Other:** Preplacement and periodic medical exams focusing on the skin nd the central nervous system are advised.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Handle this flammable, volatile material with appropriate caution.

Section 9. Special Precautions and Comments

Storage Requirements: Store *n*-hexane in closed containers in a cool, dry, well-ventilated, fireproof area away from heat and ignition sources and incompatible chemicals. Protect these containers from physical damage; shield them from direct sunlight.
Engineering Controls: To prevent static sparks, electrically ground and bond all containers, tank cars, and pipes used in shipping, receiving, or transferring operations in production and storage areas. All electrical services, including lights, must be sparkproof.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Hexane
DOT Hazard Class: Flammable liquid
DOT ID No.: UN1208
DOT Label: Flammable liquid
DOT Packaging Requirements: 49 CFR 173.119
DOT Packaging Exceptions: 49 CFR 173.118

IMO Shipping Name: Hexane *(and its isomers)*
IMO Hazard Class: 3.1
IMO Label: Flammable liquid
IMDG Packaging Group: II

***MSDS Collection* References:** 1, 6, 7, 84-94, 100, 116, 117, 119, 120, 122
Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD PS

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Material Safety Data Sheets Collection:

Sheet No. 467
Automotive Gasoline, Lead-free

Issued: 10/81 Revision: A, 9/91

Section 1. Material Identification

Automotive Gasoline, Lead-free, Description: A mixture of volatile hydrocarbons composed mainly of branched-chain paraffins, cycloparaffins, olefins, naphthenes, and aromatics. In general, gasoline is produced from petroleum, shale oil, Athabasca tar sands, and coal. Motor gasolines are made chiefly by cracking processes, which convert heavier petroleum into more volatile fractions by thermal or catalytic decomposition. Widely used as fuel in internal combustion engines of the spark-ignited, reciprocating type. Automotive gasoline has an octane number of approximately 90. A high content of aromatic hydrocarbons and a consequent high toxicity are also associated with a high octane rating. Some gasolines sold in the US contain a minor proportion of tetraethyllead, which is added in concentrations not exceeding 3 ml per gallon to prevent engine "knock." However, methyl-tert-butyl ether (MTBE) has almost completely replaced tetraethyllead.

Other Designations: CAS No. 8006-61-9, benzin, gasoline, gasolene, motor spirits, natural gasoline, petrol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*™ for a suppliers list.

R	1
I	2
S	2*
K	4

* Skin absorption

NFPA

HMIS

H	2
F	3
R	1

PPG†
† Sec. 8

Caution: Inhalation of automotive gasoline vapors can cause intense burning in throat and lungs, central nervous system (CNS) depression, and possible fatal pulmonary edema. Gasoline is a dangerous fire and explosion hazard when exposed to heat and flames.

Section 2. Ingredients and Occupational Exposure Limits

Automotive gasoline, lead-free*

1990 OSHA PELs
8-hr TWA: 300 ppm, 900 mg/m³
15-min STEL: 500 ppm, 1500 mg/m³

1990-91 ACGIH TLVs
TWA: 300 ppm, 890 mg/m³
STEL: 500 ppm, 1480 mg/m³

1990 NIOSH REL
None established

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 900 ppm/1 hr: toxic effects include sense organs and special senses (conjunctiva irritation), behavioral (hallucinations, distorted perceptions), lungs, thorax, or respiration (cough)
Human, eye: 140 ppm/8 hr: toxic effects include mild irritation
Rat, inhalation, LC_{50}: 300 g/m³/5 min

* A typical modern gasoline composition is 80% paraffins, 14% aromatics, and 6% olefins. The mean benzene content is approximately 1%. Other additives include sulfur, phosphorus, and MTBE.
† See NIOSH, *RTECS* (LX3300000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Initially, 102 °F (39 °C); after 10% distilled, 140 °F (60 °C); after 50% distilled, 230 °F (110 °C); after 90% distilled, 338 °F (170 °C); final boiling point, 399 °F (204 °C)
Vapor Density (air = 1): 3.0 to 4.0

Density/Specific Gravity: 0.72 to 0.76 at 60 °F (15.6 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear (gasoline may be colored with dye), mobile liquid with a characteristic odor recognizable at about 10 ppm in air.

Section 4. Fire and Explosion Data

Flash Point: -45 °F (-43 °C) | **Autoignition Temperature:** 536 to 853 °F (280 to 456 °C) | **LEL:** 1.3% v/v | **UEL:** 6.0% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or alcohol foam as extinguishing media. Use of water may be ineffective to extinguish fire, but use water spray to knock down vapors and to cool fire-exposed drums and tanks to prevent pressure rupture. Do not use a solid stream of water since it may spread the fuel.

Unusual Fire or Explosion Hazards: Automobile gasoline is an OSHA Class IB flammable liquid and a dangerous fire and explosion hazard when exposed to heat and flames. Vapors can flow to an ignition source and flash back. Automobile gasoline can also react violently with oxidizing agents.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode, and full protective clothing. When the fire is extinguished, use nonsparking tools for cleanup. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Automotive gasoline is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Automotive gasoline can react with oxidizing materials such as peroxides, nitric acid, and perchlorates.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of automotive gasoline can produce oxides of carbon and partially oxidized hydrocarbons.

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Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC list gasoline as a possible human carcinogen (Group 2B). Although the IARC has assigned an overall evaluation to gasoline, it has not assigned an overall evaluation to specific substances within this group (inadequate human evidence).
Summary of Risks: Gasoline vapors are considered moderately poisonous. Vapor inhalation can cause central nervous system (CNS) depression and mucous membrane and respiratory tract irritation. Brief inhalations of high concentrations can cause a fatal pulmonary edema. Reported responses to gasoline vapor concentrations are: 160 to 270 ppm causes eye and throat irritation in several hours; 500 to 900 ppm causes eye, nose, and throat irritation, and dizziness in 1 hr; and 2000 ppm produces mild anesthesia in 30 min. Higher concentrations are intoxicating in 4 to 10 minutes. If large areas of skin are exposed to gasoline, toxic amounts may be absorbed. Repeated or prolonged skin exposure causes dermatitis. Certain individuals may develop hypersensitivity. Ingestion can cause CNS depression. Pulmonary aspiration after ingestion can cause severe pneumonitis. In adults, ingestion of 20 to 50 g gasoline may produce severe symptoms of poisoning.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eye, respiratory and central nervous systems.
Primary Entry Routes: Inhalation, ingestion, skin contact.
Acute Effects: Acute inhalation produces intense nose, throat, and lung irritation; headaches; blurred vision; conjunctivitis; flushing of the face; mental confusion; staggering gait; slurred speech; and unconsciousness, sometimes with convulsions. Ingestion causes inebriation (drunkenness), vomiting, dizziness, fever, drowsiness, confusion, and cyanosis (a blue to dark purplish coloration of skin and mucous membrane caused by lack of oxygen). Aspiration causes choking, cough, shortness of breath, increased rate of respiration, excessively rapid heartbeat, fever, bronchitis, and pneumonitis. Other symptoms following acute exposure include acute hemorrhage of the pancreas, fatty degeneration of the liver and kidneys, and passive congestion of spleen.
Chronic Effects: Chronic inhalation results in appetite loss, nausea, weight loss, insomnia, and unusual sensitivity (hyperesthesia) of the distal extremities followed by motor weakness, muscular degeneration, and diminished tendon reflexes and coordination. Repeated skin exposure can cause blistering, drying, and lesions.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Give conscious victim a mixture of 2 tablespoons of activated charcoal mixed in 8 oz of water to drink. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Use nonsparking tools. Take up small spills with sand or other noncombustible absorbent. Dike storage areas to control leaks and spills. Follow applicable OSHA regulations (29 CFR 1910.120).
Aquatic Toxicity: Bluegill, freshwater, LC_{50} 8 ppm/96 hr.
licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. There are no specific NIOSH recommendations. However, for vapor concentrations not immediately dangerous to life or health, use chemical cartridge respirator equipped with organic vapor cartridge(s), or a supplied-air respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Materials such as neoprene or polyvinyl alcohol provide excellent/good resistance for protective clothing. Note: Resistance of specific materials can vary from product to product.
Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[1,6,7]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. Avoid direct sunlight. Storage must meet requirements of OSHA Class IB liquid. Outside or detached storage preferred.
Engineering Controls: Avoid vapor inhalation and skin or eye contact. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Indoor use of this material requires explosion-proof exhaust ventilation to remove vapors. Only use gasoline as a fuel source due to its volatility and flammable/explosive nature. Practice good personal hygiene and housekeeping procedures. Wear clean work clothing daily.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Gasoline (*including casing-head and natural*)
DOT Hazard Class: Flammable liquid
ID No.: UN1203
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Gasoline
IMO Hazard Class: 3.1
ID No.: UN1203
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146, 153, 159
Prepared by: M Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 470
Diesel Fuel Oil No. 2-D

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

33

Diesel Fuel Oil No. 2-D Description: Diesel fuel is obtained from the middle distillate in petroleum separation; a distillate oil of low sulfur content. It is composed chiefly of unbranched paraffins. Diesel fuel is available in various grades, one of which is synonymous with fuel oil No. 2-D. This diesel fuel oil requires a minimum Cetane No. (efficiency rating for diesel fuel comparable to octane number ratings for gasoline) of 40 (ASTM D613). Used as a fuel for trucks, ships, and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.

Other Designations: CAS No. 68334-30-5, diesel fuel.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(TM) for a suppliers list.

Cautions: Diesel fuel oil No. 2-D is a skin irritant and central nervous depressant with high mist concentrations. It is an environmental hazard and moderate fire risk.

R	1
I	-
S	2
K	2

NFPA

HMIS
H 0
F 2
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Diesel fuel oil No. 2-D*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data‡
None established	Mineral Oil Mist TWA: 5 mg/m³† STEL: 10 mg/m³	None established	Rat, oral, LD_{50}: 9 g/kg produces gastrointestinal (hypermotility, diarrhea) effects

* Diesel fuel No. 2-D tends to be low in aromatics and high in paraffinics. This fuel oil is complex mixture of: 1) >95% paraffinic, olefinic, naphthenic, and aromatic hydrocarbons, 2) sulfur (<0.5%), and 3) benzene (<100 ppm). (A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)). Although low in the fuel itself, benzene concentrations are likely to be much higher in processing areas.
† As sampled by nonvapor-collecting method.
‡ Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 340 to 675 °F (171 to 358 °C)
Viscosity: 1.9 to 4.1 centistokes at 104 °F (40 °C)
Specific Gravity: <0.86
Water Solubility: Insoluble

Appearance and Odor: Brown, slightly viscous liquid.

Section 4. Fire and Explosion Data

Flash Point: 125 °F (52 °C) min. | **Autoignition Temperature:** >500 °F (932 °C) | **LEL:** 0.6% v/v | **UEL:** 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or foam to fight fire. Use a water spray to cool fire exposed containers. Do not use a forced water spray directly on burning oil since this will scatter the fire. Use a smothering technique for extinguishing fire.

Unusual Fire or Explosion Hazards: Diesel fuel oil No. 2-D is a OSHA Class II combustible liquid. Its volatility is similar to that of gas oil. Vapors may travel to a source of ignition and flash back.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to pollution and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Diesel fuel oil No. 2-D is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: It is incompatible with strong oxidizing agents; heating greatly increases the fire hazard.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of diesel fuel oil No. 2-D can produce various hydrocarbons and hydrocarbon derivatives, and other partial oxidation products such as carbon dioxide, carbon monoxide, and sulfur dioxide.

Section 6. Health Hazard Data

Carcinogenicity: Although the IARC has not assigned an overall evaluation to diesel fuels as a group, it has evaluated occupational exposures in petroleum refining as an IARC probable human carcinogen (Group 2A). It has evaluated distillate (light) diesel oils as not classifiable as human carcinogens (Group 3).

Summary of Risks: Although diesel fuel's toxicologic effects should resemble kerosine's, they are somewhat more pronounced due to additives such as sulfurized esters. Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, vomiting, and loss of coordination, depending on concentration and exposure time. When removed from exposure area, affected persons usually recover completely. If vomiting occurs after ingestion and if oil is aspirated into the lungs, hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result. A comparative ratio of oral to aspirated lethal doses may be 1 pt vs. 5 ml. Aspiration may also result in transient CNS depression or excitement. Secondary effects may include hypoxia (insufficient oxygen in body cells), infection, pneumatocele formation, and chronic lung dysfunction. Inhalation may result in euphoria, cardiac dysrhythmias, respiratory arrest, and CNS toxicity. Prolonged or repeated skin contact may irritate hair follicles and block sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Central nervous system, skin, and mucous membranes.

Routes: Inhalation, ingestion.

Systemic effects from ingestion include gastrointestinal irritation, vomiting, diarrhea, and in severe cases central nervous system depression, progressing to coma or death. Inhalation of aerosols or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish discoloration of the skin and mucous membranes caused by deficient blood oxygenation).

Effects: Repeated contact with the skin causes dermatitis.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body have been exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately. Position to avoid aspiration.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs or abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use a noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Diesel fuel oil No. 2-D spills may be environmental hazards. Report large spills.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Eyes: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respiratory: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with a mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, entering vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and cleanliness. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[183]

Other Sections: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for a OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in storage or use areas.

Engineering Controls: Avoid vapor or mist inhalation and prolonged skin contact. Wear protective rubber gloves and chemical safety glasses to prevent contact with liquid or high mist concentration may occur. Additional suitable protective clothing may be required depending on working conditions. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. At least weekly laundering of work clothes is recommended. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.

Transportation Data (49 CFR 172.101)

Proper Shipping Name: Fuel oil

Hazard Class: Combustible liquid

No.: NA1993

Label: None

Packaging Exceptions: 173.118a

Packaging Requirements: None

Collection References: 1, 6, 7, 12, 73, 84, 101, 103, 126, 127, 132, 133, 136, 143, 146

Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: AC Darlington, MD; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 718
Portland Cement

Issued: 8/90

Section 1. Material Identification 32

Portland Cement (<1% quartz) Description: Tricalcium silicate ($3CaO \cdot SiO_2$) and dicalcium silicate ($2CaO \cdot SiO_2$) are portland cement's essential constituents, along with varying amounts of alumina, tricalcium aluminate, and iron oxide as tetracalcium aluminoferrate. Small amounts of magnesia, sodium, potassium, and sulfur are also present. Chromium may be present in the finished cement since the kiln's refractory lining and the steel balls used in the finish-milling operations are possible sources. To improve adhesion, strength, and flexibility, cement may be modified with various plastic latexes. Portland cement is used as a binding agent in concrete (a mixture of cement, gravel, and sand) and mortar. Concrete is cement diluted with 15% sand or other coarse particles, and approximately 3.75% calcium oxide.
Other Designations: CAS No. 65997-15-1, hydraulic cement, portland cement silicate.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(7) for a suppliers list.

R	0
I	2
S	3
K	0

Genium

HMIS
H 2
F 0
R 1
PPG*
* Sec. 8

Cautions: *Portland cement's primary danger is its alkalinity.* Calcium hydroxide, an alkaline, abrasive, and hygroscopic (moisture-absorbing) material, forms when water is added to dry cement. *Acute contact with wet cement may cause extensive burns; chronic exposure may lead to dermatitis.* Severe tissue damage may result if the cement hardens.

Section 2. Ingredients and Occupational Exposure Limits

Portland cement, ca 100%
Average Composition of Portland Cement:

	%
CaO (calcium oxide)	64.0
SiO_2 (silicon dioxide)	21.0
Al_2O_3 (aluminum oxide)	5.8
Fe_2O_3 [iron (III) oxide]	2.9
MgO (magnesium oxide)	2.5
Alkali Oxides	1.4
SO_3 (sulfur trioxide)	1.7

1989 OSHA PELs	1989-90 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data*
8-hr TWA: 10 mg/m³ (total dust)	TLV-TWA: 10 mg/m³ nuisance dust	None established	None listed
8-hr TWA: 5 mg/m³ (respirable fraction)			

* Monitor NIOSH, *RTECS* (VV8770000), for future data.

Section 3. Physical Data

Vapor Pressure: Approximately 0 mm **pH:** 12 (wet cement)* **Water Solubility:** Insoluble

Appearance and Odor: Odorless, gray powder with <1% crystalline silica.

* Cement's alkalinity varies from batch to batch, depending on the excessive calcium oxides the manufacturer uses.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Media: This material is noncombustible. Use extinguishing media appropriate to the surrounding fire.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece in the pressure-demand or positive-pressure mode. Calcium hydroxide forms when water is added to portland cement. Do not expose skin to wet cement. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Portland cement is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: No hazardous incompatibilities are reported.
Hazardous Products of Decomposition: None reported.

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Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list portland cement as a carcinogen.
Summary of Risks: Portland cement is a nuisance dust and skin, eyes, and mucous membrane irritant. Its principle health hazard—with the addition of water—occurs when it forms alkaline, abrasive, hygroscopic (moisture-absorbing) calcium hydroxide (slaked lime). Dry cement alone does not cause an alkaline burn. Some individuals appear to tolerate brief skin contact with wet cement, but others develop extensive skin burns. Repeated and prolonged skin contact can cause dermatitis including skin dryness, fissures, eczematous rashes, and dystrophy of nails. Allergic dermatitis may result from the presence of heavy metals such as chromium in the mixture. In one study, 15 of 95 cement workers reported dermatitis of the hands.
Medical Conditions Aggravated by Long-Term Exposure: Individuals with chronic respiratory disorders or skin diseases should minimize inhalation and skin contact.
Target Organs: Respiratory system, skin, eyes.
Primary Entry Routes: Inhalation, ingestion, skin contact.
Acute Effects: Inhalation symptoms include eye, nose, and upper respiratory tract irritation, cough, expectoration, shortness of breath, and wheezing. Eye contact (splashes) cause burning and possible corneal edema. Direct contact with wet cement may result in extensive skin burns with dermal necrosis. Within 12 to 48 hr after 1- to 6-hr exposures, first, second, and third degree burns may occur. There may be no obvious pain at the time of exposure. Ingestion of the powder or liquid form causes esophagus and stomach burns.
Chronic Effects: Chronic bronchitis and chronic dermatitis may result from chronic exposure. There are reports of x-ray changes without symptoms in cement workers exposed to portland cement. Other studies showing x-ray changes with pulmonary symptoms are noted in workers exposed primarily to the silica-containing products in portland cement. The contact dermatitis it causes may clear up only after a prolonged time after the exposures end.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Rinsing the exposed area with dextrose water may slow the hardening process. For reddened or blistered skin, consult a physician. Wash affected area with soap and water. Treat acute dermal reactions to wet cement as you would lye burns. Consult a physician immediately.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 4 to 8 oz. of milk or water. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Ingestion of large amounts of cement is unlikely. However, to prevent re-exposing the esophagus and stomach, do not induce emesis or perform gastric lavage. Immediate dilution may prevent esophageal burns. For severe esophageal burns, consider esophagoscopy within the first 24 hr. Neutralization with acidic agents is not advised because of increased risks of exothermic burns. Water-mineral oil soaks may aid in removing hardened cement from the skin. Dried on cement is extremely difficult to remove; surgical debridement and even skin grafting may be necessary. Consult an opthalmologist for ocular burns. Consider topical mydriatic-cycloplegics to guard against development of posterior synechiae and ciliary spasm.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and direct contact with wet cement. Avoid creating airborne dust conditions. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Carefully scoop spilled dry material into a suitable container (with a secure lid) for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area. Protect containers from physical damage.
Engineering Controls: Avoid dust inhalation and direct contact with skin and eyes. Wear gloves, impervious boots, and other protective gear when pouring cement. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Differentiate between cement and concrete usage and the degree of hazard. Practice good personal hygiene and housekeeping procedures.
Other Precautions: Provide preplacement and annual physical examinations with emphasis on the respiratory tract, eyes, and skin. Avoid exposing individuals sensitive to hexachromium salts. Adding iron to cements reduces chromium levels.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 26, 38, 73, 88, 89, 100, 101, 103, 126, 127, 132, 133, 134, 136, 138, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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ATTACHMENT M

RESPIRATOR INSPECTION PROCEDURES

RESPIRATOR INSPECTION PROCEDURES

Air-purifying respirators should be checked as follows before and after each use:

1. Examine the facepiece for:

   - Excessive dirt;
   - Cracks, tears, holes, or physical distortion of shape from improper storage;
   - Inflexibility of rubber facepiece (stretch and knead to restore flexibility);
   - Cracked or badly scratched lenses in full facepieces;
   - Incorrectly mounted full facepiece lenses, or broken or missing mounting clips;
   - Cracked or broken air-purifying element holder(s), badly worn threads, or missing gasket(s) if required.

2. Examine the head straps or head harness for:

   - Breaks;
   - Loss of elasticity;
   - Broken or malfunctioning buckles and attachments;
   - Excessively worn serrations on head harness, which might permit slippage (full facepieces only).

3. Examine the inhalation and exhalation valves for the following after removing its cover:

   - Foreign material, such as detergent residue, dust particles, or human hair under the valve seat;
   - Cracks, tears, or distortion in the valve material;
   - Improper insertion of the valve body in the facepiece;
   - Cracks, breaks, or chips in the valve body, particularly in the sealing surface;
   - Missing or defective valve cover;
   - Improper installation of the valve in the valve body;

4. Examine the air-purifying element for:

   - Incorrect cartridge, canister, or filter for the hazard;
   - Incorrect installation, loose connections, missing or worn gasket, or cross threading in the holder;
   - Expired shelf-life date on the cartridge or canister;
   - Cracks or dents in the outside case of the filter, cartridge or canister, indicated by the absence of sealing material, tape, foil, etc., over the inlet.

5. If the device has a corrugated breathing tube, examine it for:

- o Broken or missing end connectors;
- o Missing or loose hose clamps;
- o Deterioration, determined by stretching the tube and looking for cracks.

