Weiss Associates Environmental Science, Engineering and Management
5801 Christie Avenue, Suite 600, Emeryville, CA 94608-1939 Fax: 510-547-5043 Phone: 510-450-6000

FEASIBILITY STUDY DATA GAPS TECHNICAL REPORT

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH/ SOUTH CAMPUS DISPOSAL SITE UNIVERSITY OF CALIFORNIA, DAVIS

Prepared for:

University of California, Davis
One Shields Ave
Davis, California 95616

Prepared by:

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

February 12, 2010
Rev.0

Weiss Associates Environmental Science, Engineering and Management
5801 Christie Avenue, Suite 600, Emeryville, CA 94608-1939 Fax: 510-547-5043 Phone: **510-450-6000**

FEASIBILITY STUDY DATA GAPS TECHNICAL REPORT

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH/ SOUTH CAMPUS DISPOSAL SITE UNIVERSITY OF CALIFORNIA, DAVIS

Prepared for:

University of California, Davis
One Shields Ave
Davis, California 95616

Prepared by:

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

February 12, 2010
Rev.0

Weiss Associates Environmental Science, Engineering and Management
5801 Christie Avenue, Suite 600, Emeryville, CA 94608-1939 Fax: 510-547-5043 Phone: **510-450-6000**

FEASIBILITY STUDY DATA GAPS TECHNICAL REPORT

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH/ SOUTH CAMPUS DISPOSAL SITE UNIVERSITY OF CALIFORNIA, DAVIS

Prepared for:

University of California, Davis
One Shields Ave
Davis, California 95616

Prepared by:

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

February 12, 2010
Rev.0

Approved by: _____ Date: 2/12/10
Robert O. Devany, P.G. C.E.G., C.H.G.
Principal Hydrogeologist
Weiss Associates

CONTENTS

ACRONYMS AND ABBREVIATIONS vi

EXECUTIVE SUMMARY 1

1 CHROMIUM INVESTIGATION 1-1

1.1 Background and Introduction 1-1

1.1.1 Chromium Environmental Geochemistry 1-1

1.1.2 Pre-Data Gaps Understanding of Chromium at the Site 1-4

1.1.3 Chromium Tasks, Purpose and Scope 1-4

1.1.4 Chromium Data Gaps Investigation Activities 1-5

1.2 Chromium Investigation Results 1-6

1.2.1 Summary of Data Evaluated 1-6

1.2.2 Chromium Distribution in Groundwater 1-7

1.2.3 Evaluation of Potential Site Use History Effects on Cr(VI) Distribution 1-10

1.2.4 Evaluation of Potential Geologic/Hydrogeologic Effects on Cr(VI) Distribution 1-11

1.2.5 Evaluation of Potential Soil Geochemistry Effects on Cr(VI) Distribution 1-12

1.2.6 Evaluation of Potential Groundwater Geochemistry Effects on Cr(VI) Distribution 1-15

1.3 Evaluation of Potential Chromium Source Mechanisms 1-16

1.3.1 Chromium Source Mechanism Screening 1-16

1.3.2 Comparative Analysis of Potential Chromium Source Mechanisms 1-18

1.4 Chromium Investigation Conclusions and Recommendations 1-21

2 SOIL TO GROUNDWATER IMPACT EVALUATION 2-1

2.1 Background and Introduction 2-1

2.1.1 Soil-to-Groundwater Impact Evaluation Overview 2-1

2.1.2 Soil-to-Groundwater Impact Evaluation Tasks, Purpose and Scope 2-3
2.1.3 Soil-to-Groundwater Impact Data Gaps Investigation Activities 2-4
2.2 Current Disposal Unit Impact to Groundwater 2-5
2.3 Soil-to-Groundwater Impact Designated Level Modeling 2-8
2.3.1 Summary of Data Evaluated 2-8
2.3.2 COPC Identification 2-9
2.3.3 NUFT Modeling and Designated Levels 2-9
2.4 Soil-to-Groundwater Impact Risk Characterization 2-10
2.5 Chemicals of Concern and Preliminary Cleanup Goals 2-11
2.6 Soil-to-Groundwater Impact Conclusions and Recommendations 2-11
3 VAPOR INTRUSION EVALUATION 3-1
3.1 Introduction and Background 3-1
3.1.1 Vapor Intrusion Evaluation Overview 3-1
3.1.2 Vapor Intrusion Evaluation Scope 3-2
3.2 Soil Vapor Screening Values Determination 3-2
3.2.1 Methodology 3-2
3.2.2 Results 3-2
3.3 Vapor Intrusion Conclusions and Recommendations 3-3
4 REFERENCES 4-1

FIGURES

Figure 1-1. Chromium Data Gaps Investigation Sampling Locations, LEHR/SCDS, UC Davis, California

Figure 1-2. Chromium Distribution in HSU-1 Based on 2007-2008 Data, LEHR/SCDS, UC Davis, California

Figure 1-3. Chromium Concentrations in HSU-1 Higher Concentration Monitoring Wells Over Time, LEHR/SCDS, UC Davis, California

Figure 1-4. Chromium Concentrations in HSU-1 Lower Concentration Monitoring Wells Over Time, LEHR/SCDS, UC Davis, California

Figure 1-5. Chromium Distribution in HSU-2 Based on 2007-2008 Data, LEHR/SCDS, UC Davis, California

Figure 1-6. Off-site Supply Wells Chromium Concentrations, LEHR/SCDS, UC Davis, California

Figure 1-7. Source Mechanism 1A: Manganese Reduction, Mobilization and Reoxidation with Cr(VI) Generation, LEHR/SCDS, UC Davis, California

Figure 2-1. Soil-to-Groundwater Impact COC Risk Characterization Analysis Flow Chart, LEHR/SCDS, University of California, Davis

Figure 2-2. Designated Level COPC Analysis Flow Chart, LEHR/SCDS, University of California, Davis

Figure 2-3. Data Gaps Disposal Unit Soil, Soil Gas and Groundwater Sampling and New Monitoring Well Locations, LEHR/SCDS, University of California, Davis

Figure 2-4. Landfill Unit No. 1, Vadose Zone Sample Locations Used in Soil-to-Groundwater Impact Evaluation, LEHR/SCDS, University of California, Davis

Figure 2-5. Landfill Unit No. 2, and Eastern Trenches Vadose Zone Sample Locations Used in Soil-to-Groundwater Impact Evaluation, LEHR/SCDS, University of California, Davis

Figure 2-6. Landfill Unit No. 3, Vadose Zone Sample Locations Used in Soil-to-Groundwater Impact Evaluation, LEHR/SCDS, University of California, Davis

Figure 2-7. Southern Trenches Vadose Zone Sampling Locations Used in Soil-to-Groundwater Impact Evaluation, LEHR/SCDS, University of California, Davis

Figure 2-8. Waste Burial Holes Vadose Zone Sample Locations Used in Soil-to-Groundwater Impact Evaluation, LEHR/SCDS, University of California, Davis

TABLES

Table 1-1. Data Gaps Chromium Investigation – Scope of Work, Modifications, and Rationale, LEHR/SCDS, University of California, Davis

Table 1-2. Chromium Data Gaps Investigation, Summary of Parameters in Groundwater, LEHR/SCDS, University of California, Davis

Table 1-3. Chromium Data Gaps Investigation, Summary of Parameters in Soil, LEHR/SCDS, University of California, Davis

Table 1-4. Bench Test Results of Data Gaps Samples Evaluating the Ability of Soils to Release Cr(VI) Into Ground Water, LEHR/SCDS, University of California, Davis

Table 1-5. Evaluation of Potential Source Mechanisms for Chromium in Ground Water, LEHR/SCDS, University of California, Davis

Table 2-1. Data Gaps Disposal Unit Investigation – Scope of Work, Modifications, and Rationale, LEHR/SCDS, University of California, Davis

Table 2-2. Non-volatile Constituents of Potential Concern for Groundwater Impact in Each Disposal Unit, LEHR/SCDS, University of California, Davis

Table 2-3. VOCs in Soil Gas in UC Davis Disposal Units, LEHR/SCDS, University of California, Davis

Table 2-4. Analytical Results for Grab Groundwater Samples Collected from Locations Adjacent to UC Disposal Units during the 2008 Data Gaps Investigation, LEHR/SCDS, University of California, Davis

Table 2-5. Proposed Preliminary Soil Cleanup Goals for Groundwater Impact Chemicals of Concern, LEHR/SCDS, University of California, Davis

Table 3-1. Maximum Soil Vapor Concentrations and Risk Based Screening Values for Hypothetical Future Onsite Residents, LEHR/SCDS, University of California, Davis

Table 3-2. Maximum Soil Vapor Concentrations and Risk Based Screening Values for Onsite Indoor Researchers, LEHR/SCDS, University of California, Davis

APPENDICES

Appendix A. Chromium Data Gaps Investigation Geologic and Well Construction Logs

Appendix B Results of PRIMA Environmental Chromium and Manganese Bench Tests

Appendix C. Disposal Unit Data Gaps Investigation Geologic and Well Construction Logs

Appendix D. Groundwater Impact COPC Evaluation

Appendix E. Vapor Intrusion Screening Level Development

Appendix F. Data Gaps Supporting Data (CD)

