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Water Monitoring Plan

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D. L. STEWART

LEHR Environmental Restoration
Davis, California

January 1994

Prepared by
Dames & Moore
Sacramento, California 95826

For the San Francisco Field Office
under a Related Services Agreement
with the U.S. Department of Energy
Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
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WATER MONITORING PLAN
LEHR ENVIRONMENTAL RESTORATION
DAVIS, CALIFORNIA

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ACRONYMS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

ANOVA	Analysis of Variance
bgs	below ground surface
CAM	California Assessment Manual
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response Compensation and Liability Act of 1980.
CEQA	California Environmental Quality Act
cfs	cubic feet per second
Ci	Curie
COC	Chain-of-Custody
COD	Chemical Oxygen Demand
cpm	counts per minute
CQA	Coordinator of Quality of Assurance
CrVI	Hexavalent Chromium
DOE	Department of Energy
DWR	Department of Water Resources
EC	Electrical Conductivity
EH&S	Environmental Health and Safety
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Administration
gpm	gallons per minute
HSU	Hydrostratigraphic Unit
K	Hydraulic Conductivity
K_v	Vertical Hydraulic Conductivity
LEHR	Laboratory for Energy-Related Health Research
LRDP	Long-Range Development Plan
MCL	Maximum Contaminant Level(s)

mgd	million gallons per day
MQA	Manager of Quality Assurance
NTU	Nephelometric Turbidity Units
OVA	Organic Vapor Analyzer
PARCC	precision, accuracy, representativeness, completeness and comparability
pCi/L	picoCuries per liter
PCB	Polychlorinated Biphenyls
PCD	South Fork of Putah Creek Downstream
PCQA	Program Coordinator of Quality Assurance
PCU	South Fork of Putah Creek Upstream
PNL	Pacific Northwest Laboratories
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
RCRA	Resource Conservation and Recovery Act
RPD	Relative Percent Difference
RWQCB	Regional Water Quality Control Board
SAN	San Francisco Operations Office (DOE)
SID	Solano Irrigation District
SOP	Standard Operating Procedures
SOW	Statement of Work
STLC	Soluble Threshold Limit Concentrations
STPO	Sewage Treatment Plant Outfall
SWAT	Solid Waste Assessment Test
TDS	Total Dissolved Solids
TPHRL	Toxic Pollutant Health Research Laboratory
TTLC	Total Threshold Limit Concentrations
USGS	United States Geological Service
VOCs	Volatile Organic Compounds
WBS	Work Breakdown Structure
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

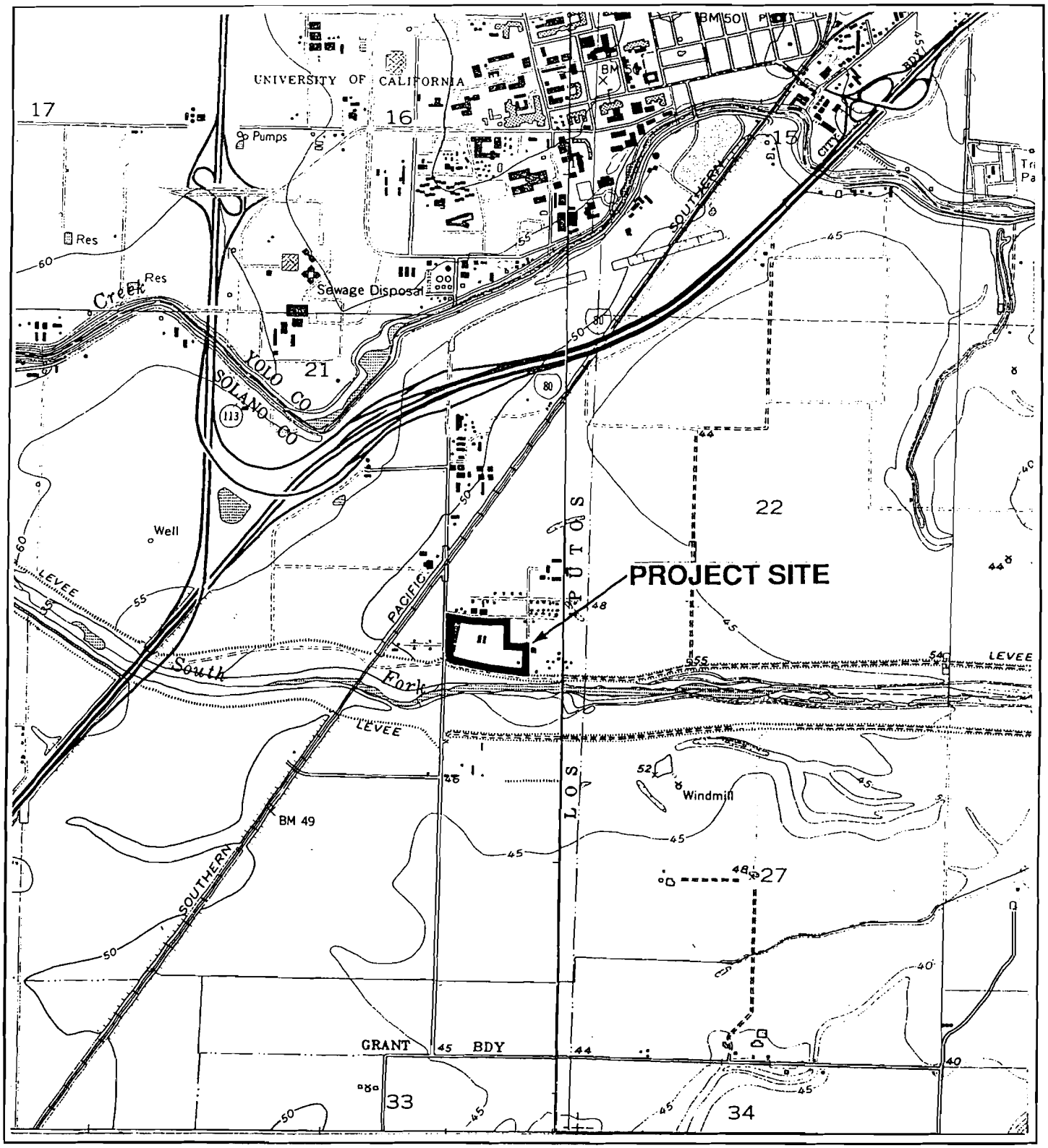
This Water Monitoring Plan presents the sample collection, analysis, and Quality Assurance/Quality Control (QA/QC) procedures for ongoing water monitoring at the Laboratory for Energy-Related Health Research (LEHR) facility located at the University of California (UC), Davis (Figure 1.1). Water monitoring is being conducted in conjunction with the Remedial Investigation/Feasibility Study (RI/FS) as part of the U.S. Department of Energy- (DOE) sponsored environmental restoration program underway at the LEHR site. Additionally, this plan is a counterpart to the existing site Environmental Monitoring Plan (ESO, 1992).

This Water Monitoring Plan complies with the DOE's General Environmental Protection Program presented in DOE Order 5400.1. This Order specifies the purpose, scope, policy and responsibilities for environmental protection, which includes environmental monitoring and surveillance programs at all DOE facilities. This Order also specifies that water monitoring programs conducted by the DOE will conform with Federal state, and local regulations.

DOE operations at the LEHR site ceased in 1989, therefore, this Water Monitoring Plan focuses primarily on environmental surveillance activities for non-operational facilities as defined in DOE Order 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). This plan describes the continuing Water Monitoring Program for the LEHR site.

1.1 PURPOSE

The purpose of the Water Monitoring Plan is to document the procedures used to characterize and monitor surface water and groundwater quality at the LEHR site. This plan is subject to revision in order to meet current and future data needs, such as the RI/FS, risk assessment, future remedial actions, and the eventual decontamination and decommissioning of the site.



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

N

0 2000

Scale in Feet

SITE VICINITY MAP

Water Monitoring Plan
LEHR Environmental Restoration

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FIGURE 1.1

1.2 APPROACH

The components of this Water Monitoring Plan include monitoring points, sample collection frequency, and data quality objectives (DQOs), which have been developed using the general requirements of the DOE Order 5400.1 and applicable federal and state regulations. Monitoring points have been identified in order to evaluate water quality and lateral and vertical extent of impact at the LEHR site. Sampling of groundwater and surface water monitoring points will continue on a quarterly basis in compliance with federal and state regulations and to obtain temporal and spatial information on chemical and radiologic constituents. The DQOs were developed by considering the various data uses which include RI/FS risk assessment, and possible remedial actions at the site. After sufficient water quality data has been obtained, the frequency or list of parameters may be modified to focus on specific constituents of concern.

1.3 ORGANIZATION OF WATER MONITORING PLAN

In Chapter 2 of this plan, the background of the facility is described including the site history. Chapter 3 presents a discussion of the existing monitoring program implemented during the Phase II Site Characterization. Chapter 4 presents the scope of this Water Monitoring Plan. Field methods and procedures are presented in Chapter 5. Chapter 6 presents the QA/QC procedures and requirements for data analysis. Chapter 7 identifies the data management and validation procedures that will be implemented for water analytical results. Analytical methods are presented in Chapter 8. Presentation formats are discussed in Chapter 9, and Chapter 10 presents references cited.

Appendix A the Quality Assurance Project Plan (QAPjP), which specifies the QA/QC protocols to be followed. Appendix B references the health and safety procedures to be followed by field personnel during sampling. Standard Operating Procedures (SOPs) for water sample collection and field measurements are presented in Appendix C.

2.0 BACKGROUND

This chapter describes the site history and site hydrogeologic conditions. The site history section explains past operations and regulatory compliance action. Hydrogeologic conditions are summarized from previous reports to provide background for the site conceptual hydrogeologic model. Additional details on the data presented in this section can be found in other environmental studies for the site. Summaries of these previous investigations are presented in the Phase II Site Characterization Report (Dames & Moore, 1993).

2.1 SITE HISTORY

The DOE has funded research on laboratory animals at the LEHR site since the 1950s. As a result of these studies, a variety of laboratory wastes, including radioactive, organic and inorganic materials were generated and disposed on-site. Full-scale experimental use of radioactive materials began at the LEHR site in 1960. Early experimentation included the use of radium-226 and strontium-90. In the early 1970s, an outdoor Cobalt-60 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 site ended in 1989.

Portions of the LEHR site were previously used as the UC Davis campus landfill. The landfill consisted of two separate disposal units. Disposal in the oldest area (Inactive Disposal Unit No. 1) began in the 1940s and ceased in the late 1950s. The area is now covered by the Cobalt-60 Field at the LEHR site. The next oldest disposal area (Inactive Disposal Unit No. 2) received wastes from 1956 to 1967. This disposal area is partially covered with the eastern most of two sets of dog pens used for animal research at the LEHR site. Reportedly, some of the wastes disposed in these cells were burned prior to being covered. A third landfill disposal area located approximately 600 feet east of the LEHR site (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 (Dames & Moore, 1990b).

Additional waste management areas at the LEHR site include DOE and UC Davis disposal trenches, outdoor dog pens, domestic septic tanks, and radiologic effluent

treatment systems. A variety of potential wastes were handled in these areas and separate chemical dispensing areas. Impact from these disposal areas and chemical dispensing areas has been evaluated during previous investigations or will be evaluated during the RI/FS program.

The primary waste management areas are summarized in Table 2.1. Detailed descriptions of known waste-generating and disposal processes are described in the Environmental Survey Preliminary Report (DOE, 1988). A discussion of waste-generating processes or potential environmental impacts at the LEHR site area is presented in Chapter 2 of the Phase II Site Characterization Report (Dames & Moore, 1993).

2.2 PREVIOUS INVESTIGATIONS

The DOE and UC Davis have sponsored 14 environmental evaluations at the LEHR site and adjacent landfill. Two surveys, the Initial Assessment Survey (Rockwell, 1984), and the Environmental Survey Preliminary Report (DOE, 1988), presented documentation of potential environmental impacts from past operations at the LEHR site. The Phase I Investigation (Wahler, 1988, and 1989) was an initial investigation of environmental impacts from past LEHR activities.

Two studies, the Solid Waste Assessment Test (SWAT) investigation (Dames & Moore, 1990b), and the Old UC Davis Landfill Additional Characterization (Dames & Moore, 1991a) addressed potential impact from the former UC Davis landfill. A Contaminant Pathway Analysis (Dames & Moore, 1990c) was conducted to assess health risk exposure from the LEHR site area on the main UC Davis campus. Other environmental evaluations 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 the South Fork of Putah Creek (Dames & Moore, 1990e) and a CEQA Preliminary Study for Characterization Activities (Dames & Moore, 1991c). The Phase II Site Characterization (Dames & Moore, 1993) provided a summary of the previous investigations and presented results of additional soil and groundwater investigations at the LEHR site.

TABLE 2.1

FORMER WASTE MANAGEMENT AREAS AT THE LEHR SITE

Waste Management Area	Type of Wastes	Comments
Imhoff treatment system	Primarily strontium-90, Nitrates, wastes from Animal Hospital- (AH) 1	Suspected overflows and leakage. Treated water containing residual radioactivity was discharged to leach fields.
Radium-226 treatment system	Radium-226, nitrates, wastes from AH-2	Treated effluent was discharged to three dry wells and a seepage trench near UCD-22.
Domestic septic tanks	Tanks reported to receive non-radioactive liquid wastes	One tank may have received radioactive effluent. Tanks were abandoned in place; sludges may not have been removed prior to abandonment.
Chemical dispensing areas	Potential spills from handling various chemicals	Chemical wastes from the dispensing areas may also have been disposed in on-site landfills and disposal pits and trenches including those intended for radioactive wastes.
Waste burial trenches	Low-level radioactive solid wastes and chemical and laboratory wastes	Reported to be 19 trenches and 49 pits; total waste volume estimated at 1,100 cubic yards. Waste reportedly covered with 4 feet of material.
Landfill units	Sanitary and chemical wastes from UC Davis; sewage sludge; possibly wastes from LEHR	Landfill Disposal Unit No. 1 used from 1940 to 1950s and now covered by Cobalt-60 field. Unit 2 operated from 1956 to 1967 and is partially covered by dog pens. A third unit is located east of the LEHR site.
Dog pen area	Dog excreta with low levels of radiologic constituents; chlordane residues from flea control activities	Two main areas originally containing approximately 350 pens. The pens held dogs which had received dosages of strontium-90 and radium-226. Annual usage of chlordane was 25-50 gallons.
Dry wells for storm water	The storm water may have carried wastes from management areas	The dry wells were deep enough to access permeable subsurface materials.

During the previous investigations a total of 24 groundwater monitoring wells were installed at the LEHR site (Figure 2.1). One of these wells (UCD-2) was abandoned in 1990 by UC Davis because it was installed through Inactive Disposal Unit No. 2. Of the remaining 23 monitoring wells, 18 are installed in the shallow zone or first hydrostratigraphic unit (HSU) and 5 wells are installed in the next deeper zone or second HSU. Because of the limitation of scope and Data Quality Objectives (DQO) of the previous investigations, data obtained from these activities may not be reliable or sufficient to draw conclusions regarding the nature and extent of contamination at the LEHR site. Data, however, were used to scope the Phase II Site Characterization activities.

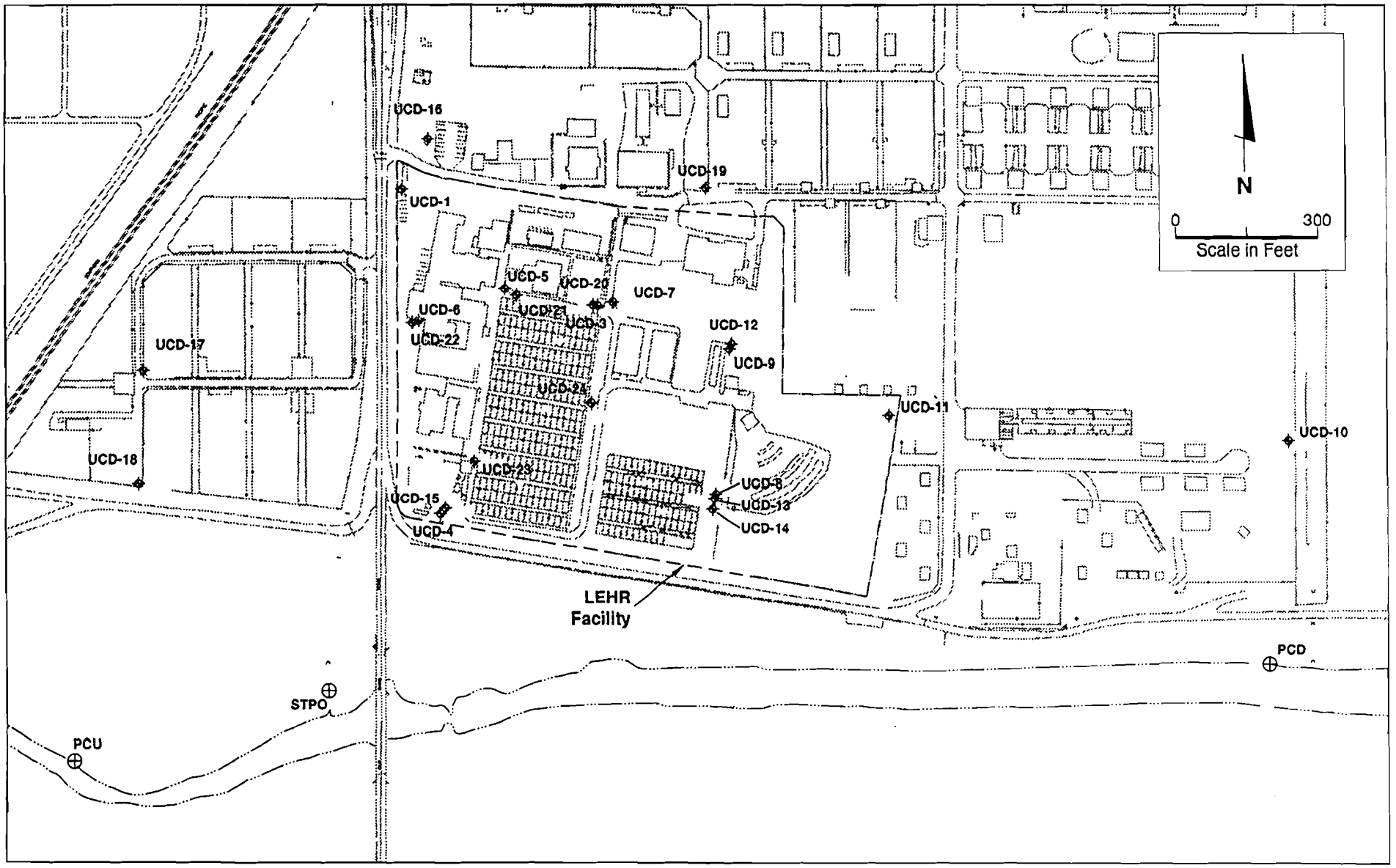
Based on results of the Phase II Site Characterization, some general findings have been identified regarding impacts to soil and water at the LEHR site. They include:

- Soils in several areas of former DOE operations have been impacted by nitrates and radiologic constituents;
- Soils at UC Davis trench areas may have been impacted by volatile organic constituents, pesticides, nitrates, and radiologics;
- Groundwater beneath the site has been impacted by nitrates, volatile organic compounds, radiologics and hexavalent chromium;
- Sporadic detections of chlorinated pesticides and several phthalates (plastics) have been reported in groundwater samples from wells at the LEHR site and in upgradient wells;
- Low levels of pesticides and nitrates have been reported in upstream and downstream surface water samples.

A more detailed discussion of Phase II Site Characterization groundwater and surface water analytical results is provided in Chapter 3.