QUALITATIVE FIT TEST PROCEDURES

An employee shall be allowed to use only the specific make(s) and model(s) of air purifying respirators for which the person has obtained a satisfactory fit verified through fit testing procedures. An employee is not permitted to use any respirator not previously fit tested or if the results of the fit test indicated that the person was unable to obtain a satisfactory fit.

The following negative and positive pressure tests should be used each time a respirator is donned to check the face to face-seal fit.

o Negative Pressure Sealing Checks For Tightly Fitting Air Purifying Respirators

The wearer performs this test after donning an air purifying respirator. The test consists of closing off the inlets of the cartridge(s), canister or filters by covering them with the palm(s) of the hand(s) so that air cannot pass, inhaling gently, and holding one's breath for at least ten seconds. If a facepiece collapses slightly and no inward leakage of air into the facepiece is detected, it can be reasonably assumed that the fit of the respirator to the wearer is satisfactory.

This is used only as a gross determination of fit when the respirator is to be worn in relatively toxic atmospheres. None the less, this test shall be used each time prior to entering a toxic atmosphere.

o Positive Pressure Seal Check for Air Purifying Respirators with Inhalation and Exhalation Valves

This test is very much like the negative pressure sealing check, above and is conducted by closing off the exhalation valve and exhaling gently. The fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece for at least 10 seconds without detecting any outward leakage of air between the sealing surface of the facepiece and the wearer's face.

This test is also used only as a gross determination of fit when the respirator is to be worn in relatively toxic atmospheres. This test shall be used each time prior to entering a toxic atmosphere.

ATTACHMENT N

INJURY AND ILLNESS PREVENTION PROGRAM SUMMARY

AND HAZARDOUS CONDITION REPORT FORM

ATTACHMENT N

INJURY AND ILLNESS PREVENTION PROGRAM SUMMARY

AND HAZARDOUS CONDITION REPORT FORM

INJURY AND ILLNESS PREVENTION PROGRAM SUMMARY

In California, all locations must implement an Injury and Illness Prevention Program (IIPP) as a result of legislation popularly known as SB 198. Field operations, such as those covered in this health and safety plan, are also covered by the IIPP. The purpose of this document is to provide a summary of the elements of Investigation Contractor's IIPP and guidance concerning aspects of the IIPP that all field personnel should be aware. Complete details of the IIPP are found in the Investigation Contractor's Health and Safety Manual at Procedure HS 330. A copy of this document is available through the PHSM.

The IIPP requires California employers to develop programs that address the minimum elements of the regulation. The Investigation Contractor has implemented the following steps to comply with the regulatory requirements and provide a safe and healthful working environment for its employees:

- The Investigation Contractor's Health and Safety Manager (HSM) is responsible for the overall implementation of the IIPP. The Project Manager or Site Safety Officer will be responsible for implementing the IIPP at the project location.

- To ensure that employees comply with safe and healthy work practices, increasing disciplinary actions will be utilized for employees who engage in unsafe or unhealthy work practices. Written acknowledgement will also be placed in the employee's personnel file for those persons who make a significant contribution toward workplace safety. Health and safety compliance will be evaluated during each employee's annual performance review.

- During field operations, information regarding health and safety matters will be communicated to employees through safety meetings and safety briefings. Employees are encouraged to report suspected workplace hazards to their supervisor, the PM, or the PHSM. However, any employee may make such notification anonymously; forms for this purpose are located behind this summary. This form is known as the Hazardous Condition Report Form. NO EMPLOYEE WILL BE RETALIATED AGAINST FOR REPORTING HAZARDS OF FOR MAKING SUGGESTIONS RELATED TO SAFETY.

- Workplace hazards will be identified by reviewing applicable regulations and consensus standards for comparison with field operations. For activities such as hazardous-substance related field work, potential hazards are evaluated during the preparation of the site-specific health and safety plan. Periodic audits will also be conducted during field activities by members of the health and safety staff.

- Workplace injuries and illnesses will be appropriately investigated. All injuries or illnesses that are known or suspected to result from workplace activities must be reported for proper recordkeeping. Certain injuries or illnesses may require formal investigation. The Accident Report Form included in Attachment C is to be completed for injuries or illnesses arising from site activities.

- Prevention of unsafe or unhealthy conditions can usually be achieved by proper training, advanced planning and resolution of issues by responsible management or a health and safety professional. Such prevention will be a primary method used by the Investigation Contractor to minimize or abate hazards. At any site, any employee may contact the PHSM if he or she is concerned that a health and safety problem may exist. The Site Safety Officer or Project Manager may stop operations at any time if it is believed that an unsafe or unhealthy condition may be developing.

DAMES & MOORE

HAZARDOUS CONDITION REPORT

Employee Name* _____ Date _____

Office Location _____ Office Number _____

Supervisor _____

DESCRIBE HAZARD:

Location or activity _____

Describe hazardous condition thoroughly _____

Immediate action taken _____

Do you have an opinion regarding how the hazard might be abated? _____

Employee Signature _____ Date _____

Please forward this completed form to Susan Gulbrandsen (SBA).

Assigned to: _____

Tracking No. _____

*If you are making an anonymous submittal, please forward this form directly to John Danby, Western Division Health and Safety Manager (SAC).

HS330.4A

ATTACHMENT O

NIOSH METHOD 1003
NIOSH METHOD 1501

FORMULA: Table 1

M.W.: Table 1

HYDROCARBONS, HALOGENATED

METHOD: 1003
ISSUED: 2/15/84
REVISION #1: 8/15/87

COMPOUNDS:	benzyl chloride	chlorobromomethane	1,1-dichloroethane	methylchloroform
(synonyms	bromoform	chloroform	1,2-dichloroethylene	tetrachloroethylene
in Table 1)	carbon tetrachloride	o-dichlorobenzene	ethylene dichloride	1,1,2-trichloroethane
	chlorobenzene	p-dichlorobenzene	hexachloroethane	1,2,3-trichloropropane

SAMPLING

SAMPLER: SOLID SORBENT TUBE
(coconut shell charcoal, 100 mg/50 mg)

FLOW RATE: 0.01 to 0.2 L/min

VOL-MIN: Table 2
-MAX: Table 2

SHIPMENT: routine

SAMPLE STABILITY: not determined

FIELD BLANKS: 10% of samples

ACCURACY

RANGE STUDIED: see EVALUATION OF METHOD [1]

BIAS: not significant [1]

OVERALL PRECISION (s_r): see EVALUATION OF METHOD [1]

MEASUREMENT

TECHNIQUE: GAS CHROMATOGRAPHY, FID

ANALYTE: compounds above

DESORPTION: 1 mL CS_2, stand 30 min

INJECTION VOLUME: 5 µL

TEMPERATURES: Table 3

CARRIER GAS: N_2 or He, 30 mL/min

COLUMN: Table 3; alternates are SP-2100, SP-2100 with 0.1% Carbowax 1500 or DB-1 fused silica capillary column

CALIBRATION: standard solutions of analyte in CS_2

RANGE: Table 3

ESTIMATED LOD: 0.01 mg per sample [2]

PRECISION (s_r): see EVALUATION OF METHOD [1]

APPLICABILITY: See Table 2 for working ranges. This method can be used for simultaneous determination of two or more substances suspected to be present by changing gas chromatographic conditions (i.e., temperature program). High humidity during sampling will prevent organic vapors from being trapped efficiently on the sorbent and greatly decreases breakthrough volume.

INTERFERENCES: None identified. The chromatographic column or separation conditions may be changed to circumvent interferences.

OTHER METHODS: This method combines and replaces P&CAM 127 [3], S101 [4], S110 [5], S113 [6], S114 [7], S115 [8], S122 [9], S123 [10], S126 [11], S133 [12], S134 [13], S135 [14], S281 [15], S314 [16], S328 [17], S335 [18], S351 [19], and Method 1003 (dated 2/15/84).

REAGENTS:
1. Carbon disulfide, chromatographic quality.*
2. Analyte, reagent grade.
3. Calibration stock solutions:
   a. benzyl chloride, 10 mg/mL in n-heptane.
   b. bromoform, 10 mg/mL in n-hexane.
   c. o-dichlorobenzene, 200 mg/mL in acetone.
   d. p-dichlorobenzene, 300 mg/mL in acetone.
   e. hexachloroethane, 25 mg/mL in toluene.
4. Decane, n-undecane, octane or other internal standards (see step 6).
5. Nitrogen or helium, purified.
6. Hydrogen, prepurified.
7. Air, filtered.

*See SPECIAL PRECAUTIONS.

EQUIPMENT:
1. Sampler: glass tube, 7 cm long, 6 mm OD, 4 mm ID, flame-sealed ends with plastic caps, containing two sections of 20/40 mesh activated (600 °C) coconut shell charcoal (front = 100 mg; back = 50 mg) separated by a 2-mm urethane foam plug. A silylated glass wool plug precedes the front section and a 3-mm urethane foam plug follows the back section. Pressure drop across the tube at 1 L/min airflow must be less than 3.4 kPa. Tubes are commercially available (e.g., SKC #226-01).
2. Personal sampling pump, 0.01 to 0.2 L/min, with flexible connecting tubing.
3. Gas chromatograph, FID, integrator and column (see Table 3).
4. Vials, 2-mL, glass, PTFE-lined septum crimp caps.
5. Volumetric flasks, 10-mL.
6. Syringes, 10-µL, readable to 0.1 µL.
7. Pipet, TD, 1-mL, with pipet bulb.

SPECIAL PRECAUTIONS: Carbon disulfide is toxic and a serious fire and explosion hazard (flash point = -30 °C); work with it only in a hood. Several of the analytes are suspect carcinogens (Table 1). n-Heptane, n-hexane, and acetone are fire hazards.

SAMPLING:
1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling. Attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.01 and 0.2 L/min for a total sample size between the limits shown in Table 2.
4. Cap the samplers. Pack securely for shipment.

SAMPLE PREPARATION:
5. Place the front and back sorbent sections of the sampler tube in separate vials. Discard the glass wool and foam plugs.
6. Add 1.0 mL CS_2 to each vial. Cap each vial.
   NOTE: A suitable internal standard, such as decane [16], n-undecane [6,19], or octane [9,13,17] at 0.1% (v/v) may be added at this step and at step 8.
7. Allow to stand 30 min with occasional agitation.

CALIBRATION AND QUALITY CONTROL:
8. Calibrate daily with at least five working standards over the appropriate range (Table 3).
   a. Add known amounts of neat analyte or calibration stock solution to CS_2 in 10-mL volumetric flasks and dilute to the mark.
   b. Analyze with samples and blanks (steps 11 and 12).
   c. Prepare calibration graph (peak area vs. mg analyte).
9. Determine desorption efficiency (DE) at least once for each lot of charcoal used for sampling in the range of interest. Prepare three tubes at each of five levels plus three media blanks.

Table 2. Sampling limits.

Compound	Air Sample Volume (L) Min	Max	Target	Working Range, ppm, at Max Sample Volume
Benzyl chloride	6 @ 1 ppm	50	10	0.6 to 5.8
Bromoform	4 @ 0.5 ppm	70	10	0.2 to 4
Carbon tetrachloride	3 @ 10 ppm	150	15	2 to 105
Chlorobenzene	1.5 @ 75 ppm	40	10	10 to 430
Chlorobromomethane	0.5 @ 200 ppm	8	5	18 to 450
Chloroform	1 @ 50 ppm	50	15	2 to 190
o-Dichlorobenzene	1 @ 50 ppm	60	3	16 to 1100
p-Dichlorobenzene	1 @ 75 ppm	10	3	27 to 330
1,1-Dichloroethane	0.5 @ 100 ppm	15	10	4 to 250
1,2-Dichloroethylene	0.2 @ 200 ppm	5	3	16 to 560
Ethylene dichloride	1 @ 50 ppm	50	3	16 to 1320
Hexachloroethane	3 @ 1 ppm	70	10	0.3 to 8.3
Methylchloroform	0.1 @ 350 ppm	8	3	18 to 1450
Tetrachloroethylene	0.2 @ 100 ppm	40	3	9 to 1900
1,1,2-Trichloroethane	2 @ 10 ppm	60	10	1.8 to 64
1,2,3-Trichloropropane	0.6 @ 50 ppm	60	10	3 to 310

Table 3. Measurement parameters.

Compound	Column*	t (°C) Column/Injector/Detector	Range (mg per sample)
Benzyl chloride	A	160/170/210	0.02 to 0.15
Bromoform	A	130/170/210	0.02 to 0.15
Carbon tetrachloride	B	60/155/200	0.2 to 7
Chlorobenzene	A	105/190/250	0.4 to 10
Chlorobromomethane	A	80/170/210	0.5 to 15
Chloroform	B	75/155/200	0.4 to 11
o-Dichlorobenzene	C	140/225/250	0.1 to 3
p-Dichlorobenzene	A	140/225/275	0.2 to 4
1,1-Dichloroethane	A	50/100/175	0.4 to 12
1,2-Dichloroethylene	A	60/170/210	0.2 to 7
Ethylene dichloride	C	70/225/250	0.1 to 4
Hexachloroethane	D	110/170/210	0.02 to 0.3
Methylchloroform	C	70/225/250	0.6 to 17
Tetrachloroethylene	C	90/225/250	0.4 to 12
1,1,2-Trichloroethane	C	70/250/225	0.05 to 2
1,2,3-Trichloropropane	E	160/180/230	0.3 to 9

*A = 3 m x 3 mm OD stainless steel, 10% SP-1000 on 80/100 mesh Chromosorb WHP.
B = 6 m x 3 mm OD, otherwise same as A.
C = 3 m x 3 mm OD stainless steel, 10% OV-101 on 100/120 mesh Chromosorb WHP.
D = 3 m x 6 mm OD glass, 3% SP-2250 on 80/100 mesh Chromosorb WHP.
E = 3 m x 3 mm OD stainless steel, 10% FFAP on 80/100 mesh Chromosorb WHP.

FORMULA: Table 1

M.W.: Table 1

HYDROCARBONS, AROMATIC

METHOD: 1501
ISSUED: 2/15/84

OSHA, NIOSH, ACGIH: Table 2

PROPERTIES: Table 1

COMPOUNDS: (Synonyms in Table 1)	benzene	cumene	α-methylstyrene	styrene	vinyltoluene
	p-tert-butyltoluene	ethylbenzene	naphthalene	toluene	xylene

SAMPLING

SAMPLER: SOLID SORBENT TUBE (coconut shell charcoal, 100 mg/50 mg)

FLOW RATE, VOLUME: Table 3

SHIPMENT: no special precautions

SAMPLE STABILITY: not determined

BLANKS: 2 to 10 field blanks per set

BULK SAMPLE: desirable, 1 to 10 mL; ship in separate containers from samples

ACCURACY

RANGE STUDIED,
BIAS and OVERALL PRECISION (s_r): Table 3

MEASUREMENT

TECHNIQUE: GAS CHROMATOGRAPHY, FID

ANALYTES: hydrocarbons listed above

DESORPTION: 1 mL CS_2; stand 30 min

INJECTION VOLUME: 5 µL

TEMPERATURE-INJECTION: 225 °C
-DETECTOR: 225 °C
-COLUMN: see step 11

CARRIER GAS: N_2 or He, 25 mL/min

COLUMN: glass, 3.0 m x 2 mm, 10% OV-275 on 100/120 mesh Chromosorb W-AW or equivalent

CALIBRATION: analytes in CS_2

RANGE AND PRECISION (s_r): Table 4

ESTIMATED LOD: 0.001 to 0.01 mg per sample with capillary column [1]

APPLICABILITY: This method is for peak, ceiling and TWA determinations of aromatic hydrocarbons It may be used for simultaneous measurements, though there is the possibility that interactions between analytes may reduce the breakthrough volumes and change desorption efficiencies.

INTERFERENCES: Use of the recommended column will prevent interference by alkanes ($\leq C_{10}$). Under conditions of high humidity, the breakthrough volumes may be reduced by as much as 50%. Other volatile organic solvents, e.g., alcohols, ketones, ethers and halogenated hydrocarbons, are possible interferences. If interference is suspected, use a less polar column or change column temperature.

OTHER METHODS: This method is based on and supercedes Methods P&CAM 127, benzene, styrene, toluene and xylene [2]; S311, benzene [4]; S22, p-tert-butyltoluene [3]; S23, cumene [3]; S29, ethylbenzene [3]; S26, α-methylstyrene [3]; S292, naphthalene [4]; S30, styrene [3]; S343, toluene [4]; S25, vinyltoluene [3]; S318, xylene [4].

REAGENTS:

1. Eluent: Carbon disulfide*, chromatographic quality containing (optional) suitable internal standard.
2. Analytes, reagent grade*
3. Nitrogen or helium, purified
4. Hydrogen, prepurified.
5. Air, filtered.
6. Naphthalene calibration stock solution, 0.40 g/mL in CS_2.

*See Special Precautions.

EQUIPMENT:

1. Sampler: glass tube, 7 cm long, 6 mm OD, 4 mm ID, flame-sealed ends, containing two sections of activated (600 °C) coconut shell charcoal (front = 100 mg, back = 50 mg) separated by a 2-mm urethane foam plug. A silylated glass wool plug precedes the front section and a 3-mm urethane foam plug follows the back section. Pressure drop across the tube at 1 L/min airflow must be less than 3.4 kPa. Tubes are commercially available.
2. Personal sampling pumps, 0.01 to 1 L/min (Table 3), with flexible connecting tubing.
3. Gas chromatograph, FID, integrator, and column (page 1501-1).
4. Vials, glass, 1-mL, with PTFE-lined caps.
5. Pipet, 1-mL, and pipet bulb.
6. Syringes, 5-, 10-, 25- and 100-µL.
7. Volumetric flasks, 10-mL.

SPECIAL PRECAUTIONS: Carbon disulfide is toxic and extremely flammable (flash point = -30 °C); benzene is a suspect carcinogen. Prepare samples and standards in a well-ventilated hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling. Attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.01 and 0.2 L/min (to 1 L/min for naphthalene or styrene) for a total sample size as shown in Table 3.
4. Cap the samplers with plastic (not rubber) caps and pack securely for shipment.

SAMPLE PREPARATION:

5. Place the front and back sorbent sections of the sampler tube in separate vials. Discard the glass wool and foam plugs.
6. Add 1.0 mL eluent to each vial. Attach crimp cap to each vial immediately.
7. Allow to stand at least 30 min with occasional agitation.

CALIBRATION AND QUALITY CONTROL:

8. Calibrate daily with at least five working standards over the appropriate range (ca. 0.01 to 10 mg analyte per sample; see Table 4).
   a. Add known amounts of analyte (calibration stock solution for naphthalene) to eluent in 10-mL volumetric flasks and dilute to the mark.
   b. Analyze together with samples and blanks (steps 11, 12 and 13).
   c. Prepare calibration graph (peak area of analyte vs. mg analyte).

Table 2. Permissible exposure limits, ppm [6-11].

Substance	OSHA TWA	OSHA C	OSHA Peak	NIOSH TWA	NIOSH C	ACGIH TLV	ACGIH STEL	mg/m³ per ppm
benzene	10	25	50[a]	1		10**	25**	3.19
p-tert-butyltoluene	10					10	20	6.06
cumene	50	(skin)				50	75 (skin)	4.91
ethylbenzene	100					100	125	4.34
α-methylstyrene		100				50	100	4.83
naphthalene	10					10	15	5.24
styrene	100	200	600[b]	50	100	50	100	4.26
toluene	200	300	500[a]	100	200*	100	150 (skin)	3.77
vinyltoluene	100					50	100	4.83
xylene	100			100	200*	100	150	4.34

[a]Maximum duration 10 min in 8 hr.
[b]Maximum duration 5 min in any 3 hr.
**ACGIH: suspect carcinogen [10].
* 10-min sample.

Table 3. Sampling flowrate[a], volume, capacity, range, overall bias and precision [3,4,12].

Substance	Sampling Flowrate (L/min)	Sampling Volume (L) VOL-NOM	Sampling Volume (L) VOL-MAX[b]	Breakthrough Volume @ Concentration (L)	Breakthrough Volume @ Concentration (mg/m³)	Range at VOL-NOM (mg/m³)	Overall Bias (%)	Overall Precision (s_r)
benzene	≤0.20	2[c]	30	>45	149	42- 165	0.8	0.059
p-tert-butyltoluene	≤0.20	10	29	44	112	29- 119	-10.4	0.071[d]
cumene	≤0.20	10	30	>45	480	120- 480	4.6	0.059
ethylbenzene	≤0.20	10	24	35	917	222- 884	-8.1	0.089[d]
α-methylstyrene	≤0.20	3[f]	30	>45	940	236- 943	-10.8	0.061[d]
naphthalene[e]	≤1.0	200	200	>240	81	19- 83	-0.5	0.055
styrene	≤1.0	5[g]	14	21	1710	426-1710	-10.7	0.058[d]
toluene	≤0.20	2[c]	8	12	2294	548-2190	3.8	0.052
vinyltoluene	≤0.20	10	24	36	952	256- 970	-9.5	0.061[d]
xylene	≤0.20	12	23	35	870	218- 870	-2.1	0.060

[a]Minimum recommended flow is 0.01 L/min.
[b]Approximately two-thirds the breakthrough volume, except for naphthalene.
[c]10-min sample.
[d]Corrected value, calculated from data in Reference 12.
[e]Naphthalene shows poor desorption efficiency at low loading; 100-L minimum volume is recommended.
[f]15-min sample.
[g]5-min sample.

ATTACHMENT P

ROUTINE BIOASSAY MONITORING PROGRAM FOR LEHR

ROUTINE BIOASSAY MONITORING PROGRAM FOR LEHR
REVISION 0

1. PURPOSE

This procedure provides specific guidance for contractor personnel working at the LEHR site on their duties and responsibilities regarding routine bioassay monitoring. This procedure will be implemented prior to the commencement of field operations.