ACRONYMS AND ABBREVIATIONS

C-14	carbon-14
COC	constituent of concern
COPGWC	constituent of potential groundwater concern
COPC	constituent of potential concern
Cr	chromium
Cr(III)	trivalent chromium
Cr(VI)	hexavalent chromium
CVRWQCB	Central Valley Regional Water Quality Control Board
DDC	density-driven convection
DL	designated level
DOE	United States Department of Energy
DO	dissolved oxygen
DQO	Data Quality Objective
DTSC	Department of Toxic Substances Control
DU	Disposal Unit
FS	Feasibility Study
ft bgs	foot/feet below ground surface
HSP	Health and Safety Plan
HSU	hydrostratigraphic unit
LEHR	Laboratory for Energy-Related Health Research
LFU	Landfill Unit
MCL	California Maximum Contaminant Level
mg/kg	milligrams per kilogram
mV	millivolts
NUFT	Non-Isothermal Unsaturated Flow and Transport
ORP	oxidation-reduction potential
PCE	tetrachloroethene
QAPP	Quality Assurance Project Plan
SCDS	South Campus Disposal Site
SVOCs	semi-volatile organic compounds
UC Davis	University of California Davis
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

VOCs	volatile organic compounds
WBHs	Waste Burial Holes
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter

EXECUTIVE SUMMARY

This report presents the results of investigations conducted to address data gaps that needed to be filled prior to completion of the Feasibility Study (FS) for remediation of the University of California Davis (UC Davis) areas of responsibility at the Laboratory for Energy-Related Health Research / South Campus Disposal Site (LEHR/SCDS or the Site). These investigations were conducted according to the work scope outlined in *Feasibility Study Data Gaps Work Plan* (Weiss Associates, 2008a) to address data gaps related to the: 1) areas of elevated hexavalent chromium [Cr(VI)] in groundwater; 2) potential impact to groundwater from constituents in UC Davis former disposal units (DUs); and, 3) potential vapor intrusion into indoor air for volatile constituents in UC Davis former DUs. This report is organized into four sections: Section 1 discusses the Data Gaps investigations and results related to Cr(VI); Section 2 presents the DU soil-to-groundwater potential impact evaluation and results; Section 3 presents the DU potential vapor intrusion evaluation and results; and Section 4 includes references cited in the first three sections.

Chromium Investigations and Results: Cr(VI) has been identified as a constituent of concern (COC) in Site groundwater and therefore must be addressed in the FS. The primary purpose of the Data Gaps investigations related to Cr(VI) was to provide data to support the development of a site conceptual model to describe the likely source and nature of above-background Cr(VI) occurrence at the Site. In addition, the Data Gaps investigations were designed to provide better definition of the Cr(VI) distribution in hydrostratigraphic unit 1 (HSU-1) and HSU-2 at and near the Site, and to gain a better understanding of chromium (Cr) fate and transport in the subsurface. The planned Cr Data Gaps investigation tasks included: 1) records review; 2) multi-port well UCD1-27 rehabilitation; 3) discrete-interval soil and groundwater Cr and geochemical analyses for two borings in the elevated Cr area and two background borings extending into the top of HSU-2; 4) HSU-1 hydropunch sampling at six locations to better define the area of elevated Cr(VI); 5) installation of two new HSU-1 wells based on the hydropunch results, and two new downgradient HSU-2 wells to better define and monitor the groundwater Cr(VI) concentration distribution; 6) contemporaneous sampling and geochemical analysis of groundwater from these new and selected existing HSU-1 and HSU-2 wells; and, 7) evaluation of all data gaps and historic Cr(VI)-related data. These tasks were conducted with only minor deviations from the plan, and these deviations had no significant impact on achievement of the data quality objectives (DQOs).

Key conclusions and recommendations based on the Cr(VI) Data Gaps tasks are:

- The geology, hydrogeology, and geochemistry of HSU-1 at the Site provide the conditions necessary to potentially generate and maintain Cr(VI) in groundwater, including: 1) soil very high in Cr and manganese (Mn) oxides; 2) groundwater with positive oxidation-reduction potential (ORP), high dissolved

oxygen (DO) and high alkalinity (bicarbonate); and 3) slow groundwater velocities resulting in relatively long groundwater resident times.

- Although a definitive source and an explanation for the distribution of elevated Cr(VI) have not been identified, it appears that: 1) it is likely that an anthropogenic effect is enhancing the oxidation of the naturally-occurring Cr; 2) organic carbon waste is the most likely anthropogenic effect causing this enhanced oxidation, through one of three possible mechanisms; and, 3) this organic carbon waste was probably not disposed in the area(s) of current elevated Cr groundwater concentrations.
- The "source" of the elevated Cr(VI) appears to be depleting or depleted based on declining or stable Cr concentrations in most HSU-1 wells. If the "source" was organic carbon from onsite waste disposal, its depletion is also indicated by the highest Cr groundwater concentrations being located significantly downgradient from disposal area(s).
- Bench tests were performed (July to September 2009) to evaluate whether Cr(VI) concentrations in Site groundwater could be reduced to Cr(III) through the addition of various reducing agents. The results of these bench tests were used to begin evaluating whether the Cr(VI) can be reduced without undesirable groundwater impacts. These tests also included a "re-oxidation" phase to evaluate whether the reduced Cr(III) is readily oxidized back to Cr(VI) once natural, baseline conditions are restored. Bench test results indicated that: 1) calcium polysulfide (CaSx) effectively reduced groundwater Cr(VI); 2) although groundwater arsenic and other metal concentrations increased due to reduction by CaSx, these concentrations were restored to near baseline levels during the re-oxidation test; 3) no significant Cr re-oxidation was observed in the initial bench tests; and, 4) although CaSx treatment increased groundwater sulfate concentrations in the initial bench tests, additional bench testing indicates that the CaSx dose can be reduced, thereby reducing sulfate generation. Based on preliminary findings, the LEHR Team regulators (i.e., the United States Environmental Protection Agency [US EPA], Central Valley Regional Water Quality Control Board [CVRWQCB], Department of Toxic Substances Control [DTSC], and California Department of Public Health Radiologic Health Branch) agreed during an August 25, 2009, conference call that a field test of CaSx could be performed. Therefore, a pilot test work plan for in situ reduction of chromium, including the laboratory bench-test results, was submitted, approved by the LEHR Team regulators, and finalized on January 7, 2010 (Weiss, 2010a). The CaSx field pilot-scale test is currently underway.
- With the completion of the Data Gaps investigations and based on the results, the current Site groundwater monitoring well network may be adequate for long-term monitoring of elevated Cr. Following the Data Gaps work described in this report, one additional HSU-1 well (UCD1-67) was installed north of the Site to improve definition of Cr and other constituents in this area (Weiss, 2009). This new well and the three new HSU-1 and two new HSU-2 Cr definition Data Gaps

monitoring wells have been added to Site groundwater monitoring program, with specific monitoring recommendations included in the recently submitted *Draft Work Plan for 2010 Well Monitoring* (Weiss, 2010b).

DU Soil-to-Groundwater Impact Evaluation: To evaluate remedial options for the UC Davis disposal units, protection of groundwater from chemicals of concern (COCs) in these units must be addressed. This pathway had not been thoroughly addressed prior to the Data Gaps work, in part because the previously planned presumptive remedy (i.e., capping) involves engineered controls to protect groundwater from landfill leaching (UC Davis, 2006). A preliminary evaluation of potential groundwater impacts was conducted in early 2008 (Brown and Caldwell, 2008b), however, this evaluation had limitations. The DU soil-to-groundwater impact Data Gaps tasks addressed the limitations of this previous evaluation through collection of new data and use of evaluation methods previously approved and applied at LEHR/SCDS (Weiss, 2005). These Data Gaps tasks included: 1) hydropunch groundwater sampling to determine the need for and locations of new DU HSU-1 monitoring wells; 2) based on these hydropunch results, installation of four new HSU-1 wells for DU monitoring; 3) four quarters of groundwater monitoring of these four new wells, with analysis for the full suite of potential Site contaminants; 4) collection of vadose zone soil and soil gas and first groundwater samples from each DU, with soil analyzed for physical properties and/or nonvolatile chemicals of potential concern for groundwater impact, soil gas analyzed for volatile organic compounds (VOCs), and groundwater analyzed for the full suite of identified chemicals of potential concern; and, 5) development of vadose zone screening levels for groundwater protection based on the new and existing Site data and using the previously-approved modeling approach (Weiss, 2005), followed by risk characterization using these vadose zone screening levels and other information to identify groundwater impact COCs for each disposal unit using approved methods (Weiss, 2005).

Key conclusions and recommendations based on the DU soil-to-groundwater impact evaluation are:

- With the completion of the Data Gaps investigations, sufficient vadose zone soil and soil gas data and HSU-1 groundwater data were available to meet the DQOs specified in the Data Gaps Work Plan (Weiss, 2008a) and adequately assess the current and potential future impact of the UC Davis DUs on groundwater.
- The soil-to-groundwater impact evaluation was conducted following the same conservative and LEHR Team-approved approach and parameters used by DOE, so the evaluation provides results that are valid and sufficiently conservative for use in the FS.
- The identified groundwater impact COCs for each DU are listed below. Preliminary soil cleanup levels for these COCs are either background or the lowest available practical quantitation limit, with the exception of those for carbon-14 (C-14) and tritium in the Waste Burial Holes (WBHs), which are the calculated vadose zone screening levels.
    - Eastern Trenches: C-14; tritium; chloroform; 1,1-dichloroethane (1,1-DCA); 1,2-DCA; 1,2-dichloropropane; 1,4-dioxane

- Landfill Unit 1 (LFU1): copper; selenium; C-14
- Landfill Unit 2 (LFU2): cadmium; C-14; acetone; chloroform; 1,1-DCA; 1,2-dichloropropane; 1,4-dioxane
- Landfill Unit 3 (LFU3): barium; cadmium; copper; C-14
- WBHs: C-14; tritium; 1,4-dioxane
- Southern Trenches: none identified.