2.3 HYDROGEOLOGIC CONDITIONS

Groundwater is first encountered in unconfined conditions beneath the site at depths ranging seasonally from approximately 45 to 70 feet below ground surface (bgs). Generally, water levels are at their highest level in early spring and at their lowest levels in



EXPLANATION

- Monitoring Wells
- Surface Water Monitoring Point

LOCATION MAP
GROUNDWATER MONITORING WELLS AND SURFACE WATER MONITORING POINTS

Water Monitoring Plan
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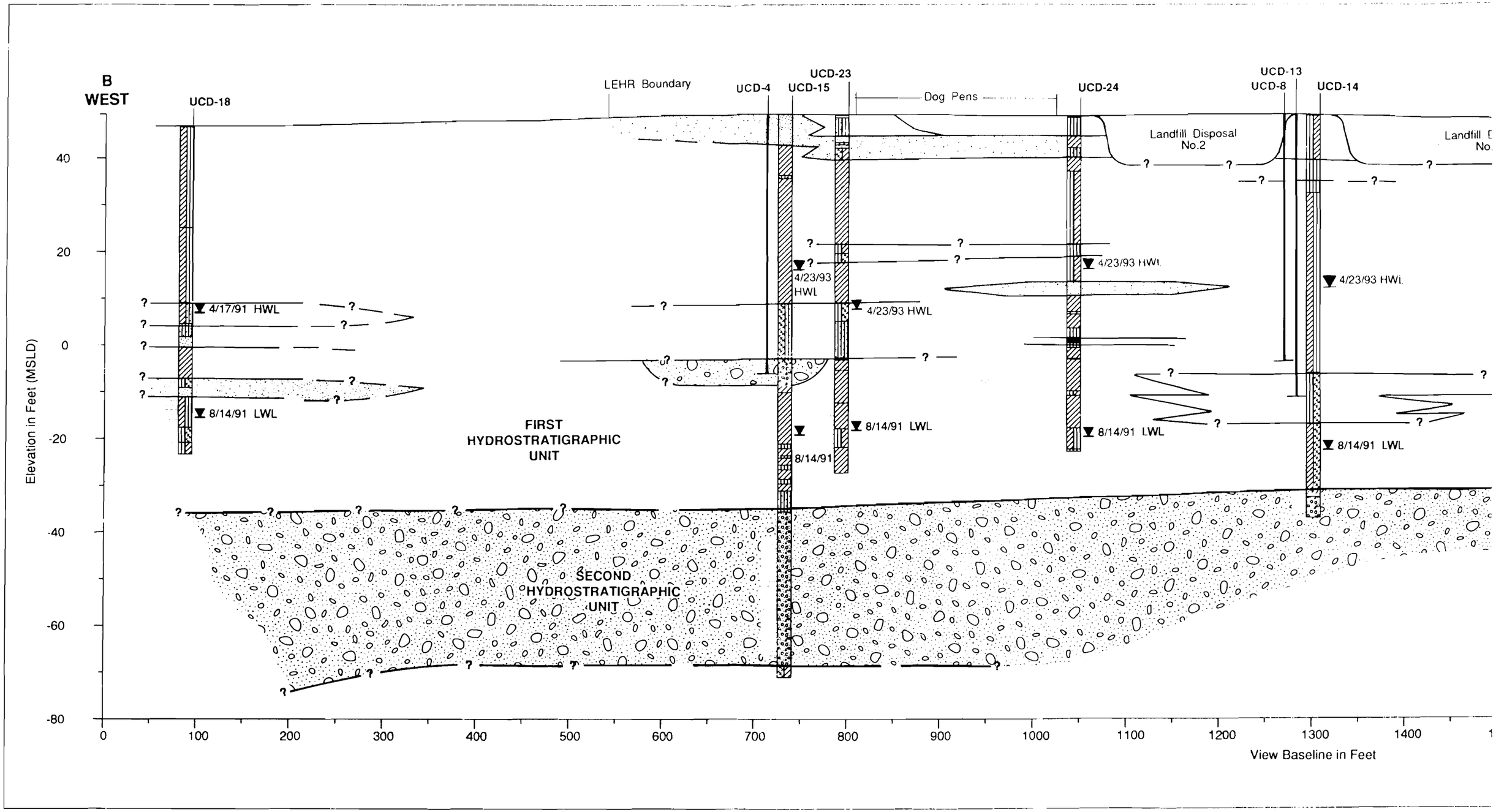
FIGURE 2.1

later summer. For the purpose of investigation, the uppermost aquifer has been separated into two HSUs based on subsurface stratigraphy (Dames & Moore, 1993). Figure 2.2 is a cross section, which shows the interrelationship of the two hydrostratigraphic units. The first HSU consists of find-grained sediments from the water table down to approximately 80 feet bgs. These fine-grained sediments include clay and silty clay with some sand lenses. The second HSU consists of cobbles and gravel present between approximately 80 and 135 bgs.

Comparison of hydrographs from wells screened in the two HSUs suggest a hydraulic connection between layers. Water levels in both HSUs show the same rise in the fall and winter, and decline in the spring and summer (Figure 2.3). The interconnection between the two units is supported by the lack of an observed aquitard between the two units and by results from three-dimensional groundwater numerical simulation. Although these two HSUs do not appear to be hydraulically separated by a confining unit, they are two distinctly different water-bearing zone with different characteristics. Additional HSUs (greater than 150 feet bgs), known to exist on a regional basis, have yet to be investigated below the LEHR site.

Generally, the groundwater flow direction in the first HSU is toward the northeast;. however, local temporary changes in flow direction and gradient do exist. Local groundwater gradients across the site in the first HSU vary from approximately 0.0001 to 0.0015 ft/ft. The estimated lateral hydraulic conductivity for the first HSU ranges from 1.9×10^{-5} cm/sec (6.2×10^{-7} ft/sec) to 9.1×10^{-3} cm/sec (3.0×10^{-4} ft/sec). The average flow velocity estimated for the first HSU is 1.6 ft/yr. Vertical gradients between the two zones vary seasonally from a downward gradient between the months of April and August to an upward gradient between the months of August and April. Vertical hydraulic conductivity, as estimated from numerical modeling, is approximately 1.01×10^{-5} cm/sec (3.3×10^{-7} ft/sec).

As with the first HSU, the second HSU also shows seasonal changes in hydraulic head on the order of 25 feet, but it does not demonstrate the wide range in gradients. The lateral gradient of the second HSU across the site is approximately 0.0015 ft/ft. The direction of flow appears to be predominantly toward the northeast. Groundwater gradient



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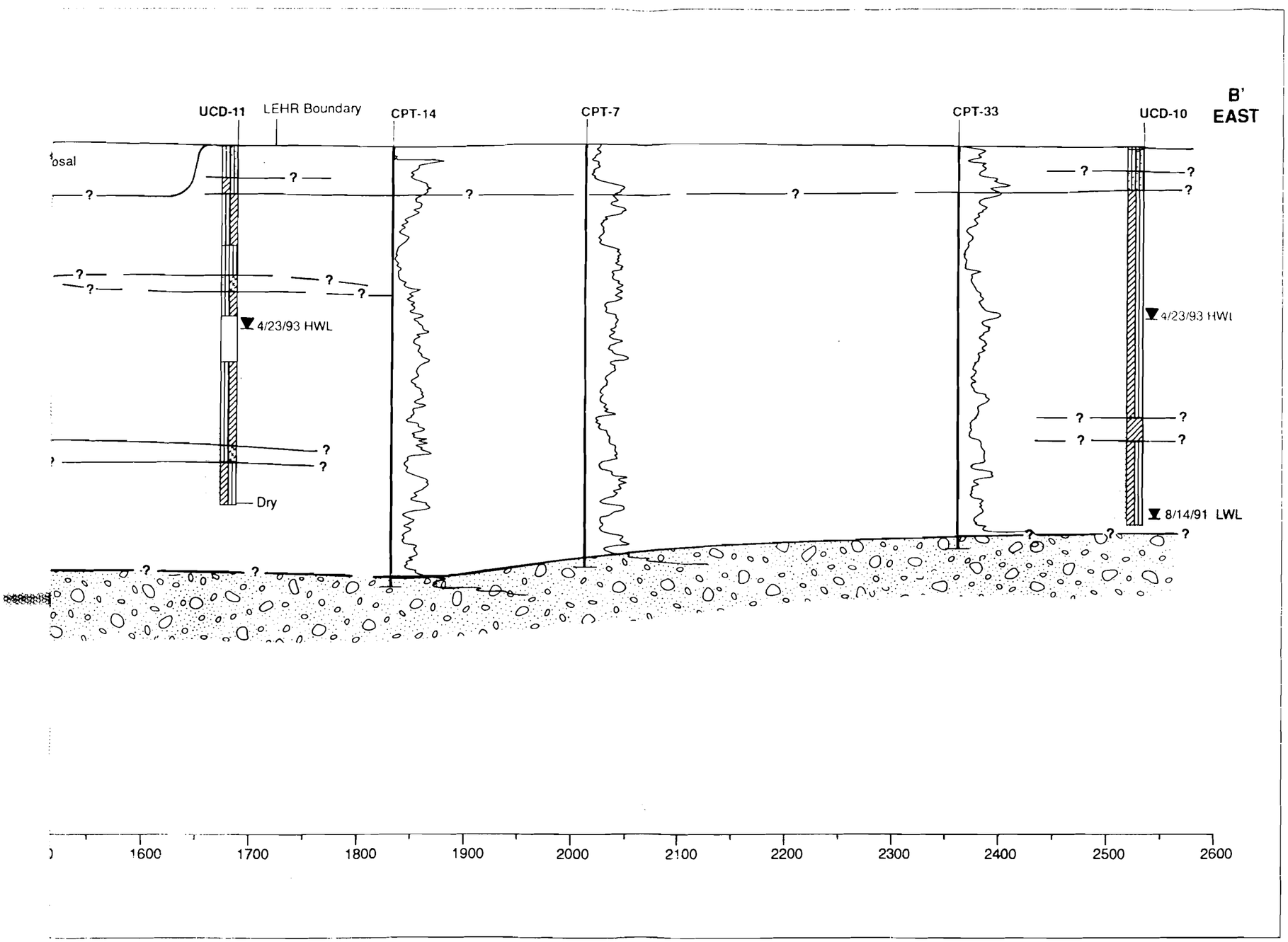


EXPLANATION

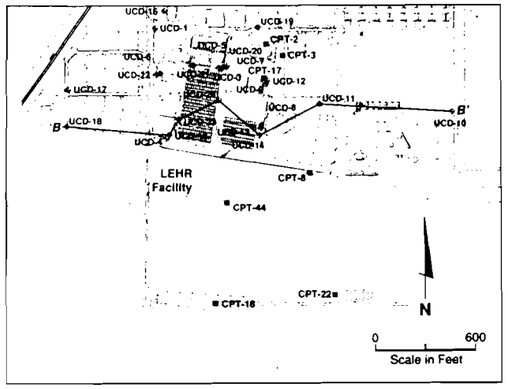
- 4/23/93 HWL — Highest Recorded Groundwater Level Between 11/90 Through 6/93
- 8/14/91 LWL — Lowest Recorded Groundwater Level Between 11/90 Through 6/93
- Screened Interval

STRATIGRAPHIC LITHOLOGY

- Interbedded Clay, Silty Clay and Silt
- Fine-Grained Sand and Silty Sand
- Well Rounded Cobbles and Gravel With Some Sand

BORING LOG LITHOLOGY

- Silty Clay, Sandy Clay, Gravelly Clay
- Clayey Silt, Sandy Silt, Gravelly Silt
- Silty Sand, Sand With Silt
- Clayey Sand, Sand With Clay
- Clayey Gravel, Gravel With Clay
- Silty Gravel, Gravel With Silt
- Sandy Gravel, Gravel With Sand
- Gravelly Sand, Sand With Gravel



GENERALIZED CROSS SECTION B-I

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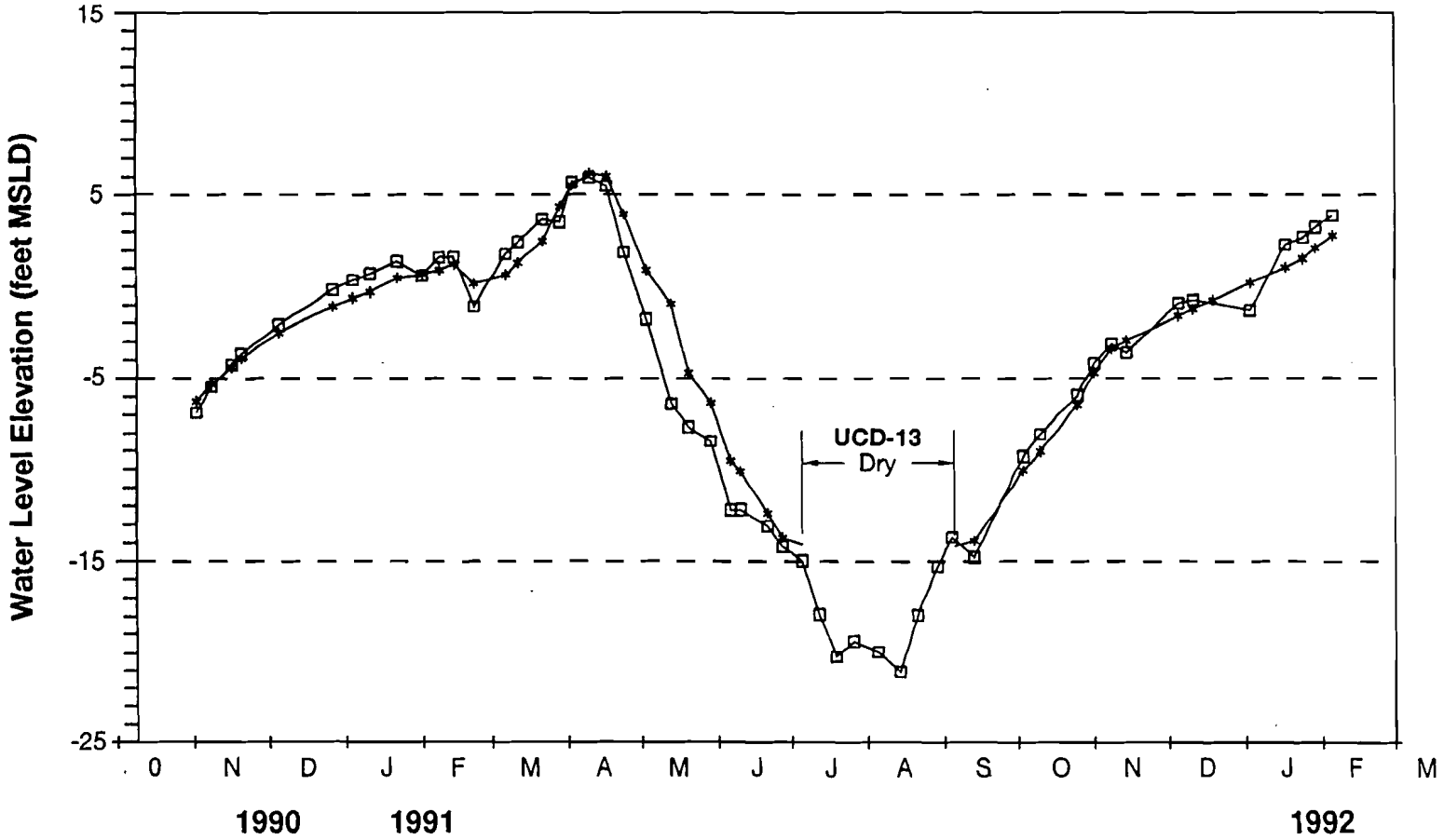
FIGURE



EXPLANATION

UCD-13 (First Hydrostratigraphic Unit)

UCD-14 (Second Hydrostratigraphic Unit)

WATER LEVEL ELEVATION HYDROGRAPHS FOR UCD-13 AND UCD-14

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FIGURE 2.3

and flow direction in the second HSU appear to be more consistent over the year than gradient and flow direction in the first HSU. Hydraulic conductivities for the second HSU are from 7.3×10^{-3} cm/sec (2.4×10^{-4} ft/sec) to 1×10^{-2} cm/sec (3.3×10^{-4} ft/sec); the average flow velocity value estimated for the second HSU is 71 ft/yr.

The only year-round surface water adjacent to the LEHR site is the South Fork of Putah Creek. The South Fork of Putah Creek is south of LEHR and is separated from the site by a levee (Figure 2.1). Based on visual observations during the year, wastewater treatment plant flow data, and the South Fork of Putah Creek stream gauge data, it appears that much of the South Fork of Putah Creek flow through the reach adjacent to the site is derived from outfall from the UC Davis wastewater treatment plant. Within two miles downstream of the LEHR site, the South Fork of Putah Creek is dry for the majority of the year. The results of the numerical modeling and the groundwater gradient information suggest that the creek acts as a continual source of recharge to the first HSU. This recharge area creates a groundwater high in the first HSU beneath the creek. The modeling indicates that recharge from the creek has a direct impact on the second HSU only at regional steady-state periods.

Stormwater runoff at LEHR is collected in two separate systems. One system collects storm water runoff from the south parking area where it is routed to a lift station and pumped under Old Davis Road where it is routed to the South Fork of Putah Creek. The second system collects storm water runoff and sanitary sewage from the LEHR site and routes it through a pump station to the UC Davis waste water treatment plant. The volumes, flow rates, and chemistry of this water have not been characterized to date. However, they will be addressed during the RI/FS program.

3.0 EVALUATION OF EXISTING WATER MONITORING SYSTEM

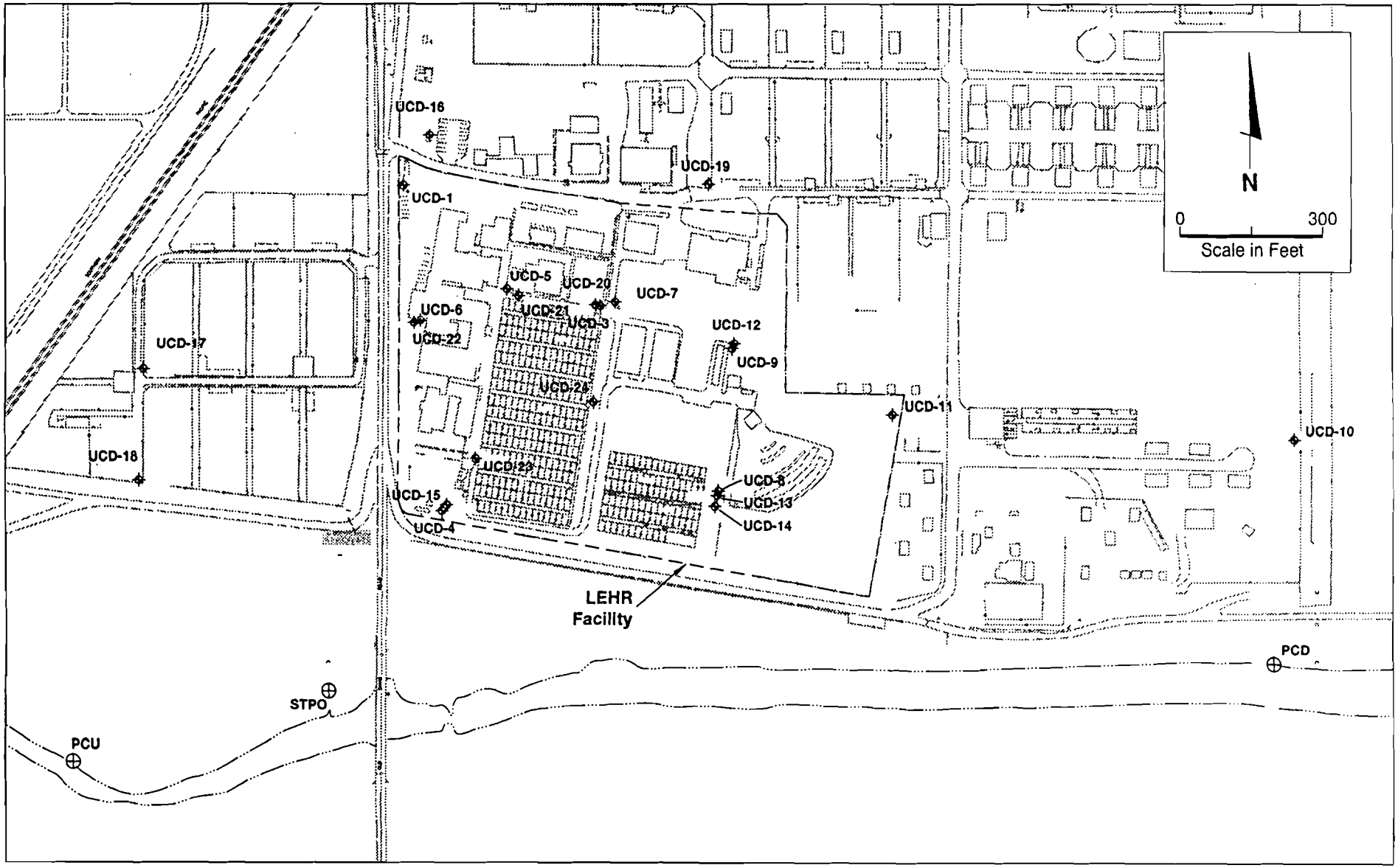
Water monitoring at the LEHR site under the Phase II Site Characterization began in November 1990 and has consisted of quarterly sampling and analysis of groundwater and surface water. The Phase II water monitoring system was developed initially by UC Davis and DOE, and later completed under the management of PNL for the DOE. The discussion below describes the Phase II monitoring program and monitoring system, and reviews the monitoring results obtained during the Phase II Site Characterization.

3.1 PHASE II WATER MONITORING PROGRAM

The Phase II water monitoring program at the LEHR site consists of quarterly sample collection, field measurements, and laboratory analysis of groundwater and surface water. The groundwater monitoring system currently includes 23 monitoring wells. Eighteen wells are screened in the first HSU and five wells are screened in the second HSU. Surface water is monitored at two locations along the South Fork of Putah Creek and at one location at the UC Davis wastewater treatment plant outfall. Locations of monitoring points are shown on Figure 3.1.