2. SCOPE

This procedure elucidates the criteria, actions, and responsibilities for the conduct of a routine bioassay monitoring program for employees working at the LEHR site. Routine bioassay monitoring of radiation workers is performed to detect intakes of radioactive materials that may otherwise go undetected through the processes of workplace and personnel contamination monitoring. The data derived from this program can also be used to verify the integrity of radioactive containments and the effectiveness of contamination control programs.
Routine monitoring includes:

- Baseline measurements, interim monitoring, and exit monitoring.

- Bioassay, which entails analysis for radionuclides in the excreta (urine and feces) or in the mucus or sputum (nasal/mouth smears).

- Analysis for tritium, uranium, and thorium. The criteria and actions can be applied to other radionuclides.

All contractor who perform work with materials that are potentially contaminated with radionuclides at the LEHR site will participate in the Bioassay program.

3. DEFINITIONS

Annual Limit on Intake (ALI). The quantity of a single radionuclide which, if inhaled or ingested for one year, would irradiate a person, represented by the Reference Man in ICRP Publication 23, to the limiting value for control of the workplace.

Baseline Bioassay. A bioassay measurement performed prior to an employee beginning work as a radiation worker at the LEHR site. The measurement will consist of both a fecal and a 24-hour urine sample, and will serve as a baseline value against which to compare future results.

Bioassay. A measurement of the amount or concentration of radioactive material in the body or in material excreted or removed from the body. This may include measurements of radionuclides in urine, feces, hair, blood, or sputum, or direct counting of the whole body or organs using external detectors.

Fecal Sample. All the material excreted in a bowel movement.

Investigation Level. The dose from internally deposited radioactive materials in a radiation worker which is regarded as sufficiently important to warrant investigation including, but not limited to follow-up bioassay, internal dose assessment, and dose management. The Investigation Level is equal to 100 mrem annual effective dose equivalent (AEDE) for the 12 months following the intake.

Nasal/Mouth Smear. A swab of the nasal or buccal cavity. Typically, three cotton tipped swabs are used; one for the left nostril, one for the right nostril, and one for the mouth.

Radiological Control Technician. The person trained and authorized to perform radiological monitoring of the workplace and contamination monitoring of personnel, including nasal and mouth smears.

Radiation Worker. An occupational worker whose job requires work with, or in the proximity of radiation producing machines or radioactive material, and who has the potential for being routinely exposed above 100 mrem per year. This total is the sum of the annual effective dose equivalent from external radiation and the committed effective dose equivalent (CEDE) from internal radiation.

Routine Bioassay Monitoring. A bioassay measurement made on a predetermined, periodic schedule, to establish a worker's internal exposure status relative to previous periods of time.

Urine Sample. The collected urine excreted over a designated period of time. A 24-hour sample is collected over one continuous day or in two consecutive 12-hour periods, such

as 6:00pm to 6:00am on consecutive evenings. Both routine baseline and exit sampling consist of 24-hour samples collected when the person is not on the LEHR site. Interim samples, which are requested during ongoing operations, consist of single void urine samples, or the collection of urine from one bladder voiding. Single void sample are used for routine tritium monitoring.

4. RESPONSIBILITIES

Project Manager. The Project Manager shall provide to the Division Health and Safety Officer a complete list of personnel assigned as radiation workers to the LEHR site, and update that list as appropriate to insure that timely baseline bioassays can be performed. The Project Manager should also select and designate a laboratory for analysis of the samples.

Site Health And Safety Officer. This individual shall assure that entrance, exit, and interim bioassays are performed for all persons or job categories as required by this procedure.

Radiological Control Technician (RCT). This individual shall perform nasal/oral smears in the field and deliver and collect interim bioassay kits to employees at the site as necessary. This individual is also responsible for conducting contamination surveys on personnel and reporting suspected internal exposures and unanticipated radiological conditions to the Project Manager and the Project Health Physicist.

Project Health Physicist. This individual is responsible for reviewing all bioassay results, and results of site contamination surveys, and making recommendations to management regarding individual follow-up screening, modification of existing procedures, frequency of interim urine sampling, etc. This individual prepares and approves all health physics procedures, and performs periodic operational reviews at the LEHR site at least monthly.

5. ROUTINE BIOASSAY MONITORING

Routine bioassay monitoring shall not be used in place of real time monitoring in the workplace. Bioassay requests will be processed using the bioassay sample request form (Figure 1). For all routine bioassay monitoring the Investigation Level is established at 100 mrem annual effective dose equivalent.

Individual Monitoring. Individuals routinely performing work where the time weighted monthly average of the air sample results is 0.1 of the Derived Air Concentration (DAC) or greater, or when the maximum value of the air sample is 0.3 of a DAC or greater, are required to participate in the interim sampling program. This program consists of single void urine samples taken on a monthly basis. The RCT and health physicist are responsible for determining whether or not this is true.

Group Monitoring. In addition to any individual monitoring that is ongoing, the RCT will select, at random, a radiation worker not participating in individual monitoring for a single void urinalysis. This random selection will occur on a monthly basis.

Derived Investigation Level (DIL). The DIL for the radionuclides of interest at LEHR in urine samples is 0.17 dpm per 24-hour sample for uranium (annual sample) and one million picocuries per liter tritium in a single void monthly urine sample. Positive results shall be reported to the RCT by the laboratory within one day. The individual will be informed of the results by the Project Manager, and two repeat bioassays will be performed. If either subsequent bioassay confirms the suspected intake by exceeding the decision level, the individuals manager and appropriate site authorities will be notified.

Positive Bioassay Actions. The RCT and Project Health Physicist will document the source of the intake and require bioassays of any other potentially exposed workers. If the cause of the positive result is not known, work on the site will be stopped and an investigation will take place to determine the cause. This investigation, including causes and corrective actions, will be documented and signed by the Project Manager and Project Health Physicist before work can resume. Bioassay results, as a measure of overall safety effectiveness, will be included in all monthly reports.

Guidelines for Uranium and Tritium Bioassay.

For uranium, if the prospective DAC-hours is less than 40, no bioassay sampling is required. For tritium, if the source term is less than one millicurie, no bioassay monitoring is required.

A baseline sample is useful for uranium. If the quantity of tritium is greater than one millicurie, a pre and post job urine sample is required, plus a weekly sample if the job is longer than seven days.

For uranium, nasal smears are required for work requiring respiratory protection when the RCT obtains a positive reading on the assault mask filters, or when the RCT suspects that an intake may have occurred. The RCT may direct a worker to supply a nasal smear at his or her discretion if an intake is suspected.

Fecal sampling is also useful for uranium and its daughters, but is normally not required except pre and post job. It is useful for other radionuclides, including plutonium. Questions about which bioassay technique is the most appropriate should be directed to the Project Health Physicist.

The Project Health Physicist will determine which radionuclides will be reported during the routine bioassay program.

All radiation workers regularly assigned to the LEHR site and working with radiological materials or potentially contaminated soils are required to undergo exit monitoring. Positive urine or fecal analyses will require two additional confirmatory analyses.

An individual who suspects they have received an intake may request a bioassay from the RCT, Project Health Physicist, or Project Manager. This request will normally be granted, and must be accompanied by an investigation of the circumstances surrounding the intake.

All bioassay results must be integrated with the external dosimetry results compiled by the University of California-Davis. The Project Health Physicist, acting under the direction of the LEHR Radiological Control Manager, will be responsible for transmitting this data to UC Davis EH&S staff for incorporation into their files. Disputes regarding implementation of this requirement shall be resolved by the LEHR Radiological Control Manager.

6. REFERENCES

DOE 5480.11. "Radiation Protection for Occupational Workers".

LEHR Rad Con Manual, Revision 1.0

ICRP Publication 23, "Measurements of Standard Man".

ICRP Publication 54, "Individual Monitoring for Intakes of Radionuclides by Workers: Design and Interpretation".

NCRP Report Number 87. "Use of Bioassay Procedures for Assessment of Internal Radionuclide Deposition".

ICRP Publication 54, "Individual Monitoring for Intakes of Radionuclides by Workers: Design and Interpretation".

NCRP Report Number 87. "Use of Bioassay Procedures for Assessment of Internal Radionuclide Deposition".

FIGURE 1. BIOASSAY SAMPLE REQUEST CARD

Routine Bioassay Sample Request
Radiological Health

Task:_____ Department____
Emp. Name: _____
Emp. No.: _____
Date Requested:_____
Manager:_____
Manager's Ext._____

Radionuclide:

__ Other Radionuclide (see notes)
__ Uranium
__ Tritium

Sample Type:

__ Fecal
__ Urine

Program:

__ Routine Individual/Random
__ Baseline
__ Termination

1. Fill in date and time sample collected
2. Seal container with Tamper Seal(s)
3. Tape this tag (both sections) to the top of the fecal container or place in urine kit box.
4. Hand carry to Receiving Station, Bldg. 123, Room 158.

Date and Time Sample Excreted:

_____

_____

Remarks: _____

Lab Sample No:_____

Routine Bioassay
Sample Request

Employee Name_____

Employee Number: _____

Extension (or Extension of foreman):

_____

Notes:

Receiving Station:

Date Received: _____

Received by: _____

Lab Sample No:_____

Radiological Control Technician

_____

Signature

ATTACHMENT Q

BLOODBORNE PATHOGENS PROGRAM SUMMARY

BLOODBORNE PATHOGENS PROGRAM SUMMARY

As addressed by OSHA's Occupational Exposure to Bloodborne Pathogens Final Rule, the Investigation Contractor recognizes the potential danger to its staff resulting from occupational exposure to bloodborne pathogens. The Investigation Contractor's Bloodborne Pathogens Program addresses the methods of compliance with 29 CFR 1910.1030 through the use of policies and standards of practice. These policies and procedures focus attention on reducing the risk of contracting a bloodborne pathogen while conducting work at various locations.

EXPOSURE CONTROL PLAN

Among the more common bloodborne diseases that contractor employee could be exposed to on the job are non-A hepatitis, non-B hepatitis, hepatitis B delta hepatitis, and human immunodeficiency virus. The two most significant are hepatitis B (HBV) and human immunodeficiency virus (HIV).

The OSHA standard protects employees who may be occupationally exposed to blood and other potential infectious materials. For the investigation contractor, this includes, but is not limited to, physicians, nurses, first aid responders, and those who have direct contact with wastes from hospitals, municipal waste sites, medical laboratories or medical facilities.

Occupational exposure means a "reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of the employee's duties". The exposure determination must be based on the definition of occupational exposure without regard to personal protective clothing and equipment.

UNIVERSAL PRECAUTIONS

Universal Precautions provide the first line of defense against the risks of exposure to bloodborne pathogens. Universal Precautions shall be practiced at all times in the vicinity of an accident. Since there is no way to know if an injured worker is infected, Universal Precautions must be consistently used for all activities involving contact with blood, tissue and body fluids or equipment or materials which may have been contaminated by these substances. Universal precautions include these practices:

- Wash hands with soap and water as soon as possible after contact with blood, body fluids or human tissue from an injured worker. When handwashing facilities are not readily available, antiseptic hand cleansers in conjunction with clean cloth/paper towels shall be used and hands should be washed with soap and water as soon afterwards as possible.

- Wear gloves when anticipating contact with blood, body fluid, tissues,mucous membranes or contaminated surfaces, or if breaks in the skin are present.

- Wear an impervious gown or apron if splattering of clothing is likely.

- Wear appropriate protective equipment at all times including a mask and eye protection if aerosolization or splattering is likely to occur when attending to an injured worker or when conducting normal work routines.

- Ensure that mouthpieces and appropriate personal protective equipment are readily available in first aid kits.

- Handle sharp objects carefully. Since the nature of our first aid training is limited to basic first aid, there should be no contact with used needles or vials.

ENGINEERING AND WORK PRACTICE CONTROLS

Engineering and work practice controls shall be used to eliminate or minimize employee exposure. Where occupational exposure remains after instituting these controls, personal protective equipment shall also be used. These controls will be in place at all work sites.

- Handwashing - All employees shall wash hands and any other skin with soap and water and flush exposed mucous membranes with water immediately or as soon as feasible following contact with blood or other potentially infectious materials. Handwashing facilities will be provided which are readily accessible to employees.

- Ingestion of bloodborne pathogens - Eating, drinking, smoking, applying cosmetics, and handling contact lenses are prohibited in work areas where there is a reasonable likelihood of occupational exposure.

- Handling of potentially infectious equipment - Equipment which may become contaminated with blood or other potentially infectious materials (such as drill rigs at municipal waste sites or equipment used in first aid response) shall be examined prior to servicing or shipping and shall be decontaminated as necessary, unless the site supervisor determines that decontamination of such equipment is not feasible.

- Personal protective equipment - Appropriate personal protective equipment will be provided by the Investigation Contractor. This includes, but is not limited to gloves, gowns, laboratory coats, face shields or masks, eye protection, mouthpieces, etc.

HEPATITIS B VACCINATION AND POST-EXPOSURE EVALUATION AND FOLLOW UP

There is a low potential risk of transmission of bloodborne diseases between First Responders and victims. Employees who are at risk of coming in contact with infectious substances will be offered the hepatitis B vaccination series. All employees who have had an exposure incident, regardless of classification, will be referred for a confidential post exposure evaluation and follow up. Hepatitis B Vaccination will be made available to all personnel who have a potential to become infected after training and within 10 working days of initial assignment.

The employee may choose to waive the vaccination by signing a waiver form. If the employee initially declines hepatitis B vaccination but at a later date decides to accept the vaccination, it will be made available at that time.

When an exposure incident is reported, the Project Manager will complete the Bloodborne Pathogens Incident Evaluation Form and will immediately refer the employee for a confidential medical evaluation and follow up. This referral must be made within 24 hours, will be conducted by a health care professional.

A copy of the Investigation Contractor's Bloodborne Pathogens Program and/or a copy of the OSHA Bloodborne Pathogens Standard is available upon request from the PHSM.

ATTACHMENT R

U.S. DOE OCCURRENCE REPORT

U.S. DEPARTMENT OF ENERGY

OCCURRENCE REPORT

NAME OF FACILITY: _____

FACILITY FUNCTION: (check only one)

[ ] Plutonium Processing/Handling
[ ] SNM Storage
[ ] Explosive
[ ] Uranium Enrichment
[ ] Uranium Conversion/Processing/ Handling
[ ] Irradiated Fissile Material Storage
[ ] Reprocessing
[ ] Nuclear Waste Operations
[ ] Tritium Activities
[ ] Fusion Activities
[ ] Environmental Restoration Operations
[ ] Category "A" Reactors
[ ] Category "B" Reactors
[ ] Solar Activities
[ ] Fossil and Petroleum Reserves
[ ] Accelerators
[ ] Balance-of-Plant

NAME OF LABORATORY, SITE OR ORGANIZATION: _____

_____

FACILITY MANAGER/DESIGNEE:

Name: _____

Title: _____

Telephone No.: _____

ORIGINATOR:

Name: _____

Title: _____

Telephone No.: _____

1. OCCURRENCE REPORT NUMBER: _____

==========

2. REPORT TYPE AND DATE:

	Date	Time
[ ] Notification Report	_____	_____
[ ] 10-Day Report	_____	
[ ] Latest 10-Day Update	_____	
[ ] Final Report	_____	

==========

3. OCCURRENCE CATEGORY: (check only one)

[ ] Emergency [ ] Unusual [ ] Off-Normal [ ] Cancelled

==========

4. DIVISION OR PROJECT: _____

==========

5. DOE PROGRAM OFFICE: (check only one)

[ ] CE	[ ] EM	[ ] RW	[ ] AD	[ ] IN
[ ] ER	[ ] DP	[ ] EH	[ ] EI	[ ] SA
[ ] FE	[ ] NE	[ ] NP	[ ] RG	

==========

6. SYSTEM, BLDG., OR EQUIPMENT:	7. UCNI: Yes [ ] No [ ]	8. PLANT AREA:

==========

9. DATE AND TIME DISCOVERED:	10. DATE AND TIME CATEGORIZED:

==========

11. DATE AND TIME OF DOE NOTIFICATION:

==========

12. DATE AND TIME OF OTHER NOTIFICATIONS:

==========

13. SUBJECT OR TITLE OF OCCURRENCE:

==========

14. NATURE OF OCCURRENCE: (check up to three)

Facility Condition
- [ ] Nuclear Safety
- [ ] Fires/Explosions
- [ ] Safety Status Degradation
- [ ] Radioactive Material Loss
- [ ] Vital System/Component Degradation
- [ ] Violation/Inadequate Procedures
- [ ] Unsatisfactory Surveillance/Inspections
- [ ] Costly Vital Structure/System/Component/Facility Deficiency
- [ ] Operational Occurrence
- [ ] Inadequate Experiment/Test Performance

Environmental
- [ ] Radionuclide Releases
- [ ] Hazardous Substances/Regulated Pollutants/Oil Releases
- [ ] Radioactive/Hazardous Material Contamination
- [ ] Ecological Resources
- [ ] Agreement/Compliance Activities

Personnel Safety
- [ ] Occupational Illness/Injuries
- [ ] Vehicular Incidents
- [ ] Miscellaneous

Personnel Radiation Protection
- [ ] Radiation Exposure
- [ ] Personnel Contamination
- [ ] Internal Uptake

Safeguards/Security
- [ ] Criminal Acts
- [ ] Loss of Control of Classified Matter
- [ ] Substance Abuse
- [ ] Hostile Intelligence Activities
- [ ] Computer Equipment/Systems
- [ ] Unplanned/Unscheduled Outage of Site Security System
- [ ] Demonstrations/Protests
- [ ] Firearms
- [ ] Other Security Concerns
- [ ] Material Control and Accountability

Transportation
- [ ] Offsite Transportation (DOT jurisdiction) Occurrences
- [ ] Onsite Transportation (DOE jurisdiction) Occurrences

[ ] Value Basis Reporting

Facility Status
- [ ] Facility/Process Securing/Curtailing Operations
- [ ] Facility/Process Shutdown Extension
- [ ] New Facility/Process Startup Delay

Cross-Category Items
- [ ] Collectively Significant Related Occurrences
- [ ] Near Miss Occurrences
- [ ] Potential Concerns/Issues

15. DESCRIPTION OF OCCURRENCE:

==========

16. OPERATING CONDITIONS OF FACILITY AT TIME OF OCCURRENCE:

==========

17. ACTIVITY CATEGORY: (check only one)

[ ] Construction
[ ] Maintenance
[ ] Normal Operations
[ ] Startup
[ ] Shutdown
[ ] Facility/System/Equipment Testing
[ ] Training
[ ] Transportation
[ ] Emergency Response
[ ] Inspection/Monitoring
[ ] Facility Decontamination/ Decommissioning

==========

18. IMMEDIATE ACTIONS TAKEN AND RESULTS:

==========

19. DIRECT CAUSE (Check only one direct cause category and check one and only one subcategory within the selected direct cause category.)

[ ] EQUIPMENT/MATERIAL PROBLEM
- [ ] Defective or Failed Part
- [ ] Defective or Failed Material
- [ ] Defective Weld, Braze, or Soldered Joint
- [ ] Error by Manufacturer in Shipping or Marking
- [ ] Electrical or Instrument Noise
- [ ] Contamination

[ ] PROCEDURE PROBLEM
- [ ] Defective or Inadequate Procedure
- [ ] Lack of Procedure

[ ] PERSONNEL ERROR
- [ ] Inadequate Work Environment
- [ ] Inattention to Detail
- [ ] Violation of Requirement or Procedure
- [ ] Verbal Communication Problem
- [ ] Other Human Error

[ ] DESIGN PROBLEM
- [ ] Inadequate Man-Machine Interface
- [ ] Inadequate or Defective Design
- [ ] Error in Equipment or Material Selection
- [ ] Drawing, Specification, or Data Errors

[ ] TRAINING DEFICIENCY
- [ ] No Training Provided
- [ ] Insufficient Practice or Hands-On Experience
- [ ] Inadequate Content
- [ ] Insufficient Refresher Training
- [ ] Inadequate Presentation or Materials

[ ] MANAGEMENT PROBLEM
- [ ] Inadequate Administrative Control
- [ ] Work Organization/Planning Deficiency
- [ ] Inadequate Supervision
- [ ] Improper Resource Allocation
- [ ] Policy Not Adequately Defined/Disseminated/Enforced
- [ ] Other Management Problem

[ ] EXTERNAL PHENOMENA
- [ ] Weather or Ambient Condition
- [ ] Power Failure or Transient
- [ ] External Fire or Explosion
- [ ] Theft, Tampering, Sabotage, Vandalism

20. CONTRIBUTING CAUSE (Check up to three contributing cause categories and check one and only one subcategory within each selected contributing cause category.)

[ ] EQUIPMENT/MATERIAL PROBLEM
- [ ] Defective or Failed Part
- [ ] Defective or Failed Material
- [ ] Defective Weld, Braze, or Soldered Joint
- [ ] Error by Manufacturer in Shipping or Marking
- [ ] Electrical or Instrument Noise
- [ ] Contamination

[ ] PROCEDURE PROBLEM
- [ ] Defective or Inadequate Procedure
- [ ] Lack of Procedure

[ ] PERSONNEL ERROR
- [ ] Inadequate Work Environment
- [ ] Inattention to Detail
- [ ] Violation of Requirement or Procedure
- [ ] Verbal Communication Problem
- [ ] Other Human Error

[ ] DESIGN PROBLEM
- [ ] Inadequate Man-Machine Interface
- [ ] Inadequate or Defective Design
- [ ] Error in Equipment or Material Selection
- [ ] Drawing, Specification, or Data Errors

[ ] TRAINING DEFICIENCY
- [ ] No Training Provided
- [ ] Insufficient Practice or Hands-On Experience
- [ ] Inadequate Content
- [ ] Insufficient Refresher Training
- [ ] Inadequate Presentation or Materials

[ ] MANAGEMENT PROBLEM
- [ ] Inadequate Administrative Control
- [ ] Work Organization/Planning Deficiency
- [ ] Inadequate Supervision
- [ ] Improper Resource Allocation
- [ ] Policy Not Adequately Defined/Disseminated/Enforced
- [ ] Other Management Problem

[ ] EXTERNAL PHENOMENA
- [ ] Weather or Ambient Condition
- [ ] Power Failure or Transient
- [ ] External Fire or Explosion
- [ ] Theft, Tampering, Sabotage, Vandalism

21. ROOT CAUSE (Check only one root cause category and check one and only one subcategory within the selected root cause category.)