- UC Davis recommends that these COCs and their preliminary cleanup levels, along with human health-based COCs and preliminary cleanup levels, be used in developing and evaluating remedial alternatives in the FS.
- With the completion of the Data Gaps investigations and based on the results, the current Site groundwater monitoring well network is adequate for long-term monitoring of potential impact directly down-gradient of the UC Davis DUs. The four new HSU-1 DU Data Gaps monitoring wells have been added to the Site groundwater monitoring program, with specific monitoring recommendations included in the recently submitted *Draft Work Plan for 2010 Well Monitoring* (Weiss, 2010b).

DU Vapor Intrusion Evaluation: The primary purpose of this evaluation was to reassess the potential vapor intrusion risk associated with VOCs present in the disposal areas, and to then determine whether revisions to the Human Health Risk Characterization for UC Davis Areas (UC Davis, 2006) are warranted based on that assessment. Potential risks due to VOC vapor inhalation had been evaluated in the Risk Characterization Report for UC Davis areas (UC Davis, 2006); however, the LEHR Team regulators requested additional evaluation based on the new, depth-discrete soil gas data collected during the Data Gaps investigations and following updated methodology. The soil gas and soil property analyses conducted for the evaluation of potential soil-to-groundwater impact during this investigation (see above) also provided data for evaluating potential vapor intrusion risks. Using the California DTSC vapor intrusion model (DTSC, 2007) and representative soil properties, area- and depth-specific vapor intrusion screening levels were calculated for each VOC of potential concern in each UC Davis disposal area. These screening levels were then compared with the new Data Gaps soil gas results to determine if any of the VOCs detected present a potential vapor intrusion risk. In addition to VOCs, each soil gas sample was also screened for methane to evaluate whether it is present at significant levels in any of the disposal units.

Key conclusions and recommendations based on the DU vapor intrusion evaluation are:

- Several VOCs (e.g., chloroform, tetrachloroethene, and 1,2-dichloropropane) in the LFU2/Eastern Trenches area are at high enough concentrations to be of potential concern for vapor intrusion under potential future Site use scenarios.

- This conclusion is consistent with the previous Risk Characterization Report for the UC Davis areas (UC Davis, 2006). Still, a reassessment of the human health risk for these areas is recommended to account for the new soil gas data collected during the Data Gaps investigations and recent revisions to the State's model for assessing vapor intrusion risk.
- In addition, 1,3-butadiene was detected in soil gas at LFU1 and other UC Davis disposal areas. This organic gas is a probable human carcinogen that had not been analyzed for prior to the Data Gaps investigations.
- Therefore, the human health risks previously calculated and the risk characterization previously conducted for the UC Davis disposal areas (UC Davis, 2006) will be updated, and the results will be used to develop preliminary risk-based cleanup levels for use in the FS. This update will also include a review of the soil and groundwater risk evaluation to address any changes in toxicity data and other new data collected since the UC Davis Risk Assessment (UC Davis, 2005) was completed. The risk evaluation update and resultant preliminary cleanup levels will be presented in an upcoming LEHR Team meeting and will be included as an appendix to the FS.
- No methane was detected in soil gas from any of the DUs; and based on these results, no additional methane evaluation is warranted.

1 CHROMIUM INVESTIGATION

1.1 Background and Introduction

This section (Section 1) of the report presents the results for the Data Gaps investigations focused on elevated hexavalent chromium [Cr(VI)] that were conducted to provide data needed to complete the Feasibility Study (FS) for the University of California Davis (UC Davis) areas of responsibility at the Laboratory for Energy-Related Health Research / South Campus Disposal Site (LEHR/SCDS or the Site). Cr(VI) has been identified as a constituent of concern (COC) in groundwater and therefore must be addressed in the FS. The primary purpose of the Data Gaps investigations related to Cr(VI) was to provide data to support the development of a site conceptual model to describe the likely source and nature of above-background Cr(VI) occurrence at the Site. In addition, the Data Gaps investigations were designed to provide better definition of the Cr(VI) distribution in hydrostratigraphic unit 1 (HSU-1) and HSU-2 at and near the Site, and to gain a better understanding of chromium (Cr) fate and transport in the subsurface. This enhanced understanding of Cr(VI) was needed in order to develop possible remediation strategies in the FS.

This sub-section (Section 1.1) provides a general overview of Cr geochemistry, a brief background on known Site Cr(VI) conditions prior to the Data Gaps investigations, and a summary of the Data Gaps Cr(VI) tasks, purpose and scope, as defined in the *Feasibility Study Data Gaps Work Plan* (Weiss, 2008a) and modified during implementation. Section 1.2 presents the Data Gaps Cr(VI)-related results, and evaluations and interpretations based on these results and previous data. Section 1.3 presents conclusions based on the results and data evaluation, and discusses how this information will be used in the FS.

1.1.1 Chromium Environmental Geochemistry

While the average concentration of Cr in the earth's crust is approximately 100 milligrams per kilogram (mg/kg) (Nriagu et al., 1988), low silica, igneous and metaigneous (ultramafic) rocks, such as the serpentinite source material for alluvial material underlying the Site, have much higher Cr concentrations, averaging approximately 2,400 mg/kg. Previous project reports have discussed the Coast Range serpentinite source material present in Putah Creek deposits in the vicinity of the Site (e.g., *Groundwater Source Investigation and Data Evaluation Report*, Dames & Moore, 1999). A recent regional soil and sediment geochemical study that included the UC Davis area was conducted by the United States Geological Survey (USGS), in which over 1300 archival soil samples were analyzed for 42 elements (Goldhaber et al., 2009). The 20,000 square kilometer area of northern California used for this regional-scale study was chosen because soils in the area contain elevated

amounts of Cr and nickel in relation to average content of soils from the conterminous US. This study demonstrates that a mixture of alluvium from ultramafic sources of the Coast Ranges and the Great Valley Group, which is itself enriched in mafic minerals, dominates the sediments contributed to the Cache and Putah Creek alluvial plains of the western Sacramento Valley, including where the Site is located (Goldhaber et al., 2009). The study found that the elements, magnesium, Cr, cobalt, nickel, and vanadium are especially enriched on the west side of the Sacramento Valley and have affinities to mafic or ultramafic rock types. Cr found in most minerals, such as chromite ($[Fe,Mg]Cr_2O_4$) and as a cation substitute in other minerals, generally occurs in its trivalent form (Nriagu et al., 1988). Anthropogenic sources of Cr can be in either the trivalent or hexavalent form.

Once in the aqueous environment, the geochemistry of Cr is quite complex due to its two common stable oxidation states, the cation trivalent chromium [Cr(III)] and the oxyanion Cr(VI) as chromate [CrO_4^{-2}] or hydrochromate [$HCrO_4^-$], which have greatly different toxicity and transport characteristics. While Cr(III) is the predominant form in reducing to moderately oxidizing waters, it generally does not enter solution because it is strongly sorbed on mineral surfaces (Guertin et al., 2005). However, experiments by Oze et al., 2007, have demonstrated that although chromite is considered geochemically inert, accelerated dissolution of chromite and subsequent oxidation of Cr(III) to aqueous Cr(VI) is feasible in the presence of manganese minerals. The solubility and dissolution rates of the Cr(III) host minerals, the solution pH and the accessibility of aqueous Cr(III) to mixed valences Mn(IV/III) oxides in ultramafic rocks thereby control the rates of the aqueous Cr(VI) production. Additionally, the aqueous concentrations of Cr(VI) derived from these ultramafic and serpentinite materials are dependent on the mass balance between average rates of production and consumption. The consumption of Cr(VI) and production of Cr(III) is primarily linked to activities of microorganisms and to sorption of Cr(VI) onto trivalent iron and aluminum oxides (Oze et al., 2007).

Non-chelated aqueous Cr(III) can be quickly oxidized to Cr(VI) by manganese oxides, however, the fate of organically chelated Cr(III) is yet not fully understood. Many organic compounds in the soil environment can chelate Cr and maintain it in soluble forms. Studies have shown that Cr(III) can be chelated by low to moderate molecular weight organic compounds such as fulvic and citric acids, and thus remain stable and soluble in solution at higher pH than unbound Cr(III). This soluble, organically bound Cr(III) may subsequently oxidize to Cr(VI) since it is mobile enough to come in contact with immobile manganese oxide surfaces (United States Environmental Protection Agency [US EPA], 2000; Bartlett, 1991), which are common in deposits derived from ultramafic rocks. However, these complexes form slowly, and once formed are difficult to break (Hossner et al., 1998). In addition, Cr(III) is in competition with other cations, notably Fe(III), for the chelate. Fe(III) chelation could greatly limit the extent of Cr(III) chelation due to the much greater quantity of Fe(III) relative to Cr(III) within the soil. It is therefore not well understood if organically chelated Cr(III) is a major source of Cr(VI).