3.1.1 Water Monitoring Locations

Groundwater monitoring wells were installed during three previous investigations: the Phase I investigation, the SWAT investigation, and the Phase II Site Characterization. During the Phase I investigation, nine wells were installed (UCD-1 through UCD-9). During the SWAT investigation of the Old UC Davis Landfill at the LEHR site, five groundwater monitoring wells (UCD-10 through UCD-14) were installed. Ten groundwater monitoring wells were installed as part of the Phase II Site Characterization. Nineteen of these wells (UCD-1 through UCD-6, UCD-8 through UCD-13, and UCD 18 through UCD-24) were installed in the first HSU, and five wells (UCD-7 and UCD-14 through UCD-17) were installed in the second HSU. Monitoring Well UCD-2 was abandoned by UC Davis in 1990 because it was installed through the UC Davis Landfill Disposal Unit No. 2.



EXPLANATION

- ⊕ Monitoring Wells
- ⊕ Surface Water Monitoring Point

LOCATION MAP
GROUNDWATER MONITORING WELLS AND SURFACE WATER MONITORING POINTS

Water Monitoring Plan
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FIGURE 3.1

One first-HSU well, UCD-18, and one second-HSU well, UCD-17, are located off site and upgradient of the LEHR site; the other wells were placed to assess groundwater quality downgradient of potential source areas. Table 3.1 presents information on the wells installed during the Phase I, SWAT, and the Phase II Investigation.

Groundwater monitoring began in November 1990 under the Phase II Site Characterization and included quarterly sample collection, field measurements, and laboratory analysis. Monitoring is conducted at only 18 of the 23 existing wells because 5 wells (UCD-3, UCD-5, UCD-6, UCD-8, and UCD-9) installed as part of the Phase I investigation are typically dry. Wells included in the quarterly monitoring are: 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, and UCD-24.

The existing surface water monitoring program at the LEHR site also began in November 1990 and is conducted quarterly at three locations along the South Fork of Putah Creek. Monitoring point PCU is located upstream of the LEHR site; point PCD is located downstream of the LEHR site; and point STPO is located at the outfall of the UC Davis wastewater treatment plant which discharges into the South Fork of Putah Creek between points PCU and PCD. Monitoring at these locations is conducted quarterly, and for the same list of analytes as groundwater samples.

3.1.2 Analytical Program

Table 3.2 summarizes the chemical and radiologic analyses of water samples collected between November 1990 and November 1992 from the monitoring wells and surface water locations discussed above. The analytes on this list were selected by UC Davis and DOE to address the potential chemicals that may have been used and disposed at the LEHR site or the UC Davis landfill units. Other parameters including cations and anions were included in the analyte list in order to gain an overall understanding of the groundwater and surface water geochemical conditions. Analysis for these constituents, with the exception of carbon-14, began in November 1990. Carbon-14 analysis was initiated in May 1991 on groundwater samples collected from six wells and was based on information obtained regarding the waste burial trenches in the southwest portion of the site. The wells currently being sampled for carbon-14 are UCD-4, UCD-13, UCD-14, UCD-15, UCD-17, and UCD-18.

TABLE 3.1

SUMMARY OF MONITORING WELLS AT THE LEHR SITE

Well Name	Total Depth (feet bgs)	Screened Interval (feet bgs)	HSU[1]	Well Location[2]	Date Completed
UCD - 1	56.5	46.5 - 56.5	First	Northwest corner of site	10/09/87
UCD - 3	49.0	39 - 49	First	Northeast corner of west dog pen area	10/23/87
UCD - 4	57.2	45 - 55	First	Southwest corner of site	10/14/87
UCD - 5	48.0	38 - 48	First	East of Main Admin. Building	10/22/87
UCD - 6	50.0	40 - 50	First	Southwest corner of AH-1	10/21/87
UCD - 7	90.0	80 - 90	Second	Northeast corner of west dog pen area	11/05/87
UCD - 8	53.5	43.5 - 53.5	First	West of midsection of Cobalt-60 field, and adjacent to low-level radioactive waste trenches	11/03/87
UCD - 9	50.0	40 - 50	First	Northeast of Landfill Disposal Unit 2	11/04/87
UCD - 10	70.0	54 - 69	First	Landfill Disposal Unit 3	10/11/89
UCD - 11	66.5	50 - 65	First	Northeast corner of Cobalt-60 field, and Landfill Disposal Unit 1	10/17/89
UCD - 12	65.0	49.5 - 64.5	First	Northeast of Landfill Disposal Unit 2	10/19/89
UCD - 13	65.0	50 - 65	First	West of midsection of Cobalt-60 field, and adjacent to low-level radioactive waste trenches	10/26/89
UCD - 14	85.0	75 - 85	Second	West of midsection of Cobalt-60 field, and adjacent to low-level radioactive waste trenches	11/15/89
UCD - 15	120.5	91 - 116	Second	Southwest corner of site	03/28/90

TABLE 3.1 (continued)

SUMMARY OF MONITORING WELLS AT THE LEHR FACILITY

Well Name	Total Depth (feet bgs)	Screened Interval (feet bgs)	HSU[1]	Well Location[2]	Date Completed
UCD - 16	122.0	92 - 117	Second	50 feet north of site boundary, north of Main Admin. Bldg.	04/04/90
UCD - 17*	143.0	88 - 113	Second	700 feet west of west site boundary	04/10/90
UCD - 18*	70.0	54 - 69	First	700 feet west of southwest site boundary	10/04/90
UCD - 19	74.5	71.5 - 56.5	First	50 feet north of site boundary, north of TPHRL	10/01/90
UCD - 20	73.0	57 - 72	First	Northeast corner of west dog pen area	10/09/90
UCD - 21	73.0	57 - 72	First	Northwest corner of west dog pan area	10/11/90
UCD - 22	73.0	57 - 72	First	Southwest corner of AH-1	10/25/90
UCD - 23	73.0	56.5 - 71.5	First	Southeast of Specimen Storage Building	10/17/90
UCD - 24	73.0	57 - 72	First	East of west dog pen area, and west of Landfill Disposal Unit 2	10/22/90

(1) HSU = Hydrostratigraphic Unit.

(2) See Figure 3.1

* Upgradient monitoring well.

NOTE: UCD-2 was abandoned by UC Davis in 1990 because it was installed through the UC Davis Landfill Disposal Unit No. 2.

TABLE 3.2

PHASE II SITE CHARACTERIZATION –
GROUNDWATER AND SURFACE WATER ANALYTES

Parameter	Method	Instrument	Monitoring Points
Metals			
Silver	200.7	ICP[1]	G[2],S[3]
Arsenic	206.3	GFAA[4]	G,S
Barium	200.7	ICP	G,S
Beryllium	200.7	ICP	G,S
Cadmium	213.2	GFAA	G,S
Cobalt	200.7	ICP	G,S
Chromium (total)	200.7	ICP	G,S
Chromium (hexavalent)	218.4	CVAA[5]	G,S
Copper	200.7	ICP	G,S
Mercury	245.1	CVAA[6]	G,S
Nickel	200.7	ICP	G,S
Lead	239.2	GFAA	G,S
Antimony	204.2	GFAA	G,S
Selenium	270.2	GFAA	G,S
Thallium	279.2	GFAA	G,S
Vanadium	200.7	ICP	G,S
Zinc	200.7	ICP	G,S
Cations			
Calcium	200.7	ICP	G,S
Magnesium	200.7	ICP	G,S
Sodium	200.7	ICP	G,S
Potassium	200.7	ICP	G,S

(1) ICP - Inductively coupled plasma spectroscopy.
(2) G - All groundwater wells.
(3) S - All surface water.
(4) GFAA - Graphite Furnace Atomic Absorption spectroscopy.
(5) CVAA - Cold Vapor-trap Atomic Absorption spectroscopy
(6) IC - Ion Chromatograph.
(7) These wells were sampled May, August, and November 1991.
(8) GC/MS - Gas Chromatograph/Mass Spectrometer.

TABLE 3.2 (continued)

PHASE II SITE CHARACTERIZATION –
GROUNDWATER AND SURFACE WATER ANALYTES

Parameter	Method	Instrument	Monitoring Points
Anions			
Chloride	300.0	IC[6]	G,S
Nitrate	300.0	IC	G,S
Phosphate	300.0	IC	G,S
Sulfate	300.0	IC	G,S
General Parameters			
Turbidity	180.1	Turbidimetric	G,S
TDS	160.1	Spectrophotometer	G,S
Alkalinity	310.1	Titrimetric	G,S
COD	410.1	Wet	G,S
Field Parameters			
pH	SW-846	Specific ion electrode	G,S
EC	SW-846	Portable meter	G,S
Temperature	SW-846	Portable meter	G,S
Organics			
Formaldehyde	Modified NIOSH	Spectrophotometer	G,S
Volatiles	624	GC/MS[8]	G,S
Semi-Volatiles	625	GC/MS	G,S
Organochlorine Pesticides	608	GC/MS	G,S

(1) ICP - Inductively coupled plasma spectroscopy.
(2) G - All groundwater wells.
(3) S - All surface water.
(4) GFAA - Graphite Furnace Atomic Absorption spectroscopy.
(5) CVAA - Cold Vapor-trap Atomic Absorption spectroscopy
(6) IC - Ion Chromatograph.
(7) These wells were sampled May, August, and November 1991.
(8) GC/MS - Gas Chromatograph/Mass Spectrometer.

TABLE 3.2 (continued)

PHASE II SITE CHARACTERIZATION –
GROUNDWATER AND SURFACE WATER ANALYTES

Parameter	Method	Instrument	Monitoring Points
Radionuclides			
Gross Alpha	9310	Low-Level Planchet Country System	G,S
Gross Beta	9310	Low-Level Planchet Country System	G,S
Tritium	D-04	Scintillation Counter	G,S
Carbon-14	Radioassay Procedures for Environmental Samples	Scintillation Counter	UCD-4, UCD-13, UCD-14, UCD-15, UCD-17, UCD-18[7]
Strontium-90	Radioassay Procedures for Environmental Samples	Low Background System	G,S
Gamma Emitters	Radioassay Procedures for Environmental Samples	Gamma Spectrometer	G,S

(1) ICP - Inductively coupled plasma spectroscopy.
(2) G - All groundwater wells.
(3) S - All surface water.
(4) GFAA - Graphite Furnace Atomic Absorption spectroscopy.
(5) CVAA - Cold Vapor-trap Atomic Absorption spectroscopy
(6) IC - Ion Chromatograph.
(7) These wells were sampled May, August, and November 1991.
(8) GC/MS - Gas Chromatograph/Mass Spectrometer.

The techniques for collecting water samples during the Phase II Site Characterization are described in the Phase II Site Characterization Work Plan (Dames & Moore, 1990). The field and laboratory QA/QC procedures were performed according to the ESO Quality Assurance Program Plan (Dames & Moore, 1990) and EPA procedures described in "Test Methods for Evaluating Solid Wastes" (SW-846, third edition),(EPA, 1986).

3.2 ANALYTICAL RESULTS OF THE WATER MONITORING PROGRAM

Tables 3.3 and 3.4 present the number of detections and range of concentrations for the constituents measured in groundwater and surface water, respectively, during the Phase II Site Characterization, from November 1990 through November 1991. A complete discussion of these results with regard to upgradient geochemical and hydrologic conditions is presented in the Phase II Site Characterization Report (Dames & Moore, 1993). A brief discussion of the trends of these data is presented below.

Results reported from the current monitoring show volatile, semi-volatile and chlorinated organic compounds in groundwater samples from some wells and surface water monitoring locations at the LEHR site. Chloroform, 1,1-dichloroethene, 1,1-dichloroethane, and 1,2-dichloroethane are consistently reported in groundwater samples (Table 3.3) collected downgradient from Landfill Disposal Units No. 1 and 2 (Figure 3.1) and in surface water (Table 3.4). Semivolatile phthalate compounds were reported sporadically in samples analyzed from selected wells throughout the site. Low concentrations of organochlorine pesticides were also reported in surface water samples and in samples from several wells including upgradient wells UCD-17 and UCD-18.

TABLE 3.3

PHASE II SITE CHARACTERIZATION –
DETECTIONS IN GROUNDWATER

Group	Parameter	Number Detected	Number Sampled	Lowest Detection	Highest Detection
Volatiles (μg/liter)	1,1-Dichloroethane	3	94	23.0	27.0
	1,1-Dichloroethene	3	94	3.9	53.8
	1,2-Dichloroethane	3	94	15.5	20.0
	Bromodichloromethane	1	94	2.4	2.4
	Chloroform	21	94	1.6	24,000.0
	Methylene Chloride	3	94	2.9	3.9
	Trichloroethene	1	94	3.1	3.1
Semivolatiles (ug/liter)	Benzyl Butyl Phthalate	3	93	5.0	13.4
	Bis(2-ethylhexyl)phthalate	16	93	3.1	33.3
	Di-n-butylphthalate	1	93	7.6	7.6
Organochlorine Pesticides (μg/liter)	4,4'-DDE	3	94	0.006	0.008
	Aldrin	2	94	0.004	0.006
	Alpha-BHC	5	94	0.003	0.020
	Beta-BHC	2	94	0.007	0.012
	Delta-BHC	1	94	0.129	0.129
	Dieldrin	6	94	0.004	0.030
	Endrin	2	94	0.010	0.020
	Endrin Aldehyde	1	94	0.028	0.028
	Gamma-BHC	4	94	0.004	0.044
	Heptachlor	10	94	0.004	0.020

TABLE 3.3 (Continued)

PHASE II SITE CHARACTERIZATION —
DETECTIONS IN GROUNDWATER

Group	Parameter	Number Detected	Number Sampled	Lowest Detection	Highest Detection
Metals (μg/liter)	Antimony (Total)	53	93	2.0	340.0
	Barium (Total)	81	93	30.0	560.0
	Beryllium (Total)	24	93	1.0	6.0
	Cadmium (Total)	16	93	1.0	7.0
	Chromium (Total)	58	93	11.0	377.0
	Chromium, Hexavalent (+6)	87	93	10.0	400.0
	Copper (Total)	3	93	30.0	30.0
	Lead (Total)	8	93	1.0	3.0
	Mercury (Total)	2	93	0.4	0.5
	Molybdenum (Total)	34	93	30.0	260.0
	Selenium (Total)	10	93	10.0	31.0
	Nickel (Total)	5	93	30.0	50.0
	Thallium (Total)	75	93	2.0	280.0
	Zinc (Total)	11	93	30.0	40.0

TABLE 3.3 (Continued)

PHASE II SITE CHARACTERIZATION –
DETECTIONS IN GROUNDWATER

Group	Parameter	Number Detected	Number Sampled	Lowest Detection	Highest Detection
Anions and Cations (μg/liter)	Calcium (Total)	92	93	15,000.0	103,000.0
	Chloride	93	93	11,300.0	455,000.0
	Magnesium (Total)	93	93	500.0	320,000.0
	Nitrate (as N)	93	93	1,000.0	123,000.0
	Phosphate, total (as P)	78	93	100.0	1,000.0
	Potassium (Total)	89	93	400.0	5,600.0
	Sodium (Total)	93	93	10,400.0	166,000.0
	Sulfate	93	93	8,110.0	489,000.0
General Chemical Parameters (mg/liter)	Alkalinity (as CACO3)	90	93	25.5	885.0
	Chemical Oxygen Demand	87	93	0.0	269.0
	Total Dissolved Solids	93	93	392.0	9,190.0
	Turbidity (reported in ntu)	93	93	0.0	1,370.0
Radiochemicals (pCi/liter)	Carbon-14	5	17	662.0	1,815.0
	Cesium-137	1	93	11.0	11.0
	Gross alpha	28	93	3.0	27.0
	Gross beta	47	93	3.0	62.0
	Strontium-90	7	93	0.8	5.7
	Tritium	17	94	652.0	29,066.0

TABLE 3.4

PHASE II SITE CHARACTERIZATION –
DETECTIONS IN SURFACE WATER

Group	Parameter	Number Detected	Number Sampled	Lowest Detection	Highest Detection
Volatiles (μg/liter)	Bromodichloromethane	3	20	2.2	5.8
	Chloroform	13	20	2.0	14.0
	Dibromochloromethane	1	20	3.4	3.4
	Methylene Chloride	3	20	4.4	5.7
Semivolatiles (μg/liter)	bis(2-ethylhexyl)phthalate	2	19	4.4	7.8
	Di-n-butylphthalate	3	19	4.4	4.6
Organochlorine Pesticides (μg/liter)	4,4'-DDD	3	19	0.018	0.047
	4,4'-DDE	2	19	0.005	0.005
	4,4'-DBT	2	19	0.013	0.015
	Aldrin	1	19	0.037	0.037
	Alpha-BHC	5	19	0.005	0.013
	Beta-BHC	2	19	0.019	0.024
	Delta-BHC	7	19	0.012	0.033
	Dieldrin	4	19	0.007	0.015
	Endosulfan I	3	19	0.062	0.103
	Endosulfan II	3	19	0.006	0.007
	Gamma-BHC	3	19	0.006	0.023
	Heptachlor	2	19	0.012	0.018
Metals (μg/liter)	Antimony (Total)	13	24	1.0	110.0
	Barium (Total)	19	24	30.0	120.0
	Beryllium (Total)	6	24	1.0	6.0
	Cadmium (Total)	8	24	1.0	2.0
	Chromium (Total)	6	24	11.0	110.0
	Chromium, Hexavalent (+6)	9	20	10.0	20.0

TABLE 3.4 (Continued)

PHASE II SITE CHARACTERIZATION –
DETECTIONS IN SURFACE WATER

Group	Parameter	Number Detected	Number Sampled	Lowest Detection	Highest Detection
Metals (con't) (µg/liter)	Copper (Total)	4	24	30.0	50.0
	Lead (Total)	18	24	1.0	7.0
	Molybdenum (Total)	6	24	50.0	71.0
	Nickel (Total)	2	24	50.0	70.0
	Selenium (Total)	2	24	39.0	54.0
	Silver (Total)	4	24	30.0	80.0
	Thallium (Total)	10	24	1.0	100.0
	Zinc (Total)	16	24	30.0	1190.0
Anions and Cations (µg/liter)	Calcium (Total)	24	24	10800.0	25400.0
	Chloride	20	20	8490.0	161360.0
	Magnesium (Total)	24	24	5070.0	36700.0
	Nitrate (as N)	17	20	400.0	11900.0
	Phosphate, Total (as P)	17	20	1000.0	11700.0
	Potassium (Total)	24	24	1700.0	16900.0
	Sodium (Total)	24	24	19900.0	286000.0
	Sulfate	20	20	22400.0	84560.0
General Chemical Parameters (mg/liter)	Alkalinity (as CACO3)	20	20	115.0	246.3
	Chemical Oxygen Demand	20	20	8.0	496.0
	Total Dissolved Solids	20	20	196.0	646.0
	Turbidity (reported in ntu)	20	20	4.5	58.3
Radiochemicals (pCi/liter)	Gross alpha	7	20	3.0	31.0
	Gross beta	19	20	3.0	62.0
	Strontium-90	6	20	0.8	5.4
	Tritium	4	20	704.0	1341.0

Consistent detections of hexavalent and total chromium have been reported at concentrations that exceed upgradient levels in samples from several on-site wells. Metals such as antimony, barium and thallium are regularly reported in samples from both upgradient and downgradient wells. With the exception of total chromium and hexavalent chromium, metals reported in samples from wells at the LEHR site on a random basis and are considered to be from a regional source. Additional evaluation of potential sources will be addressed in the RI/FS.

Nitrate was consistently reported at higher concentrations in samples from downgradient wells compared with samples from upgradient wells. Surface water samples have had reported elevated detections of nitrate. Other anion, cation, or general-chemical parameters with consistently elevated concentrations included TDS, sodium chloride, calcium, and magnesium, and may be indicative of the geochemical conditions of the regional groundwater.

Reported measurements of gross alpha, gross beta, and gamma activity suggest that groundwater and surface water samples collected at the LEHR site do not have elevated alpha, beta, or gamma activity with regard to upgradient conditions. Measurements of water samples for strontium-90 show sporadic activity, although blind duplicate analyses suggest that these results may not be representative. Consistent measurements of carbon-14 and tritium activity have been reported in groundwater samples collected from wells UCD-13 and UCD-14.