[ ] EQUIPMENT/MATERIAL PROBLEM
- [ ] Defective or Failed Part
- [ ] Defective or Failed Material
- [ ] Defective Weld, Braze, or Soldered Joint
- [ ] Error by Manufacturer in Shipping or Marking
- [ ] Electrical or Instrument Noise
- [ ] Contamination

[ ] PROCEDURE PROBLEM
- [ ] Defective or Inadequate Procedure
- [ ] Lack of Procedure

[ ] PERSONNEL ERROR
- [ ] Inadequate Work Environment
- [ ] Inattention to Detail
- [ ] Violation of Requirement or Procedure
- [ ] Verbal Communication Problem
- [ ] Other Human Error

[ ] DESIGN PROBLEM
- [ ] Inadequate Man-Machine Interface
- [ ] Inadequate or Defective Design
- [ ] Error in Equipment or Material Selection
- [ ] Drawing, Specification, or Data Errors

[ ] TRAINING DEFICIENCY
- [ ] No Training Provided
- [ ] Insufficient Practice or Hands-On Experience
- [ ] Inadequate Content
- [ ] Insufficient Refresher Training
- [ ] Inadequate Presentation or Materials

[ ] MANAGEMENT PROBLEM
- [ ] Inadequate Administrative Control
- [ ] Work Organization/Planning Deficiency
- [ ] Inadequate Supervision
- [ ] Improper Resource Allocation
- [ ] Policy Not Adequately Defined/Disseminated/Enforced
- [ ] Other Management Problem

[ ] EXTERNAL PHENOMENA
- [ ] Weather or Ambient Condition
- [ ] Power Failure or Transient
- [ ] External Fire or Explosion
- [ ] Theft, Tampering, Sabotage, Vandalism

22. DESCRIPTION OF CAUSE:

==========

23. EVALUATION: (By Facility Manager/Designee)

==========

24. IS FURTHER EVALUATION REQUIRED: Yes [ ] No [ ]

IF YES, BEFORE FURTHER OPERATION: Yes [ ] No [ ]
IF YES, BY WHOM: _____
BY WHEN: _____

==========

25. CORRECTIVE ACTIONS:

Corrective Action	Target Completion Date	Actual Completion Date

==========

26. IMPACT ON ENVIRONMENT, SAFETY AND HEALTH:

==========

27. PROGRAMMATIC IMPACT:

==========

28. IMPACT UPON CODES AND STANDARDS:

==========

29. FINAL EVALUATION AND LESSONS LEARNED:

==========

30. SIMILAR OCCURRENCE REPORT NUMBERS:

==========

31. DOE FACILITY REPRESENTATIVE INPUT:

Entered by: _____ Date: _____

==========

32. PROGRAM MANAGER INPUT:

Entered by: _____ Date: _____

==========

33. SIGNATURES:

FACILITY MANAGER/DESIGNEE

Approved by: _____ Date: _____

Typed Name: _____

DOE FACILITY REPRESENTATIVE/DESIGNEE

Approved by: _____ Date: _____

Typed Name: _____

DOE PROGRAM MANAGER/DESIGNEE

Approved by: _____ Date: _____

Typed Name: _____

APPENDIX D
FINAL DRAFT
WASTE MANAGEMENT PLAN FOR INVESTIGATION DERIVED WASTES
RI/FS
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

APPENDIX D
FINAL DRAFT
WASTE MANAGEMENT PLAN FOR INVESTIGATION DERIVED WASTES
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TABLE OF CONTENTS

Section — Page

EXECUTIVE SUMMARY ES.1

1.0 INTRODUCTION 1.1
- 1.1 PURPOSE AND OBJECTIVES 1.1
- 1.2 APPLICABLE LAWS, REGULATIONS, AND GUIDANCE DOCUMENTS . 1.2
  - 1.2.1 Requirements under the NCP and CERCLA 1.2
  - 1.2.2 Area of Contamination Concept 1.3
- 1.3 PLAN ORGANIZATION 1.4

2.0 GENERAL SITE INFORMATION 2.1
- 2.1 SITE LOCATION AND OWNERSHIP 2.1
- 2.2 SITE SETTING, GEOLOGY, AND HYDROGEOLOGY 2.1
- 2.3 LEHR OPERATIONAL HISTORY 2.2
- 2.4 HISTORY OF WASTE GENERATION AND MANAGEMENT 2.3
- 2.5 PERSONNEL 2.4
  - 2.5.1 Identification and Responsibilities 2.4
  - 2.5.2 Training 2.5

3.0 REMEDIAL INVESTIGATION METHODS 3.1
- 3.1 RI ACTIVITIES WITH THE POTENTIAL TO GENERATE WASTE 3.1
- 3.2 IDW AND THE WASTE SCREENING PROCESS 3.2
  - 3.2.1 Wastes From Backhoe Test Pits/Soil Trenching 3.3
  - 3.2.2 Wastes From Soil Borings 3.4
  - 3.2.3 Wastes From CPT/Hydropunch™ 3.8
  - 3.2.4 Wastes From Well Installation 3.9
  - 3.2.5 Wastes From Well Development 3.9
  - 3.2.6 Wastes From Groundwater Sampling 3.10
  - 3.2.7 Aquifer Testing 3.10
  - 3.2.8 Wastes From Septic Tank Sampling 3.11
- 3.3 POTENTIAL QUANTITY OF IDW PRODUCED BY RI ACTIVITIES 3.11

4.0 ON-SITE MANAGEMENT AND STORAGE OF IDW 4.1

4.1 RECORD KEEPING 4.1
4.2 WASTE PACKAGING 4.3
4.2.1 Drums 4.3
4.2.2 Baker Tanks and Roll-Off Bins 4.3
4.3 WASTE HANDLING LOCATIONS 4.4
4.3.1 Controlled Storage Area 4.4
4.3.2 Accumulation Area 4.4
4.4 FENCING AND POSTING 4.5

5.0 IDW WASTE CLASSIFICATION PROCESS 5.1
5.1 WASTE CLASSIFICATIONS 5.1
5.1.1 Low-Level Radioactive Wastes 5.1
5.1.2 Hazardous/Dangerous Wastes 5.2
5.1.3 Radioactive Mixed Wastes 5.2
5.1.4 Hazardous Substances 5.2
5.1.5 Other Wastes 5.3
5.2 WASTE CLASSIFICATION 5.3
5.2.1 Laboratory Analysis 5.3
5.2.2 IDW Database 5.4
5.2.3 Review of Analytical Results 5.4
5.2.4 Waste Segregation and Resampling 5.6
5.2.5 Reviewing Results and Updating Database 5.7

6.0 MANAGEMENT AND DISPOSAL OF SPECIFIC WASTE CATEGORIES 6.1
6.1 HAZARDOUS WASTES 6.1
6.1.1 Hazardous Waste Storage 6.1
6.1.2 Hazardous Waste Disposal 6.1
6.2 RADIOACTIVE AND MIXED WASTES 6.2
6.2.1 Radioactive and Mixed Waste Storage 6.3
6.2.2 Radioactive and Mixed Waste Disposal 6.3
6.3 OTHER WASTES 6.3
6.3.1 Storage of Other Wastes 6.4
6.3.2 Disposal of Other Wastes 6.4

7.0 IDW WASTE MANAGEMENT SCHEDULE 7.1
7.1 RI/FS SCHEDULE 7.1
7.2 WASTE GENERATION SCHEDULE 7.1
7.3 WASTE CLASSIFICATION SCHEDULE 7.2
7.4 DATABASE MANAGEMENT SCHEDULE 7.3
7.5 WASTE DISPOSAL SCHEDULE 7.3

8.0 REFERENCES CITED 8.1

TABLE **PAGE**

TABLE D-3.1
INTERPRETATION OF FIELD EVALUATION OF IDW 3.6
TABLE D-3.2
POTENTIAL QUANTITIES OF IDW BY INVESTIGATION AREA 3.13
TABLE D-5.1
ANALYTICAL PARAMETERS FOR ENVIRONMENTAL SAMPLES COLLECTED
DURING THE RI AT THE LEHR SITE 5.5

LIST OF FIGURES

FIGURE

FIGURE D-2.1 SITE LOCATION MAP
FIGURE D-2.2 SITE VICINITY MAP
FIGURE D-2.3 SITE STRUCTURES AND FEATURES
FIGURE D-4.1 LABEL FOR WASTE CONTAINER
FIGURE D-4.2 SCHEMATIC DRAWING OF THE IDW CONTROLLED STORAGE AREA
FIGURE D-5.1 LEHR WASTE CLASSIFICATION

LIST OF ATTACHMENTS

ATTACHMENT D-1: EVALUATION PROCESS FOR IDW GENERATED AT THE LEHR FACILITY
ATTACHMENT D-2: EXCERPT FROM TITLE 40 CFR PART 261
ATTACHMENT D-3: EXCERPT FROM TITLE 22 CCR, DIVISION 45, CHAPTER 11
ATTACHMENT D-4: MASTER LIST OF HAZARDOUS SUBSTANCES
ATTACHMENT D-5: DETERMINATION OF REPORTABLE QUANTITIES

APPENDIX D
FINAL DRAFT
WASTE MANAGEMENT PLAN FOR INVESTIGATION DERIVED WASTES
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

EXECUTIVE SUMMARY

This Waste Management Plan (Plan) presents waste handling, evaluation, storage, and classification procedures for investigation derived wastes (IDW) anticipated to be generated during the upcoming remedial investigation (RI) at the Laboratory for Energy-Related Health Research (LEHR) site. Additionally, the Plan identifies key personnel and outlines their responsibilities so that proper implementation of plan procedures can occur. Details of the RI investigative methods are presented in the Draft Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Dames & Moore, 1994). The Plan has been prepared in general accordance with the United States Environmental Protection Agency (USEPA) document Management of Investigation Derived Wastes During Site Inspections (USEPA, 1991); and the United States Department of Energy (DOE) document 5820.2A Radioactive Waste Management.

The approach to waste management for the RI/FS focuses on protecting human health and the environment while applying the Area of Contamination (AOC) unit concept (USEPA, 1991) for each of the waste disposal areas of the LEHR site. This concept or approach involves leaving a site in no worse condition than existed prior to the investigation, minimizing the quantity of generated wastes and leaving on-site wastes that do not require off-site disposal or extended above-ground containerization. This approach is consistent with USEPA and other regulatory agency recommendations to minimize removal of wastes from a site as long as those wastes do not pose a threat to human health or the environment. If necessary, wastes left on site within an AOC could be treated or disposed as part of the selected remedial alternatives for that area.

In some situations, IDW will be removed from the AOC. This IDW may include purged groundwater, soil cuttings or excavated debris, discarded personal protective equipment (PPE), disposable sampling equipment, and decontamination fluids from cleaning of equipment. These materials will be managed so that they do not pose a threat to human health or the environment.

The Plan addresses the generation and management of IDW at the LEHR site, including preliminary screening, temporary storage, storage area inspections, and segregation into five waste categories. The IDW categories are: 1) hazardous/ dangerous wastes, 2) low level radioactive wastes, 3) radioactive mixed wastes, 4) hazardous substances, and 5) "other wastes" (those that contain low levels of hazardous substances, or contain non-hazardous contaminants).

In some instances, IDW that is hazardous/dangerous waste, low-level radioactive waste, radioactive mixed waste, or which contains substances that are hazardous pursuant to state and federal regulations, will need to be containerized and potentially transported to off-site treatment or disposal areas. Treatment and/or disposal procedures for IDW is not included in the Plan. IDW that is hazardous waste under California or federal regulations will be sent to an appropriate treatment or disposal facility. As discussed in the Plan, an appropriate treatment or disposal facility for hazardous waste will be selected as information is developed during the RI.

1.0 INTRODUCTION

This Waste Management Plan (Plan) for investigation derived wastes (IDW) has been prepared to address IDW that will be produced during the remedial investigation (RI) at the Laboratory for Energy Related Health Research (LEHR), University of California, Davis, California (UC Davis). The LEHR site is currently proposed for listing on the National Priority List (NPL). As such, the planned RI will be conducted using appropriate guidelines for investigations under the Comprehensive Environmental Resource Compensation and Liability Act (CERCLA).

The LEHR site was operated by UC Davis for the Department of Energy (DOE) for approximately 30 years. Primary research at the site focused on the long-term effect of low-level radiation on animals. Current DOE efforts are focused on site decontamination and remediation in order to return the restored facilities and property to UC Davis. Investigation activities at the LEHR site will result in the production of IDW. This Plan has been prepared so that proper management of the IDW during generation, storage, and disposal will occur.

1.1 PURPOSE AND OBJECTIVES

The purpose of this Plan is to provide an approach for proper management of IDW produced during the RI at the LEHR site. The approach presented reflects a goal to protect human health and the environment and to minimize waste generated, and waste disposal off-site. To achieve this goal, the following objectives have been established for the Plan.

- Provide background information on the LEHR site and a discussion of the categories of IDW that may be produced during the RI.
- Identify the applicable waste classification requirements.
- Estimate the quantities of IDW that may be produced during the RI.
- Describe the procedures that will be used to screen, contain, classify, and store IDW produced during the RI.

1.2 APPLICABLE LAWS, REGULATIONS, AND GUIDANCE DOCUMENTS

The RI investigation at the LEHR site will be conducted in general compliance with guidance documents developed for site assessment activities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by SARA. Procedures for sampling, quality assurance and quality control, and health and safety will be as defined in the applicable sections of the Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP), respectively, developed for the RI. These documents have been submitted concurrently with this document as Appendices A, B, and C, respectively, of the RI/FS Work Plan. The following guidance documents were primarily utilized for development of this Plan

- Management of Investigation Derived Wastes During Site Inspections, U.S. EPA, 1991.
- QAPP.
- LEHR Radiological Control Manual, 1993.
- DOE 5280.2A.

Additional documents used are listed in Section 8.0.

1.2.1 Requirements under the NCP and CERCLA

CERCLA Section 101(23) defines "removal" to include actions that may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances. Therefore, the RI investigations to be conducted at LEHR can be considered removal actions. The National Contingency Plan (NCP) directs that these actions attain applicable or relevant and appropriate requirements (ARARs), both state and federal, "to the extent practicable considering the exigencies of the situation" (Section 300.415(i) of the NCP). Practicability is assessed by examining factors such as the urgency of the situation and the scope of the action being

conducted. This pretence is further supported by the preamble to the NCP that states, ". . . removal actions cannot be expected to contain all ARARs. . . ."

In assessing what is "practicable" for this RI, the scope and purpose of the RI activities were considered; that is, to gather information about site impacts, not to remediate. Actions taken during the RI leave conditions at the site essentially unchanged and should not require a detailed analysis of the ARARs or assurance that conditions at the site after the action is taken will comply with ARARs.

General compliance with the NCP and other ARARs will be accomplished during the RI by the following general procedures.

1) Identifying contaminants, if any, present in IDW, based on existing information, best professional judgment, and field screening.

2) Assessing ARARs and, to the extent to which it is practicable, to comply with them.

3) Delineating an area of contamination (AOC) (see Section 1.2.2) based on existing information.

4) Burying soil cuttings within the AOC, so long as there is no information to suggest that an increased hazard to human health or the environment will be created.

5) Containerizing potentially hazardous development water and other potentially hazardous material, including disposable sampling equipment and decontamination fluids.

1.2.2 Area of Contamination Concept

An important concept in evaluating which ARARs apply is the AOC. The AOC can be described as a non-discrete land area, on or in which there is generally dispersed contamination. If IDW is moved within an AOC, the EPA does not consider this "land disposal," and therefore federal and state land disposal restrictions should not be triggered, even if the material is hazardous. If IDW generated during the LEHR

RI are being moved only within the AOC, it is not considered subject to state or federal land disposal restrictions.

Each operable unit defined in the RI/FS Work Plan (see Figure D-2.3) is considered an AOC for the purpose of this Plan. The IDW (primarily soil cuttings) developed within each of these areas will be buried within these areas in a way to decrease or eliminate hazards to human health or the environment.

1.3 PLAN ORGANIZATION

This Plan consists of nine chapters, including the Introduction. Chapter 2 provides general information about the LEHR site. Chapter 3 provides information on investigation methods and material handling procedures that may be used during the RI. Chapter 4 provides an overview of on-site management of IDW and identifies the categories of waste that may be produced during the RI. Chapter 5 describes the classification process for IDW that may be generated. Chapter 6 describes management practices for specific categories of IDW and presents possible disposal options for IDW. Chapter 7 presents a schedule for IDW management activities, and Chapter 8 contains references for this document.

2.0 GENERAL SITE INFORMATION

Detailed information on the LEHR site setting, history of operations, and environmental characteristics is presented in the Draft RI/FS Work Plan prepared for the LEHR Environmental Restoration Program (Dames & Moore, 1994). The RI/FS Work Plan also contains detailed summaries of past waste disposal areas and the results of investigations and monitoring programs conducted at the LEHR site. A description of the LEHR site, the operational history, and wastes generated at the LEHR site are presented in the following sections.

2.1 SITE LOCATION AND OWNERSHIP

The LEHR site is located approximately 1.5 miles south of the main UC campus and the town of Davis on County Road 79 (Old Davis Road) in Solano County, California, as shown on Figure D-2.1. The site is owned by the Regents of the University of California and leased to the DOE. All structures at the LEHR site are owned by the DOE.

The LEHR site encompasses approximately 15 acres and consists of laboratories, office buildings, and animal-handling facilities. Of the 15 acres, approximately 40 percent (6 acres) is paved with asphalt or concrete, or covered by structures. Approximately 30 percent (4 1/2 acres) is unpaved and kept relatively free of vegetation. The remaining land is occupied by outdoor dog pens and heavy vegetation. Other UC research facilities are located adjacent to the LEHR site, and all these facilities are surrounded by private property (Figure D-2.2). Most of the private land is used for agricultural purposes.

2.2 SITE SETTING, GEOLOGY, AND HYDROGEOLOGY

The site is situated on relatively flat-lying land termed the Putah Plain which is typical of the broad, relatively flat Sacramento Valley. The Sacramento River, the primary drainage of the Sacramento Valley, is approximately 12 miles east of the site.

The site is not within the 100-year flood plain as defined in the 1982 FEMA Flood Insurance Maps.

Surficial soils at the site are underlain by a sequence of interbedded clay, silty clay, silt, and sand that is typically 80 feet thick and contains some coarser-grained units of coarse sand and gravel. The groundwater table varies in depth from approximately 45 to 65 below ground surface (bgs), depending upon the season. Well-rounded cobbles and gravels are encountered at approximately 80 feet bgs, and appear to be laterally continuous beneath the LEHR site. The thickness of this unit is approximately 40-52 feet. Clay and silt underlie the cobbles and gravels and are encountered at depths ranging from 120 to 137 feet bgs.

2.3 LEHR OPERATIONAL HISTORY

UC Davis has conducted radiological studies on laboratory animals for the DOE since the 1950s. Full-scale experimental use of radioactive materials, including strontium-90 and radium-226, began at the LEHR site in 1960.

In the early 1970s, a Cobalt-60 irradiator facility was constructed at the LEHR site to study the effects of chronic exposure to penetrating gamma ray irradiation on bone marrow cells of dogs. The cobalt-60 study was terminated in 1985; the Cobalt-60 source was removed in January 1993.

In 1975, a program in basic aerosol science was initiated at the LEHR site. The DOE reported that research activities in this program focused on the potential health effects of release to the atmosphere of combustion products from fossil fuel power plants with emphasis on coal flyash.

In 1983, construction of the Toxic Pollutant Health Research Laboratory (TPHRL) was completed at the LEHR site (Figure D-2.3). This facility was designed for the study of highly toxic and carcinogenic agents including both radioactive and chemical materials. Research at the TPHRL included studies of the behavior of plutonium-241 and americium-241 in dogs and monkeys; radioactive and toxic gas-

particle mechanistic aerosol studies; monodisperse aerosol inhalation deposition; intratracheal applications of carcinogen-coated particles; and an organic vapor uptake utilizing dogs (DOE, 1988).

Most DOE related work at the LEHR site ceased in 1989. The current DOE involvement with the LEHR site is in decommissioning the facility and returning control of the property to UC Davis.

Most buildings at the LEHR site are now being used by UC Davis for research facilities and offices. Some buildings have been scheduled for decontamination and decommissioning by the DOE. The DOE is utilizing contractors to conduct a Remedial Investigation/Feasibility Study of the site as part of the decommissioning efforts.

2.4 HISTORY OF WASTE GENERATION AND MANAGEMENT

In the initial stages of research at the LEHR site, LEHR wastes were handled at the central handling facility on the main UC Davis campus. However, waste handling for LEHR-generated waste was returned to the LEHR site in the early 1960s. A variety of wastes, including radioactive, biologic, organic, and inorganic materials were generated and disposed of in unlined trenches on-site. Previous site investigations (Dames & Moore, 1993) have shown that past waste management and disposal practices have resulted in impacts to the environment including soil and groundwater at the LEHR site.

In addition to on-site disposal of LEHR generated wastes, two separate locations on the LEHR site were used as the UC Davis campus landfill. Disposal in the oldest landfill unit began in the 1940s and ceased in the late 1950s to early 1960s. The next oldest disposal unit received wastes from 1956 to 1967. A third landfill disposal unit, located approximately 600 feet east of the LEHR site, was used from 1963 to 1967. The combined total acreage for the three disposal areas is estimated at approximately six acres. Additionally, UC Davis disposed of campus-generated wastes in unlined trenches and pits at the LEHR site.