The oxidation of Cr(III) by manganese oxide, which serves as the electron acceptor, occurs in aerobic but not in anaerobic sediments. Oxidation of Cr(III) by dissolved oxygen (DO) is possible but insignificant when compared with manganese oxide, which is the primary oxidant of Cr(III) in natural systems (Schroeder and Lee, 1975; Izbicki et al., 2008; Oze et al., 2007). Although manganese oxides are typically small and in low-abundance, their chemical influence on the soil

system is significant due to their dynamic redox behavior and surface characteristics (i.e., high negative surface charge, large surface area, low crystallinity) (Negra et al., 2005). Manganese oxides are powerful oxidizers and substantial evidence exists that manganese abundance is positively correlated to Cr being oxidized in soils. However, despite the fact that manganese oxides have been extensively studied, significant gaps in knowledge of the manganese distribution in bulk soil exist (UC Davis, 2003; Negra et al., 2005). Manganese oxides/hydroxides are largely present in the fine-grained fraction of the soil, and are present as dispersed particles or small nodules and poorly crystalline masses or soil coatings. Their unusually high adsorption and scavenging capacities provide one of the major controls of trace metals in soil systems (UC Davis, 2003).

Recent experiments indicate that serpentinite-bearing soils (such as those at LEHR) containing a common manganese oxide mineral (suspected to be present at LEHR based on source rock, soil manganese concentrations, Site redox conditions, and abundant black minerals reported in boring logs) and at pH/Eh conditions similar to those at LEHR/SCDS (i.e., circum-neutral pH and high Eh, or oxidation-reduction potential [ORP]) can generate Cr(VI) at such a rate that pore water concentrations exceed 50 micrograms per liter (µg/L) in 100 days (Oze et al., 2007). While Cr(VI) is typically sorbed by iron oxides at acidic and near neutral pH, it is not strongly sorbed at higher pH (Izbicki et al., 2008). Other factors affecting the degree to which Cr(VI) is present in groundwater, rather than being sorbed to oxides, include its ionic strength (Izbicki et al., 2008) and the presence of "competing" anions such as sulfate, phosphate, or nitrate (Guertin et al., 2005). In Western Australia, naturally high Cr(VI) has been shown to correlate directly with the presence of ultramafic rocks regardless of water pH, with groundwater concentrations as high as 430 µg/L reported (Gray, 2003). Dissolved Cr(VI) concentrations as high as 700 µg/L in pore-water have been reported for soils derived from ultramafic rocks in New Caledonia (Oze et al., 2007). These soils had been amended with phosphate as a nutrient, which displaced Cr(VI) from mineral surfaces and contributed to the highest reported natural Cr(VI) concentrations (Oze et al., 2007). In the Mojave Desert, higher Cr(VI) concentrations have been correlated with higher sulfate concentrations associated with animal wastes (Izbicki et al., 2008).

Reduction of Cr(VI) to Cr(III) occurs through both biotic and abiotic processes in the presence of organic material and other reducing agents (Izbicki et al., 2008). Reduced Cr(III) rapidly precipitates (as a chromium or chromium-ferric hydroxide) or adsorbs on existing minerals, thus being removed from solution. Cr(VI) can be reduced to immobile Cr(III) in the subsurface by redox transformations that depend on pH, oxygen concentration, nitrate concentration, presence of naturally existing reductants, and ligands. It has been thought that reductions of Cr(VI) to Cr(III) can occur in soils of normal pH and redox conditions; however, investigations have shown that reduction of Cr(VI) in soil under normal pH is not very rapid under aerobic conditions (Guertin et al., 2005). Soil organic matter and the associated microbial communities present, have been shown to be complex and central to the environmental fate of Cr(VI). It has been suggested that Cr(VI) reduction under anaerobic conditions transpires mainly from iron-reducing bacteria feeding on organic matter and linking this to Fe(III) reduction. A product of the reaction is microbially-generated Fe(II), which then acts as a facile reductant of Cr(VI) (Guertin et al., 2005). Recently it has been suggested that Cr(VI) reduction may also be limited by the presence of nitrate, which provides a more thermodynamically favorable electron acceptor (USGS, 2008; Izbicki et al., in press). Especially in sandy soils and soils that have low organic content, chromate can be relatively stable and highly

mobile (Guertin et al., 2005). Studies demonstrate that the aqueous phase contributes less than one percent of the oxidation and reduction capacities of aquifer systems, while the solid matrix contributes the remaining fraction. Thus, any discussion of Cr(VI) reduction or Cr(III) oxidation in the subsurface must focus on the solid matrix (Barcelona and Helom, 1991; UC Davis, 2003).

1.1.2 Pre-Data Gaps Understanding of Chromium at the Site

Several investigations focused on the elevated Cr(VI) in HSU-1 at LEHR/SCDS had been conducted prior to the Data Gaps investigation (UC Davis, 2003; Brown and Caldwell, 2008a). As presented in the work plan (Weiss, 2008a), the pre-Data Gaps understanding of conditions and outstanding questions related to Cr(VI) were:

(1) Site conditions had been shown to be favorable for naturally-occurring Cr(VI) in groundwater. Soil at the Site is partly derived from ultramafic rocks of the Coast Ranges and is naturally high in Cr (up to 306 mg/kg measured in background samples) and manganese oxides needed to oxidize Cr. Site groundwater conditions are oxic so that Cr(VI) tends to persist in groundwater once it is formed.

(2) Site had been shown to be in an area where natural Cr(VI) is known to occur in groundwater. USGS reports that groundwater with 30 to 50 µg/L Cr is not uncommon in the area (USGS, 2006). Supply wells south of Putah Creek in an area not impacted by the Site have reported Cr concentrations as high as 180 µg/L.

(3) Neither anthropogenic sources of Cr nor Cr(VI)-enhancing geochemical changes had been identified through environmental investigations as impacting Site soil or groundwater, and the cause of the elevated Cr in HSU-1 groundwater remained unclear. Several proposed hypotheses remained unproven.

(4) Elevated (i.e., greater than 50 µg/L) Cr in HSU-1 groundwater occurs most notably in an "anomalous Cr area" near well UCD1-28, where concentrations have been stable above 400 ug/L for over ten years.

(5) Defined lateral extent of elevated Cr in HSU-1, although adequate, needed some improvement. In addition, the "background" Cr(VI) level in HSU-1 in the area has not been defined.

(6) HSU-2 Cr concentrations in LEHR/SCDS are generally less than 70 µg/L and were not believed to significantly impact HSU-2 above the regional "background" level, although this level has not been established. Additional characterization data were needed to confirm whether significant impacts from the Site are occurring now, or if they could occur in the future.

1.1.3 Chromium Tasks, Purpose and Scope

The following summarizes the Cr tasks proposed in the Work Plan and describes each task's intended purpose. Section 1.1.4 below and Table 1-1 summarize the scope of work for each of the tasks, and discuss variances from the proposed work and the reasons for these variances. Figure 1-1 shows all the Data Gaps sampling locations for the Cr tasks.

Task Cr1: Records Review and Analysis. The purpose of this task was to review available data and information in light of potential Cr(VI) source mechanisms to help determine specific sampling locations and the analytic plan for the detailed Cr evaluation (Task Cr3). Much of Task Cr1 was completed during preparation and finalization of the Work Plan.

Task Cr2: Leak-testing, Pumping and Sampling of UCD2-27 Well "Cluster". The plan was to rehabilitate and re-sample this multi-port well so as to obtain reliable depth-discrete HSU-1 and HSU-2 groundwater Cr and related geochemical data, which may have been useful in understanding the Cr(VI) source mechanism and transport between HSU-1 and HSU-2. However, as described in Section 1.1.4, this task was not completed due to the well conditions.

Task Cr3: Discrete Interval Soil and Groundwater Geochemical Sampling. The purpose of this task was to provide data for comparing vadose zone and HSU-1 soil lithology and soil/groundwater geochemistry in background and Cr anomaly area locations for insight into Cr(VI) source and for use in evaluating potential remedial alternatives.

Task Cr4: Chromium HSU-1 Hydropunch Investigation. This purpose of this task was to better delineate the extent of elevated HSU-1 groundwater Cr to guide the locations of new wells (Task Cr5).

Task Cr5: New Well Installation. The purpose of this task was to provide additional long-term monitoring wells for tracking the Cr groundwater plumes in HSU-1 and HSU-2. These wells also help define the HSU-1 and HSU-2 chloroform plumes, and one of the wells also serves as a new downgradient monitoring well for Landfill Unit (LFU) 1 (see Section 2.2).

Task Cr6: Well Water Geochemical Analysis. The purpose of this task was to provide comprehensive, contemporaneous geochemical data for the new and selected existing wells that could provide insight into the Cr(VI) source and distribution, as well as providing data for evaluating remedial options.

Task Cr7: Data Evaluation. The purpose of this task was to incorporate the new Data Gaps data with the existing Site data to assess: 1) the source of elevated Cr in groundwater; 2) the extent and temporal evolution of elevated Cr in HSU-1; 3) the impact of elevated Cr in HSU-1 on HSU-2; and, 4) the future fate of elevated Cr in groundwater, with or without remediation.