4.0 PROPOSED WATER MONITORING PROGRAM

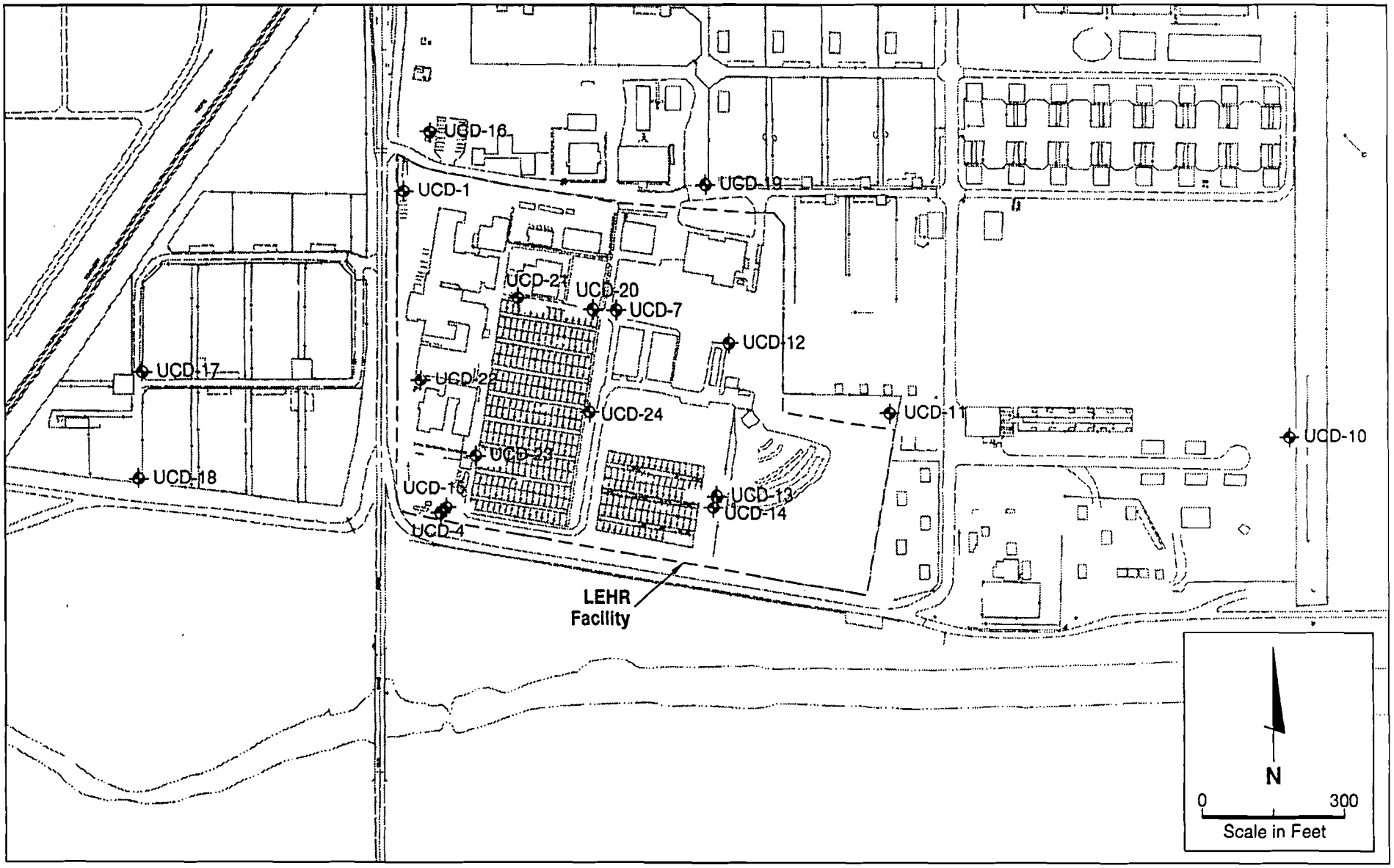
Based on observations made during the Phase II Site Characterization and as discussed in Chapter 3, the Water Monitoring Plan consists of the existing water monitoring program with some specific modifications. The modifications include the addition of monitoring points, the analysis of additional parameters, and changes in analyte methodology. This chapter presents detailed descriptions of groundwater, surface water, and storm water monitoring points, sampling frequency, and analytical parameters. Section 4.1 presents groundwater monitoring; Section 4.2 presents surface water monitoring; and Section 4.3 presents storm water runoff monitoring. Section 4.4 presents the analytical methods for each water monitoring parameter.

4.1 GROUNDWATER MONITORING

Groundwater monitoring at the LEHR site will be conducted to evaluate the presence and distribution of contaminants in the uppermost aquifer beneath the site. Two HSUs (as described in Section 2.3) will be monitored. The first HSU consists of the saturated fine-grained sediments that occur from the first-encountered water (30 to 50 feet bgs) to approximately 80 feet bgs. The second HSU consists of mostly gravel present between approximately 80 and 135 feet bgs.

4.1.1 Monitoring Locations

As shown on Figure 4.1, eighteen wells are currently part of the environmental restoration program and will continue to be included in the groundwater monitoring program. Thirteen existing wells (UCD-1, UCD-4, UCD-10, UCD-11, UCD-12, UCD-13, UCD-18, UCD-19, UCD-20, UCD-21, UCD-22, UCD-23, and UCD-24) monitor the first HSU. Five existing wells (UCD-7, UCD-14, UCD-15, UCD-16, and UCD-17) monitor the second HSU. Five additional monitoring wells (UCD-3, UCD-5, UCD-6, UCD-8, and UCD-9) will be checked for water level measurements quarterly, but will not be included in the sampling program.



EXPLANATION

Existing Monitoring Well

LOCATION MAP
EXISTING GROUNDWATER MONITORING POINTS

Water Monitoring Plan
LEHR Environmental Restoration

DAMES & MOORE

10805-720-044 SJR 4/15/93 WATER-2

FIGURE 4.1

Two wells, UCD-17 (screened in the second HSU) and UCD-18 (screened in the first HSU), are located off-site and upgradient of the site. Two wells, UCD-1 (first HSU) and UCD-16 (second HSU) are located to a sidegradient and northwest of the LEHR site. The remaining 13 wells are located downgradient of potential source areas. The location and well specifications for each well are described in Table 3.1.

4.1.2 Monitoring Parameters and Schedule

Groundwater sampling and analysis will continue on a quarterly schedule. Phase II Site Characterization results (Dames & Moore, 1993) have shown sporadic detections of pesticides, semi-volatiles, and most metals in groundwater samples collected from both upgradient and downgradient wells. Therefore, the frequency of analysis for some analytes may be reduced from quarterly to semi-annually or annually at a later date.

The groundwater analytical program is summarized in Table 4.1. Two types of parameters are identified for measurement or collection and analysis: field parameters and laboratory parameters. Due to the past use and disposal practices of radionuclides at LEHR, carbon-14 and radium-226 will be added to the list of quarterly analytes for all wells. Additional analyses for specific radionuclides may be performed for gross alpha and gross beta activity.

Four additional parameters, total organic carbon (TOC), total kjeldahl nitrogen (TKN), ammonia, and reduction/oxidation (Eh) potential have been added to the water monitoring program. TOC in groundwater may influence the mobility of metals through the formation of soluble organometallic complexes or through changes in Eh potential. Ammonia and TKN are potential sources of nitrate through the process of microbiological transformations. This information will be useful to evaluate contaminant fate and transport and potential remedial alternatives. The rationale for including each of the chemical and radiologic parameters is summarized on Table 4.2.

TABLE 4.1

ANALYTICAL PARAMETERS GROUNDWATER SAMPLES [1]

Field	Laboratory	
pH Electrical Conductivity Temperature Turbidity EH Water Level	Volatile Organic Compounds Semi-Volatile Organic Compounds Tritium, Strontium-90, Gross Alpha, Gross Beta, Gamma Emitters, and Carbon-14 Radium-226 Pesticides and PCBs Metals Antimony, Arsenic, Barium, Beryllium, Cadmium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Vanadium, and Zinc	Total Chromium Hexavalent Chromium Nitrate TKN Ammonia Total Organic Carbon Total Dissolved Solids Formaldehyde Turbidity Alkalinity Cations Anions

(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 on a quarterly basis for a minimum of one year for these same analytes.

TABLE 4.2

RATIONALE FOR WATER SAMPLE ANALYSES

Constituent	Rationale*	Constituent	Rationale*	Constituent	Rationale*
Gross Alpha	6, 7, 8, 9	Metals	3, 4, 5, 7, 8, 9, 10	TOC	6, 8, 9, 10
Gross Beta	6, 7, 8, 9	Hexavalent Chromium	2, 4, 7, 8, 9	pH	6, 7, 8, 9, 10
Gamma Spec	3, 4, 5, 6, 7, 8, 9	Pesticides	1, 3, 4, 5, 7, 8, 9	Electrical Conductivity	6, 8, 9, 10
Strontium-90	1, 3, 4, 5, 7, 8, 9	Formaldehyde	1, 3, 4, 7, 8	Eh	6, 8, 9, 10
Radium-226	1, 4, 5, 7, 8, 9	VOCs	1, 2, 4, 5, 7, 8	Turbidity	6, 8, 9, 10
Carbon-14	1, 2, 4, 7, 8, 9	Semi VOCs	1, 3, 4, 5, 7, 8	TDS	6, 7, 8, 9, 10
Tritium	1, 2, 4, 5, 7, 8, 9	Nitrate	2, 4, 5, 6, 7, 8, 9, 11		
Cesium-137	1, 3, 4, 7, 8, 9	Alkalinity	6, 7, 8, 9, 10		
Sodium-22	1, 4, 7, 8, 9	TKN	4, 6, 7, 8, 9, 10, 11		
Uranium-238	1, 4, 7, 8, 9	Ammonia	4, 6, 7, 8, 9, 10, 11		
Cobalt-60	1, 4, 7, 8, 9	Anions	2, 4, 6, 7, 8, 9, 10		
Chlorine-36	1, 4, 7, 8, 9	Cations	2, 4, 6, 7, 8, 9, 10		

* **Rationale:**

1 Known constituent used or disposed on site.
2 Suspected site constituent based upon consistent detections in groundwater.
3 Suspected site constituent based upon sporadic detections in groundwater.
4 Suspected site constituent based upon previous disposal practices.
5 Suspected site constituent based upon detections in previous soil investigations.
6 Indicator parameter for other constituent.
7 Data needed for RI.
8 Data useful for FS.
9 Data needed to establish background versus on-site concentration.
10 Influences mobility of other constituents.
11 May contribute to nitrate loading.

Sampling and analysis of groundwater collected from new wells added during the RI/FS-EA program will be conducted on a quarterly basis for all the parameters listed on Table 4.1 for a minimum of one year (four quarters).

4.2 SURFACE WATER MONITORING

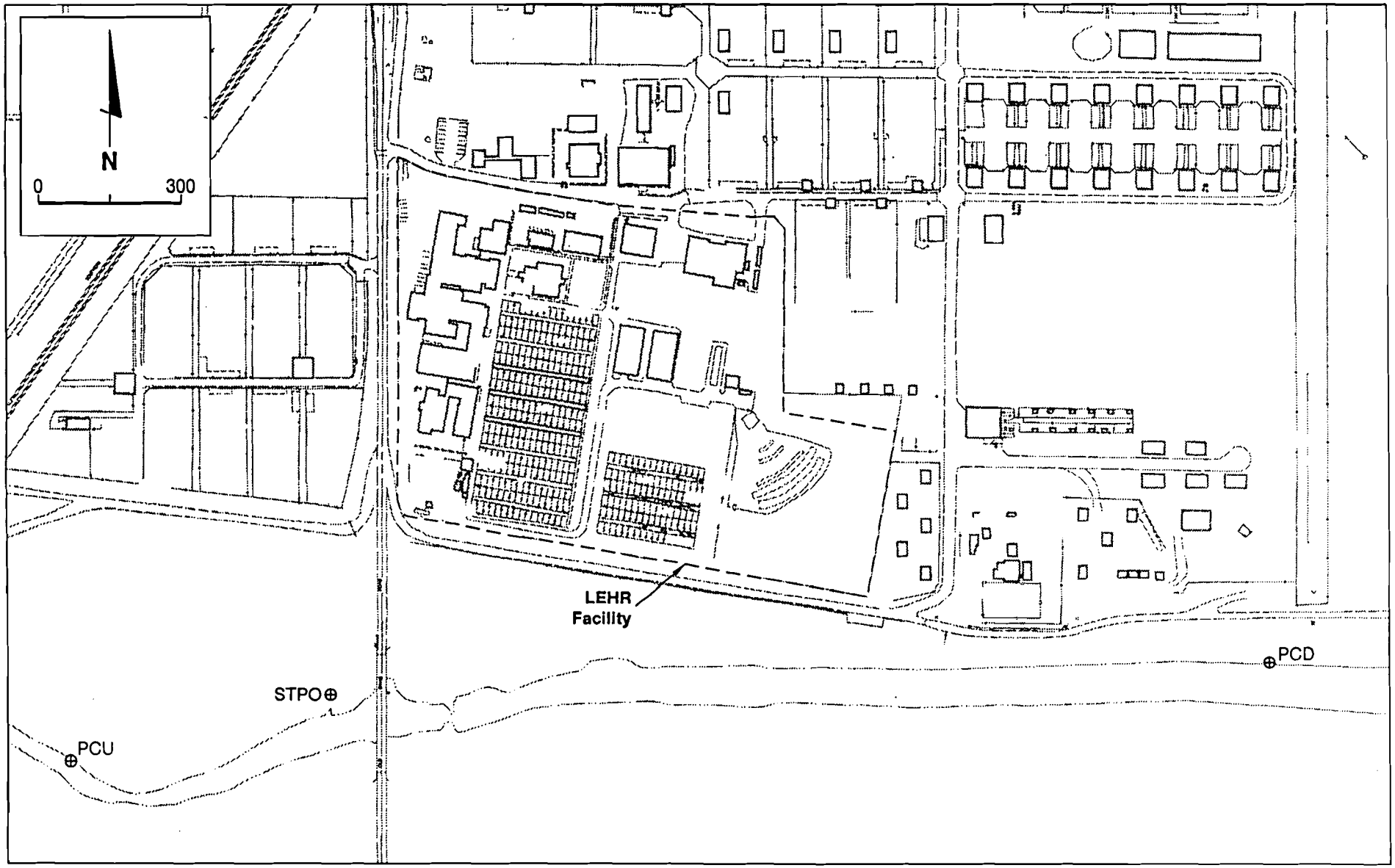
Surface water monitoring at the LEHR site will continue on a quarterly basis at the same locations to evaluate the extent of site constituents of concern in the South Fork of Putah Creek. Sampling will be conducted to: identify potential impacts from the site and surrounding areas on the South Fork of Putah Creek; and to identify potential impacts from the South Fork of Putah Creek to the groundwater system.

4.2.1 Monitoring Locations

Surface water monitoring will be conducted at three locations along the South Fork of Putah Creek: the UC Davis wastewater treatment plant outfall tributary (designated STPO); upstream of the LEHR site (designated PCU); and downstream of the LEHR site (designated PCD). Surface water monitoring points are shown on Figure 4.2. When the South Fork of Putah Creek is flowing, sample location PCU serves as a monitoring point upgradient of the facility, and sample location PCD serves as a monitoring point downgradient of the LEHR site. Based on previous studies, during the summer months the South Fork of Putah Creek does not flow in the vicinity of the LEHR site and most water present at the PCU and PCD locations is apparently stagnant.

4.2.2 Monitoring Parameters and Schedule

The surface water analytical program is shown on Table 4.3. Surface water monitoring will consist of field measurements and collecting samples for laboratory analyses on a quarterly basis. Each surface water monitoring location will be sampled quarterly in conjunction with groundwater monitoring. As with the groundwater data, the results of the Phase II Site Characterization have shown only sporadic detections of semi-volatile compounds and metals. Therefore, sampling for some of these parameters may be reduced to an annual frequency at a later date.



EXPLANATION

⊕ Surface Water Sample Location

LOCATION MAP
SURFACE WATER
MONITORING POINTS

Water Monitoring Plan
LEHR Environmental Restoration

TABLE 4.3

SURFACE WATER MONITORING PARAMETERS [1]

Field	Laboratory	
pH Electrical Conductivity Temperature Turbidity Eh Flow Velocity (estimate from staff gauge)	Volatile Organic Compounds Semi-Volatile Organic Compounds Pesticides and PCBs Tritium, Strontium-90, Gross Alpha, Gross Beta, Gamma Emitters, Carbon-14, and Radium-226 Metals Antimony, Arsenic, Barium, Beryllium, Cadmium, Cobalt, Lead, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Vanadium, and Zinc, Copper	Total Chromium Hexavalent Chromium Nitrate Ammonia TKN Total Organic Carbon Total Dissolved Solids Formaldehyde Turbidity Alkalinity Cations Anions

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

4.3 STORM WATER RUNOFF MONITORING

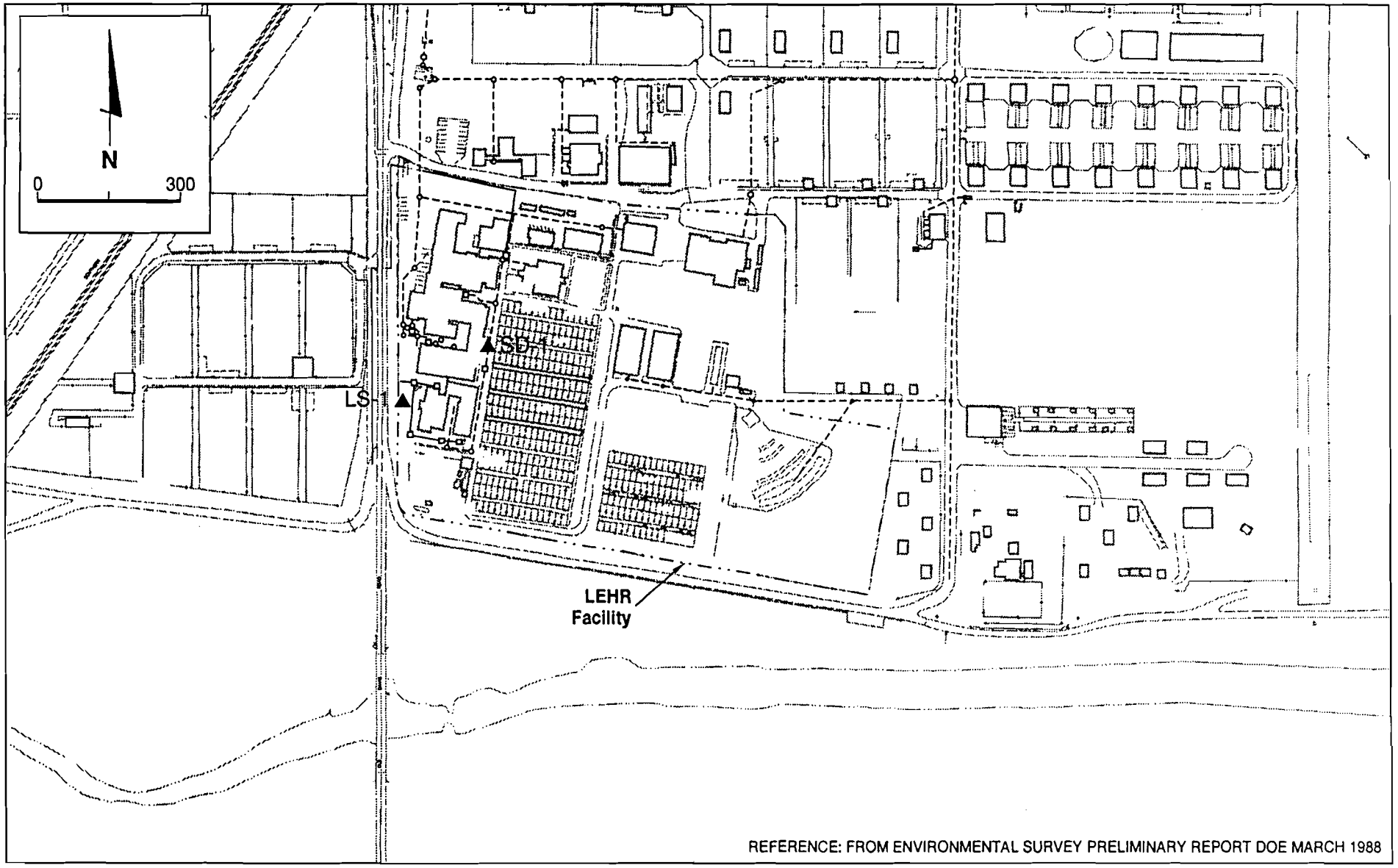
Two additional monitoring points will be added to the water monitoring program in order to establish levels of site constituents in storm water runoff. Storm water runoff from the LEHR site collects at various storm drains on the facility and is removed from the site in two areas (Figure 4.3). One collection area is a lift station located along the west side of the site which pumps runoff under Old Davis Road where it is routed to the South Fork of Putah Creek. The second area is located to the north of the facility along Old Davis Road and directs storm water runoff and sewage wastes from the ITEH and other UC Davis facilities to the UC Davis wastewater treatment plant.

4.3.1 Monitoring Locations

Storm water runoff monitoring will be conducted at two on-site locations, as shown on Figure 4.3. Field measurements and samples will be collected directly from the lift station (designated LS-1) located in the southwest corner of the LEHR site, and from a storm drain (designated SD-1) located along the western side of the main dog pen area. The lift station monitoring location (LS-1) will monitor storm water runoff from the southwest corner of the LEHR site. The storm drain monitoring location (SD-1) will monitor storm water runoff from the southern portion of the LEHR site and the dog pen area. The sampling location within SD-1 will be selected so that runoff is monitored before it mixes with sanitary sewage from the site facilities.