A number of investigations have been conducted at the LEHR site. During these investigations, IDW from borings, well construction, and sampling were placed into drums and stored in the cobalt-60 field area pending characterization.

2.5 PERSONNEL

The following sections describe the key personnel and associated responsibilities for management of IDW. Additionally, training requirements for IDW management personnel are discussed.

2.5.1 Identification and Responsibilities

The RI subcontractor will be responsible for coordinating the management of IDW, and will coordinate with the LEHR Environmental Restoration (ER) staff and UC Davis on issues related to the management of IDW. The primary responsibilities for the management of IDW at the LEHR site are identified below.

- The RI subcontractor Project Manager is responsible for preparation of this Plan and supporting documents necessary for the management of IDW produced during the RI. The Project Manager may make necessary arrangements for disposal of IDW at appropriate disposal sites, if required. The Project Manager will approve and review Work Plans for RI field activities that produce or manage IDW, including those that specify field sampling procedures, quality assurance and health and safety requirements, and will maintain liaison with LEHR ER staff and UC Davis personnel responsible for the LEHR site.

- The RI subcontractor Field Coordinator is responsible for oversight of field activities during the RI and for compliance with this Plan and applicable portions of the RI/FS Work Plan in the field. Any UC Davis, or LEHR ER staff shall inform the Field Coordinator of any difficulties encountered with the management of IDW at the LEHR facility. The Field Coordinator is responsible for notifying the Project Manager and the LEHR ER Project Manager of any reported problems and for implementing field actions to correct the noted deficiencies. The Field Coordinator shall also maintain liaison with the appropriate UC Davis personnel.

- The Radiological Control Technician (RCT) will be responsible for initial screening of IDW using field instruments. Initial screening will be used for preliminary segregation of IDW in the controlled accumulation area pending receipt and evaluation of analytical results. The RCT will perform periodic inspections of the storage areas and document the condition and integrity of the storage area.

- The LEHR ER Project Manager is responsible for approval of this Plan on behalf of DOE and for representing DOE in determining the treatment and disposal practices that will be used for IDW and for resolution of any difficulties identified during implementation of the Plan. The LEHR ER Project Manager is responsible for identifying the person(s) authorized to manifest waste shipped from the LEHR site. The LEHR ER Project Manager is also responsible for coordinating with the RI subcontractor Project Manager to identify any changes in the LEHR Environmental Restoration Program which could affect the management of IDW.

- The on-site logistical subcontractor Project Manager is responsible for supplying review and comment of this Plan on behalf of UC Davis and for representing UC Davis in evaluating on-site management practices for IDW that may impact campus activities. The UC Davis Project Manager will maintain liaison with the RI subcontractor Project Manager and the LEHR ER Project Manager.

2.5.2 Training

All personnel involved in handling or management of wastes produced during RI activities at LEHR will have training appropriate for their responsibilities. Field personnel will have the 40-hour training for hazardous materials sites as required by OSHA regulations and as specified in the HASP for the RI investigation. Selected personnel will have DOT and waste minimization training. Personnel involved in storing and shipping wastes that are radioactive will have 16-hour Radiological Worker II training. Additionally, all personnel involved with field activities or handling IDW will have Radiological Worker Training based on the planned activities noted in the LEHR ER contractor questionnaire used to identify required training and as specified in the LEHR Radiological Control Manual.

3.0 REMEDIAL INVESTIGATION METHODS AND ASSOCIATED WASTES

This section provides a description of subsurface investigation methods that will be employed during the RI that may generate waste. Additionally, the associated waste material screening and handling methods, and an estimate of the quantity of waste that may be generated are also discussed. Detailed descriptions of each investigation method are presented in the Standard Operating Procedures (SOP) provided as attachments to the Field Sampling Plan (FSP), Appendix A of the Draft RI/FS Work Plan (Dames & Moore, 1994).

3.1 RI ACTIVITIES WITH THE POTENTIAL TO GENERATE WASTE

This section provides a brief description of subsurface investigation methods which may generate waste during the RI. Types of waste that may be generated by each method are described in Section 3.2.

- Exploratory backhoe test pits/trenches: Test pits/trenches allow direct observation and sample collection of shallow (less than fifteen feet bgs) subsurface materials and/or soil. Test pits and/or trenches will be excavated using a backhoe equipped with a 2- to 3-foot wide bucket. Test pits are typically 2 to 3 feet wide, 5 to 15 feet deep, and 5 to 10 feet long.

- Soil borings: Soil borings are used for characterizing subsurface geology and hydrogeology and for collecting soil cores and depth-discrete samples for physical, chemical, and/or radiologic analysis. A boring is typically 6 to 12 inches in diameter and can be used for soil observation and sampling only, or can extend beneath the water table and be used to construct a groundwater monitoring well or piezometer.

- Cone Penetrometer Testing (CPT)/Hydropunch™: Cone penetrometer testing is a technique used to collect data on the characteristics of subsurface materials such as stiffness, density, moisture, and grain size without collecting samples or cores or creating drill cuttings that require handling and disposal. A CPT rig pushes a 2-inch-diameter cone-tipped tool downward through the subsurface up to 90 feet bgs.

- Groundwater Monitoring Well installation: Construction of a well is accomplished by placement of well construction materials (well casing, well screen, filter pack sand, and sealing materials) at specific depths in a boring based on geologic/hydrogeologic conditions and the specific purpose of the well.

- Well development: Development typically consists of using a surge block to pull formation water and excess fine-grained material from the filter pack and immediately surrounding formation into the well. The well is then bailed or pumped to remove the solids and developed by additional pumping.

- Groundwater sampling: Prior to sampling, a well is purged of three to five "casing volumes" of water (the amount of water standing in the well prior to pumping) so that sampled groundwater is representative of groundwater in the formation and not water that has been standing in the well.

- Aquifer testing: Three types of aquifer testing may be conducted at LEHR to evaluate aquifer characteristics beneath the site. The tests include slug tests, pumping tests, and single-well tracer tests. During a pumping test or a single-well tracer test, large quantities of water may be produced. No water is produced during a slug test.

- Septic tank sampling: Domestic septic tanks and leach fields at LEHR will be sampled by locating the tanks and leach fields, removing overlying materials, inspecting the interior of each tank, and collecting a sample of tank contents, if any. If tanks are empty, wipe samples of tank interiors will be collected. Soil samples will be collected adjacent to the bases of the tanks and leachlines but at slightly greater depth than the bases.

3.2 IDW AND THE WASTE SCREENING PROCESS

This section provides a description of the types of wastes that may be generated by each of the investigation procedures described above and a description of the screening process that will be used to determine if wastes will be removed from the area of investigation or stored on-site pending classification and disposal. On-site waste management and storage are described in Section 4. The waste classification process is described in more detail in Section 5.

Investigation methods have been selected that will, to the best extent possible, minimize the generation of IDW. Initial non-intrusive techniques such as geophysics or soil vapor surveys are being utilized to collect the data without generating wastes. Wastes from backhoe excavations will be returned to the excavation wherever possible. Sonic drilling methods — generating little or no cuttings — will be used, except where there are site access restrictions for this equipment. The CPT/Hydropunch methods generate little or no waste. Waste generated from CPT/Hydropunch work is anticipated to be non-hazardous. Wherever possible, initial steam cleaning water will remain in the AOC. Decontamination fluids from the permanent decontamination area will be stored in Baker tanks, pending characterization.

3.2.1 Wastes From Backhoe Test Pits/Soil Trenching

Materials generated during construction of backhoe test pits and soil trenches may include:

- excavated soil or fill debris, including biological debris, bottles, or concrete;
- plastic sheeting;
- unused sample material;
- personal protection equipment (PPE) and wipe samples; and
- decontamination wash/rinse water.

Excavation will be conducted by removing soil in approximately 2-foot thick layers. Each 2-foot layer of soil and/or fill material will be placed in a separate pile on plastic sheeting laid adjacent to the excavation and screened visually and with an organic vapor detector and a radioactivity meter. Visual observations and instrument readings will be recorded on the field log and will correlate to the two-foot layer (e.g., 0-2 feet reading, 2-4 feet reading, etc.). Selected materials encountered during exploration trenching, such as intact containers, will be left in place and marked for a removal action at a later date.

If screening levels are below established criteria (see Table D-3.1), excavated materials will be replaced into the excavation in the general order in which they were

removed, and compacted with the backhoe. It is anticipated that there will be no excess excavated soil or other material to be stored in drums. Plastic sheeting will be collected and placed in 55-gallon drums or roll-off bins specifically designated for this type of waste material. Disposable sampling equipment and disposable personal protection equipment (PPE) including, gloves, Tyvek coveralls, and boot covers, will be double-bagged for off-site landfill disposal.

Decontamination wastes will consist of water used to clean the backhoe bucket, sample collection tools, and personnel wash water. When possible, preliminary decontamination will be conducted so that sediment and rinsate from equipment will be discharged into a shallow depression in the area where it was generated unless screening indicates that elevated radioactivity or organic vapors could pose a threat to health or the environment from such placement (see Figure D-3.5). If screening criteria as presented in Table D-3.1 indicate the need, decontamination wastes will be placed in 55-gallon drums. All waste containers will be labelled to indicate the type of waste, date produced, source of the waste, and will be managed as described in Section 4 of this Plan.

Samples collected but not submitted for laboratory analysis will be archived in an on-site refrigerator for possible future testing. Excess soil sample material may remain after sample analysis. Sample material not consumed by analysis procedures will be shipped back to the LEHR site and temporarily stored on-site in the appropriate area based on the waste classification indicated by the analytical results.

3.2.2 Wastes From Soil Borings

Soil borings will be drilled using sonic drilling methods wherever possible to minimize waste generation. If necessary, either hollow stem auger or air-rotary equipment will be used in other areas. Materials generated by this activity will include:

- drill cuttings (soil);
- plastic sheeting;
- produced water produced during drilling;
- drilling materials, such as, excess grout or metal casing;

TABLE D-3.1
INTERPRETATION OF FIELD EVALUATION OF IDW

FIELD EVALUATION METHOD	EVALUATION FREQUENCY	RESULTS INDICATING CONTAMINATION REQUIRING CONTAINERIZATION
Odor	Continuous when in the presence of excavated material and not wearing respiratory protection	Chemical odor that is not associated with natural environmental processes
Color	Continuous in the presence of excavated material	Staining or discoloration not associated with natural environmental processes
Radiation meter	Borings with cores: maximum of every 5 feet Borings with cuttings only: approximately every 3-5 feet.	Readings of 48 μR/hr[1] above background[2] after meter is calibrated according to procedures in Appendix A of the RI/FS Work Plan
Organic Vapor Analyzer (PID; 11.5 eV or greater)	Borings with cores: maximum of every 5 feet Borings with cuttings only: approximately every 3-5 feet.	Readings above 5 ppm[3] in the breathing space after meter is calibrated according to procedures in Appendix A of the RI/FS Work Plan

1 48 μR/hr corresponds to 100,000 μR/year dose limit for visitors and public (100,000 μR/year/2080 hrs/year) (DOE, 1992).

2 Background values for alpha and beta/gamma activities will be calculated by collecting five measurements at each of four off-site locations and adding two standard deviations to the mean of the 20 readings.

3 Dames & Moore Health and Safety Plan criteria based on anticipated contaminants and their respective Permissible Exposure Limits (PEL).

- drilling materials, such as, excess grout or metal casing;
- unused sample material;
- personal protection equipment and wipe samples; and
- decontamination wash/rinse water.

Working areas of drill sites will be covered with plastic sheeting to minimize the amount of potential surface impacts. After drilling is completed, used plastic sheeting, PPE, wipe samples, and decontamination wastes will be double-bagged for off-site disposal. Drill cuttings (soil brought to the surface by the drill rig as a boring is advanced) will be produced if hollow stem, air rotary drilling, or sonic drilling techniques are used.

Soil cores are generally collected from the intervals between soil samples collected for laboratory analysis. Soil cores are used for characterization of subsurface geology and hydrogeology and are stored in boxes designed to hold 10 linear feet of core. Soil core boxes will be stored on-site in a pre-designated location with other unused samples. Soil cores will be handled appropriately based on the results for samples and cuttings from the same depth.

When drilling with hollow-stem equipment, cuttings are brought to the surface along the outside of the augers. Cuttings obtained from borings drilled in off-site or upgradient uncontaminated areas will be spread adjacent to the boring location or placed in a shallow excavation adjacent to the boring and covered with compacted native soil.

For borings drilled on the LEHR site, cuttings will be visually examined and evaluated with field screening instruments. Observations and screenings will be conducted and recorded in the field log every 5 feet of boring. Material that appears contaminated based on observations and worker safety-based instrument readings (see Table D-3.1), will be placed in 55-gallon drums. Each drum will be labelled with the boring number and depth interval the cuttings represent and the date(s) produced.

Cuttings that do not exceed screening levels (Table D-3.1) will be placed in a shallow excavation adjacent to the boring. The location of the excavation will be noted on a map and included in the IDW database, the base of the excavation will be separated

noted on a map and included in the IDW database, the base of the excavation will be separated from in-situ soil with perforated plastic sheeting, and the cuttings will be covered with plastic sheeting and compacted native soil so that a slight mound is formed.

With the air-rotary drilling method, soil cuttings are brought to the surface through the interior of the drill casing either by circulating air or a mixture of air and water. The water is either added to help lift cuttings to the surface or will be groundwater from drilling below the water table. Cuttings obtained from off-site or upgradient uncontaminated areas will be discharged near the boring location. If the adjacent area is paved, the cuttings will be contained and then discharged at a proper location as close to the drill site as possible. In instances where any mixture of cuttings and water is placed adjacent to a boring, the placement area will be of sufficient size so that the liquid discharge does not pond.

Cuttings produced with the air-rotary drilling method on the LEHR site will be discharged directly from the drill rig into a plastic-lined roll-off bin. If excessive quantities of water are produced during drilling, the water will be pumped from the roll-off bin into a designated holding tank. Cuttings from the bins will be spread or buried in the AOC by the same procedures presented for the soil borings. The solids from installation procedures for drill sites in congested or paved areas will be spread out near UCD-12.

3.2.3 Wastes From CPT/Hydropunch™

Cone penetrometer testing (CPT) and Hydropunch™ methods allow the collection of subsurface soil and water data without the waste generation associated with soil borings. No soil cuttings are produced when using the CPT. Materials produced by this field activity are limited to:

- PPE and wipe samples; and
- Decontamination wastes.

The above-listed wastes will be handled as non-hazardous. The PPE will be double-bagged and disposed as non-hazardous refuse. Decontamination waste will be disposed of at each off-site CPT and Hydropunch™ location. All CPT and Hydropunch™ locations are off-site.

3.2.4 Wastes From Well Installation

Wells will be installed both on- and off-site. After soil borings are completed at the well locations, well installation consists only of addition of materials to the subsurface and ground surface. Waste materials resulting from well installation are limited to:

- PPE;
- excess grout and PVC casing; and
- decontamination wastes.

Excess grout and PVC will be managed as normal construction debris. Debris and PVC will be collected and contained in refuse boxes prior to being disposed off-site. Excess grout will either be mixed into surface soils or collected and disposed of as refuse. PPE from wells will be double-bagged and handled as non-hazardous refuse.

3.2.5 Wastes From Well Development

Well development is intended to withdraw fine-grained sediment (fine sand, silt, and clay) from the well and surrounding filter pack material. Materials generated by this activity will include:

- well development water (may contain minor amounts of fine sand, silt and clay);
- PPE and wipe sample waste; and
- decontamination wash/rinse water.

Well development water from on-site and downgradient wells will be contained in a holding tank. Well development equipment will be decontaminated by washing

the equipment over a container to collect the washwater generated. The washwater will be added to the tank holding the well development water. Water in the tank will then be transferred to an on-site holding tank and stored pending characterization (as described in Section 5) based on analytical results for samples from monitoring wells or samples of the water in the tank. PPE and wipe sample waste will be handled as described in previous sections for other field activities. When characterization is completed, the tanks will be marked to indicate the appropriate waste classification. Appropriate disposal procedures will then be selected.

3.2.6 Wastes From Groundwater Sampling

Sampling of groundwater monitoring wells is similar to well development with respect to the wastes generated. Materials generated by this activity will include:

- pre-sampling purge water;
- disposable sample collection equipment;
- PPE and wipe sample wastes; and
- decontamination wash/rinse water.

Pre-sample purge water and equipment rinse water from upgradient wells will be discharged to the ground in the vicinity of the well. In areas that are paved, water will be directed to the closest area to the well with exposed ground. Water will be discharged so that it does not pond or collect, to aid in evaporation.

PPE will be worn while sampling most wells. PPE and disposable teflon bailers used to withdraw groundwater samples from the well will be double-bagged and disposed of as non-hazardous.

3.2.7 Aquifer Testing

Aquifer testing will be conducted during the LEHR RI to obtain information on the characteristics of the aquifer. Testing will include slug tests, a pumping test and possibly, a single-well tracer test. Materials generated by these activities will include:

- purge water;
- PPE and disposable equipment; and
- decontamination wastes.

No purged water will be produced from slug testing. Purged water will be produced during the pumping test, and a single-well tracer test, if performed. Because the pumping test and single-well tracer tests are planned to be conducted in an off-site well, all purged water associated with these tests will be discharged to the surface near the well.

PPE and decontamination wastes will also be generated during either of these tests. All PPE and disposable equipment will be double bagged and disposed of as non-hazardous.

3.2.8 Wastes From Septic Tank Sampling

Septic tank sampling will consist of uncovering septic tanks and collecting a grab sample of tank contents or a wipe sample of the tank interior walls or floor. If liquid is present in the tank, a sample will be collected using a disposable bailer. Materials generated by this type of activity will include:

- asphalt, concrete, gravel, and/or soil contained in or overlying each tank;
- plastic sheeting;
- PPE, disposable bailers, wipe sample waste; and
- decontamination wash/rinse water.

Material overlying each tank will be temporarily placed on plastic sheeting adjacent to the tank. Upon completion of sampling of each tank, as much of the overlying material will be replaced in the excavation as possible.

PPE, bailers, and wipe samples will be double-bagged for disposal as non-hazardous. Plastic sheeting will be disposed in a dumpster for non-hazardous waste.

3.3 POTENTIAL QUANTITY OF IDW PRODUCED BY RI ACTIVITIES

As presented in this plan, most of the IDW will not be containerized and will be left on-site. It is not possible to predict the amount of each type of IDW (LLW, hazardous/dangerous, etc.) However, the maximum total quantities of IDW can be estimated based on the quantity of IDW associated with the various RI activities. Maximum estimated quantities of IDW produced by the planned RI activities are shown in Table D-3.2.

TABLE D-3.2
POTENTIAL QUANTITIES OF IDW BY INVESTIGATION AREA

AOC	Potential Quantity of Investigation Derived Waste*					
	Soil (1)	Produced Water (2) Drilling/Sampling	Development Water (per well)	Decontamination Fluids (5)	PPE/DE (3)	Other (4)
Background Study	42	0	0	500 gal.	3	0
Operable Unit 1 DOE Disposal Areas UC Davis Disposal Trenches	 80 650	 35 gal. 35 gal.	 0 0	 1000 gal. 1675 gal.	 20 25	 25 50
Operable Unit 2 Radium-226 Treatment System Strontium-90 Treatment System	 65 40	 0 0	 0 0	 800 gal. 500 gal.	 20 20	 0 0
Operable Unit 3 Dog Pens and North Chemical Dispensing Area	25	0	0	270 gal.	3	0
Operable Unit 4 Domestic Septic Tanks	200	0	0	1950 gal.	20	0
Operable Unit 5 UC Davis Landfill Units	150	60 gal.	0	500 gal.	25	50
Operable Unit 6 Groundwater Monitoring Wells (units per well) CPT/Hydropunch™	 1st HSU - 120 2nd HSU - 150 0	 1st HSU - 0/50 gal. 2nd HSU - 1000/150 gal. 0	 1st HSU - 500 gal. 2nd HSU - 1500 gal. 0	 1st HSU - 280 2nd HSU - 600 25 gal.	 1st HSU - 5 2nd HSU - 5 1	 0 0 0

* Total IDW generated. Waste contained will be significantly less.
(1) Units in cubic feet; Includes total volume of boreholes plus 75% bulking factor upon excavation and containerization. One 55-gallon drum equals approximately 7 cubic feet.
(2) Includes water produced during drilling, in-situ groundwater sampling and quarterly sampling.
(3) Units in cubic feet; Includes personal protective equipment (PPE) and disposable sampling equipment (DE).
(4) Units in cubic feet; Includes miscellaneous debris.
(5) Assumes 2 gal/foot for borings and monitoring wells; 25 gal/backhoe excavation.

4.0 ON-SITE MANAGEMENT AND STORAGE OF IDW

This section provides a general overview of the procedures to manage IDW that requires containerization. The procedures are designed to deal with the IDW from the point of waste generation to placement in the accumulation area at the LEHR site. The procedures include record keeping, waste packaging, and waste handling and storage prior to waste classification and waste disposal. The waste classification process is described in Section 5. Following classification, waste is moved to storage areas for specific categories (e.g., radioactive, hazardous, etc.). Section 6 of this Plan describes management and disposal methods for specific categories of waste.

4.1 RECORD KEEPING

All IDW containers will be labeled at the time waste is placed in the container. A representative label is shown in Figure D-4.1. Also, a multiple-copy waste container description form will be started when waste is first placed in the container. The container description form will be updated if waste is added to the container and when the container is moved. Copies from the container description form will be stored on-site and used to input information to the database used for IDW tracking. Information on the waste container description form will include:

- date for all waste placement into the container;
- identification of waste source;
- description of waste;
- record of field observations and meter readings for waste screening;
- identification of corresponding samples sent for laboratory analysis;
- container location in temporary storage area (including grid coordinates, if appropriate);
- date of sampling of container contents and sample identification (if applicable);
- waste classification (when available) and date of classification; and
- waste disposal destination and (if applicable) manifest number.