1.1.4 Chromium Data Gaps Investigation Activities

Sample locations for the Cr Data Gaps field work are shown on Figure 1-1. With the exception of the four quarters of Cr monitoring of groundwater wells, the Cr Data Gaps field work was conducted in late September and early October 2008. The quarterly sampling events were conducted in early October 2008 (summer event), early December 2008 (fall), February 2009 (winter), and May 2009 (spring). To the extent possible, the Data Gaps sampling events were conducted to coincide with the quarterly schedule already established for the routine site-wide groundwater monitoring program. These routine events were scheduled to occur in August and

November of 2008 and February and May of 2009. The only significant deviation from this schedule was for the August (summer) event, which was delayed until early October because installation and development of the new Data Gaps monitoring wells was not completed until that time. Because the rainy season had not begun and the water levels were significantly lower during the October event than during the previous and subsequent events, the results for this event are considered representative of summer conditions and this delay has no significant effect on achieving DQOs. The fall (December) event was only delayed a few weeks from the planned monitoring schedule and the February (winter) and May (spring) events were conducted according to schedule. With a few minor exceptions (Table 1-1), the field and laboratory activities for the Cr Data Gaps tasks were conducted in accordance with the *Feasibility Study Data Gaps Work Plan* (Weiss, 2008a), including compliance with the *Project Health and Safety Plan* (HSP) (Weiss, 2008b), and the *Quality Assurance Project Plan* (QAPP) (Dames & Moore, 1998, as revised by Weiss, 2008c). Table 1-1 summarizes the work as it was proposed in the Work Plan, and describes all deviations from the proposed work and the rationale for these changes. None of these changes has a significant impact on meeting the Cr investigation data quality objectives (DQOs) that were presented in the Work Plan (Weiss, 2008a).

1.2 Chromium Investigation Results

1.2.1 Summary of Data Evaluated

The following summarizes the information and data that were considered as part of the Data Gaps evaluation to better understand Cr(VI) source, distribution, fate, and transport:

Site and Surrounding Area Use Information: The Remedial Investigation (RI) report (UC Davis, 2004) and other previous investigation reports; historical aerial photographs; historical topographic maps; other historical maps and drawings; University archive documents on landfill and old wastewater treatment system; first-person anecdotal information; information on land use at other sites with elevated groundwater Cr(VI).

Hydrogeologic/geologic information: RI and other previous investigation reports; boring logs for previous and Data Gaps boreholes (Appendix A); pump test results; HSU-1 and HSU-2 historical groundwater elevation contour maps; water level versus time plots for individual wells; drawdown during well purging records; downhole magnetic susceptibility, gamma and conductivity logging of selected Site wells; hydrogeologic/geologic information for other sites with elevated groundwater Cr(VI).

Geochemical information: RI and other previous investigation reports, including two specifically focused on Cr(VI) (UC Davis, 2003, UC Davis, 2004, Geomatrix, 2005, and Brown and Caldwell, 2008a); previous and Data Gaps chromium, other metals, cation/anion, pH, ORP, and other geochemical data for soil and groundwater; results of previous and Data Gaps laboratory extraction

tests performed by PRIMA Environmental (Appendix B) and Chung et al. (2001); stable Cr isotope data for two Site wells; geochemical data for other sites with elevated groundwater Cr(VI).

1.2.2 Chromium Distribution in Groundwater

This section presents the current understanding of Cr distribution in HSU-1 and HSU-2 groundwater and its variability over time. Interpretation of what these data may mean in terms of source mechanism and fate and transport is presented in subsequent sections.

Past groundwater analyses at the Site indicated that the Cr in groundwater is essentially all in the Cr(VI) form, and the Data Gaps investigations have corroborated this. As shown on Table 1-3, Cr and Cr(VI) results are very similar for those samples analyzed for both, with the Cr(VI) concentration ranging from 85% to 140% of the Cr concentration. Given analytical uncertainty, these results can be considered essentially equivalent; therefore all discussions of Cr in groundwater can also be considered discussions of Cr(VI) in groundwater.

1.2.2.1 HSU-1 Groundwater

The distribution of Cr in HSU-1 groundwater based on recent monitoring well data, November 2007 hydropunch data, and Data Gaps hydropunch data collected in September 2008 is depicted on Figure 1-2, and Cr data for the selected wells sampled quarterly for the Data Gaps investigation are shown on Table 1-2. As shown, Cr in groundwater is highest in the vicinity of well UCD1-28, where concentrations exceed 400 µg/L in wells UCD1-028 and UCD1-053, and were 530 µg/L in Data Gaps hydropunch sample HSCr-2 (706 µg/L was reported for 2007 hydropunch sample, HPCr-11, at this same location). Cr concentrations appear to decrease in all directions from this area, with a gentler concentration gradient decrease to the southwest and north/northeast, and a much steeper gradient decrease to the east/southeast to values below 50 µg/L. A “background” concentration for Cr(VI) in groundwater in the area has not been defined; however, UC Davis is currently working towards establishing one in response to a Central Valley Regional Water Quality Control Board (CVRWQCB) request (CVRWQCB, 2009).

Cr concentrations over time in HSU-1 wells are presented on Figures 1-3 and 1-4. As shown on these figures, HSU-1 Cr concentrations have generally declined since the early 1990s. The most notable decreases have occurred in the well UCD1-25 Cr concentration, which has decreased steadily from approximately 400 µg/L in the mid-90s to approximately 75 µg/L in recent samples; the well UCD1-11 Cr concentration, which decreased from over 300 µg/L in the early 1990s to approximately 150 µg/L, where it has remained since 2003; and the well UCD1-12 Cr concentration, which decreased from approximately 250 µg/L in the early 90s to approximately 100 µg/L in 2001 and then increased slightly to approximately 120 to 140 µg/L, where it has remained since 2003. As shown on Figures 1-3 and 1-4, Cr concentrations in other HSU-1 wells have shown less dramatic decreases or have remained relatively stable over time. As shown on Figure 1-4, many of the lower Cr concentration wells showed significantly higher and more variable Cr concentrations prior to 1994. This may indicate actual variability in Cr concentrations in these wells during this time, or may reflect the less rigorous sampling/analysis protocols used during this early phase of the project. A

review of the UC Davis LEHR/SCDS chemical database did not indicate any recorded differences in sampling or analytic methods that would explain the variability.

There is no apparent link between groundwater levels or flow and the long-term decreasing concentration Cr trends observed in HSU-1 wells. Graphs showing water levels and Cr concentrations over time for HSU-1 wells are included on the CD in Appendix F. While water levels reached lower elevations and measured Cr concentrations were higher in the early 1990s than they have been since, sampling and analytic documentation is less reliable for this timeframe and this potential correlation is not confirmed by data collected since the early 1990s. Variability over time in the direction and magnitude of both the horizontal and vertical HSU-1 groundwater gradients was also compared with Cr concentration and no apparent correlations were noted. Wells UCD1-11 and UCD1-12 are located immediately downgradient of UC Davis DUs, and the significantly decreasing trend observed in these wells may reflect the natural depletion of whatever had caused the elevated Cr concentrations in those wells (see Section 1.3 for discussion of potential mechanisms).

The more dramatic and ongoing decrease in Cr concentration in downgradient well UCD1-25 may reflect a combination of depletion of upgradient "source" and localized reducing effects of nearby well UCD1-27. Unlike the decreasing Cr trends in other HSU-1 wells, the decrease in well UCD1-25 Cr concentration has been accompanied by an increase in total organic carbon (TOC) and Mn concentrations. As described in the *Data Gaps Work Plan* (Weiss, 2008a), nearby well UCD1-27 is a multi-port monitoring well with three discrete, two-foot long screened intervals in HSU-1 (and four discrete intervals in HSU-2). Monitoring results for these HSU-1 intervals have been consistently anomalous, with very low Cr and significant Mn groundwater concentrations, suggesting locally reducing conditions. Although no direct measurements of redox conditions (e.g., ORP or DO) are available, low nitrate concentrations and decreasing sulfate concentrations in well UCD1-027Z1 might indicate slightly reducing conditions. Nitrate concentrations in this particular interval Z1 averaged 3.8 mg/L from 2002 to 2006, while sulfate concentrations decreased from 115 mg/L to 26.2 mg/L over the same time period. Additionally, the detection of significant concentrations of dissolved Mn (average of 1,565 µg/L; 2002-2006) and dissolved nickel (average of 1,214 µg/L; 2002-2006) suggests that oxide minerals are being reduced. Although not all of the planned Data Gaps work on well UCD1-27 could be completed (see Table 1-1), it was confirmed that the well sampling and purge ports are not leaking, and therefore that the samples collected from these ports have been formation water and not stagnant casing water. This, in combination with the data discussed above and trends observed in well UCD1-25, suggest that locally reducing conditions occur in the well UCD1-27 HSU-1 zones and that these conditions are increasingly affecting well UCD1-25, located less than 20 ft away. Average TOC concentrations of 8.9 mg/L (2002-2006) were detected in well UCD1-027Z, which could foster these reductions by providing energy and carbon to microorganisms. These microorganisms can then use nitrate or oxide minerals, such as manganese oxides, as electron acceptors, thereby creating reducing conditions. The cause of these reducing conditions is unknown, although it is recorded that bentonite with a biodegradable coating was used to seal off the discrete monitoring zones and this may be the cause. These results are of interest for the FS because they suggest that slightly reducing conditions that remove Cr(VI) from groundwater can be at least locally created and sustained in HSU-1 at the Site.