4.3.2 Monitoring Parameters and Schedule

Monitoring will be conducted during two separate rainfall events per year for the parameters listed on Table 4.4. The first storm water runoff sampling event will occur at the first precipitation event of the rainy season that provides enough runoff for sampling. The purpose of this event is to sample runoff that may carry material that accumulated on the ground surface during the summer months. The second sampling event will occur in the middle or late in the rainy season. Because storm water runoff monitoring has not been conducted previously, samples will be analyzed for the entire list of parameters shown on Table 4.4 during each event for two years. After two years (four sampling events), the list of analytes may be modified.



EXPLANATION

- ------- Sanitary Sewer
- ——— Storm Drain
- ○ Lift Station
- ▫ Catch Basin
- • Manhole
- ▲ Storm Water Runoff Monitoring Point

LOCATION MAP
LEHR SANITARY SEWERS, STORMWATER COLLECTION SYSTEM, AND STORMWATER RUNOFF MONITORING POINTS

Water Monitoring Plan
LEHR Environmental Restoration

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FIGURE 4.3

TABLE 4.4

ANALYTICAL PARAMETERS STORM WATER RUNOFF [1]

Field	Laboratory — Each Storm Event
To be collected during two storm events per year from both locations	To be collected two storm events per year from both locations[2]
pH Electrical Conductivity Temperature Turbidity Eh Approximate Flow Rate	Total Oil and Grease Volatile Organic Compounds Semi-Volatile Organic Compounds Pesticides and PCBs Tritium, Strontium-90, Gross Alpha, Gross Beta, Gamma Emitters, Carbon-14, and Radium-226 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 Turbidity

(1) LS-1 and SD-1.

(2) After two years of monitoring (four events) parameters may modified.

4.4 ANALYTICAL METHODS

Analytical methods for groundwater, surface water, and storm water runoff samples are presented in Table 4.5. The table lists the specific analyte and a reference for the method of analysis. The analytical methods recommended in this Water Monitoring Plan are primarily derived from SW-846 and the EPA Contract Laboratory Program. In contrast, during the Phase II Site Characterization, the analytical method numbers used for water analyses were primarily U.S. Environmental Protection Agency (EPA) methods, as shown in Table 3.2. Although the actual analytical methodology and instrumentation of these two methods are very similar, the methods listed in Table 4.5 will be used for the following reasons:

- Referenced methods will be used during the RI/FS Program for both soil and water samples. Therefore, laboratory procedures and QA/QC protocols will be essentially the same for soil and water analyses;

- The QA/QC procedures for the referenced methods are more directly translatable to the CLP data requirements that will be necessary under the RI/FS-EA program; and

- CLP methods achieve adequate detection limits to allow the use of data in environmental and human health risk assessment and evaluation of remedial alternatives.

TABLE 4.5

ANALYTICAL METHODS FOR AQUEOUS SAMPLES

Analyte Fraction	Analytical Parameter	Method Reference
VOCs:	Target Compound List	CLP SOW OLC 02.0
SVOCs:	Target Compound List	CLP SOW OLM 01.8
Pesticides/PCBs:	Target Compound List	CLP SOW OLM 01.8
Metals	Antimony	ILC SOW 2.0
	Arsenic	ILC SOW 2.0
	Barium	ILC SOW 2.0
	Beryllium	ILC SOW 2.0
	Cadmium	ILC SOW 2.0
	Chromium (total)	ILC SOW 2.0
	Chromium^{6+} (Hexavalent)	EPA 7196
	Cobalt	ILC SOW 2.0
	Iron	ILC SOW 2.0
	Lead	ILC SOW 2.0
	Manganese	ILC SOW 2.0
	Mercury	ILC SOW 2.0
	Molybdenum	ILC SOW 2.0
	Nickel	ILC SOW 2.0
	Selenium	ILC SOW 2.0
	Silver	ILC SOW 2.0
	Thallium	ILC SOW 2.0
	Vanadium	ILC SOW 2.0
	Zinc	ILC SOW 2.0
Radiological	Tritium	EPA 906.0
	Strontium 90	EPA 905.0
	Gamma Spectral Analysis	EPA 901.1
	Gross Alpha	EPA 9310
	Gross Beta	EPA 9310
	Carbon-14	EPA C-01 M
	Radium-226	EPA 903.1

TABLE 4.5

ANALYTICAL METHODS FOR AQUEOUS SAMPLES (continued)

Analyte Fraction	Analytical Parameter	Method Reference
Miscellaneous Organics	Formaldehyde	Modified NIOSH 3500
	Total Organic Carbon	415.2 (9060)
	Total Oil and Grease	
Miscellaneous Inorganics	Alkalinity, as $CaCO_2$	EPA 310.1
	Ammonia	EPA 350.1 (350.2)
	Anions	
	Chloride	EPA 300.0
	Nitrate	EPA 300.0
	Phosphate	EPA 365.2
	Sulfate	EPA 300.0
	Cations	
	Calcium	EPA 6010
	Magnesium	EPA 6010
	Sodium	EPA 6010
	Potassium	EPA 6010
	Chemical Oxygen Demand	EPA 410.1
	Total Dissolved Solids	EPA 160.1
	Total Kjeldahl Nitrogen (TKN)	EPA 351.2
	Turbidity	EPA 180.1
Field Parameters	pH	SOP 2.0
	Turbidity	SOP 2.0
	Temperature	SOP 2.0
	Electrical Conductivity (EC)	SOP 2.0
	Redox Potential (Eh)	SOP 2.0

5.0 FIELD METHODS AND PROCEDURES

This Chapter presents field methods to be used in sample collection, field measurement, sample packaging, and sample shipment for the water monitoring program. Specific Standard Operating Procedures (SOPs) referenced below are attached in Appendix C of this Water Monitoring Plan.

5.1 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 two rainfall events, 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 listed in Table 5.1, and presented in Figure 5.1.

Prior to quarterly groundwater, surface water, and storm water runoff monitoring, the Field Operations Lead (responsible for collecting and shipping samples) will conduct set-up activities, and will gather and inspect equipment and instruments to see that they are in proper working condition. These activities will include:

- Notifying the analytical Laboratory 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. Containers for storm water sampling will be stored at the LEHR site until they are used during a precipitation event;

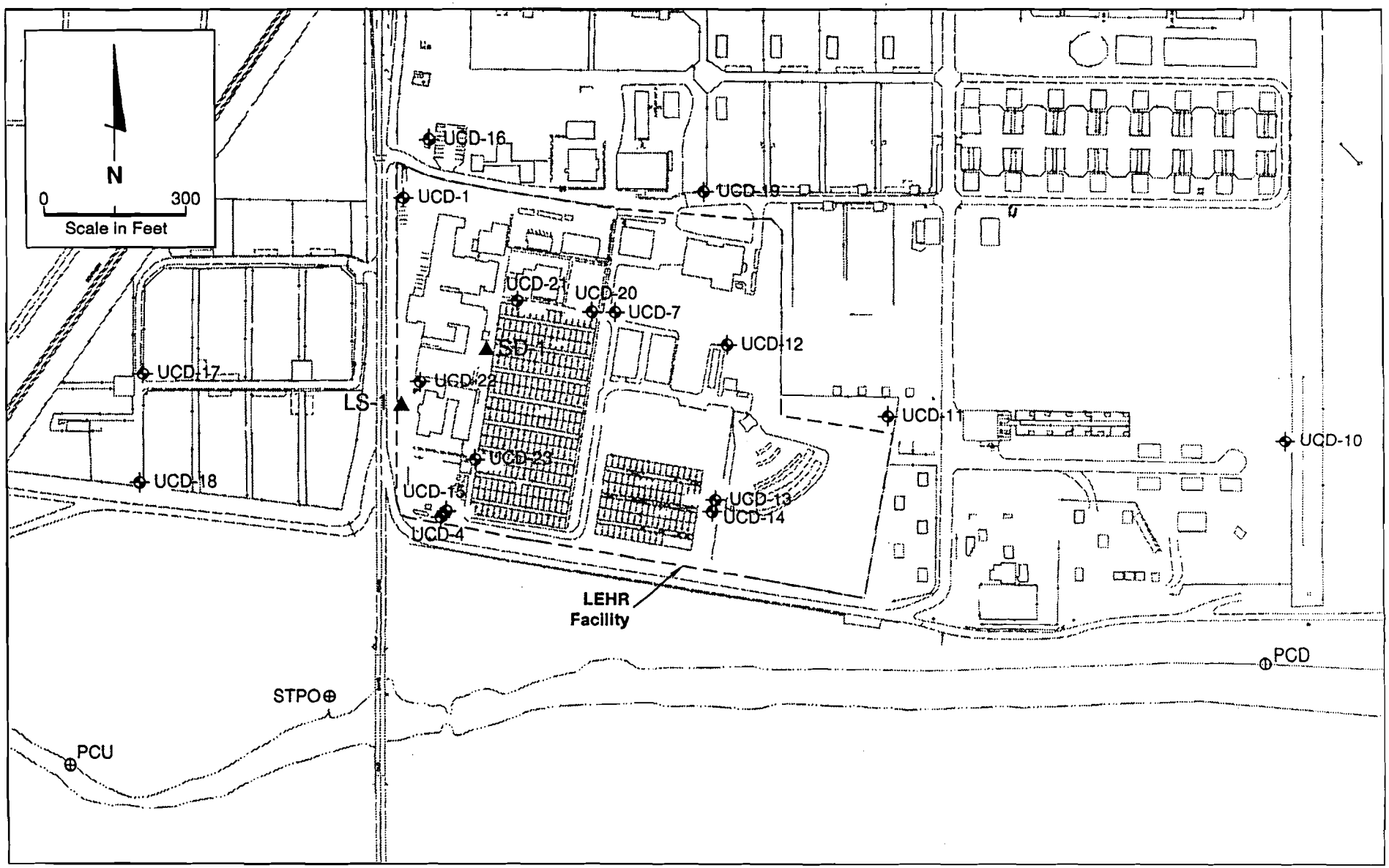
- Notifying PNL and UC Davis staff of upcoming sampling schedule;

- Checking the combination 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 μmho/cm, 1,000 μmho/cm NIST traceable EC solutions, and checking the temperature meter with a NIST traceable thermometer. Checking the Eh meter according to manufacturer's instructions;

TABLE 5.1

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		



EXPLANATION

- ◆ Existing Monitoring Well
- ⊕ Surface Water Sample Location
- ▲ Storm Water Runoff Monitoring Point

LOCATION MAP
WATER MONITORING POINTS

Water Monitoring Plan
LEHR Environmental Restoration

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FIGURE 5.1

- Checking that the turbidity meter, water-level indicator, electrical generator, and pump control box are in proper working condition;
- Assembling a water-resistant 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 presented in Appendices B and C of this plan and in the Phase II Site Characterization Work Plan.

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, quality control procedures, and field documentation.

5.2 GROUNDWATER MONITORING

Groundwater monitoring will consist of water level measurements, field measurements and the collection of groundwater samples. Prior to sampling activities, a groundwater level measurement will be collected from each monitoring well in order to construct groundwater 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.

Groundwater sampling at the LEHR site will be conducted by purging and sampling monitoring wells using dedicated sampling systems. The dedicated systems consist of variable-speed submersible electric pumps. Any new wells installed as part of the RI/FS will be fitted with the same electric submersible pump system. If the static water level drops below the level of a pump, that well will not be sampled. Purging and sampling procedures are described in SOP 1.0 (Appendix C). 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 reading.

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 observations, measurements, and calibration information will be recorded in the bound field notebook (see SOP 1.0).

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 each quarter for analytes presented in Table 5.2. Selected analyte Samples will be filtered using a 045-micron filter, and preserved as indicated in Table 5.2. Sample containers will be labeled with site name, well identification, date, time, requested analyses, preservation method, and sampler's initials.

5.3 SURFACE WATER MONITORING PROCEDURES

Surface water monitoring will consist of the collection of field measurements and water samples. Monitoring will be conducted at two South Fork of Putah Creek locations (PCU and PCD) and the UC Davis wastewater treatment plant outfall (STPO) according to sampling procedures described in SOP 1.0. Samples will be collected each quarter for analytes listed in Table 5.2. Prior to sampling at each location, three field measurements of pH, electrical conductivity, temperature, turbidity, and Eh will be recorded. Additionally, estimates of flow velocity in the South Fork of Putah Creek, and the UC Davis wastewater treatment plant outfall will be made, the stream gage will be checked, and flow in the

TABLE 5.2

WATER MONITORING PARAMETERS AND ANALYTICAL METHODS

FIELD PARAMETERS:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
pH	SOP 2.0	NA	NA	NA	NA
EC	SOP 2.0	NA	NA	NA	NA
Temperature	SOP 2.0	NA	NA	NA	NA
Turbidity	SOP 2.0	NA	NA	NA	NA
Eh	SOP 2.0	NA	NA	NA	NA
Water Level	SOP 2.0	NA	NA	NA	NA

Abbreviations used in Table 5.2

SOP Standard Operating Procedure
CLP Contract Laboratory Program
SOW Statement of Work
LSC Liquid Scintillation Counter
OLM Organic Analysis Multimedia Multiconcentration
NA Not Applicable

TABLE 5.2 (CONTINUED)

WATER MONITORING PARAMETERS AND ANALYTICAL METHODS

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	Page C-2 & 3 of SOW OLC 02.0[1]	14 days
Semivolatile organic compounds	CLP SOW OLM 01.8	1 Liter, Amber G	4°C	Page C-4 & 5 of SOW OLM 01.8[1]	7 days to extraction, 40 days to analysis
Pesticides and PCBs	CLP SOW OLM 01.8(M)[2]	1 Liter, Amber G	4°C	Page C-6 of SOW OLC 02.0[1]	7 days to extraction, 40 days to analysis

1 Tables are attached for reference.
2 CRQLs reported at OLC 02.0 levels.

TABLE 5.2 (CONTINUED)

WATER MONITORING PARAMETERS AND ANALYTICAL METHODS

RADIOLOGIC ANALYSES:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Gross Alpha	9310	1 Liter P,G	Filter, HNO_3, pH<2	2 pCi/L	180 days
Gross Beta	9310	1 Liter P,G	Filter, HNO_3, pH<2	3 pCi/L	180 days
Tritium	906.0	1 Liter P,G	None	300 pCi/L	180 days
Carbon-14	LSC C-01	1 Liter P,G	None	500 pCi/L	180 days
Strontium-90	905.0(M)[3]	2 Liter P,G	Filter, HNO_3 pH<2	1.0 pCi/L	180 days
Gamma Spectral Analysis	901.1	4 Liter P,G	Filter, HNO_3, pH<2		180 days
TH-234				170 pCi/L	
RA-226				80 pCi/L	
PB-214				10 pCi/L	
BI-214				10 pCi/L	
PB-210				380 pCi/L	
U-235				5 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	
Radium-226	903.1	1 liter P,G	Filter, HNO_3, pH<2	0.5	180 days

3 Modified procedure specified in laboratory SOP.

TABLE 5.2 (CONTINUED)

WATER MONITORING PARAMETERS AND ANALYTICAL METHODS

METALS ANALYSES:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
				CRDL	
Hexavalent Chromium	7196	1 Liter, P	4°C, Filter	10 μg/L	24 hours
Total Chromium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 μg/L	6 months
Antimony	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	5 μg/L	6 months
Arsenic	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	2 μg/L	6 months
Barium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	20 μg/L	6 months
Beryllium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	1 μg/L	6 months

TABLE 5.2 (CONTINUED)

WATER MONITORING PARAMETERS AND ANALYTICAL METHODS

METALS ANALYSES (CONTINUED):					
Cadmium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	1 μg/L	6 months
Cobalt	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 μg/L	6 months
Copper	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 μg/L	6 months
Iron	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	100 μg/L	6 months
Lead	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3 pH<2	2 μg/L	6 months
Manganese	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 μg/L	6 months
Mercury	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	0.2 μg/L	28 days
Molybdenum	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 μg/L	6 months

TABLE 5.2 (CONTINUED)

WATER MONITORING PARAMETERS AND ANALYTICAL METHODS

METALS ANALYSES (CONTINUED):					
Nickel	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, H<2	20 µg/L	6 months
Selenium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, H<2	3 µg/L	6 months
Silver	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, H<2	10 µg/L	6 months
Thallium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, H<2	10 µg/L	6 months
Vanadium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, H<2	10 µg/L	6 months
Zinc	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, H<2	20 µg/L	6 months

TABLE 5.2 (CONTINUED)

WATER MONITORING PARAMETERS AND ANALYTICAL METHODS

GENERAL CHEMICAL ANALYSES:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Alkalinity	310.1	1 Liter P	Filter	10.0 mg/L	14 days
Sodium	6010	1 Liter, P	Filter, HNO_3, pH<2	2.0 mg/L	6 months
Potassium			Filter, HNO_3, pH<2	2.0 mg/L	6 months
Calcium			Filter, HNO_3, pH<2	2.0 mg/L	6 months
Magnesium			Filter, HNO_3, pH<2	2.0 mg/L	6 months
Chloride	300.0	1 Liter P,G	Filter 4°C	1.0 mg/L	28 days
Sulfate				1.0 mg/L	28 days
Phosphate	365.2			1.0 mg/L	48 hours

TABLE 5.2 (CONTINUED)

WATER MONITORING PARAMETERS AND ANALYTICAL METHODS

GENERAL CHEMICAL ANALYSES (CONTINUED):					
Nitrate (as Nitrogen)	300.0	1 Liter P,G	Filter	0.1 mg/L	48 hours
Total Kjeldahl Nitrogen	351.2	500 ml P,G	Filter H_2SO_4 pH<2	0.5 mg/L	28 days
Total Dissolved Solids	160.1	1 Liter P,G	Filter 4° C	20.0 mg/L	7 days
Formaldehyde	3500 Modified NI OSH	2, 40 ml G	H_2SO_4 pH<2	1.0 mg/L	7 days
Total Organic Carbon	415.2	1 Liter G	H_2SO_4 pH<2	1.0 mg/L	28 days
Ammonia	350.1	500 ml P,G	Filter, H_2SO_4 pH<2	0.05 mg/L	7 days
Turbidity	180.1	500 ml P,G	4° C	0.1 NTU	48 hours
Total Oil and Grease	413.2	1 Liter, G	H_2 SO_4 pH<2, 4°C	1.0 mg/L	28 days

South Fork of Putah Creek will be calculated each quarter. Field measurements will be conducted according to procedures described in SOP 2.0. Grab samples will be collected directly into the sample containers or by disposable containers or glass bottles and then transferred to the appropriate sample containers. Selected analytes will be filtered using a 0.45-micron filter, and preserved as indicated in Table 5.2. Sample containers will be labelled with site name, location identification, date, time, requested analyses, preservation method, and sampler initials.

5.4 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. Samples will be collected from a storm event early in the rainy season and in the middle to late in the rainy season. During each event, the storm water samples will be collected at two locations 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 5.2. 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 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 using a clean, disposable container, such as a disposable bailer, and transferred into the proper sample containers. Selected analytes will be filtered using a 0.45-micron filter, and preserved as indicated in Table 5.3. Sample containers will be labelled with site name, location identification, date, time, requested analyses, preservation method, and sampler's initials

5.5 FIELD QUALITY ASSURANCE SAMPLING

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 shipped for Volatile Organic Compound analyses each day of sampling.

TABLE 5.3

PROPOSED WATER MONITORING SCHEDULE FOR ONE MONITORING YEAR

Monitoring Point	Samples per Event	Dupli-cates	Field Blanks	Trip Blanks	Event Total	Monitoring Events per Year[1]	Total
Eighteen Existing Monitoring Wells	18	1	1	8	20	4 (quarters – spring, summer, fall, winter)	80
Surface Water Samples	3	1	–	2	4	4 (quarters – spring, summer, fall, winter)	16
Storm Water Runoff Samples	2	1	–	1	3	2 (storm events)	6
Ten Proposed Monitoring Wells	10	1	1	3	12	4 (quarters – spring, summer, fall, winter)	40

(1) Trip blanks analyzed for VOCs only. Total number of blanks depends on the number of sampling days.

During each quarterly monitoring round, one field blank will be collected for every 20 groundwater and surface water samples. Field blanks will be collected on-site near a monitoring point and will consist of laboratory supplied water poured directly into the sample containers. Field blanks will be collected and analyzed for the parameters listed in Table 5.2. "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 identification. Duplicate samples will be collected from different wells and surface water monitoring points each quarter and documented in the bound field notebook. Field blanks and duplicate samples will be filtered, preserved, packaged, and shipped in an identical fashion to groundwater and surface water samples.