4.2 WASTE PACKAGING

The following sections describe the anticipated waste packaging containers that will be used to store IDW, pending characterization. The packaging containers include drums and roll-off bins for solids, and Baker tanks for liquids.

4.2.1 Drums

In order to allow separation of contaminated and uncontaminated materials, it is generally necessary to maintain the waste in discrete containers and locations. Hence, when IDW that is potentially hazardous, LLW, or RMW is generated during the RI, it will generally be placed into a number of smaller containers (such as 55-gallon drums) rather than a few large containers. When waste classification is complete, specific wastes may be combined if it is appropriate to do so and there is apparent benefit in using fewer and larger containers. A new label and waste container description form will be completed when waste is transferred to a new container, and the database will be updated.

4.2.2 Baker Tanks and Roll-Off Bins

In some instances, larger containers will be used for initial storage of IDW. Soil cuttings produced during drilling operations for on-site second HSU monitoring wells will be collected in roll-off bins, and water from development of on-site wells will be stored in Baker tanks. Baker tanks and roll-off bins will remain at the drill sites until drilling and well installation procedures are complete. It is anticipated that the monitoring well drill cuttings will not trigger the field screening criteria requiring the wastes to be stored in the controlled storage area. These wastes will be discharged to the surface around the well or other appropriate location such as near UCD-12. If the field screening indicates contamination, the storage tanks or bins may be transported to the controlled storage area.

Based on screening results, the Baker tanks and roll-off bins may be discharged at their current location, transported to a disposal site, or transported to the on-site

IDW storage area. When necessary to transport large containers, appropriate heavy equipment (trucks, backhoe, forklift, etc.) may be used, or the container contents may be transferred to smaller containers by pump, backhoe, or other suitable equipment. Containers will be properly sealed and a new label and waste container description form will be used for containers which receive transferred IDW.

4.3 WASTE HANDLING LOCATIONS

The following sections describe the waste-handling locations that will be used to control containerized wastes. The wastes will be stored in these areas pending analytical characterization and preparation for disposal.

4.3.1 Controlled Storage Area

To facilitate handling and to assist in maintaining secure on-site storage for IDW, a fenced area of the LEHR site will be designated as the controlled storage area. It is anticipated that the controlled storage area will be within the existing cobalt-60 field. A schematic drawing of the IDW controlled storage area is shown in Figure D-4.2. Material that may be placed back into its area of origin will be left near to the point of generation until it has been adequately characterized. Material not replaced into an excavation will be transferred from the point of generation to an on-site accumulation area within the controlled storage area as soon as practical after it is generated. After characterization, IDW will be transferred to the on-site storage area appropriate for the waste category. All storage locations will provide adequate access for transfer and other necessary handling of IDW.

4.3.2 Accumulation Area

Because of the potential for IDW to contain radioactive or hazardous substances, it will be necessary to temporarily store some IDW in secure locations until waste classification is complete and appropriate disposal can be implemented. All IDW containers will be labelled as described in Section 4.1, and a waste container description form completed prior to the container being transported to the

accumulation area. The accumulation area will be fenced and posted with appropriate signs to control access.

The accumulation area will be mapped using a grid system, and the grid location of each storage container will be entered into the IDW database. Containers will initially be stored in an accumulation area that is segregated into areas designated for soil, water, or PPE and disposable equipment. Following receipt of environmental sample analyses results, containers will be further segregated by specific waste type (LLW, RMW, hazardous/dangerous, or "other").

4.4 FENCING AND POSTING

Fencing and posting of the specific waste storage areas will comply with requirements for the waste type. Specifically, hazardous and radioactive wastes will be stored in fenced and posted locations. All IDW will be transported for disposal as soon as possible, and no IDW will remain in storage longer than the period permitted by law.

5.0 IDW WASTE CLASSIFICATION PROCESS

This Section describes the waste classification process for IDW that is screened and determined necessary to be contained. First, the regulatory waste classifications are listed and described. Next, the process for classifying waste is presented. Based on the waste classification, appropriate disposal can be selected as described in Section 6 of this Plan. The general waste classification process for containerized wastes is presented in Figure D-5.1. Additionally, the detail procedures to classify the wastes for disposal are presented in Appendices A, and supporting regulations are attached in Appendices B through D.

5.1 WASTE CLASSIFICATIONS

IDW produced during the RI at the LEHR site will be evaluated to determine if it is a low-level radioactive waste (LLW), hazardous waste pursuant to California regulations or the Resource Conservation and Recovery Act (RCRA), a radioactive mixed waste (RMW), contains hazardous substances subject to regulation under CERCLA and/or California regulations, or "other waste" as described in Section 5.1.5. Classification of IDW under state regulations may be necessary only if the IDW is potentially dangerous waste and disposal may occur in another state (i.e., at the Hanford facility in Washington, or Envirocare in Utah). Waste classifications are further discussed in the following subsections.

5.1.1 Low-Level Radioactive Wastes

As defined in the Low Level Radioactive Waste Policy Act (42 U.S.C. 2021b et seq), the term "low level radioactive waste" means radioactive material that is not a high-level radioactive waste, spent nuclear fuel, or by-product material. DOE 5820.2A expanded the definition to exclude transuranic wastes from LLW. Additionally, for purposes of this investigation, wastes may be designated as LLW if radioactivity meets the definition presented in DOE 5820.2A and exceeds established background levels for the LEHR site. The background levels for radioactivity in soil and groundwater at the LEHR site will be established during the RI by analyzing samples from locations that have not been impacted by site activities (see Section 5.1 of the Work Plan).

There is a potential that some IDW produced during the collection of environmental samples during the RI may contain low specific activity amounts of ^{90}Strontium, ^{226}Radium, ^{241}Plutonium, ^{232}Thorium, ^{229}Thorium, and/or trace amounts of other radionuclides. All PPE and disposable equipment used in areas where radionuclides could be elevated above background will be handled as LLW pending analytical results of appropriate soil, water, or wipe samples.

5.1.2 Hazardous/Dangerous Wastes

The criteria for RCRA hazardous waste are presented in the attached sections of Part 261, Title 40, Code of Federal Regulations (40 CFR) (Appendices B and E); the criteria for California hazardous waste are presented in Chapter 11, Title 22, California Code of Regulations (CCR) (Appendices C and D). It is possible that IDW produced from soil borings during characterization of waste disposal areas at the LEHR site could be hazardous/dangerous wastes.

5.1.3 Radioactive Mixed Wastes

Radioactive mixed waste (RMW) are those that meet the criteria for both radioactive waste (Section 5.1.1) and hazardous or dangerous waste as described in Section 5.1.2. Any RMW produced is expected to contain low specific-activity amounts of the radionuclides discussed in Section 5.1.1 and in addition may contain solvents, metals, or pesticides. Typically, RMW is treated so that the resulting materials no longer meet the criteria for mixed wastes. Such treatment typically, results in a radioactive waste and a separate hazardous or dangerous waste.

5.1.4 Hazardous Substances

CERCLA addresses the mitigation of threats to health or the environment posed by the release of hazardous substances. CERCLA hazardous substances are defined in 40 CFR Part 302 and includes RCRA hazardous wastes. The California Health and Safety Code, Chapter 6.8, Section 25316 defines California hazardous substances; the California definition includes CERCLA hazardous substances.

5.1.5 Other Wastes

The IDW that does not meet the criteria for hazardous/dangerous waste or for radioactive waste is not subject to treatment, storage, and disposal requirements developed for those categories of waste. Likewise, if the IDW is not a hazardous substance, it is not subject to CERCLA requirements. However, the IDW may still be a California Designated Waste as defined in Section 2522(a) of the CCR, and must be managed to avoid potential adverse impacts on the waters of the state. Some IDW with detectable levels of site constituents may not pose any apparent threat to the environment and can be managed with very few restrictions.

5.2 WASTE CLASSIFICATION PROCESS

All wastes containerized for storage during RI activities at the LEHR site will be classified prior to disposal. Stored wastes will be classified based on results from analytical laboratory analysis of corresponding environmental samples collected during the investigation or analysis of additional samples collected from IDW containers. Appropriate storage and disposal procedures for specific containers of IDW will be selected based on the waste classification. A database will be used to control storage and disposal of IDW. These procedures are further described in the subsections below. The classification process is diagramed in Figure D-5.1.

5.2.1 Laboratory Analysis

The laboratory utilized for soil and water samples from the LEHR site will be certified by the State of California for the requested analyses and be required to participate in the DOE Environmental Measurements Laboratory (EML) Program. The laboratory will meet the requirements of the Quality Assurance/Quality Control (QA/QC) Plan that was considered in development of the Quality Assurance Project Plan (QAPjP) included as Appendix B of the RI/FS Work Plan.

The analytical parameters that will be utilized for environmental samples collected during the RI have been selected based on historical operations at the facility and results from the Phase II Site Characterization. These parameters are presented in Table D-5.1.

The results for the environmental samples collected nearest to the IDW will provide information that is used to select proper storage and disposal procedures for specific storage containers. If the analytical results indicate that stored materials are potentially hazardous or radioactive, but are insufficient to complete waste classification, individual IDW containers may be sampled as described in Section 5.2.4, below.

5.2.2 IDW Database

As discussed in Section 4.1, each container of IDW generated during the RI/FS will be described on a waste container description form. Information on the forms will be entered into an IDW database. Part of the information in the database will link the contents of a particular drum to screening information and specific environmental samples submitted for analysis. When analytical results are received and verified, results will be correlated to the IDW containers and used for waste classification as discussed in Section 5.2.3.

After a container of IDW has been classified, the IDW database will be updated to reflect the classification and, if appropriate, the new storage location in a specific waste storage area. The information in the database will be provided to individuals responsible for selecting treatment or disposal options for the classified IDW.

5.2.3 Review of Analytical Results

Stored soil and water IDW will have corresponding environmental samples submitted for inorganic, organic, and radiologic analysis. After data validation, according to the procedures in the QAPP for the RI/FS, analytical results for these samples will be compared to regulatory standards or background concentrations established for waste classification. The applicable regulations are referenced in

TABLE D-5.1
ANALYTICAL PARAMETERS FOR ENVIRONMENTAL SAMPLES COLLECTED DURING THE RI AT THE LEHR SITE

SOIL ANALYTICAL PARAMETERS	GROUNDWATER ANALYTICAL PARAMETERS
pH Electrical Conductivity Bacteriological Count	pH Electrical Conductivity Temperature Turbidity Redox Potential (EH) Water Level
Water Soluble Anions Total Alkalinity Total Kjeldahl Nitrogen Ammonia Nitrates (as Nitrogen) Sulfide Metals* Hexavalent Chromium	Total Dissolved Solids Chemical Oxygen Demand Cations Anions Alkalinity Nitrate, Total Kjeldahl Nitrogen (TKN), Ammonia Antimony, Arsenic, Barium, Beryllium, Cadmium, Cobalt, Lead, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Vanadium, and Zinc Total Chromium Hexavalent Chromium
Total Organic Carbon Volatile Organic Compounds Semi-Volatile Organic Compounds Organochlorine Pesticides and PCBs	Total Organic Carbon Volatile Organic Compounds Semi-Volatile Organic Compounds Pesticides and PCBs Formaldehyde
Gross Alpha Gross Beta Gamma Spectral Analysis Tritium, Strontium 90, Carbon 14	Gross Alpha Gross Beta Gamma Emitters Tritium, Strontium-90, Carbon-14, Radium-226

* Metals include 17 CAM Metals, Mg, Ca, Mn, and Fe.

Section 5.1 and included in Appendices B through E. If possible, based on review of the analytical results and consideration of the regulations, an appropriate waste classification will be assigned to individual containers of IDW. The IDW database will be updated as discussed in Section 5.2.2 with sample analysis results.

In some instances, the results of the environmental sample analyses alone may not be adequate to determine if the waste is hazardous or dangerous waste according to state and federal regulations, or to adequately characterize radioactive waste for disposal. When necessary, additional testing will be conducted on the environmental samples or on samples of the IDW. The specific testing needed will be identified as part of the review of initial analytical results. Additional sampling of individual containers of IDW is described in Section 5.2.4.

5.2.4 Waste Segregation and Resampling

Based on the waste classification determined by review of analytical results from environmental samples, containers of IDW will be moved to on-site waste storage areas designated for storage of specific waste types. Specific waste storage areas will be segregated according to the appropriate regulation. The IDW database will be modified to reflect the new storage location for the container.

If stored wastes cannot be adequately classified based on environmental sample analytical results, the IDW may be sampled directly for waste classification purposes. The resampling will involve collecting representative samples from containers of IDW and submitting the samples for selected laboratory testing as determined during the analytical data review described in Section 5.2.3.

If the initial analytical results indicate the IDW is potentially hazardous waste, but are insufficient to complete waste classification, individual IDW containers may be sampled in order to classify the IDW for disposal. Additional tests may include the Toxic Characteristic Leaching Potential (TCLP) and/or the Waste Extraction Test (WET) as needed to evaluate the leaching potential of certain soluble constituents.

If IDW is a radioactive waste, it will be characterized with sufficient detail so that proper identification, segregation, treatment, transportation, storage, and disposal will occur. Additional gamma spectral analysis or a specific radiochemical analysis of IDW may be necessary in order to evaluate the appropriate disposal category for LLW waste.

5.2.5 Reviewing Results and Updating Database

Once analytical results are received for IDW that was resampled, the data will be reviewed to identify the appropriate waste classification. Based on the assigned waste classification, containers of IDW will be moved to appropriate on-site storage areas for specific wastes. The IDW database will be modified to reflect the new storage location for the container, and a copy of the database will be provided to personnel responsible for selecting treatment or disposal options.

6.0 MANAGEMENT AND DISPOSAL OF SPECIFIC WASTE CATEGORIES

This section discusses regulations which apply to storage and disposal of the specific types of waste that may be containerized during RI/FS activities at the LEHR site. These regulations may address labeling of containers, storage facilities, duration of storage, shipping procedures, treatment requirements, disposal site options, agency notification, record keeping, etc. On-site management practices and off-site disposal options for different categories of IDW at the LEHR site are discussed below.

6.1 HAZARDOUS WASTES

Disposal of hazardous waste is regulated by the Environmental Protection Agency under RCRA and, generally, by one or more agencies in the state where the disposal facility is located. In California, the state agency primarily involved with regulation of hazardous waste disposal is the California Department of Toxic Substances Control. There are also federal and state regulations which apply to the transportation of hazardous waste from the point of generation to the disposal site. The primary federal regulations that apply to the disposal of hazardous waste are contained in Title 40 CFR Parts 262-268 and Title 49 CFR Parts 100-178. The applicable California regulations are in Title 22 CCR.

6.1.1 Hazardous Waste Storage

IDW identified as hazardous waste will be placed in storage containers that are clearly marked to identify their contents, and the containers will be kept in a secure area which is appropriately posted. On-site storage of hazardous waste will be in compliance with RCRA and Title 22 CCR Part 262. Prior to the end of the appropriate storage period, the waste will be manifested and shipped off-site to a permitted hazardous waste treatment, storage, or disposal (TSD) facility.

6.1.2 Hazardous Waste Disposal

The TSD facility will be selected based on waste characteristics, shipping logistics, and available capacity. Until the IDW is generated and characterized, it is not possible to identify an appropriate waste disposal site that will be utilized. However, based on the potential for disposal of hazardous waste, the following standard practices have been identified for use at LEHR.

Packaging, Shipping, and Manifesting

All shipments of hazardous waste will be manifested as required by applicable federal and state requirements .All transporters utilized for hazardous waste shipment will be currently registered and licensed for that service. Procedures will be established to comply with applicable packaging and transportation requirements established by DOE 5480.3 "Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes", the Department of Transportation (DOT), and the requirements of all states along the transportation route.

Land Disposal Restrictions

Land disposal restrictions presented in 40 CFR Part 268 contain requirements that limit the disposal of hazardous waste which has not been treated. Until IDW at LEHR is characterized, it is not possible to determine what, if any, treatment is needed prior to disposal. If treatment is necessary, IDW from LEHR will most likely be shipped off-site for treatment unless there is an apparent benefit to on-site treatment.

6.2 RADIOACTIVE AND MIXED WASTES

It is anticipated that any radioactive IDW produced will be LLW, and will be managed as required by DOE 5820.2A, "Radioactive Waste Management" and by Chapter 4 of the LEHR Radiological Control Manual. Likewise, any RMW generated will have only low-level radioactivity. The amounts of LLW and RMW generated will

be minimized by avoiding transfer of radioactive material to uncontaminated material during field activities by the use of field screening. The amount of LLW and RMW shipped will be minimized by concentrating and compacting the wastes to the extent reasonably achievable.

6.2.1 Radioactive and Mixed Waste Storage

The LLW and RMW produced during the RI will be managed to protect public health and safety. Containers utilized for storage of materials identified as LLW and RMW will meet labeling requirements specified in the LEHR Radiological Control Manual. All LLW resulting from the RI will be stored in a secure and appropriately posted location for the minimum amount of time necessary to prepare and arrange for transportation to an appropriate treatment or disposal facility.

Any RMW generated during the RI will be stored only until shipment to a treatment site or appropriate disposal facility can be initiated. RMW will be stored in a designated portion of the radioactive waste storage area incompliance with applicable hazardous waste regulations.

6.2.2 Radioactive and Mixed Waste Disposal

It is anticipated that any LLW and RMW produced during the RI will be disposed at an appropriate facility. Therefore, all LLW and RMW to be shipped must meet the receiving facility's waste acceptance criteria. To the extent possible, RMW will be treated to reduce or remove hazardous components and otherwise managed as described in Section 4.2. California hazardous waste regulations contained in Chapter 11, Title 22, California Code of Regulations (CCR) will be considered in the identification and management of RMW shipped to an off-site facility. All LLW transportation activities will comply with DOT regulations contained in 49 CFR and Nuclear Regulatory Commission (NRC) requirements in 10 CFR Part 71.

6.3 OTHER WASTES

It is expected that most of the IDW produced during the RI will not be hazardous, LLW, or RMW, and will be designated as "other wastes". However, some "other wastes" may contain hazardous substances pursuant to CERCLA and/or California regulations and, therefore, must be properly managed.

It is also possible that some "other wastes," which do not contain hazardous substances, may pose a potential threat to water quality if not properly managed, and hence may be classified as "designated waste" pursuant to California Water Resources Control Board programs. An example of such IDW would be water or soil containing nitrates at levels that could degrade waters of the state if not properly managed.

6.3.1 Storage of Other Wastes

Based on the waste characterization results, those containers that hold hazardous substances will be appropriately marked and will be stored in a manner similar to that used for hazardous waste. IDW that are designated wastes will be managed to prevent any impact to water quality. In general, such management will consist of isolating the material from contact with rainfall or runoff.

"Other wastes" that are not designated wastes may be classified as "inert wastes." These wastes will be placed in locations where they will not contact contaminated material and may be disposed of at a Class III landfill or other appropriate disposal location.

6.3.2 Disposal of Other Wastes

If it is necessary to dispose of waste containing hazardous substances during the RI, discussions will be held with appropriate regulatory agencies, DOE, and UC Davis to identify appropriate management practices and disposal sites. If it is necessary to dispose of designated waste during the RI, an appropriate disposal site will be selected after consultation with the Central Valley Regional Water Quality Control Board.

Disposal procedures for inert released wastes generated during the RI will be selected by the Department of Energy and the University of California. Inert soils may be disposed on site or at a Class III landfill. If the material goes to a Class III landfill, the steel drum may be reused, and only the liner and drum contents will be sent to the landfill. Water that is inert released waste can be discharged to a sewage treatment plant (STP), used for dust suppression or irrigation, or sprayed over paved surfaces in order to enhance evaporation. If discharge to the UC Davis STP is proposed, all discharges will be coordinated with the plant operator.

After classification, IDW will be transferred to the on-site storage area appropriate for the waste category. Disposal facilities may also promulgate requirements which affect the choice of disposal sites and the disposal procedures that are utilized.

7.0 IDW WASTE MANAGEMENT SCHEDULE

The schedule for management of IDW at LEHR is dependent on the overall RI/FS schedule. This section provides an overview of the RI/FS schedule and discusses the timing of related waste management activities.

7.1 RI/FS SCHEDULE

The LEHR site is not currently under any regulatory enforcement actions; therefore, a project schedule for the completion of the RI/FS has not been mandated.

It is anticipated that work conducted on-site will start with the least intrusive tasks, such as literature reviews and surface geophysical methods. Completion of these tasks is not anticipated to produce IDW. After the literature review and geophysical surveys have been completed, invasive investigative techniques that could potentially generate IDW will be implemented. It is anticipated that the majority of the IDW will be generated during the site characterization tasks presented in Section 3.0 of this Plan.

7.2 WASTE GENERATION SCHEDULE

Initial invasive investigative activities during the RI/FS will utilize CPT/ Hydropunch™ and soil gas measurements. These activities will not generate significant amounts of IDW. Subsequent investigation activities will utilize backhoes and soil boring equipment to investigate on-site septic systems, disposal trenches, and landfill cells. Cuttings from some of the borings may be placed in labeled 55-gallon drums and transferred to the waste storage area. Wastes have the potential to start arriving in the controlled storage area within 60 days of start-up of the RI/FS.

Existing monitoring wells will be sampled between two and three months after the start of the RI/FS. Purge water will be discharged to the surface and PPE/DE will be double-bagged and disposed. Currently, during each quarterly sampling round, approximately 1350 gallons (25 drums) of water are produced.

Approximately three to five months after start-up, soil borings for installation of new monitoring wells will be conducted. Development water produced during on-site drilling and development water produced from on-site and downgradient wells will be placed into Baker tanks pending characterization based on analytical results for environmental samples.

Existing monitoring wells will again be sampled between five and six months after start of the RI/FS. New monitoring wells will then be incorporated into the quarterly sampling schedule, and all wells will be sampled between eight and nine months after start of the RI/FS. Addition of the 11 new monitoring wells will result in an increase in the volume of purge water produced each quarter to approximately 2500 gallons (45 drums).