1.2.2.2 HSU-2 Groundwater

The distribution of Cr in HSU-2 based on recent groundwater monitoring data is shown on Figure 1-5, and Cr data for the selected wells sampled quarterly for the Data Gaps investigation are shown on Table 1-2. As with HSU-1, UC Davis is currently working to define a "background" level for Cr(VI) in area HSU-2 groundwater (CVRWQCB, 2009). Site HSU-2 groundwater Cr concentrations are generally below 50 µg/L and comparable to offsite, presumably background well concentrations. Exceptions exceeding 50 µg/L are three wells east/northeast of the Site, including new Data Gaps well UCD2-59 located approximately 1700 ft east/northeast of the Site; well UCD2-46 located approximately 3500 ft northeast of the Site (Figure 1-5), both of which have approximately 60 µg/L Cr in groundwater; and well UCD2-56 located approximately 800 ft north of the northeastern corner of the Site (Figure 1-5), which has Cr reported at approximately 80 to 90 µg/L. Unlike most other "UCD2" wells, which either fully penetrate HSU-2 or are screened across the highly permeable HSU-2 gravels, well UCD2-56 is screened only in the upper 10 ft of HSU-2 sand, which may explain the somewhat anomalously high Cr concentrations reported for this well.

As discussed in the next section, many HSU-2 wells have had somewhat variable Cr concentrations over time, and some of these variations correlate with seasonal water level changes. However, with the exception of three monitoring wells near the HSU-2 groundwater extraction well that are showing an increasing Cr concentration trend (discussed in more detail in the next section), HSU-2 wells do not show any clear long-term concentration trends.

1.2.2.3 Potential Impact of Chromium in HSU-1 on HSU-2 Groundwater

While there is no direct correlation between the Cr concentrations reported for HSU-1 wells and nearby HSU-2 wells, Cr in HSU-1 appears to have some influence on HSU-2 concentrations based on:

1. Increases in Cr concentration observed since 2006 for the HSU-2 groundwater extraction system and the three monitoring wells located close to the extraction well (i.e., wells UCD2-29, UCD2-30, and UCD2-31) suggest that HSU-1 groundwater from the elevated Cr area overlying these HSU-2 wells is being drawn downward into HSU-2.

2. Generally higher HSU-2 Cr concentrations at and to the east (downgradient) of higher Cr concentrations in HSU-1 suggest that HSU-1 Cr may be impacting HSU-2.

3. Many HSU-2 wells have shown seasonal variations in Cr concentration that correlate with water level changes, with higher Cr concentrations observed during periods of lower water level (Geomatrix, 2005). These wells are located in areas where the Cr concentrations in the overlying HSU-1 are significantly higher than those in HSU-2 (see graphs in Appendix F), suggesting increased Cr transport from HSU-1 into HSU-2 may occur when water levels are dropping and downward vertical gradients are present.

The groundwater modeling effort that is currently underway (UC Davis, 2009a) will significantly enhance the understanding of groundwater flow and Cr(VI) mass flux in and between HSU-1 and HSU-2. Results of this modeling will be presented in an appendix to the FS.

1.2.2.4 Regional and Other Sites

As part of the Data Gaps investigations, available Cr data for other sites were considered. Data for studied sites not in the immediate vicinity of the LEHR/SCDS site are referred to in Section 1.1.1. Cr data for the immediate Site vicinity that were reviewed included data for wells on the neighboring supply well monitoring program. Based on well construction information, which is available for only some of the wells, these supply wells primarily tap high-producing zones below HSU-2, with typical screened interval depths between 100 and 300 feet below ground surface (ft bgs). As shown on Figure 1-6, available groundwater Cr data from these agricultural and domestic water supply wells in the immediate vicinity of the Site show concentrations ranging from as low as three µg/L in former well 22N immediately downgradient of the Site to as high as 180 µg/L in well CMDW located approximately a mile crossgradient from the Site and south of Putah Creek. The elevated Cr concentrations detected in well CMDW and several others south of Putah Creek indicate that elevated groundwater Cr is present in other nearby areas that are not impacted by Site activities. Therefore, it appears that whatever has caused the elevated Cr at the Site may also be causing elevated Cr in other nearby areas.

1.2.3 Evaluation of Potential Site Use History Effects on Cr(VI) Distribution

Potential Site activities that could affect Cr(VI) distribution in groundwater fall under three categories: 1) activities that added Cr(VI) or total Cr to the subsurface; 2) activities that introduced oxidants that directly converted Cr(III) in the subsurface to Cr(VI); and, 3) activities that either enhanced the mobility of Cr(VI) or enhanced the mobility of Cr(III) and/or Mn-oxides such that these were brought into proximity of one another thereby enhancing the oxidation of Cr(III) to Cr(VI).

Historical Site activities that could have potentially added Cr to the system include disposal of chromic acid or other Cr(VI) containing chemical either in one of the DUs or elsewhere at the Site. No records or evidence of Cr(VI) use or disposal were located; however, chromic acid may have been used for cooling towers, cleaning laboratory glassware, or other purposes at UC Davis, with the waste ending up in the DUs at the Site, either as waste chemical or within wastewater sludge. Any Cr(VI) that ended up in wastewater and subsequently in wastewater sludge would have almost certainly been reduced to Cr(III). Other potential anthropogenic sources of Cr(III) that may have been disposed of in the DUs include paint pigments, fertilizer, and chrome-plated metal. Little evidence of metal debris and no evidence of paint or fertilizer were reported in the investigatory trench logs for the Site DUs.

There is no evidence and it is unlikely that oxidants (e.g., permanganates or peroxides) were disposed of at the DUs in any significant quantity, so direct enhanced oxidation of Cr(III) is unlikely. On the other hand, there are several known or potential historical Site activities that could have

enhanced the mobility of Cr(VI), or enhanced the mobility of Cr(III) and/or Mn-oxides to result in increased oxidation to Cr(VI). These are discussed further in Section 1.3.1 and include:

- Wastewater sludge and other organic waste disposed of in DUs or elsewhere at the Site, which could generate reducing conditions that result in manganese mobilization, with downgradient re-oxidation and concomitant oxidation of Cr(III) to Cr(VI).
- Organic waste disposed of in DUs or elsewhere at the Site that generates ligands that could complex with Cr(III) thereby mobilizing it and bringing it into contact with Mn-oxides for potential oxidation to Cr(VI).
- Animal waste, fertilizer, or wastewater sludge, which could: a) provide phosphate and/or sulfate that could act as competing anions to displace any Cr(VI) sorbed to oxides or clays; and/or b) provide nitrate that could limit Cr(VI) reduction by providing a more thermodynamically-favorable electron acceptor.

1.2.4 Evaluation of Potential Geologic/Hydrogeologic Effects on Cr(VI) Distribution

One hypothesis for the source of elevated Cr(VI) in Site groundwater is that it is entirely naturally-occurring, and that the variability in concentration is due to geologic and/or hydrogeologic variability. Geologic factors that could potentially result in variability in groundwater Cr(VI) include variability in the amount, distribution, and type of Cr-containing minerals; variability in the amount, distribution, and type of the manganese oxides that are known to oxidize the Cr; variability in the amount, distribution, and type of iron oxides to which Cr(VI) may bind; and variability in the amount of organic matter, which could affect metals oxidation state and hence metals mobility. Hydrogeologic factors that could potentially result in variability in groundwater Cr(VI) include variability in fresh water recharge, hydraulic conductivity, hydraulic gradients, and/or effective porosity, which could affect groundwater residence time, which could in turn potentially have an impact on Cr concentration variability.

The evaluation of potential geologic influences on Cr(VI) distribution included: 1) continuous logging of two boreholes in the area of elevated Cr (borings HSCr-1 and HSCr-2) and two boreholes in “background” areas (borings BGCr-1 and BGCr-2) through HSU-1 and into the top of HSU-2 (Appendix A), with particular attention to evidence of manganese oxides (black or brown-black staining and specks) and iron oxides (rust-colored staining and specks); 2) review of existing boring logs and cross sections for evidence of manganese oxides, iron oxide, natural organic matter, and any other geologic differences in HSU-1 that might affect Cr distribution; and 3) review of USGS magnetic susceptibility logs, which provide an indication of the amount of magnetite present, which is a mineral often rich in chromium. None of these provided evidence that the variability in Cr distribution is due to geologic variability. Evidence of manganese oxides and iron oxides was reported commonly in HSU-1 deposits throughout the Site, regardless of Cr groundwater concentration. Although conclusive field identification of Mn oxides is difficult, most Mn oxide minerals are brown-black and typically occur as intimately intermixed, fine-grained, poorly

crystalline masses or coatings (Post, 1999). Therefore, the black staining and specks observed in the soil core were assumed to be Mn oxides. Similarly, iron oxides typically have a distinctive rust color, therefore the rust-colored staining and specks were assumed to be iron oxides. Although no X-ray diffraction or similar analyses were performed specifically on the presumed Mn/Fe minerals, the high concentrations of easily reducible Mn in soil from background and hotspot locations (see Section 1.2.5 below) indicate that these soils contain significant Mn oxides. Consistent with the field observations, no statistical difference between the Mn oxide concentrations in the hotspot and in the background locations was identified (Section 1.2.5). Little evidence of natural organic matter was reported in any boring. Although there may be a correlation between magnetic susceptibility and total Cr in soil, the amount of total Cr in soil does not correlated with the Cr(VI) concentration in groundwater (see Section 1.2.5).