During storm runoff monitoring, one blind duplicate sample and one trip blank will be collected for each monitoring event. The duplicate sample will be collected for the complete list of storm water runoff analytes, as presented in Table 5.2. A table presenting the proposed sample collection schedule for one monitoring year is included in Table 5.3. This table includes an estimate of the number of duplicate and field blank samples that will be collected per sampling event.

5.6 SAMPLE PACKAGING AND SHIPPING

The samples 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 a courier 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 missing or damaged containers are identified, sample water may be taken from undamaged containers from the same well, if possible. If sufficient sample water cannot be extracted from remaining bottles, analyses for that sample may be halted and the monitoring point resampled. Samples will not be collected or shipped on Fridays to avoid potential Saturday delivery and analysis problems.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

This chapter discusses specific applications of the QAPjP to the Water Monitoring Plan. The QAPjP is presented in Appendix A of this Water Monitoring Plan. Data obtained through implementation of this Water Monitoring Plan will be used in the groundwater and surface water characterization under the RI/FS program for the LEHR site. Therefore, the QA/QC protocols outlined in the QAPjP will be consistent with the site-wide QA/QC protocols developed for the RI/FS program, as well as other activities anticipated during the LEHR environmental restoration. Additionally, the analytical laboratory will participate in the DOE Environmental Measurements Laboratory (OEMS) program, as required by DOE.

6.1 QUALITY ASSURANCE TRAINING

All project staff involved with the LEHR environmental restoration will receive quality assurance (QA) training. QA training will focus on the principals of total quality management (TQM) as well as specific requirements of this project including the proper techniques of QA sampling, equipment calibration, documentation, problems encountered in the field, and associated topics.

6.2 OPERATION OF FIELD EQUIPMENT AND FIELD INSTRUMENTS

In addition to QA training, field personnel are trained in the proper use of field equipment pertaining to water sampling including generators, pumps, bailers, and proper sampling techniques for volatile samples, duplicates, etc. Field instruments require special attention with regard to documenting the proper function, standard calibration procedures, the use of NIST traceable standard solutions, and the proper corrective action when an instrument fails to perform. Specific forms have been developed for instrument calibration and are included in SOP 2.0. Calibration frequency is specified in this SOP for each parameter.

6.3 QUALITY ASSURANCE SAMPLING

As discussed in Section 5.6, three types of quality assurance samples will be collected to aid in evaluating the analytical data quality. Blind duplicate samples will be

collected at the rate of 5 percent, or 1 duplicate sample for every 20 samples or fraction thereof. Field blanks will be analyzed for volatile organic compounds at the rate of 5 percent or 1 blank for every 20 samples for indication of potential contamination during sample handling and transport. Trip blanks are prepared by the laboratory and are shipped daily.

6.4 PRELIMINARY QC DATA EVALUATION

Preliminary data evaluation is routinely performed in advance of more extensive data validation procedures described in Chapter 7. Quality Assurance samples including blind duplicates, field blanks, and trip blanks are evaluated prior to data validation by the Program Coordinator of Quality Assurance (PCQA).

Chemical analyses of blind duplicate samples are routinely compared to the primary sample for their relative percent difference (RPD) as described in the QAPjP. If the RPD values indicate a trend for a particular analyte or a particular sampling event, that data is flagged and reported to the PCQA for possible corrective action.

Results of field and trip blank analysis will be used to evaluate potential for field, transport, and laboratory contamination. When volatile compounds are detected in primary water samples and field blanks, an airborne source of the chemical may be indicated. Detections of volatile compounds in primary water samples and trip blanks may indicate possible transport or laboratory contamination.

6.5 DOCUMENTATION

All field work including any water sampling activity is documented with the use of specific forms provided in the SOP for that activity. The required contents of field memorandum, equipment calibration forms, chain-of-custody forms, and sample tracking forms are all part of the QA program.

7.0 DATA MANAGEMENT PLAN

This section presents the Data Management Plan (DMP) that will be followed for this project. This plan encompasses procedures for receiving, storing, and reporting data derived from field activities and laboratory analyses. Procedures for receiving data include filing original hardcopy, sample tracking, and data entry. Data storage includes merging entered data into a computer database, verification of entered data, and backup procedures for electronic and hardcopy data. Data reporting procedures include the processes for extracting information from the database into tabular, graphic, and other informational forms.

7.1 DATA RECEIPT

In addition to original oems, a computer database will be maintained to store results of field measurements, laboratory chemical and radiologic analyses, and groundwater level measurements. The results of these analyses and field investigations will be received primarily on standardized data forms, designed to fulfill the needs of both the technical and data management staffs. These data forms are illustrated in the QAPjP (Appendix A). The completed forms will be sent to the Sacramento Dames & Moore office with copies retained by the originators. When the data forms are received, they will be stamped with the date of receipt, copied,and filed. A log will be maintained to document the progress and status of the data from receipt through storage in the computer database. Each entry will be dated and initialed by the individual performing the particular task described on the form.

7.1.1 Sample Tracking

Sample tracking procedures are used to indicate whether analytical samples collected at the LEHR site are contained, transported, and analyzed according to methods and holding times specified. The sample tracking form is used to verify that analyses requested for each sample listed on the chain-of-custody were performed by the analytical laboratory and results have been received. The form is maintained in a computer spreadsheet format and automatically calculates laboratory turn-around times and sample holding times to aid in the data validation process.

7.1.2 Data Entry

Data is entered into the database manually or by direct download of laboratory supplied electronic data. Regardless of the method of data entry, data entry quality control is maintained through several types of data checking. Data checking is carried out prior to merging the temporary input file with the master database file. This checking system involves direct comparison of hardcopy listings of the temporary input database to the hardcopy laboratory or field reports. If corrections are required, they will be written directly on the printout. Once the correction is made, a revised printout will be placed with the original to document the change. Notations will be made of the date and the initials of the reviewer. After the corrections are completed, the log will be dated and initialed. Following correction of any inconsistencies in either the data file or the laboratory reports, the temporary input file is merged to a proxy master file. This proxy file is used as a daily working file, and backups of it as well as the master file are maintained.

All field analytical data including pH, EC, temperature, and Eh will be entered by hand and the original field sampling groundwater level data is entered into the groundwater elevation module of the database. This subsystem provides listings for quality assurance checks, and calculates water level elevations based on elevation survey data for each well.

7.2 DATA STORAGE

Following data entry, the data will be stored in Dames & Moore's Database Management System. This desktop computer based system was originally developed to meet the data management needs of the Phase II Site Characterization (Dames & Moore, 1993). This Database Management System has been enhanced through use in the quarterly monitoring program. Features of the system include management of chemical and physical data for soils, groundwater, surface water, and production of a variety of reports meeting EPA requirements. Other general features of the system include data sorting, querying, and statistical analysis. Data subsets may be exported to other applications for graphical, statistical, modeling or other specialized needs.

The Data Management System consists of a set of integrated software program modules written in the Clipper programming language, a compiled language which is an extension of dBase. The advantages of Clipper include speed, flexibility, and compatibility with the standard dBase file format. Extensions available in the Clipper language facilitate menu and window features which help to provide a "user friendly" interface. The modular programming structure allows for easy addition of features. The program modules manipulate the data files which constitute the database, and which are in an "X-Base" format. This format allows for data exchange with other database systems.

7.3 DATA VALIDATION

Data validation will be performed on analytical results received from the laboratory for groundwater, surface water, and storm water runoff. The purpose of data validation will be to identify data that does 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 the QAPjP (Appendix A) and agreed on by the laboratory. The general data validation process and resulting deliverable are reviewed in sections 7.3.1 and 7.3.2. Specific procedures and descriptions are presented in the QAPjP.

Data received from the laboratory will be reviewed with respect to the PARCC parameters (precision, accuracy, representativeness, comparability, and completeness). PARCC are indicators of data quality and apply to the field program and analytical results as well as to the laboratory procedures. The PARCC parameters for water monitoring at LEHR are specified below. Analyte-specific precision and accuracy objectives are listed in the QAPP for the LEHR site.

A USEPA Contract Laboratory Program (CLP) or CLP-equivalent data package will be provided for groundwater, surface water, and storm water runoff laboratory results. When received, a detailed validation of 10% of the analytical data will be performed, based on USEPA National Functional Guidelines. The remaining 90% of the data set will be reviewed for a limited set of validation criteria. Specific procedures for data validation are presented as part of the QAPjP in the Data Validation Plan (Appendix A).

The objective of the detailed data evaluation according to USEPA National Functional Guidelines is to randomly select 10% of the data packages and then to completely regenerate the data values based on the original raw data (e.g., chromatograms, instrument values), standards, instrument calibration runs, GC/MS tuning, etc. This level of data validation technique will allow an appropriately trained person outside the project to independently validate a data package at any later date.

The remaining 90% of the data will have the same CLP or equivalent data package; however, a limited validation will be performed. Holding times will be checked, surrogate recovery, blanks, matrix spikes, matrix spike duplicates will also be checked against the quality control guidelines.

8.0 DATA EVALUATION

Graphic and statistical methods will be used to aid in evaluating the chemical and radiologic data generated. When adequate background data has been obtained, statistical comparisons between on-site and background samples will be completed.

The objectives of both graphic and statistical analyses are: 1) to evaluate the adequacy of background monitoring points; 2) to define impacted areas of the site and impacted monitoring points; 3) to develop a focused list of analytical constituents of concern; and 4) to identify any release of site constituents to the surface water or to groundwater. The following sections present information on some of the graphic and statistical methods to be used to evaluate LEHR site data.

8.1 GRAPHICAL DATA PRESENTATIONS

At least three types of visual or graphical presentations of the data will be completed. First, time-series graphs will present concentrations of analytes over time in order to display trends or seasonality of the data. Second, stiff diagrams or piper trilinear plots will be completed to compare the general chemical composition of different water samples. Third, contour maps of constituent concentrations throughout the site may be prepared for groundwater plume delineation. These presentations will be included in an annual summary of water monitoring at the LEHR site (see Chapter 9.)

8.2 STATISTICAL ANALYSES

Based on supporting hydrologic and chemical information, statistical comparisons may be completed. The objective of a statistical comparison between any specific monitoring points would be to attempt to identify site constituents and to separate the impacted monitoring points from non-impacted points upgradient or upstream of the site.

When the background monitoring points can be established, off-site influences on water quality can be evaluated quantitatively. With background and on-site monitoring points, statistical comparisons, including analysis of variance, may facilitate the distinction between constituents of concern from the site from off-site influences. The site constituents of

concern form the target analytes which are analyzed on a more frequent basis until remedial actions have been completed.

Additional statistical evaluations may be performed on a more frequent basis for a variety of reasons. These reasons include an evidence of a release of a site constituent, or trend analysis which may document statistically significant increasing concentration of a constituent found at an on-site or off-site location.

9.0 DATA TRANSMITTALS

Analytical data will be transmitted to PNL on a quarterly basis. Three quarterly data transmittals and one annual report will be prepared each year. The annual report will include data from the fourth quarterly sampling round and summarize results from the previous quarters.

After analytical data have been validated using procedures described in the QAPjP, the results will be submitted to PNL in quarterly water monitoring data transmittals. The quarterly data transmittals will present water level data, summary tables of the analytical results, a summary of field methods and a summary of QA/QC procedures as described in the QAPjP.

The annual report will present more detailed analysis of the monitoring results and statistical evaluation of identified impacts. The annual report will also include information regarding hydrogeologic parameters, including groundwater gradients and flow directions, established throughout the year. It is anticipated that the annual report will be prepared after the fall quarterly sampling results have been received, and will contain storm water runoff data from the previous rainy season.

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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, a study utilizing cobalt-60 was initiated to investigate the effects of chronic exposure to penetrating gamma-ray irradiation on bone marrow cells of beagles. The DOE studies were 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 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 eastern most 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 environmental evaluations at the LEHR facility and adjacent landfill. Two surveys, the Initial Assessment Survey (Rockwell, 1984), and the Environmental Survey Preliminary Report (DOE, 1988), present documentation of potential environmental impacts from past waste disposal 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, sampling locations, and sampling schedule.

1.3.1 Water Monitoring Plan

The Water Monitoring Plan presents sampling, analytical, and Quality Assurance/Quality Control (QA/QC) procedures for ongoing water monitoring at the LEHR facility. Water monitoring is being conducted in conjunction with the RI/FS as part of the U.S. Department of Energy (DOE) sponsored environmental restoration program underway at LEHR. The Water Monitoring Plan is part of a larger General Environmental Protection Program conducted by the DOE. The DOE's General Environmental Protection Program is presented in DOE Order 5400.1. This Order specifies the purpose, scope, policy and responsibilities for environmental protection, via effluent monitoring and environmental surveillance programs at all DOE facilities. Since DOE operations ceased in 1988, this Water Monitoring Plan focuses primarily on environmental surveillance activities. Quarterly monitoring of groundwater and surface water has been conducted since November 1990 as a portion of the Phase II Site Characterization. This Water Monitoring Plan describes the continuing Water Monitoring Program.

1.3.2 Target Compounds

A summary of the analyses for this monitoring program is provided in Table A-1.1. A rationale for selection of these parameters is provided in Chapter 4.0 of this Monitoring Plan.

TABLE A-1.1

SUMMARY OF ANALYSES

Volatiles (VOCs)	Semivolatiles (SVOCs)	Pesticides and PCBs	Miscellaneous Organics
Target Compound List	Target Compound List, Base Neutrals Only	Target Compound List	Formaldehyde Total Organic Carbon
Metals	**Radiological**	**Miscellaneous Inorganics**	**Field Properties**
Antimony Arsenic Barium Beryllium Cadmium Chromium (total) Chromium (hexavalent) Cobalt Iron Lead Manganese Mercury Molybdenum Nickel Selenium Silver Thallium Vanadium Zinc	Tritium Strontium-90 Gamma Emitters Gross Alpha Gross Beta Carbon-14 Radium-226	Alkalinity, as $CaCO_3$ Ammonia Chloride Nitrate Phosphate Sulfate Calcium Magnesium Sodium Potassium Total Dissolved Solids Total Kjeldahl Nitrogen Turbidity	pH Turbidity Temperature Electrical Conductivity Redox Potential (Eh) Water Level

B. Level IV

Level IV is defined as data which will be used for legal proceedings. It is essentially Level III 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.

C. Level III

Level III is defined as data which will be used for risk assessment and determining the nature and extent of any contamination present and for use in support of engineering judgements. This level can accurately identify and quantify any 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, RFI) and groundwater monitoring programs may employ Level III data quality.

D. 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.

E. 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 A-1.2

SUMMARY OF DATA QUALITY OBJECTIVES

Task	Data Quality Level	Field Samples	Trip Blanks	Field Blanks	Dupli-cates	Total Samples[1]
Water Level	II	NA	NA	NA	NA	NA
Temperature, pH, Redox Potential, Turbidity, Conductivity	I	NA	NA	NA	NA	NA
Groundwater Sampling	IV & V	72	50	4	4	130
Surface Water Sampling	IV & V	12	8	2	2	24
Storm Water Sampling	IV & V	4	4	--	2	10
Total Samples		88	62	6	8	164

[1]Total number may vary if new monitoring points are added.

1.3.4 Sampling Locations

The following information provides a brief summary of the existing and proposed water monitoring program. The Water Monitoring Plan expands this information and includes specific details regarding sample locations.

The groundwater monitoring system currently includes 23 monitoring wells. Seventeen wells are screened in the first HSU and five wells are screened in the second HSU. Surface water is monitored at two locations along nearby Putah Creek and at the UC Davis wastewater treatment plant outfall that discharges into Putah Creek. Locations

of monitoring points are shown on Figure 3.1 of the Water Monitoring Plan. These locations have been monitored quarterly since November 1990.

The existing surface water monitoring program at the LEHR facility also began in November 1990 and is conducted quarterly at three locations along Putah Creek. Monitoring point PCU is located upstream of the LEHR facility; point PCD is located downstream of the facility; and point STPO is located at the outfall of the UC Davis Wastewater Treatment Plant which discharges into Putah Creek between points PCU and PCD. Surface water samples are analyzed for the same list of parameters as groundwater samples. Surface water monitoring points are shown on Figure 4.2 of the Water Monitoring Plan.

Storm water runoff monitoring will be conducted at two on-site locations (Figure 4.3 - Water Monitoring Plan). Field measurements and samples will be collected directly from the lift station (designated LS-1) located in the southwest corner of the Facility, and from a storm drain (designated SD-1) located along the west side of the main dog pen area.

1.3.5 Schedule

The following information provides a brief description of the water monitoring schedule. Specific details are included in the Water Monitoring Plan.

Groundwater sampling and analysis will continue on a quarterly schedule under the RI/FS program. Groundwater monitoring parameters and frequencies of monitoring for existing and new monitoring wells are presented in Tables 3.2 and 3.3 of the Water Monitoring Plan. Two types of parameters are identified: field parameters, and laboratory parameters. Field parameters include pH, electrical conductivity, temperature, turbidity, and redox potential, and will be measured and recorded in the field for each well during every quarterly sampling round. Laboratory parameters will be sampled and analyzed each quarter and include parameters of concern for the site.

Sampling and analysis of new wells added during the RI program will be conducted on a quarterly basis for all parameters for a minimum of one year (four quarters). After one year of monitoring, the frequency of monitoring may be modified.

Each surface water monitoring location will be monitored quarterly in conjunction with groundwater monitoring. The parameters and frequencies of monitoring for the surface water locations are presented in Table 3.4 of the Water Monitoring Plan. Surface water monitoring will consist of taking field measurements and collecting samples for laboratory parameters. Samples will be collected and field measurements will be recorded each quarter (spring, summer, fall, winter) for all three surface water monitoring locations.

Monitoring will be conducted during a storm event two times per year for parameters listed in Table 3.5 of the Water Monitoring Plan. Because storm water runoff monitoring has not been conducted previously, samples will be collected for the entire list of analytes during each event for the first year.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents quality assurance and technical lead responsibilities during implementation of the Water Monitoring Plan including; organizational reporting structure, training requirements, documentation control, qualification of suppliers/subcontractors, and surveillance/audit activities.

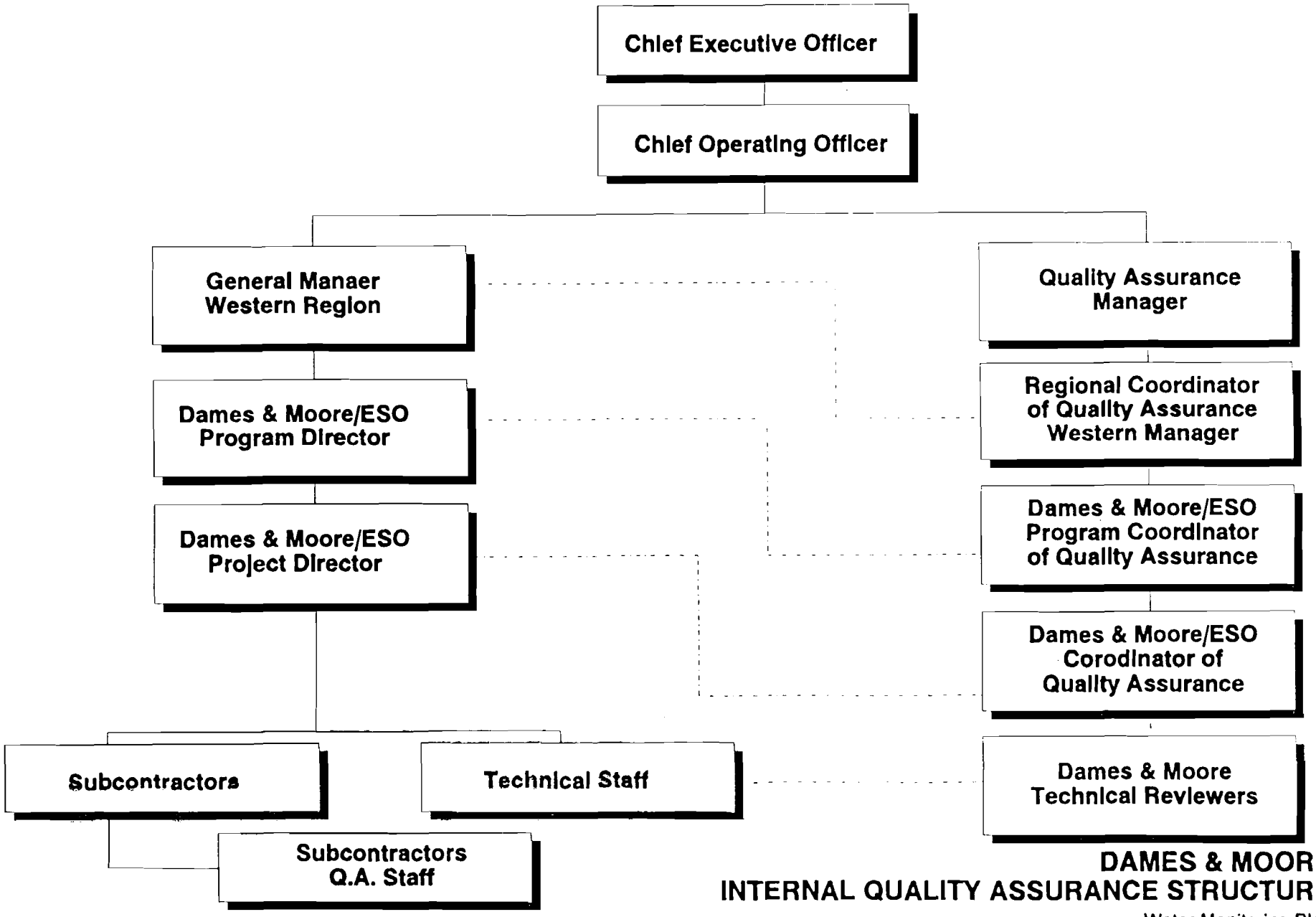
2.1 QUALITY ASSURANCE RESPONSIBILITIES

Organization of the Quality Assurance (QA) staff to be used during implementation of the Water Monitoring Plan is illustrated in Figure A-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 Technical Lead/Project Manager. 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 the responsibility to stop work if the data quality objectives are not met. In addition, the quality assurance staff will evaluate and document the performance of the technical staff. The QA staff must maintain records and control of project controlling documents, surveillances, audits, corrective action, and quality assurance training of the technical staff.