It is anticipated that most invasive investigation activities will be completed within 12 months of start-up of the RI. Some unused sample material may be returned by the laboratory. Some archived samples held on-site may be identified as unneeded and become IDW. The only additional waste generated after 12 months from start-up will consist of purge water produced during quarterly groundwater sampling.

7.3 WASTE CLASSIFICATION SCHEDULE

Approximately 30 to 45 days after the first environmental samples are submitted to the laboratory, analytical results will be received. Approximately 30 additional days will be required for data quality control review. After the quality control review of data, results will be used to determine appropriate classifications for the stored waste materials; this task will take approximately 14 days. If necessary, individual drums of stored material will be sampled so that further waste characterization can be done. The earliest identification of hazardous waste or LLW will occur approximately 75 days after samples were submitted to the laboratory.

Waste classification and disposed will be an ongoing process as laboratory reports are received. During the first 12 months that reports are received, IDW will consist of soil, water, and PPE. After 12 months, laboratory reports for environmental

samples will be primarily for water collected during groundwater sampling events. Laboratory reports for the last water samples will be received approximately 28 months after RI/FS start-up.

7.4 DATABASE MANAGEMENT SCHEDULE

Initial entries to the database will occur when IDW is generated. When waste classification for any containers of IDW is completed, the database will be updated. Additionally, when drums are moved to the appropriate location for storage for the waste classification, the database will be updated.

The database will be updated weekly as new IDW is produced, classified, and moved within the on-site controlled storage area. After the completion of waste classification for all soil IDW (approximately 12 months after start-up), records of waste management will be reviewed to assess the potential for any wastes to have been left in locations where they pose a risk to the environment or human health.

Information on stored waste will be periodically reviewed to identify appropriate disposal options and to ensure that storage time limits are not exceeded. This activity will be repeated while wastes remain in the on-site storage areas (see Section 7.5). Essentially, database activity will occur from the start of the RI/FS program through disposal of all IDW.

7.5 WASTE DISPOSAL SCHEDULE

Since the first containers of waste will not be classified until approximately 75 days from start-up, waste disposal will not start until approximately 3 to 4 months from start-up. Waste disposal will continue as an ongoing process throughout the duration of the RI/FS program.

It is anticipated that within 90 days of the last classification of IDW produced during the RI/FS, all IDW should have been sent for treatment or disposal. However, it

should be noted that there is no current storage limit on waste that is not radioactive or hazardous.

8.0 REFERENCES CITED

Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended, Public Law 96-510, 94 Stat. 2767, 42 USC 9601, et seq.

Dames & Moore, 1993. Phase II Site Characterization Report.

DOD, 1988. Radioactive Waste Management, DOE Order 5820.2A, U.S. Department of Energy, Washington, D.C.

DOE, 1985. Safety Requirements for the packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes, DOE Order 5480.3, U.S. Department of Energy, Washington, D.C.

DOE, 1992. Radiological Control Manual, DOE N 5480.6.

DOT, 1990. Transportation, Title 49, Code of Federal Regulations, Parts 100 to 199, U.S. Department of Transportation, Washington, D.C.

DOE, 1992. Radiological Control Manual, DOE N5480.6.

EPA, 1989a. Identification and Listing of Hazardous Waste, Title 40, Code of Federal Regulations, Part 261, as amended, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1987. Standards Applicable to Generators of Hazardous Waste, Title 40, Code of Federal Regulations, Part 262, as amended, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991. Management of Investigation Derived Wastes During Site Inspections, OSWER Directive 9345.3-02, Environmental Protection Agency, Washington, D.C.

EPA, 1989d. Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Title 40, Code of Federal Regulations, Part 264, as amended, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989c. Land Disposal Restrictions, Title 40, Code of Federal Regulations, Part 268, as amended, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989b. Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Title 40, Code of Federal

Regulations, Part 265, as amended, U.S. Environmental Protection Agency, Washington, D.C.

LEHR, 1993. Radiological Control Manual.

Low-Level Radioactive Waste Policy Amendments of 1985, 42 USC 2021b, et seq.

Resource Conservation and Recovery Act of 1976, as amended, Public Law 94-580, 90 Stat. 2795, 42 USC 6901, et seq.

State of California, Hazardous Substance Account, Chapter 6.8, Health and Safety Code, as amended.

State of California, Environmental Health Standards for the Management of Hazardous Waste, Code of California Regulations, Chapter 11, Title 26, as amended.

State of California, Water, Code of California Regulations, Division 3, Title 23, as amended.

ATTACHMENT D-1

EVALUATION PROCESS FOR IDW GENERATED AT THE LEHR FACILITY

LEHR ENVIRONMENTAL RESTORATION
INVESTIGATION WASTE MANAGEMENT PLAN

ATTACHMENT D-1: EVALUATION PROCESS FOR IDW GENERATED AT THE LEHR FACILITY

Note: Outlined below is a detailed waste evaluation process. All steps or criteria will not be applied to all wastes.

I. For each waste container:
   A. Obtain the laboratory results which correspond to the waste.
   B. Verify that results are complete:
      1. All necessary analysis were requested.
      2. All requested analyses were satisfactorily completed.
   C. Determine the appropriate waste classification as described in the following sections.

II. Determine if waste is radioactive:
   A. Compare radiologic test results to established background levels.
   B. If test results exceed background:
      1. Complete radioactive waste description form.
      2. Transfer container(s) to radioactive waste storage area.
      3. Label the container and include the date of classification.
      4. Determine if the waste is also:
         a. A RCRA Hazardous Waste (section III below), or
         b. A California Hazardous Waste (section IV below), or
         c. A waste as classified by the disposal facility location.

III. Determine if the material is a "RCRA Hazardous Waste":
   A. Note: no listed RCRA wastes are known to have been discharged at the LEHR site.
   B. Note: no wastes that exhibit RCRA characteristics of ignitability, corrosivity, or reactivity have been, or are expected to be, generated during remedial investigations at LEHR.
   C. Determine if the waste exhibits the characteristic of toxicity:
      1. For waste with <0.5% filterable solids, compare the analytical values to Table 1 in § 261.24 of 40 CFR (see Attachment D-2).
      2. For other wastes, determine if total levels of toxic constituents exceed the levels in Table 1:
         a. If less than listed values, the waste is not RCRA hazardous.
         b. If greater than listed values, perform TCLP (reference 40 CFR, Part 261, Appendix II) and compare values to Table 1).
            (1) If less than listed values, the waste is not RCRA hazardous.
            (2) If greater than listed values, the waste is RCRA hazardous.
   D. If the material is a RCRA hazardous waste:
      1. Complete a hazardous waste description form.
      2. Label the container and include the date of classification.
      3. Transfer container(s) to hazardous waste storage area.

IV. Determine if waste is a "Hazardous Waste" under California regulations:

A. All RCRA wastes are hazardous waste under California regulations.

B. For other wastes, determine if the waste exhibits the characteristic of toxicity according to § 66261.24 of Title 22, California Code of Regulations (CCR):

1. The material is a California hazardous waste if it has any of the following characteristics:
   a. An acute oral LD_{50} < 5,000 milligrams per kilogram.
   b. An acute dermal LD_{50} < 4,300 milligrams per kilogram.
   c. An acute inhalation LD_{50} < 10,000 ppm as a gas or vapor.
   d. An acute aquatic 96-hour LC_{50} < 500 milligrams per liter when tested as specified in § 66261.24.
   e. It contains ≥ 0.001 weight percent of the carcinogens listed in part (a)(7) of § 66261.24.
   f. It has been shown through experience or testing to pose a hazard to human health or the environment.
2. For other waste with <0.5% filterable solids, compare the analytical values to STLC values in Table 1, § 66261.24 of Title 22, CCR (see Attachment D-3). If STLC values are exceeded, the material is a California hazardous waste.
3. For other wastes, determine if total levels of toxic constituents exceed the STLC levels in Table 1:
   a. If total values are greater than the TTLC values, the material is a California hazardous waste.
   b. If less than the TTLC values, but greater than STCL values, perform a WET (reference Title 22 CCR, Chapter 11, Appendix II) and compare results to STLC values.
      (1) If greater than listed values, it is a California hazardous waste.
      (2) If less than listed values, the material is not a California hazardous waste.

C. If the material is a California hazardous waste:

1. Complete a hazardous waste description form.
2. Label the container and include the date of classification.
3. If the material is also a radioactive waste, leave the container in that storage area.
4. If the material is not radioactive, transfer container(s) to hazardous waste storage area.

V. Determine requirements of receiving facility:

A. Only if the waste is radioactive and will be shipped to an appropriate facility.

B. If the material is a Dangerous Waste in receiving state.

1. Complete a hazardous waste description form.
2. Label the container and include the date of classification.
3. Leave the container(s) in the radioactive waste storage area.

VI. If the waste is not hazardous, determine if it contains "Hazardous Substances":

A. Refer to the "Master List of Hazardous Substances" (see Attachment D-4).
B. If the waste contains hazardous substances:
   1. Determine the reportable quantity pursuant to 40 CFR, § 117.3, Table 117.3 (see Attachment D-5).
   2. If the material contains a reportable quantity of a hazardous substance, disposal must comply with 40 CFR, § 117 et seq.
C. If the material contains a hazardous substance:
   1. Complete a hazardous substance description form.
   2. Label the container and include the date of classification.
   3. Transfer container(s) to hazardous substance storage area.

VII. If the material is not a hazardous substance, determine if it is a designated waste:
A. This determination applies to material containing substances which could adversely affect water quality if not properly managed.
   1. Materials to be evaluated include non-hazardous waste containing hazardous substances below the reportable quantity.
   2. Determination is dependent upon site specific environmental factors.
      a. Factors for the LEHR facility if material will be discharged to land at the facility, or
      b. Factors for another proposed discharge site.
B. Procedures for making the determination are contained in "The Designated Level Methodology for Waste Classification and Cleanup Level Determination", a Central Valley RWQCB Staff Report.
C. The basic steps of determination are as follow:
   1. Identify the waste constituents that could adversely impact water quality.
   2. Select a tentative disposal site.
   3. Determine the leachability of the constituents if discharged at the site.
   4. Determine attenuation factors for the constituents at the site.
   5. Calculate the designated level(s) for the constituent(s) and the designated level for the waste.
   6. If the site selected was not appropriate, consider another site.
   7. When an appropriate site is identified, propose discharge at the site.
   8. Obtain the concurrence of the site owner/operator, and, if appropriate, the RWQCB.
D. If the material is a designated waste:
   1. Move the container(s) to the designated waste storage area
   2. Label the container to:
      a. Note that the material is a designated waste.
      b. Identify the associated documentation.
      c. Identify the appropriate disposal site when selected
   3. Prepare necessary documentation and proceed to discharge the waste.

VIII. If the waste does not contain constituents that could adversely impact water quality:

A. It is a "Non-hazardous Solid Waste" if it contains significant amounts of biodegradable materials and must go to a Class III (or better) landfill.
B. Otherwise, it is an "Inert Waste" and can go to an unclassified disposal site.
C. Label the container(s) with the appropriate designation and move to the "Clean Wastes" storage area.

ATTACHMENT D-2

EXCERPT FROM TITLE 40 CFR PART 261

LEHR ENVIRONMENTAL RESTORATION INVESTIGATION WASTE MANAGEMENT PLAN

ATTACHMENT D-2: EXCERPT FROM TITLE 40 CFR PART 261

Subpart B—Criteria for Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste

s§ 261.10 Criteria for identifying the characteristics of hazardous waste.

(a) The Administrator shall identify and define a characteristic of hazardous waste in subpart C only upon determining that:

(1) A solid waste that exhibits the characteristic may:

(i) Cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or

(ii) Pose a substantial present or potential hazard to human health or the environment when it is improperly treated, stored, transported, disposed of or otherwise managed; and

(2) The characteristic can be:

(i) Measured by an available standardized test method which is reasonably within the capability of generators of solid waste or private sector laboratories that are available to serve generators of solid waste; or

(ii) Reasonably detected by generators of solid waste through their knowledge of their waste.

s§ 261.11 Criteria for listing hazardous waste.

(a) The Administrator shall list a solid waste as a hazardous waste only upon determining that the solid waste meets one of the following criteria:

(1) It exhibits any of the characteristics of hazardous waste identified in subpart C.

(2) It has been found to be fatal to humans in low doses or, in the absence of data on human toxicity, it has been shown in studies to have an oral LD 50 toxicity (rat) of less than 50 milligrams per kilogram, an inhalation LC 50 toxicity (rat) of less than 2 milligrams per liter, or a dermal LD 50 toxicity (rabbit) of less than 200 milligrams per kilogram or is otherwise capable of causing or significantly contributing to an increase in serious irreversible, or incapacitating reversible, illness. (Waste listed in accordance with these criteria will be designated Acute Hazardous Waste.)

(3) It contains any of the toxic constituents listed in Appendix VIII and, after considering the following factors, the Administrator concludes that the waste is capable of posing a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed.

(i) The nature of the toxicity presented by the constituent.

(ii) The concentration of the constituent in the waste.

(iii) The potential of the constituent or any toxic degradation product of the constituent to migrate from the waste into the environment under the types of improper management considered in paragraph (a)(3)(vii) of this section.

(iv) The persistence of the constituent or any toxic degradation product of the constituent.
(v) The potential for the constituent or any toxic degradation product of the constituent to degrade into non-harmful constituents and the rate of degradation.
(vi) The degree to which the constituent or any degradation product of the constituent bioaccumulates in ecosystems.
(vii) The plausible types of improper management to which the waste could be subjected.
(viii) The quantities of the waste generated at individual generation sites or on a regional or national basis.
(ix) The nature and severity of the human health and environmental damage that has occurred as a result of the improper management of wastes containing the constituent.
(x) Action taken by other governmental agencies or regulatory programs based on the health or environmental hazard posed by the waste or waste constituent.
(xi) Such other factors as may be appropriate.

Substances will be listed on Appendix VIII only if they have been shown in scientific studies to have toxic, carcinogenic, mutagenic or teratogenic effects on humans or other life forms.
(Wastes listed in accordance with these criteria will be designated Toxic wastes.)

(b) The Administrator may list classes or types of solid waste as hazardous waste if he has reason to believe that individual wastes, within the class or type of waste, typically or frequently are hazardous under the definition of hazardous waste found in section 1004(5) of the Act.
(c) The Administrator will use the criteria for listing specified in this section to establish the exclusion limits referred to in § 261.5(c).

Subpart C—Characteristics of Hazardous Waste

s§ 261.20 General.

(a) A solid waste, as defined in § 261.2, which is not excluded from regulation as a hazardous waste under § 261.4(b), is a hazardous waste if it exhibits any of the characteristics identified in this subpart.
(b) A hazardous waste which is identified by a characteristic in this subpart is assigned every EPA Hazardous Waste Number that is applicable as set forth in this subpart. This number must be used in complying with the notification requirements of section 3010 of the Act and all applicable recordkeeping and reporting requirements under parts 262 through 265, 268, and 270 of this chapter.
(c) For purposes of this subpart, the Administrator will consider a sample obtained using any of the applicable sampling methods specified in Appendix I to be a representative sample within the meaning of part 260 of this chapter.

s§ 261.21 Characteristic of ignitability.

(a) A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:

(1) It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume and has flash point less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester, using the test method specified in ASTM Standard D-93-79 or D-93-80 (incorporated by reference, see § 260.11), or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D-3278-78 (incorporated by reference, see § 260.11), or as determined by an equivalent test method approved by the Administrator under procedures set forth in §§ 260.20 and 260.21.

(2) It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.

(3) It is an ignitable compressed gas as defined in 49 CFR 173.300 and as determined by the test methods described in that regulation or equivalent test methods approved by the Administrator under §§ 260.20 and 260.21.

(4) It is an oxidizer as defined in 49 CFR 173.151.

(b) A solid waste that exhibits the characteristic of ignitability has the EPA Hazardous Waste Number of D001.

s§ 261.22 Characteristic of corrosivity.

(a) A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:

(1) It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using either an EPA test method or an equivalent test method approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21. The EPA test method for pH is specified as Method 5.2 in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods" (incorporated by reference, see § 260.11).

(2) It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F) as determined by the test method specified in NACE (National Association of Corrosion Engineers) Standard TM-01-69 as standardized in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods" (incorporated by reference, see § 260.11) or an equivalent test method approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21.

(b) A solid waste that exhibits the characteristic of corrosivity has the EPA Hazardous Waste Number of D002.

s§ 261.23 Characteristic of reactivity.

(a) A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:

(1) It is normally unstable and readily undergoes violent change without detonating.
(2) It reacts violently with water.
(3) It forms potentially explosive mixtures with water.
(4) When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
(5) It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
(6) It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
(7) It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
(8) It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR 173.53 or a Class B explosive as defined in 49 CFR 173.88.
(b) A solid waste that exhibits the characteristic of reactivity has the EPA Hazardous Waste Number of D003.

s§ 261.24 Toxicity characteristic.

(a) A solid waste exhibits the characteristic of toxicity if, using the test methods described in Appendix II or equivalent methods approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21, the extract from a representative sample of the waste contains any of the contaminants listed in Table 1 at the concentration equal to or greater than the respective value given in that table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering using the methodology outlined in Appendix II, is considered to be the extract for the purpose of this section.
(b) A solid waste that exhibits the characteristic of toxicity has the EPA Hazardous Waste Number specified in Table I which corresponds to the toxic contaminant causing it to be hazardous.

Table I - Maximum Concentration of Contaminants for the Toxicity Characteristic:

EPA HW No	Contaminant	CAS Number	Regulatory Level, Mg/l
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D018	Benzene	71-43-2	0.5
D006	Cadmium	7440-43-9	1.0
D019	Carbon tetrachloride	56-23-5	0.5
D020	Chlordane	57-74-9	0.03
D021	Chlorobenzene	108-90-7	100.0
D022	Chloroform	67-66-3	6.0
D007	Chromium	7440-47-3	5.0
D023	o-Cresol	95-48-7	200.0 [1]
D024	m-Cresol	108-39-4	200.0 [1]
D025	p-Cresol	106-44-5	200.0 [1]
D026	Cresol	200.0 [1]	
D016	2,4-D	94-75-7	10.0
D027	1,4-Dichlorobenzene	106-46-7	7.5
D028	1,2-Dichloroethane	107-06-2	0.5
D029	1,1-Dichloroethylene	75-35-4	0.7
D030	2,4-Dinitrotoluene	121-14-2	0.13
D012	Endrin	72-20-8	0.02
D031	Heptachlor (and its epoxide)	76-44-8	0.008
D032	Hexachlorobenzene	118-74-1	0.13
D033	Hexachlorobutadiene	87-68-3	0.5
D034	Hexachloroethane	67-72-1	3.0
D008	Lead	7439-92-1	5.0
D013	Lindane	58-89-9	0.4
D009	Mercury	7439-97-6	0.2
D014	Methoxychlor	72-43-5	10.0
D035	Methyl ethyl ketone	78-93-3	200.0
D036	Nitrobenzene	98-95-3	2.0
D037	Pentachlorophenol	87-86-5	100.0
D038	Pyridine	110-86-1	5.0 [2]
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D039	Tetrachloroethylene	127-18-4	0.7
D015	Toxaphene	8001-35-2	0.5
D040	Trichloroethylene	79-01-6	0.5
D041	2,4,5-Trichlorophenol	95-95-4	400.0
D042	2,4,6-Trichlorophenol	88-06-2	2.0
D017	2,4,5-TP (Silvex)	93-72-1	1.0
D043	Vinyl chloride	75-01-4	0.2

[1] If o-, m- and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/l.

[2] Quantitation limit is greater than the calculated regulatory level. The quantitation limit therefore becomes the regulatory level.

Subpart D—Lists of Hazardous Wastes

s§ 261.30 General.

(a) A solid waste is a hazardous waste if it is listed in this subpart, unless it has been excluded from this list under §§ 260.20 and 260.22.

(b) The Administrator will indicate his basis for listing the classes or types of wastes listed in this subpart by employing one or more of the following Hazard Codes:

Ignitable Waste	(I)
Corrosive Waste	(C)
Reactive Waste	(R)
Toxicity Characteristic Waste	(E)
Acute Hazardous Waste	(H)
Toxic Waste	(T)

Appendix VII identifies the constituent which caused the Administrator to list the waste as a Toxicity Characteristic Waste (E) or Toxic Waste (T) in §§ 261.31 and 261.32.

(c) Each hazardous waste listed in this subpart is assigned an EPA Hazardous Waste Number which precedes the name of the waste. This number must be used in complying with the notification requirements of Section 3010 of the Act and certain recordkeeping and reporting requirements under parts 262 through 265, 268, and part 270 of this chapter.

(d) The following hazardous wastes listed in § 261.31 or § 261.32 are subject to the exclusion limits for acutely hazardous wastes established in § 261.5: EPA Hazardous Wastes Nos. FO20, FO21, FO22, FO23, FO26, and FO27.

s§ 261.31 Hazardous wastes from non-specific sources.

(a) The following solid wastes are listed hazardous wastes from non-specific sources unless they are excluded under §§ 260.20 and 260.22 and listed in Appendix IX.

(Table not reproduced in this Appendix)

s§ 261.32 Hazardous wastes from specific sources.

The following solid wastes are listed hazardous wastes from specific sources unless they are excluded under §§ 260.20 and 260.22 and listed in Appendix IX.

(Table not reproduced in this Appendix)

s§ 261.33 Discarded commercial chemical products, off-specification species, container residues, and spill residues thereof.

The following materials or items are hazardous wastes if and when they are discarded or intended to be discarded as described in § 261.2(a)(2)(i), when they are mixed with waste oil or used oil or other material and applied to the land for dust suppression or road treatment, when they are otherwise applied to the land in lieu of their original intended use or when they are contained in products that are applied to the land in lieu of their original intended use, or when, in lieu of their

original intended use, they are produced for use as (or as a component of) a fuel, distributed for use as a fuel, or burned as a fuel.