The evaluation of potential hydrogeologic influences on Cr(VI) included: 1) comparison of HSU-1 soil types and estimated permeabilities based on previous and Data Gaps boring logs; 2) comparison of previous HSU-1 well slug test results and drawdown during well purging; 3) review of historical HSU-1 groundwater elevation contour maps; and, 4) review of water levels over time and HSU-1/HSU-2 vertical gradient over time. None of these data indicated potential variabilities that could explain the Cr(VI) distribution. Variability in HSU-1 hydraulic conductivity based on soil types and available aquifer test results does not correlate with Cr(VI) variability. Previous investigations (State Water Resources Control Board, 1996) indicate that Putah Creek provides significant recharge to both HSU-1 and HSU-2, and Putah Creek water is more reducing than HSU-1 groundwater and contains only trace concentrations (averaging about 3 µg/L) of Cr(VI). The hydraulic gradient in HSU-1 adjacent to the creek generally falls between approximately 0.001 to 0.01 ft/ft, while it is essentially flat in the elevated Cr area around well UCD1-28, so the HSU-1 apparently has a longer residence time in the UCD1-28 area. Based on this, it is not surprising that the wells closest to Putah Creek have low Cr(VI) levels. However, proximity to Putah Creek alone cannot explain the Cr(VI) distribution in HSU-1 groundwater across the Site, since there are areas of significantly lower Cr(VI) concentrations at greater distances from Putah Creek than the well UCD1-28 area where the highest Cr(VI) concentrations are detected.

While there do appear to be some correlations between water levels and Cr concentrations in both HSU-1 and HSU-2 wells, these correlations are not consistent and do not appear to explain the overall distribution of Cr(VI) in HSU-1. As mentioned in Section 1.2.2.3 above, many HSU-2 wells have shown some correlation between seasonal water level changes and chromium concentration, with lower water levels correlating with higher Cr concentrations. HSU-1 wells UCD1-13, UCD1-19, and UCD1-20 also show evidence of higher Cr concentrations with seasonally lower water levels. However, longer-term water level trends do not appear to have had a predictable effect on Cr concentrations.

1.2.5 Evaluation of Potential Soil Geochemistry Effects on Cr(VI) Distribution

In order to evaluate whether local soil geochemistry could be affecting groundwater Cr(VI) distribution at the Site, the Data Gaps investigations included detailed soil logging and sampling from two off-site background borings (BGCr-1 and BGCr-2) and two onsite Cr anomaly area borings (HSCr-1 and HSCr-2) at locations shown on Figure 1-1. While these boring locations were selected

based on all available data to best represent background and the Cr anomaly areas, they may not fully represent the geochemical variability associated with these areas due to the limited number of samples collected. Soil samples from these borings were analyzed for a variety of parameters to determine if there are any clear correlations between soil geochemistry and groundwater Cr, and to assess whether Cr(VI) could be generated or leached from the serpentinite-bearing soils underlying the Site. The analytical data for these soil samples are presented in Tables 1-3 and 1-4, and methods used by PRIMA Environmental for bench testing are described in Appendix B. Although statistical analyses using the Student's T-test indicate some significant (i.e., $p < 0.05$) correlations as described below, no differences were found between "hot spot" and background soil samples that would explain the significantly higher Cr(VI) groundwater concentrations in the HSU-1 Cr anomaly area.

The Cr concentrations of the off-site, background samples are not statistically different from those of the onsite samples (*t*-test, $p = 0.26$). Total Cr concentrations in "hot spot" sample locations HSCr-1 and HSCr-2 range from 48 mg/kg to 150 mg/kg (mean = 95 mg/kg), while total Cr concentrations in background sample locations BGCr-1 and BGCr-2 range from 42 mg/kg to 230 mg/kg (mean = 113 mg/kg), within the range defined as "background" for the Site (Weiss, 2008a). Cr(VI) was not detected by alkaline digestion above the laboratory reporting limit of 0.05 mg/kg in any "hot spot" or background soil samples. This is not surprising, since sorption of Cr(VI) anions by soil surfaces is very low in alkaline (pH above eight) environments. The Data Gaps background soils and soils from the two Cr anomaly area locations had soil pH values commonly exceeding eight and soil OPRs greater than 200 millivolts (mV) (Table 1-3). Under these oxic and alkaline pH conditions, adsorption of Cr(VI) anions to oxide or oxyhydroxide surface minerals diminishes to nearly zero and Cr(VI) becomes freely mobile in both the vadose zone and saturated aquifers (Qafoku et al., 2009; Chung et al., 2001).

These results were generally confirmed by soil leaching tests using both deionized (DI) water and a phosphate buffer solution (Table 1-4). Results for the leaching tests with DI water are assumed to represent the Cr dissolved in pore water plus any Cr loosely bound to soil. These results ranged from below the reporting limit of 0.1 mg/kg (of soil plus pore water) to 0.24 mg/kg in Cr "hot spot" locations and from below the reporting limit of 0.1 mg/kg to 0.20 mg/kg in off-site background locations. Based on an estimated moisture content of 20% by weight (DB Stephens, 2008) and assuming all the Cr measured in the DI extracts was dissolved in pore water, these results would equate to pore water concentrations ranging from less than approximately 500 μg/L to approximately 1,200 μg/L, with significant uncertainty in these values given the detection limits and presence of Cr in the control samples (see Appendix B). The anionic phosphate solution is designed to displace chromate anions from soil into groundwater by directly competing for adsorption sites. Chromium was not detected in the extract above 0.1 mg/kg in most of the exchangeable Cr samples (Table 1-4), however, indicating the soils did not contain significant leachable Cr(VI).

As seen in the standard Cr oxidation test, "hot spot" and background soil samples also demonstrated the ability to oxidize dissolved Cr(III) to Cr(VI) (Table 1-4). Both soils were able to oxidize a significant amount of Cr(VI) from added Cr(III). The produced Cr(VI) concentrations in "hot spot" samples were not statistically different from Cr(VI) concentrations in background samples (*t*-test, $p = 0.88$). The Cr(VI) production in "hot spot" samples ranged from 0.1 mg/kg to 12.9 mg/kg (0.01 mg/L to 1.29 mg/L), and ranged from 1.9 mg/kg to 12.5 mg/kg (0.19 mg/L to 1.25 mg/L) in

background samples. These results indicate that significant amounts of Cr(VI) can be generated from the serpentine-rich soils, if native soluble Cr(III) is present in the aqueous phase. Based on these results, it also appears that "hot spot" and background soils from shallower depths (less than 40 ft bgs) are able to oxidize more Cr(III) than soils from deeper depths (Table 1-4).

The available amount of Cr(III) and possibly manganese that can be leached by low concentrations of organic chelating substances was determined by a leaching test with sodium citrate, one of the strongest Cr chelators persistent in natural systems. A significant difference (*t*-test, $p = 0.01$) in Cr concentrations was detected between "hot spot" samples (mean = 0.83 mg/kg) and background samples (mean = 0.38 mg/kg). The concentrations of dissolved and chelated Cr(III) in "hot spot" samples ranged from 0.14 mg/kg to 2.01 mg/kg (of the original soil plus pore water mass), while the Cr(III) concentrations in background samples ranged from 0.06 mg/kg to 0.86 mg/kg. This indicates that these soils contain some weakly bound Cr, which can be chelated and solubilized by organic ligands. This Cr is likely not Cr(VI), since it was not leached from test soils in the exchangeable Cr test. More likely, it is Cr(III) that binds more strongly to the chelating agent than to soil minerals. The Cr concentrations measured in this test were consistently higher in the "hot spot" soils than in the background soils, implying that the "hot spot" soils contain more weakly bound Cr than the background soils. As described above in Section 1.1.1, it has been speculated that Cr(III) in a complexed form may be mobile in groundwater and therefore brought into contact with Mn oxides and readily oxidized, although this has not been documented in the field (Guertin et al., 2005). It is therefore not well understood if organically chelated Cr(III) is a significant source of Cr(VI) at the Site.

As described in Section 1.1.1, Mn oxides play a key role in the natural oxidation of Cr. Comparison of the "hot spot" and background soils shows that concentrations of total manganese are not significantly different (*t*-test, $p = 0.77$). Total manganese concentrations in background soils range from 320 mg/kg to 1,100 mg/kg (mean = 559 mg/kg), while manganese concentrations in the "hot spot" soils range from 130 mg/kg to 1,900 mg/kg (mean = 600 mg/kg). The easily reducible manganese test, an aggressive method for measuring the amount of reducible manganese oxide compounds in the soils that may be available to oxidize Cr(III) to Cr(VI), indicated no significant difference (*t*-test, $p = 0.82$) between "hot spot" (mean = 228 mg/kg) and background (mean = 236 mg/kg) samples. This easily-reducible manganese oxide content is linearly related to the Cr(VI) generated during the standard Cr oxidation test for both the "hot spot" ($R^2 = 0.30$, $p = 0.035$) and the background ($R^2 = 0.42$, $p = 0.01$) locations. In addition, the available manganese that can be chelated by organic substances was also determined during the citrate leach test. As with the available Cr(III), a significant difference (*t*-test, $p = 0.03$) in available manganese concentrations was detected between "hot spot" samples (mean = 226 mg/kg) and background samples (mean = 151 mg/kg). This available manganese is linearly related to Cr(VI) generated during the standard Cr oxidation test for both the "hot spot" ($R^2 = 0.57$, $p = 0.001$) and the background ($R^2 = 0.27$, $p = 0.0049$) locations. It is not known, however, if manganese is solubilized and chelated as manganese oxides and if these manganese oxides still have the potential for oxidizing Cr(III) to Cr(VI).