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, directly involved in the Water Monitoring Plan 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



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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 retain a copy of project controlling and other documents pertaining to quality assurance aspects of the LEHR Environmental Restoration work. These documents are discussed in more detail in Sections 8.0, 9.1, 9.4, 10.0, 13.0, and 14.0 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 Dames & Moore. The approved laboratory will be required to participate in the DOE EML intercomparison program for radiologic samples. A summary of its participation will be included in the Annual Monitoring Report.

2.1.4 Surveillances and Audits

Surveillances will be conducted by the CQA and 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 Section 10.0. of this QAPjP.

2.2 TECHNICAL LEAD RESPONSIBILITIES

Dames & Moore 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 2.2.1 to 2.2.3.

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. The laboratory subcontractor will be selected based on past experience on similar projects, past experience with Dames & Moore, 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.

2.2.3 Selection of Suppliers

The Technical Lead/Project Manager will be responsible for purchasing all materials for the Water Monitoring 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 from the LEHR site in a manner which ensures that all 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 below 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.

Field 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.

Performance Audit: The use of an independent sample to check the analytical accuracy.

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 access 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.

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.

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 Section 12.0 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 the project are listed below. A summary of the QA Objectives for all aqueous matrices is provided in Table A-3.1: Quality Assurance Objectives for Aqueous Samples.

TABLE A-3.1

QUALITY ASSURANCE OBJECTIVES FOR AQUEOUS SAMPLES

Fraction	Parameter	Reference	Precision / Accuracy	Completeness
VOCs:	Target Compound List	CLP SOW OLC 02.0	8240 p. 36	95%
SVOCs:	Target Compound List	CLP SOW OLM -2/9	8270 p. 28	95%
Pesticides/PCBs:	Target Compound List	CLP SOW OLM -2/9 (Modified)	8080B p. 15	95%
Metals	Antimony	CLP SOW OLC 02.0	±25/±20%	95%
	Arsenic	CLP SOW OLC 02.0	±25/±20%	95%
	Barium	CLP SOW OLC 02.0	±25/±20%	95%
	Beryllium	CLP SOW OLC 02.0	±25/±20%	95%
	Cadmium	CLP SOW OLC 02.0	±25/±20%	95%
	Chromium (total)	CLP SOW OLC 02.0	±25/±20%	95%
	Chromium^{6+}	CLP SOW OLC 02.0	±25/±20%	95%
	Cobalt	CLP SOW OLC 02.0	±25/±20%	95%
	Iron	CLP SOW OLC 02.0	±25/±20%	95%
	Lead	CLP SOW OLC 02.0	±25/±20%	95%
	Manganese	CLP SOW OLC 02.0	±25/±20%	95%
	Mercury	CLP SOW OLC 02.0	±25/±20%	95%
	Molybdenum	CLP SOW OLC 02.0	±25/±20%	95%
	Nickel	CLP SOW OLC 02.0	±25/±20%	95%
	Selenium	CLP SOW OLC 02.0	±25/±20%	95%
	Silver	CLP SOW OLC 02.0	±25/±20%	95%
	Thallium	CLP SOW OLC 02.0	±25/±20%	95%
	Vanadium	CLP SOW OLC 02.0	±25/±20%	
	Zinc	CLP SOW OLC 02.0	±25/±20%	
Radiological	Tritium	EPA 680 4-75-001	±25/±20%	95%
	Strontium 90	EPA 600 4-75-008	±25/±20%	95%
	Gamma Emitters	HASL-300	±25/±20%	95%
	Gross Alpha	SW-846	±25/±20%	95%
	Gross Beta	SW-846	±25/±20%	95%
	Carbon-14	EPA 680 4-75-001	±25/±20%	95%

TABLE A-3.1 (continued)

QUALITY ASSURANCE OBJECTIVES FOR AQUEOUS SAMPLES

Fraction	Parameter	Reference	Precision / Accuracy	Completeness
Miscellaneous Organics	Formaldehyde	NIOSH	±25/±20%	95%
	Total Organic Carbon	EPA 600 4-79-20	±25/±20%	95%
Miscellaneous Inorganics	Alkalinity, as $CaCO_2$	EPA 600 4-79-20	±25/±20%	95%
	Ammonia	EPA 600 4-79-20	±25/±20%	95%
	Chloride	EPA 600 4-84-017	±25/±20%	95%
	Nitrate	EPA 600 4-84-017	±25/±20%	95%
	Phosphate	EPA 600 4-84-017	±25/±20%	95%
	Sulfate	EPA 600 4-84-017	±25/±20%	95%
	Calcium	SW-846	±25/±20%	95%
	Magnesium	SW-846	±25/±20%	95%
	Sodium	SW-846	±25/±20%	95%
	Potassium	SW-846	±25/±20%	95%
	Total Dissolved Solids	EPA 600 4-79-20	±25/±20%	95%
	Total Kjeldahl Nitrogen	EPA 600 4-79-20	±25/±20%	95%
	Turbidity	EPA 600 4-79-20	±25/±20%	95%
Properties	Water Levels	SOP 2.0	±25/±20%	100%
	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%	

3.2.1 Precision

- 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 (QA Plan) which will be attached to this document following the laboratory selection process.

3.2.2 Accuracy

- Water level - The accuracy of water level measurements is limited by the measuring instrument. The electric tape to be used must be properly calibrated using an Appropriate Standard. The accuracy of the water level measurements will be ±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 which will be attached to this document following the laboratory selection process.

3.2.3 Completeness

- 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%.

3.3.4 Representativeness and Comparability

- Water level - Use of SOPs as provided in Appendix C and appropriate selection of sample locations as identified in Chapter 3 of the Water Monitoring 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 Appendix C and appropriate selection of sample locations as identified in Chapter 3 of the Water Monitoring 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 Water Monitoring 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 Water Monitoring 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 determinations whereas laboratory data is intended to be quantitative to the degree defined by the EPA (SW-846) 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 given in the Water Monitoring Plan. To maintain quality control in the collection of water samples, several steps will be followed in the office:

1. The Field Operations Lead notifies the laboratory of the upcoming sampling event so that the laboratory can prepare the appropriate type and number of sample containers. The anticipated number of sampling sites, the list of parameters to be analyzed for each site, the duplicate requirements, and the number of extra bottles needed for quality control testing are specified to the laboratory Project Manager.

2. The Field Operations Lead notifies the UCD staff prior to sampling so the staff is available for Health and Safety and site access.

3. All sample containers, hand samplers, tubing and other miscellaneous equipment to be used during sampling are collected and inspected. Inspection is documented in the field log book, and, in the case of newly acquired equipment, on receipt inspection forms.

4. Field meters to be used during samples (the pH, specific conductance, turbidity, and redox potential meters) are checked and calibrated in the office. The meters will be calibrated as explained in Section 6.1.

5. All forms to be used in the field (including the field memoranda, chain-of-custody sheets, sample labels, and sample analyses request forms) are assembled.

6. The field staff review proper sampling protocols described in the Water Monitoring Plan. In addition, proper health and safety protocols are reviewed to reduce the possibility of injuries occurring during the sampling event.

4.1 WATER SAMPLING

Prior to water sampling the correct number and type of containers are assembled beforehand, in the office. Bottles are "pre-labeled" prior to sampling in order to reduce confusion in the field. Certain information (e.g., well number or location identification, preservative, and analyses requested) can be affixed to the label with permanent ink during the pre-field activities. The chain-of-custody (COC) forms are prepared for the water sampling activities to take place that day (to match the information typed onto the "pre-labeled" sample containers).

In the field, sampling locations are confirmed with the Water Monitoring Plan. After samples are collected and recorded on the COC as described in Section 5.1, the sample number is recorded on a Water Sample Tracking Form (Figure A-4.1), to document replicate (duplicate) samples. After the chain-of-custody is signed, and the sample cooler is sealed, the sampler relinquishes custody of the samples to the courier, for overnight delivery to the analytical laboratory.

4.2 FIELD PROCEDURES

Before starting work, field personnel will conduct daily health and safety meetings. The meeting time, place, attendees, and subjects discussed will be documented in the field log book. All field personnel will read the H & S plan (Appendix C of the Phase II Site Charactertization Work Plan) and sign a release, acknowledging their understanding of this plan. Before any operations take place, Dames & Moore Field Operations Lead confirms the sampling locations.

WATER SAMPLE TRACKING FORM

Page ___ of ___

PROJECT: _____

JOB NUMBER: _____

Sample ID	Groundwater	Surface Water	Storm Water	Field Blank	Date	Time	QA Dupli-cate

WATER SAMPLE TRACKING FORM

Water Monitoring Plan

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FIGURE A-4.1

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 A-5.1) records possession of the samples from the time of collection, until disposal or archival of the sample. This section describes the custody procedures for water samples collected on this project. project. These procedures are slightly different methods than those detailed in Procedure 14 of the QA Program Plan, but achieve the same goals. Details of sample shipment are presented in Appendix C.

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 (composite or grab), and sample locations are documented in the investigator's field memoranda;
- Information on the sample labels, including site name, sample identification, time and date of collection, requested analyses, preservation, and name of sampler; and
- Sample identification, sample type (soil or water), date, time, number of containers, are documented on the COC.

Samples collected by field personnel are the responsibility of each sampler until the samples are delivered to a courier. The Dames & Moore 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.

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

VOCs
Semi-VOCs
Organochlorine Pesticides

Gross α, Gross β, Tritium
Chlorine-36, Radium-226
Carbon-14, Strontium-90
Gamma Spectral Analysis

Metals: Total Cr, Sb, As, Ba, Be, Cd, Co, Cu, Fe, Pb, Hg, Mn, Mo, Ni, Se, Ag, Tl, V, Zn

Hexavalent Cr.
Alkalinity, TDS, TOC
Na, K, Ca, Mg
Cl, SO_4, Phosphorus
Nitrate, TKN, Ammonia
Formaldehyde
Turbidity

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: _____

CHAIN OF CUSTODY FORM

Water Monitoring Plan
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FIGURE A-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, conducts a radiologic screening of the cooler, inspects sample containers, and cross-references sample labels against the COC. Acceptance of samples will be designated by laboratory sample the custodian performing the radiologic survey and check-in;

- The chain-of-custody 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 is then sent to Dames & Moore immediately, and analysis of samples authorized by the Project Manager. The original COC is mailed to Dames & Moore with analytical results for the samples.

- 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 Dames & Moore, Sacramento with analytical data.

6.0 CALIBRATION PROCEDURES

Calibration is the process of establishing the relationship between standard materials and the output of the 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 into separate forms according to Procedure 13 of the QA Program Plan. This section presents information on equipment calibration procedures for field and laboratory equipment.

6.1 FIELD EQUIPMENT

During water monitoring, four parameters (temperature, pH, conductivity, and Eh) will be measured by a single instrument, a YSI Combination the Hydac Digital Conductance, Temperature, pH, and Eh monitoring system, Model 3500 (YSI, Incorporated, Yellow Springs, Ohio). In addition, turbidity will be measured by a portable turbidity meter (Model No. DRT-15C, HF Scientific) and redox potential measured by a portable Eh meter. Standards purchased for the field measurement instruments will be traceable to NIST standards.

6.1.1 pH Meter Calibration

The pH meter must be performance checked in the field each day before water pH measurements are taken. The pH meter must be calibrated at the end of each day, and at any time unexpected pH readings are observed. The calibration operation should be documented in the daily field memoranda kept by field staff, and retained by the Technical Lead/Project Manager for water sampling and field pH measurements. In addition, all calibration information, including equipment name, type, and serial number, date and time of calibration, name of person, standards used, and results of calibration, will be recorded on the Instrument Calibration Form (Figure A-6.1). The procedure for pH calibration is explained in the Standard Operating Procedures attached as Appendix C of the Water Monitoring Plan. The project staff will compile all pH calibration information from field logs onto a calibration log using forms similar to Exhibit A from Procedure 13 of the QA Program Plan.

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:

FIELD INSTRUMENT CALIBRATION LOG

LEHR Environmental Restoration

FIGURE A-5.1

6.1.2 Conductivity Calibration

The conductivity cell of the YSI meter is calibrated at the factory. The Field Operations Lead will check and document the calibration of the YSI conductivity cell once per month during water sampling, or at any time an erroneous reading is suspected. The procedure for testing and re-calibrating the YSI conductivity cell is detailed in Appendix C of the Water Monitoring Plan (SOPs) Forms similar to Exhibit A in Procedure 13 of the QA Program Plan, will be completed by the Technical Operation Lead and kept on file by the CQA.

6.1.3 Temperature Calibration

The temperature sensor is calibrated at the factory. The Field Operations Lead will check and document the performance of the digital thermometer on the Instrument Calibration Form once per month during water sampling, or at any time an erroneous reading is suspected. Documentation of this check will be kept on file by the CQA as described in Section 6.1.2.

6.1.4 Turbidity Calibration

Field check of the portable turbidity meter is accomplished using the methods described in the owners manual. The check is conducted using one standard (0.10 NTU) supplied by the manufacturer. The steps for field calibration checks include:

- Insert the 0.10 NTU standard and cover with the light shield to keep out ambient light.
- Turn the range control on the DRT-15C to the 20 range.
- Adjust the Reference adjust control until a reading of 0.10 NTU is obtained.
- If the Reference control cannot be adjusted to read 0.10 NTU, the machine is not working properly and must be recalibrated at the factory.
- Remove the light shield and the standard solution. The portable turbidity meter is ready for use.

6.1.5 Redox Potential Calibration

Field check of the portable redox potential meter is accomplished using the methods described in the owners manual. The Eh probe is factory calibrated and field checked with a solution of known redox potential (Zoebell's Solution). The probe is field checked daily and every four hours during continuous use.

6.1.6 Radiologic Monitoring

Calibration of the meter for radiologic screening of sample containers will be conducted per the manufacturer's specifications. It is anticipated that the meter will be returned to the manufacturer approximately every six months for calibration to a traceable standard. All calibration records will be kept on file in the project office and a calibration sticker will be affixed to the meter and probe. In addition to bi-annual calibrations, when used, daily performance checks will be conducted in the field using known sources.

6.2 LABORATORY PROCEDURES

Each analytical method has its own set of calibration procedures and verification. Calibration procedures will comply with the analytical laboratory QA Plan which will be attached to this document following the laboratory selection process.

7.0 ANALYTICAL METHODS

The analytical methods used for this project are primarily EPA and HASL-300 methods and are listed in Table A-7.1. Specific analytical method procedures will be detailed in the laboratory QA Plan which will be attached to this document following the laboratory selection process.

TABLE A-7.1 (CONTINUED)

SAMPLE ANALYSES - WATER

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	Page C-2 & 3 of SOW OLC 02.0[1]	14 days
Semivolatile organic compounds	CLP SOW OLM 01.8	1 Liter, Amber G	4°C	Page C-4 & 5 of SOW OLM 01.8[1]	7 days to extraction, 40 days to analysis
Organochlorine Pesticides	CLP SOW OLM 01.8(M)[2]	1 Liter, Amber G	4°C	Page C-6 of SOW OLC 02.0[1]	7 days to extraction, 40 days to analysis

1 Tables are attached for reference.
2 CRQLs reported at OLC 02.0 levels.

TABLE A-7.1 (CONTINUED)

SAMPLE ANALYSES - WATER

RADIOLOGIC ANALYSES:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT MDA	HOLDING TIME
Gross Alpha	9310	1 Liter P,G	Filter, HNO_3, pH<2	2 pCi/L	180 days
Gross Beta	9310	1 Liter P,G	Filter, HNO_3, pH<2	3 pCi/L	180 days
Tritium	906.0	1 Liter P,G	None	300 pCi/L	180 days
Carbon-14	LSC C-01	1 Liter P,G	None	500 pCi/L	180 days
Strontium-90	905.0(M)[3]	2 Liter P,G	Filter, HNO_3 pH<2	1.0 pCi/L	180 days
Gamma Spectral Analysis	901.1	4 Liter P,G	Filter, HNO_3, pH<2		180 days
TH-234				170 pCi/L	
RA-226				80 pCi/L	
PB-214				10 pCi/L	
BI-214				10 pCi/L	
PB-210				380 pCi/L	
U-235				5 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	
Radium-226	903.1	1 liter P,G	Filter, HNO_3, pH <2	0.5	180 days

3 **Modified procedure specified in laboratory SOP.**

TABLE A-7.1 (CONTINUED)

SAMPLE ANALYSES - WATER

METALS ANALYSES:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT	HOLDING TIME
				CRDL	
Hexavalent Chromium	7196	1 Liter, P	4°C, Filter	10 μg/L	24 hours
Total Chromium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 μg/L	6 months
Antimony	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	5 μg/L	6 months
Arsenic	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	2 μg/L	6 months
Barium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	20 μg/L	6 months
Beryllium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	1 μg/L	6 months

TABLE A-7.1 (CONTINUED)

SAMPLE ANALYSES - WATER

METALS ANALYSES (CONTINUED):					
Cadmium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	1 µg/L	6 months
Cobalt	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 µg/L	6 months
Copper	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 µg/L	6 months
Iron	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2,	100 µg/L	6 months
Lead	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3 pH<2	2 µg/L	6 months
Manganese	CLP SOW ILC 02.0	1 Liter, P	Filter HNO_3, pH<2	10 µg/L	6 months
Mercury	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	0.2 µg/L	28 days
Molybdenum	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 µg/L	6 months

TABLE A-7.1 (CONTINUED)

SAMPLE ANALYSES - WATER

METALS ANALYSES (CONTINUED):					
Nickel	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	20 μg/L	6 months
Selenium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	3 μg/L	6 months
Silver	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 μg/L	6 months
Thallium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 μg/L	6 months
Vanadium	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	10 μg/L	6 months
Zinc	CLP SOW ILC 02.0	1 Liter, P	Filter, HNO_3, pH<2	20 μg/L	6 months

TABLE A-7.1 (CONTINUED)

SAMPLE ANALYSES - WATER

GENERAL CHEMICAL ANALYSES:					
ANALYTE	METHOD	CONTAINER	SAMPLE HANDLING	DETECTION LIMIT Reporting Limit	HOLDING TIME
Alkalinity	310.1	1 Liter P	Filter	10.0 mg/L	14 days
Sodium	6010	1 Liter, P	Filter, HNO_3, pH<2	2.0 mg/L	6 months
Potassium			Filter, HNO_3, pH<2	2.0 mg/L	6 months
Calcium			Filter, HNO_3, pH<2	2.0 mg/L	6 months
Magnesium			Filter, HNO_3, pH<2	2.0 mg/L	6 months
Chloride	300.0	1 Liter P,G	Filter 4°C	1.0 mg/L	28 days
Sulfate				1.0 mg/L	28 days
Phosphate	365.2			1.0 mg/L	48 hours

TABLE A-7.1 (CONTINUED)

SAMPLE ANALYSES - WATER

GENERAL CHEMICAL ANALYSES (CONTINUED):					
Nitrate (as Nitrogen)	300.0	1 Liter P,G	Filter	0.1 mg/L	48 hours
Total Kjeldahl Nitrogen	351.2	500 ml P,G	Filter H_2SO_4 pH<2	0.5 mg/L	28 days
Total Dissolved Solids	160.1	1 Liter P,G	Filter 4° C	20.0 mg/L	7 days
Formaldehyde	3500 Modified NI OSH	2, 40 ml G	H_2SO_4 pH<2	1.0 mg/L	7 days
Total Organic Carbon	415.2	1 Liter G	H_2SO_4 pH<2	1.0 mg/L	28 days
Ammonia	350.1	500 ml P,G	Filter, H_2SO_4, pH<2	0.05 mg/L	7 days
Turbidity	180.1	500 ml P,G	4° C	0.1 NTU	48 hours

TARGET COMPOUND LIST (TCL) AND
CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

Volatiles	CAS Number	Quantitation Limits Water mg/L
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. 2-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
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	108-10-1	5
28. 2-Hexanone	591-78-6	5
29. Tetrachloroethene	127-18-4	1

TARGET COMPOUND LIST (TCL) AND
CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)
(CONT'D.)