(a) Any commercial chemical product, or manufacturing chemical intermediate having the generic name listed in paragraph (e) or (f) of this section.

(b) Any off-specification commercial chemical product or manufacturing chemical intermediate which, if it met specifications, would have the generic name listed in paragraph (e) or (f) of this section.

(c) Any residue remaining in a container or in an inner liner removed from a container that has held any commercial chemical product or manufacturing chemical intermediate having the generic name listed in paragraphs (e) or (f) of this section, unless the container is empty as defined in § 261.7(b) of this chapter.

Comment: Unless the residue is being beneficially used or reused, or legitimately recycled or reclaimed; or being accumulated, stored, transported or treated prior to such use, re-use, recycling or reclamation, EPA considers the residue to be intended for discard, and thus, a hazardous waste. An example of a legitimate re-use of the residue would be where the residue remains in the container and the container is used to hold the same commercial chemical product or manufacturing chemical intermediate it previously held. An example of the discard of the residue would be where the drum is sent to a drum reconditioner who reconditions the drum but discards the residue.

(d) Any residue or contaminated soil, water or other debris resulting from the cleanup of a spill into or on any land or water of any commercial chemical product or manufacturing chemical intermediate having the generic name listed in paragraph (e) or (f) of this section, or any residue or contaminated soil, water or other debris resulting from the cleanup of a spill, into or on any land or water, of any off-specification chemical product and manufacturing chemical intermediate which, if it met specifications, would have the generic name listed in paragraph (e) or (f) of this section.

Comment: The phrase "commercial chemical product or manufacturing chemical intermediate..." refers to a chemical substance which is manufactured or formulated for commercial or manufacturing use which consists of the commercially pure grade of the chemical, any technical grades of the chemical that are produced or marketed, and all formulations in which the chemical is the sole active ingredient. It does not refer to a material, such as a manufacturing process waste, that contains any of the substances listed in paragraph (e) or (f). Where a manufacturing process waste is deemed to be a hazardous waste because it contains a substance listed in paragraph (e) or (f), such waste will be listed in either § 261.31 or § 261.32 or will be identified as a hazardous waste by the characteristics set forth in subpart C of this part.]

(e) The commercial chemical products, manufacturing chemical intermediates or off-specification commercial chemical products or manufacturing chemical intermediates referred to in paragraphs (a) through (d) of this section, are identified as acute hazardous wastes (H) and are subject to be the small quantity exclusion defined in § 261.5(e).

These wastes and their corresponding EPA Hazardous Waste Numbers are:

(Table not reproduced in this Appendix)

(f) The commercial chemical products, manufacturing chemical intermediates, or off-specification commercial chemical products referred to in paragraphs (a) through (d) of this section, are identified as toxic wastes (T), unless otherwise designated and are subject to the small quantity generator exclusion defined in § 261.5 (a) and (g).

These wastes and their corresponding EPA Hazardous Waste Numbers are:

(Table not reproduced in this Appendix)

Appendix I—Representative Sampling Methods

The methods and equipment used for sampling waste materials will vary with the form and consistency of the waste materials to be sampled. Samples collected using the sampling protocols listed below, for sampling waste with properties similar to the indicated materials, will be considered by the Agency to be representative of the waste.

Extremely viscous liquid——ASTM Standard D140-70 Crushed or powdered material——ASTM Standard D346-75 Soil or rock-like material——ASTM Standard D420-69 Soil-like material——ASTM Standard D1452-65

Fly Ash-like material——ASTM Standard D2234-76 [ASTM Standards are available from ASTM, 1916 Race St., Philadelphia, PA 19103]

Containerized liquid wastes——"COLIWASA" described in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods,"[1] U.S. Environmental Protection Agency, Office of Solid Waste, Washington, D.C. 20460. [Copies may be obtained from Solid Waste Information, U.S. Environmental Protection Agency, 26 W. St. Clair St., Cincinnati, Ohio 45268]

Liquid waste in pits, ponds, lagoons, and similar reservoirs.——"Pond Sampler" described in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods." 1a

This manual also contains additional information on application of these protocols.

Appendix II—Method 1311 Toxicity Characteristic Leaching Procedure (TCLP)

§261xII

1.0 Scope and Application

1.1 The TCLP is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes.

1.2 If a total analysis of the waste demonstrates that individual analytes are not present in the waste, or that they are present but at such low concentrations that the appropriate regulatory levels could not possibly be exceeded, the TCLP need not be run.

1.3 If an analysis of any one of the liquid fractions of the TCLP extract indicates that a regulated compound is present at such high concentrations that, even after accounting for dilution from the

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[1] These methods are also described in "Samplers and Sampling Procedures for Hazardous Waste Streams," EPA 600/2-80-018, January 1980.

other fractions of the extract, the concentration would be equal to or above the regulatory level for that compound, then the waste is hazardous and it is not necessary to analyze the remaining fractions of the extract.

1.4 If an analysis of extract obtained using a bottle extractor shows that the concentration of any regulated volatile analyte equals or exceeds the regulatory level for that compound, then the waste is hazardous and extraction using the ZHE is not necessary. However, extract from a bottle extractor cannot be used to demonstrate that the concentration of volatile compounds is below the regulatory level.

Appendix III—Chemical Analysis Test Methods

§261xIII

Tables 1, 2, and 3 specify the appropriate analytical procedures, described in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," (incorporated by reference, see § 260.11) which shall be used to determine whether a sample contains a given Appendix VII or VIII toxic constituent.

Table 1 identifies each Appendix VII or VIII organic constituent along with the approved measurement method. Table 2 identifies the corresponding methods for inorganic species. Table 3 summarizes the contents of SW-846 and supplies specific section and method numbers for sampling and analysis methods.

Prior to final sampling and analysis method selection the analyst should consult the specific section or method described in SW-846 for additional guidance on which of the approved methods should be employed for a specific sample analysis situation.

(Tables not reproduced in this Appendix)

ATTACHMENT D-3

EXCERPT FROM TITLE 22 CCR, DIVISION 45, CHAPTER 11

LEHR ENVIRONMENTAL RESTORATION
INVESTIGATION WASTE MANAGEMENT PLAN

ATTACHMENT D-3: EXCERPT FROM TITLE 22 CCR, DIVISION 45, CHAPTER 11

§ 66261.24. Characteristic of Toxicity.

(a) A waste exhibits the characteristic of toxicity if representative samples of the waste have any of the following properties:

(1) when using the Toxicity Characteristic Leaching Procedure (TCLP) in Appendix I of chapter 18 of this division or equivalent methods approved by the Department under the procedures set forth in section 66260.21, the extracts from representative samples of the waste contain any of the contaminants listed in Table I of this section at a concentration equal to or greater than the respective value given in that table unless the waste is excluded from classification as a solid waste or hazardous waste or is exempted from regulation pursuant to 40 CFR section 261.4. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering, is considered to be the extract for the purposes of this section;

(A) a waste that exhibits the characteristic of toxicity pursuant to subsection (a)(1) of this section has the EPA Hazardous Waste Number specified in Table I of this section which corresponds to the toxic contaminant causing it to be hazardous;

(B) Table I - Maximum Concentration of Contaminants for the Toxicity Characteristic:

(Table is the same as Table 1 in Appendix B)

(2) it contains a substance listed in subsections (a)(2)(A) or(a)(2)(b) of this section at a concentration in milligrams per liter of waste extract, as determined using the Waste Extraction Test(WET) described in Appendix II of this chapter, which equals or exceeds its listed soluble threshold limit concentration or at a concentration in milligrams per kilogram in the waste which equals or exceeds its listed total threshold limit concentration;

(A) Table II - List of Inorganic Persistent and Bioaccumulative Toxic Substances and Their Soluble Threshold Limit Concentration:

(STLC) and Total Threshold Limit Concentration (TTLC) Values.

Substance [5] [7]	STLC mg/l	TTLC Wet-Weight mg/kg
Antimony and/or antimony compounds	15	500
Arsenic and/or arsenic compounds	5.0	500
Asbestos		1.0 (as percent)
Barium and/or barium compounds (excluding barite)	100	10,000 [8]
Beryllium and/or beryllium compounds	0.75	75
Cadmium and/or cadmium compounds	1.0	100
Chromium (VI) compounds	5	500
Chromium and/or chromium (III) compounds	5 [8]	2,500
Cobalt and/or cobalt compounds	80	8,000
Copper and/or copper compounds	25	2,500
Fluoride salts	180	18,000
Lead and/or lead compounds	5.0	1,000
Mercury and/or mercury compounds	0.2	20
Molybdenum and/or molybdenum compounds	350	3,500
Nickel and/or nickel compounds	20	2,000
Selenium and/or selenium compounds	1.0	100
Silver and/or silver compounds	5	500
Thallium and/or thallium compounds	7.0	700
Vanadium and/or vanadium compounds	24	2,400
Zinc and/or zinc compounds	250	5,000

[5] STLC and TTLC values are calculated on the concentrations of the elements, not the compounds.

[6] If the soluble chromium, as determined by the TCLP set forth in Appendix I of chapter 18 of this division, is less than 5 mg/l, and the soluble chromium, as determined by the procedures set forth in Appendix II of chapter 11, equals or exceeds 560 mg/l and the waste is not otherwise identified as a RCRA hazardous waste pursuant to section 66261..100, then the waste is a non-RCRA hazardous waste.

[7] In the case of asbestos and elemental metals, the specified concentration limits apply only if the substances are in a friable, powdered or finely divided state. Asbestos includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

[8] Excluding barium sulfate.

(B) Table III - List of Organic Persistent and Bioaccumulative Toxic Substances and Their Soluble Threshold Limit Concentrations (STLC) and Total Threshold Limit Concentration (TTLC) Values:

Substance	STLC mg/l	TTLC Wet Weight mg/kg
Aldrin	0.14	1.4
Chlordane	0.25	2.5
DDT, DDE, DDD	0.1	1.0
2,4-Dichlorophenoxyacetic acid	10	100
Dieldrin	0.8	8.0
Dioxin (2,3,7,8-TCDD)	0.001	0.01
Endrin	0.02	0.2
Heptachlor	0.47	4.7
Kepone	2.1	21
Lead compounds, organic	——	13
Lindane	0.4	4.0
Methoxychlor	10	100
Mirex	2.1	21
Pentachlorophenol	1.7	17
Polychlorinated biphenyls (PCBs)	5.0	50
Toxaphene	0.5	5
Trichloroethylene	204	2,040
2,4,5-Trichlorophenoxypropionic acid	1.0	10

(3) it has an acute oral LD_{50} less than 5,000 milligrams per kilogram;
(4) it has an acute dermal LD_{50} less than 4,300 milligrams per kilogram;
(5) it has an acute inhalation LC_{50} less than 10,000 parts per million as a gas or vapor;
(6) it has an acute aquatic 96-hour LC_{50} less than 500 milligrams per liter when measured in soft water (total hardness 40 to 48 milligrams per liter of calcium carbonate) with fathead minnows (Pimephales promelas), rainbow trout (Salmo gairdneri) or golden shiners (Notemigonus crysoleucas) according to procedures described in Part 800 of the "Standard Methods for the Examination of Water and Wastewater (16th Edition)," American Public Health Association, 1985 and "Static Acute Bioassay Procedures for Hazardous Waste Samples," California Department of Fish and Game, Water Pollution Control Laboratory, revised November 1988 (incorporated by reference, see section 66260.11), or by other test methods or test fish approved by the Department, using test samples prepared or meeting the conditions for testing as prescribed in subdivisions (c)and (d) of Appendix II of this chapter, and solubilized, suspended, dispersed or emulsified by the cited procedures or by other methods approved by the Department;
(7) it contains any of the following substances at a single or combined concentration equal to or exceeding 0.001 percent by weight:

(A) 2-Acetylaminofluorene (2-AAF);
(B) Acrylonitrile;
(C) 4-Aminodiphenyl;
(D) Benzidine and its salts;
(E) bis (Chloromethyl) ether (BCME);
(F) Methyl chloromethyl ether;
(G) 1,2-Dibromo-3-chloropropane (DBCP);
(H) 3,3'-Dichlorobenzidine and its salts (DCB);
(I) 4-Dimethylaminoazobenzene (DAB);
(J) Ethyleneimine (EL);
(K) alpha-Naphthylamine (1-NA);
(L) beta-Naphthylamine (2-NA);
(M) 4-Nitrobiphenyl (4-NBP);
(N) N-Nitrosodimethylamine (DMN);
(O) beta-Propiolactone (BPL);
(P) Vinyl chloride (VCM);

(8) it has been shown through experience or testing to pose a hazard to human health or environment because of its carcinogenicity, acute toxicity, chronic toxicity, bioaccumulative properties or persistence in the environment.

(b) A waste containing one or more materials which exhibit the characteristic of toxicity because the materials have the property specified in subsection (a)(5) of this section may be classified as nonhazardous pursuant to section 66260.200 if the waste does not exhibit any other characteristic of this article and is not listed in article 4 of this chapter and its head space vapor contains no such toxic materials in concentrations exceeding their respective acute inhalation LC_{50} or their LC_{LO}. The head space vapor of a waste shall be prepared, and two milliliters of it shall be sampled using a five milliliter gas-tight syringe, according to Method 5020 in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 2nd edition, U.S. Environmental Protection Agency,1982 (incorporated by reference, see section 66260.11). The quantity in milligrams of each material, which exhibits the characteristic of toxicity because it has the property specified in subsection (a)(5)of this section, in the sampling syringe shall be determined by comparison to liquid standard solutions according to the appropriate gas chromatographic procedures in Method 8010, 8015, 8020, 8030 or 8240 in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd edition, U.S. Environmental Protection Agency,1986 (incorporated by reference, see section 66260.11). The concentration of each material in the head space vapor shall be calculated using the following equation:

$$C_A = \frac{Q_A}{MW} \times \frac{29.8ml}{mmole} \times \frac{1}{2 \times 10^{-6} M^3}$$

where C (in parts per million) is the concentration of material A in head space vapor, Q (in milligrams) is the quantity of material A in sampling syringe and MW (in milligrams per millimole) is the molecular weight of material A. Where an acute inhalation LC_{50} is not available, an LC_{50} measured for another time (t) may be converted to an eight-hour value with the following equation:

Eight-hour LC_{50} = (t/8) x (t-hour LC_{50}).

(c) A waste containing one or more materials which exhibit the characteristic of toxicity because the materials have either of the properties specified in subsection (a)(3) or (a)(4) of this section may be classified as nonhazardous pursuant to section 66260.200 if the waste does not exhibit any other characteristic of this article and is not listed in article 4 of this chapter and the calculated oral LD_{50} of the waste mixture is greater than 5,000 milligrams per kilogram and the calculated dermal LD_{50} is greater than 4,300 milligrams per kilogram by the following equation:

$$\text{Calculated oral or dermal } LD_{50} = \frac{100}{\sum_{x=1}^{n} \frac{\%A_x}{{}^{T}A_x}}$$

where $\%A_x$ is the weight percent of each component in the waste mixture and ${}^{T}A_x$ is the acute oral or dermal LD_{50} or the acute oral LD_{LO} of each component.

ATTACHMENT D-4

MASTER LIST OF HAZARDOUS SUBSTANCES

LEHR ENVIRONMENTAL RESTORATION
INVESTIGATION WASTE MANAGEMENT PLAN

ATTACHMENT D-4: MASTER LIST OF HAZARDOUS SUBSTANCES

The "Master List of Hazardous Substances" is produced by the Department of Toxic Substances Control as required by Section 25281 of Chapter 6.7, Division 20, of the California Health and Safety Code. The referenced law states:

§25281. For purposes of this chapter, the following definitions apply:

(b) "Board" means the State Water Resources Control Board. "Regional board" means a California regional water quality control board.

(c) "Department" means the State Department of Health Services.

§25282. (a) The department shall compile a comprehensive master list of hazardous substances. The master list shall be made available to the public and mailed to each local agency no later than June 30, 1984, notwithstanding any other provision of law, including Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code. Local agencies and owners or operators of underground storage tanks shall use the master list or, when adopted, the revised list adopted pursuant to subdivision (b), to determine which underground storage tanks require permits pursuant to this chapter. Hazardous substances included on the list may be denominated by scientific, common, trade, or brand names.

(b) The department may revise, when appropriate, the master list of all the hazardous substances specified in subdivision (a). The revised list of hazardous substances shall be prepared and adopted, and may be further revised, in accordance with Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code.

ATTACHMENT D-5: DETERMINATION OF REPORTABLE QUANTITIES
(Excerpt from 40 CFR Part 117)

§ 117.3 Determination of Reportable Quantities.

Each substance in Table 117.3 that is listed in Table 302.4, 40 CFR part 302, is assigned the reportable quantity listed in Table 302.4 for that substance.

Table 117.3—Reportable Quantities of Hazardous Substances Designated Pursuant to Section 311 of the Clean Water Act

Note: The first number under the column headed "RQ" is the reportable quantity in pounds. The number in parentheses is the metric equivalent in kilograms. For convenience, the table contains a column headed "Category" which lists the code letters "X", "A", "B", "C", and "D" associated with reportable quantities of 1, 10, 100, 1000, and 5000 pounds, respectively.

Material	Category:	RQ in pounds (kilograms)
Aldrin	X	1 (0.454)
Ammonia	B	100 (45.4)
Benzene	A	10 (4.54)
Captan	A	10 (4.54)
Carbaryl	B	100 (45.4)
Carbofuran	A	10 (4.54)
Chlordane	X	1 (0.454)
Chlorpyrifos	X	1 (0.454)
Cupric sulfate	A	10 (4.54)
2,4-D Acid	B	100 (45.4)
2,4-D Esters	B	100 (45.4)
DDT	X	1 (0.454)
Diazinon	X	1 (0.454)
Dicamba	C	1,000 (454)
Dichlobenil	B	100 (45.4)
Dichlone	X	1 (0.454)
Dichloropropane	C	1,000 (454)
Dichloropropene	B	100 (45.4)
Dichloropropene-Dichloropropane (mixture)	B	100 (45.4)
Dichlorvos	A	10 (4.54)
Dicofol	A	10 (4.54)
Dieldrin	X	1 (0.454)
Diquat	C	1,000 (454)
Disulfoton	X	1 (0.454)
Diuron	B	100 (45.4)
Endosulfan	X	1 (0.454)
Endrin	X	1 (0.454)
Ethion	A	10 (4.54)
Ethylene dibromide	X	1 (0.454)
Guthion	X	1 (0.454)
Heptachlor	X	1 (0.454)
Lindane	X	1 (0.454)
Malathion	B	100 (45.4)
Methoxychlor	X	1 (0.454)
Methyl parathion	B	100 (45.4)
Mevinphos	A	10 (4.54)

Mexacarbate	C	1,000 (454)
Naled	A	10 (4.54)
Parathion	A	10 (4.54)
Pentachlorophenol	A	10 (4.54)
Sodium arsenate	X	1 (0.454)
Sodium arsenite	X	1 (0.454)
2,4,5-T acid	C	1,000 (454)
2,4,5-T amines	D	5,000 (2,270)
2,4,5-T esters	C	1,000 (454)
2,4,5-T salts	C	1,000 (454)
2,4,5-TP acid	B	100 (45.4)
2,4,5-TP acid esters	B	100 (45.4)
Toxaphene	X	1 (0.454)
Zinc sulfate	C	1,000 (454)

Subpart B—Applicability

§ 117.11 General Applicability.

This regulation sets forth a determination of the reportable quantity for each substance designated as hazardous in 40 CFR part 116. The regulation applies to quantities of designated substances equal to or greater than the reportable quantities, when discharged into or upon the navigable waters of the United States, adjoining shorelines, into or upon the contiguous zone, or beyond the contiguous zone as provided in section 311(b)(3) of the Act, except to the extent that the owner or operator can show such that discharges are made:

(a) In compliance with a permit issued under the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1401 et seq.);

(b) In compliance with approved water treatment plant operations as specified by local or State regulations pertaining to safe drinking water;

(c) Pursuant to the label directions for application of a pesticide product registered under section 3 or section 24 of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended (7 U.S.C. 136 et seq.), or pursuant to the terms and conditions of an experimental use permit issued under section 5 of FIFRA, or pursuant to an exemption granted under section 18 of FIFRA;

(d) In compliance with the regulations issued under section 3004 or with permit conditions issued pursuant to section 3005 of the Resource Conservation and Recovery Act (90 Stat. 2795; 42 U.S.C. 6901);

(e) In compliance with instructions of the On-Scene Coordinator pursuant to 40 CFR part 1510 (the National Oil and Hazardous Substances Pollution Plan) or 33 CFR 153.10(e) (Pollution by Oil and Hazardous Substances) or in accordance with applicable removal regulations as required by section 311(j)(1)(A);

(f) In compliance with a permit issued under § 165.7 of Title 14 of the State of California Administrative Code;

(g) From a properly functioning inert gas system when used to provide inert gas to the cargo tanks of a vessel;

(h) From a permitted source and are excluded by § 117.12 of this regulation;

(i) To a POTW and are specifically excluded or reserved in § 117.13; or

(j) In compliance with a permit issued under section 404(a) of the Clean Water Act or when the discharges are exempt from such requirements by section 404(f) or 404(r) of the Act (33 U.S.C. 1344(a), (f), (r)).

§ 117.13 Applicability to Discharges From Publicly Owned Treatment Works and Their Users.

(a) [Reserved]

(b) These regulations apply to all discharges of reportable quantities to a POTW, where the discharge originates from a mobile source, except where such source has contracted with, or otherwise received written permission from the owners or operators of the POTW to discharge that quantity, and the mobile source can show that prior to accepting the substance from an industrial discharger, the substance had been treated to comply with any effluent limitation under sections 301, 302 or 306 or pretreatment standard under section 307 applicable to that facility.