Volatiles	CAS Number	Quantitation Limits Water mg/L
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

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.

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

Semivolatiles	CAS Number	Quantitation Limits* Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	On Column (ng)
34. Phenol	108-95-2	10	330	10000	(20)
35. bis(2-Chloroethyl) ether	111-44-4	10	330	10000	(20)
36. 2-Chlorophenol	95-57-8	10	330	10000	(20)
37. 1,3-Dichlorobenzene	541-73-1	10	330	10000	(20)
38. 1,4-Dichlorobenzene	106-46-7	10	330	10000	(20)
39. 1,2-Dichlorobenzene	95-50-1	10	330	10000	(20)
40. 2-Methylphenol	95-48-7	10	330	10000	(20)
41. 2,2'-oxybis (1-Chloropropane)#	108-60-1	10	330	10000	(20)
42. 4-Methylphenol	106-44-5	10	330	10000	(20)
43. N-Nitroso-di-n-propylamine	621-64-7	10	330	10000	(20)
44. Hexachloroethane	67-72-1	10	330	10000	(20)
45. Nitrobenzene	98-95-3	10	330	10000	(20)
46. Isophorone	78-59-1	10	330	10000	(20)
47. 2-Nitrophenol	88-75-5	10	330	10000	(20)
48. 2,4-Dimethylphenol	105-67-9	10	330	10000	(20)
49. bis(2-Chloroethoxy) methane	111-91-1	10	330	10000	(20)
50 2,4-Dichlorophenol	120-83-2	10	330	10000	(20)
51. 1,2,4-Trichlorobenzene	120-82-1	10	330	10000	(20)
52. Naphthalene	91-20-3	10	330	10000	(20)
53. 4-Chloroaniline	106-47-8	10	330	10000	(20)
54. Hexachlorobutadiene	87-68-3	10	330	10000	(20)
55. 4-Chloro-3-methylphenol	59-50-7	10	330	10000	(20)
56. 2-Methylnaphthalene	91-57-6	10	330	10000	(20)
57. Hexachlorocyclopentadiene	77-47-4	10	330	10000	(20)
58. 2,4,6-Trichlorophenol	88-06-2	10	330	10000	(20)
59. 2,4,5-Trichlorophenol	95-95-4	25	800	25000	(50)
60. 2-Chloronaphthalene	91-58-7	10	330	10000	(20)
61. 2-Nitroaniline	88-74-4	25	800	25000	(50)
62. Dimethylphthalate	131-11-3	10	330	10000	(20)
63. Acenaphthylene	208-96-8	10	330	10000	(20)
64. 2,6-Dinitrotoluene	606-20-2	10	330	10000	(20)
65. 3-Nitroaniline	99-09-2	25	800	25000	(50)
66. Acenaphthene	83-32-9	10	330	10000	(20)
67. 2,4-Dinitrophenol	51-28-5	25	800	25000	(50)
68. 4-Nitrophenol	100-02-7	25	800	25000	(50)

Previously known by the name bis(2-Chloroisopropyl) ether

Semivolatiles	CAS Number	Quantitation Limits* Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	On Column (ng)
69. Dibenzofuran	132-64-9	10	330	10000	(20)
70. 2,4-Dinitrotoluene	121-14-2	10	330	10000	(20)
71. Diethylphthalate	84-66-2	10	330	10000	(20)
72. 4-Chlorophenyl-phenyl ether	7005-72-3	10	330	10000	(20)
73. Fluorene	86-73-7	10	330	10000	(20)
74. 4-Nitroaniline	100-01-6	25	800	25000	(50)
75. 4,6-Dinitro-2-methylphenol	534-52-1	25	800	25000	(50)
76. N-nitrosodiphenylamine	86-30-6	10	330	10000	(20)
77. 4-Bromophenyl-phenylether	101-55-3	10	330	10000	(20)
78. Hexachlorobenzene	118-74-1	10	330	10000	(20)
79. Pentachlorophenol	87-86-5	25	800	25000	(50)
80. Phenanthrene	85-01-8	10	330	10000	(20)
81. Anthracene	120-12-7	10	330	10000	(20)
82. Carbazole	86-74-8	10	330	10000	(20)
83. Di-n-butylphthalate	84-74-2	10	330	10000	(20)
84. Fluoranthene	206-44-0	10	330	10000	(20)
85. Pyrene	129-00-0	10	330	10000	(20)
86. Butylbenzylphthalate	85-68-7	10	330	10000	(20)
87. 3,3'-Dichlorobenzidine	91-94-1	10	330	10000	(20)
88. Benzo(a)anthracene	56-55-3	10	330	10000	(20)
89. Chrysene	218-01-9	10	330	10000	(20)
90. bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10000	(20)
91. Di-n-octylphthalate	117-84-0	10	330	10000	(20)
92. Benzo(b)fluoranthene	205-99-2	10	330	10000	(20)
93. Benzo(k)fluoranthene	207-08-9	10	330	10000	(20)
94. Benzo(a)pyrene	50-32-8	10	330	10000	(20)
95. Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000	(20)
96. Dibenz(a,h)anthracene	53-70-3	10	330	10000	(20)
97. Benzo(g,h,i)perylene	191-24-2	10	330	10000	(20)

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

TARGET COMPOUND LIST (TCL) AND
CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)
(CONT'D.)

Pesticides/PCBs	CAS Number	Quantitation Limits Water mg/L
1. alpha-BHC	319-84-6	0.01
2. beta-BHC	319-85-7	0.01
3. delta-BHC	319-36-8	0.01
4. gamma-BHC (Lindane)	58-89-9	0.01
5. Heptachlor	76-44-8	0.01
6. Aldrin	309-00-2	0.01
7. Heptachlor epoxide	1024-57-3	0.01
8. Endosulfan I	959-98-8	0.01
9. Dieldrin	60-57-1	0.02
10. 4,4'-DDE	72-55-9	0.02
11. Endrin	72-20-8	0.02
12. Endosulfan II	33213-65-9	0.02
13. 4,4'-DDD	72-54-8	0.02
14. Endosulfan sulfate	1031-07-8	0.02
15. 4,4'-DDT	50-29-3	0.02
16. Methoxychlor	72-43-5	0.10
17. Endrin ketone	53494-70-5	0.02
18. Endrin aldehyde	7421-36-3	0.02
19. alpha-Chlordane	5103-71-9	0.01
20 gamma-Chlordane	5103-74-2	0.01
21. Toxaphene	8001-35-2	1.0
22. Aroclor-1016	12674-11-2	0.20
23. Aroclor-1221	11104-28-2	0.40
24. Aroclor-1232	11141-16-5	0.20
25. Aroclor-1242	53469-21-9	0.20
26. Aroclor-1248	12672-29-6	0.20
27. Aroclor-1254	11097-69-1	0.20
28. Aroclor-1260	11096-82-5	0.20

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 Water Monitoring Program. Validation of field data is accomplished by proper sampling and measurement techniques and 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 Section presents information on data reduction, validation, reporting, handling, and technical review procedures.

8.1 DATA REDUCTION

8.1.1 Field

Data reduction will occur for the field measurements at the point of sampling. At the point of sampling, the data as measured by the field instrument will be reported in the field notebooks and on required forms.

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 Section 7.0 of the Water Monitoring 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

Data reduction in the laboratory is covered in detail in the laboratory's QA Plan which will be attached to this document after a laboratory is selected.

8.2 DATA VALIDATION

Data validation will be performed on analytical results received from the laboratory for groundwater, surface water, and storm water runoff. The purpose of data validation will be to identify data that meets 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 (precision, accuracy, representativeness, comparability, and completeness).

A USEPA Contract Laboratory Program (CLP) or CLP-equivalent data package will be obtained from the laboratory for groundwater, surface water, and storm water runoff laboratory results. When received, Dames & Moore will perform a detailed validation of 10% of the analytical data, based on the *USEPA National Functional Guidelines for Laboratory Data Review*. The remaining 90% of the data will be reviewed using a subset of the National Functional Guidelines validation criteria. The SOP to validate 90% of the data is provided in Attachment A-1.

8.3 DATA REPORTING

Any proposed equivalents to forms required below will be closely scrutinized. The use of equivalents must be justified by the laboratory and approved in advance by Dames & Moore. To be considered equivalent, the proposed forms must include all of the

information included in the CLP deliverable formats specified in SOW OLMO1.0, organics and SOW ILMO2.0, inorganics.

8.3.1 Level IV

All USEPA CLP forms and raw data deliverable requirements will apply. The deliverable requirements for Level IV are specified in Document Number OLMO1.0 (inc. rev's 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 in Figure A-8.1: QA/QC Summary.

QA/QC SUMMARY

Batch ID:
Matrix: Fraction:
Related Samples:

Parameter	Passed	Failed	Narrative Note
Holding time			
Surrogates			
Spikes			
Duplicate			
Blanks			
Calibration			
LCS			

Narrative Notes:

Reviewer's Signature

FIGURE A-8.1: QA/QC SUMMARY

8.4 DATA HANDLING

As stated in Section 8.0 of the QAPjP, the authenticity and then the validity (Section 8.2) of the data must 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 Dames & Moore'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.

During data screening, data verification, and data review activities of field- and laboratory-generated data, unacceptable or suspect data must be evaluated to determine its cause. The results of this investigation must 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 Section 13.0 of the QAPjP and Procedure 18 of the QA Program Plan. If the suspect data have been included in the database, the data must be flagged to indicate its suspect status. All electronic data will be backed up regularly and stored in a fire-resistant safe. Additionally, the laboratory will be required to maintain copies of all data and QA/QC support documentation.

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 Data Acceptance Checklist (Figure B-8.1) must be reviewed by the Technical Lead who signs the Data Acceptance Checklist. Only then will the data be placed in the project file.

9.0 INTERNAL QUALITY CONTROL

This section 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

9.1.1 Preparation

The format for the Water Monitoring 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 Water Monitoring 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 Water Monitoring 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 Water Monitoring Plan or QAPjP will be distributed to these individuals. Controlled copies of the Water Monitoring 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 Water Monitoring Plan has been completed by independent reviewers whose comments have been incorporated directly by the Technical Lead/Project Manager.

9.2 FIELD QC CHECKS

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 Section 6.0 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

9.2.2.1 Trip blanks

The primary purpose of this type of blank is to detect any potential additional source 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. 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. 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

- 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 onsite for a maximum of one week. They must be shipped back to the lab at the end of the seventh calendar day with the same sample bottles they accompanied into the field regardless of whether all the sample bottles were used. The temperature of the trip blanks must be maintained at 4°C while onsite 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 Field blanks

The primary purpose of this type of blank is to provide an additional check on possible sources of contamination such as ambient air and sampling instruments. The reason for performing field blanks in the most contaminated area is to attempt to simulate a worst-case scenario regarding ambient air contributions to sample contamination. Field blanks should be handled, transported and analyzed in the same manner as the samples acquired that day. Field blanks must return to the lab with the same set of sample bottles they accompanied into the field. Field blanks must be packaged with their associated matrix.

Other requirements affecting the use and integrity of field blanks include the following:

- Handling The field blank water and sand should be returned to the laboratory within one week of its receipt at the site. The temperature

of the blank water and sand must be maintained at 4°C while onsite and during shipment.

- Holding Time Holding times for individual parameters are dictated by the specific analytical method being used. The holding-time clock for the field blanks begins at the time of sample collection of the field blank.

9.2.2.3 Equipment blanks

The equipment blank is similar to the field blank except that the laboratory-supplied water is passed through clean sample equipment and placed in the empty sample container for 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 A-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.

Duplicate or replicates of water samples will be obtained by alternately filling sample containers from the sampling device for each parameter. Groundwater samples for volatile organic analysis from monitoring wells will be filled from the same bailer-full of water whenever possible and will be the first set of containers filled. When other sampling devices are used, the vials for duplicate or replicate volatile organics should be alternately filled.

9.2.4 Spike samples

For QA/QC purposes, 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

Laboratory Checks

Analytical activities used by the laboratory as QC checks include:

- Bottle 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 check sample frequency, 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 must prepare calculations, computer programs, and prepare drawings needed for reports to clients. The Technical Lead/Project Manager will assign an independent, qualified Dames & Moore 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.

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.

9.4.3 Computer Program Certification

Procedure 7 of the QA Program Plan will be implemented and applied to all computer programs used in the Water Monitoring Program.

9.4.4 Preparation of Drawings

Procedure 9 for the QA Program Plan will be applied to all drawings required in the preparation of external drawings.

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.

10.2 SURVEILLANCES

Surveillance programs are conducted by the quality assurance staff to evaluate that field activities comply with the project controlling documents. Surveillances of the Dames & Moore field staff will be performed as described in Procedure 15 of the QA Program Plan. A surveillance of each significant field sample collection activity will be performed at least once during the project.

11.0 PREVENTIVE MAINTENANCE

Dames & Moore is responsible for documenting the maintenance of all field equipment under the procedures described in Section 6.0 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

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).

$$\%RPD = \left(\frac{Rep1 - Rep2}{(Rep1 + Rep2)/2}\right) \times 100$$

The precision objectives are noted in Section 3.0 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 Section 13.0 of this QAPjP.

12.1.1 Water level

At the beginning of each water level measurement round, a minimum of four measurements will be made at the first well using a calibrated tape to evaluate precision. Using the four measurements, the Standard Deviation will be calculated. If one Standard Deviation is 0.01, single measurements for other wells using the same procedures will be acceptable.

12.1.2 Temperature, pH, conductivity, turbidity, and redox potential

If duplicate measurements fail to meet precision objectives, two additional 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 Section 8.0 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 Section 3.0 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 Section 13.0 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, traceable to lengths set by the National Institute of Standards and Technology (NIST), will be taken by the principle 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's QA Plan. Independent data validation will also be provided as a further check on laboratory performance (see Section 8.0 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 Section 3.0 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 Section 13.0 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 modifications of established protocols to achieve meaningful results. It is necessary, however, that these problem samples/analyses be identified and discussed with the QA

Officer at the laboratory 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. If the Water Monitoring Plan requires modification in the field for any reason, the Field Operations Lead will document the problem and then attempt to contact the Project Manager or the Lead Consultant. If these individuals are not available, the EMO Project Manager will be informed of the situation and field work will continue. The Field Operations Lead will document the situation in his daily field memoranda. The Field Operations Lead will inform the Project Manager immediately after returning from the field, who will review and distribute copies of the memoranda to the CQA if corrective action was taken.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Procedure 19 of the QA Program Plan will be implemented for the control and retention of Quality Assurance Records.

Nonconformance 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. The frequency of these reports will be determined by the CQA on an "as needed" basis.

15.0 REFERENCES

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

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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.

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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.

Hicks, G., 1991, "Quality Assurance Program Plan EMO" Revision 1, July 1991, Atlanta, Georgia

ATTACHMENT A-1

STANDARD OPERATING PROCEDURE
DATA VALIDATION

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:

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) . . . . . .

YES NO N/A

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 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? . . . . . .

YES NO N/A

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"

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".

YES NO N/A

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:

- 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.

YES NO N/A

- 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) . . . . . .

YES NO N/A

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 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"

YES NO N/A

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"

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:

YES NO N/A

- 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

YES NO N/A

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:
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? . . . . . .
90-100 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? . . . . . .

YES NO N/A

90-100 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.

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? . . . . . .

YES NO N/A

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.
- 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.

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

APPENDIX B

HEALTH AND SAFETY PLAN

APPENDIX B

HEALTH AND SAFETY PLAN

Groundwater, surface water, and storm water monitoring described in this Water Monitoring Plan will be conducted in conjunction with the Site-Wide RI/FS program. At the time of this draft, the RI/FS Work Plan and the RI/FS Health and Safety Plan have not completed the review and approval process. At present, ongoing groundwater and surface water monitoring is conducted under the Phase II Work Plan and its approved Health and Safety Plan. When this Water Monitoring Plan is approved, water monitoring will be conducted under this plan and under the approved Phase II Site Characterization Health and Safety Plan. Water monitoring will be conducted under the RI/FS Health and Safety Plan when it is approved.

APPENDIX C

STANDARD OPERATING PROCEDURES

APPENDIX C

STANDARD OPERATING PROCEDURES

This Appendix presents the Standard Operating Procedures (SOPs) referenced in the text of this Water Monitoring Plan. These SOPs are included as an appendix of the Sampling and Analysis Plan of the RI/FS-EA Work Plan. This Appendix includes the following SOPs:

SOP 1.0 - Water Sampling
SOP 2.0 - Field Measurements
SOP 3.0 - Equipment Decontamination
SOP 4.0 - Soil, Water, and Waste Disposal
SOP 5.0 - Sample Shipment

Field documentation forms that are referenced in these SOPs are included at the end of this Appendix. These forms include:

- Field Memorandum;
- Water Sample Tracking Form;
- Field Record of Water Sampling;
- Sample Chain-of-Custody; and
- Instrument Calibration Form;

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, and 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' length)
pH meter, conductivity meter, 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
Blue ice

Documentation:

Field Memorandum
Water Sample Tracking Form
Field Record of Water Sampling
Sample Chain of Custody
Instrument Calibration Form
(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, pre-label sample containers;

- Notify on-site personnel of sampling schedule, and clear access to wells and/or surface water sampling locations;

- Check and calibrate 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;

- 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. 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.

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 either dedicated electric submersible or dedicated bladder pumps. Purged water will be contained in 55-gallon, DOT-approved drums. If the static water level drops below the level of dedicated pumps, the pumps will be removed, placed in clean plastic bags, and the well will be purged and sampled using a disposable bailer. 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:

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

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 percent.

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.

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 the second time. 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/minutes 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
- Other Parameters

Volatile Organic Compounds will be collected in containers with no head space. Sample fractions for metals and other inorganic compounds will be filtered and preserved in the field according to laboratory instruction. 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 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 2.0.

Non-dedicated and non-disposable bailers, pumps, meters, reel, water levels meters, and teflon tubing will be decontaminated upon completion of sampling (see SOP 18.0 Equipment Decontamination). Disposable materials will be discarded according to the LEHR Waste Management Plan.

1.2.2 In-situ Groundwater Sampling

In-situ groundwater samples may be collected during drilling by the dual-tube percussion or casing hammer methods. See SOP 3.0 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 a depth that will allow adequate production of water to purge and sample. 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 in Section SOP 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.
- Measure pH, conductivity, turbidity, and temperature (see SOP 2.0).

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

- Volatile organic compounds
- Semi-volatile organic compounds
- Metals
- 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 chain-of-custody documents and Field Records.

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, 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.

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

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURE 2.0
FIELD MEASUREMENTS - WATER

Purpose and Scope: These procedure 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, turbidity, temperature, Eh, dissolved oxygen, and groundwater elevation. Procedures below were derived from manufacture 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)
Turbidity Meter
Eh Meter
Water Level Indicator
Distilled or Deionized Water
Spray Water Bottle
Sample Cup or Beaker
Extra Batteries

Documentation:

Field Memorandum
Field Record of Water Sampling
Instrument Calibration Forms
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. If necessary, water levels will be measured prior to well evacuation. Water levels will be measured 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 less than 0.01 foot. Measuring devices will be decontaminated prior to and after 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 total depth measurement and the well specifications do not match, the dedicated pumps will be temporarily removed from the well into a plastic bag to ensure that there is no interference 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 as and when 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 about 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.

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.

- 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.

- 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 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.
- Decontaminate probe when finished.

2.6 TURBIDITY

The general procedures for the operation and calibration 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.

2.7 Eh (OXIDATION-REDUCTION POTENTIAL)

The Eh meter is in the process of being procured. Because Eh measurement is assigned a Level I DQO, calibration of the Eh meter and Eh measurements will be accomplished according to manufacturer's specifications.

STANDARD OPERATING PROCEDURES
STANDARD OPERATING PROCEDURES 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®);

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 Equipment

Drilling equipment, including 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 well or soil boring. 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.

A designated area on-site 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 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, lysimeter and piezometer 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.)
Appropriate sample containers and sampling equipment

Documentation: Field memorandum

4.1 CONTAINMENT

Both drill cuttings and any water generated during drilling will be kept separate and containered 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 water-proof ink markers will be used.

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 PROCEDURES 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
Zip-lock bags
Ludlum Model 2929 Dual Channel Sealer
Swipes

Documentation:
Field Memorandum
Sample Tracking Form
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, and 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 may be packaged with "blue-ice" or wet "block-ice". Enough ice will be used to keep the samples at the appropriate temperature during shipment.

4. The completed COC will be placed in a plastic zip-lock bag and tape 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 calls should be made to the laboratory Project Manager to inform them of the coming shipment and to confirm receipt of the previous days shipment.