Additionally, statistically significant differences ($p<0.05$) for boron, nitrate, sulfate, and phosphate concentrations in soils were found between the Data Gaps off-site background locations and the onsite Cr anomaly area locations, with the onsite area having the higher concentrations.

When comparing all available Site soil data for these analytes, a significant difference between background and onsite soil samples was only detected for boron ($p<0.001$), with the onsite samples having higher concentrations. Boron may be naturally occurring or anthropogenic, and the significance of this correlation, if any, is not known. The slightly higher nitrate, sulfate, and phosphate concentrations in the Cr anomaly area may reflect natural variation or the historical and ongoing presence of manure in this area. However, the differences are small (Table 1-3) and not significant in terms of the elevated Cr(VI) in groundwater in this area. Although these anions have been reported to compete with Cr(VI) for sorption sites on soil, thereby releasing the Cr(VI) to groundwater (see Section 1.1.1), very little if any Cr(VI) is present on Site soil as described above.

1.2.6 Evaluation of Potential Groundwater Geochemistry Effects on Cr(VI) Distribution

As part of the Data Gaps evaluations, the concentration distribution of geochemical parameters in groundwater at the Site was compared to Cr to determine if any significant correlations exist. In general, onsite groundwater is considered a magnesium bicarbonate type water with a neutral to alkaline pH (i.e., pH 6.5 to 8.1), high DO concentrations (i.e., 1 – 9 mg/L) and positive ORPs (ORP > 100 mV). As mentioned above, under these oxidizing and alkaline conditions, Cr(VI) is extensively hydrolyzed and therefore present as an anion, generally forming chromate and hydrogen chromate. A very strong correlation (R^2 = 0.99) between the dissolved Cr and Cr(VI) in hydropunch and monitoring well groundwater data demonstrates that virtually all of the Cr is in the hexavalent state. Adsorption of Cr(VI) anions to soil surfaces is therefore suppressed, resulting in increased mobility in the subsurface, especially in the presence of other competing anions such as sulfate, phosphate, or bicarbonate. However, no significant correlations between Cr and these competing anions have been found, suggesting that Cr(VI) is not significantly sorbed to soil mineral surfaces (see also Section 1.2.5). Dissolved or total organic carbon concentrations generally show no correlation with aqueous Cr, suggesting that the groundwater does not possess a sufficient capacity to reduce aqueous Cr(VI) concentrations. Similar concentrations of dissolved Cr and Cr(VI) also suggest that Cr(III) is not significantly complexed by organic matter.

Due to the oxidizing nature of HSU-1 and HSU-2, little or no Mn is detected in groundwater from most Site wells (Table 1-2) because only the reduced form, Mn(II), is significantly soluble. Surprisingly, several of the hydropunch samples collected from “hot spot” HSCr-1 and background locations BGCr-1 and BGCr-2 show significant dissolved Mn concentrations (up to 480 µg/L as shown in Table 1-2; the 17,000 µg/L Mn detected in BGCR-1-85 is considered unreliable based on the anomalously high concentrations of other constituents also detected in that sample). In general, the higher Mn concentrations correlate with lower Cr concentrations, as would be expected if this correlation is due to redox variations. This might indicate that subsurface conditions are slightly reducing at these discrete sampling depths at the bottom of HSU-1 and top of HSU-2 in some areas but not in others (e.g. not in the HSCr-2 location).

As with soil, the only significant correlation found in sitewide HSU-1 and HSU-2 groundwater is between boron and chromium. Groundwater data suggest that boron is linearly related to Cr in a plot of all HSU-1 wells (R^2 = 0.57, p < 0.001) and of all HSU-2 hydropunch and well groundwater samples (R^2 = 0.50, p = 0.01). The significance of this correlation is uncertain.

Chloride concentrations in HSU-1 and HSU-2 hydropunch groundwater samples from the Cr anomaly area are higher than in samples from the background locations. The chloride concentrations in hydropunch "hot spot" samples range from 44 mg/L to 82 mg/L, while background concentrations range from 11 mg/L to 21 mg/L. Similarly, sodium levels are slightly higher in these "hot spot" samples than in background samples, with concentrations ranging from 76,000 µg/L to 97,000 µg/L in the "hot spot" areas and 28,000 µg/L to 64,000 µg/L in the background areas (Table 1-2). However, no significant correlations between Cr and chloride, and Cr and sodium were detected in Sitewide HSU-1 and HSU-2 hydropunch and well groundwater. A very weak but statistically significant correlation in HSU-1 hydropunch and groundwater samples was detected for Cr and nitrate ($R^2 = 0.19$, $p = 0.018$). When Cr and nitrate concentrations in groundwater samples only from monitoring wells were compared, a more significant correlation ($R^2 = 0.37$, $p = 0.002$) was detected. This might indicate that the source(s) of Cr and nitrate are related, or that nitrate potentially interferes with the bacterially mediated reduction of Cr(VI) to Cr(III). No evidence of significant nitrate reduction has been observed at the Site, however, and some wells (i.e., UCD1-11, UCD1-19) have shown an increase in nitrate concentrations while Cr concentrations have declined. No significant correlation in HSU-2 hydropunch and groundwater samples was detected for Cr and nitrate.

1.3 Evaluation of Potential Chromium Source Mechanisms

1.3.1 Chromium Source Mechanism Screening

In the Data Gaps Work Plan (Weiss, 2008a), the following general categories of potential source mechanism were identified: anthropogenic Cr(VI); anthropogenic Cr(III) with anthropogenic oxidation and/or mobilization; anthropogenic Cr(III) with natural oxidation and/or mobilization; natural Cr(III) with anthropogenic oxidation and/or mobilization; natural Cr(III) with natural oxidation and/or mobilization; and, natural Cr(VI) mobilization. Based on the Data Gaps data and evaluations as summarized in Section 1.2 above, several of these general categories have been screened out as unlikely, while others have been further developed and refined, as follows:

- <u>Anthropogenic Cr(VI)</u>: This would be chromic acid or other Cr(VI) containing chemical that was either released from one of the DUs or elsewhere at the Site. As discussed in Section 1.2.3, no records of Cr(VI) use or disposal were located; however, chromic acid may have been used for cooling towers, cleaning laboratory glassware, or other purposes at UC Davis, with the waste ending up in the DUs at the Site, either as waste chemical or within wastewater sludge. Disposal in the UC Davis DUs of enough waste Cr(VI) chemicals to explain the elevated area in HSU-1 is considered highly unlikely, given what is known about the waste based on historical use records, trench logs, and soil/waste Cr analyses (see Section 1.2 and Weiss, 2008a). Any Cr(VI) that ended up in wastewater and subsequently in wastewater sludge almost certainly would have been reduced to Cr(III), and therefore would fall under one of the next two categories of potential release mechanism (i.e., anthropogenic Cr(III) that is subsequently re-oxidized). Release of wastewater Cr(VI) directly into the leach

fields associated with septic systems and wastewater treatment systems at the Site is considered unlikely because there is no record and low probability that significant quantities of chromic acid or other Cr(VI) chemical were used at the Site.

- Anthropogenic Cr(III)/ Anthropogenic oxidation and/or mobilization: Potential anthropogenic sources of Cr(III) that may have been disposed of in the DUs include paint pigments, fertilizer, and chrome-plated metal. As discussed in Section 1.2.3, these are considered unlikely to be the source of the elevated Cr(VI) in groundwater based on Site use history and investigation results. Reduced Cr in wastewater sludge (see above) is a more likely source of added Cr(III) in the DUs, although no evidence has been detected at the Site. In addition, even if Cr(III) was disposed of at the Site, anthropogenic oxidation of this Cr(III) is considered very unlikely, as discussed below.
- Anthropogenic Cr(III)/ Natural oxidation and/or mobilization: As stated above and discussed in Section 1.2, anthropogenic Cr(III) is considered unlikely to be the source of the elevated Cr(VI) in groundwater based on Site use history and investigation results. In addition, significant oxidation of any Cr(III) in waste is unlikely because it would be expected to be very stable and would not be expected to be brought into close contact with the natural Mn-oxides needed for significant Cr oxidation.
- Natural Cr(III)/ Anthropogenic oxidation and/or mobilization: Direct anthropogenic oxidation would require the release of large quantities of an oxidant, such as permanganate or peroxide. Reduced species other than Cr(III) in the subsurface would also consume this released oxidant. Based on the Site use history and investigation data (see Section 1.2.3), it is highly unlikely that sufficient oxidant to result in the observed elevated Cr(VI) in groundwater could have been released at the Site. On the other hand, there are two potential mechanisms by which anthropogenic organic carbon at the Site could mobilize Cr(III) and/or Mn-oxides such that these two are brought into close proximity and Cr oxidation is enhanced (see Section 1.1.1).
- Natural Cr(III)/ Natural oxidation and/or mobilization: Although the natural system has been demonstrated to be capable of generating significant Cr(VI), this mechanism is considered less likely to explain all of the Site Cr(VI) than anthropogenically-enhanced oxidation because: 1) no other similar sites with natural Cr(VI) groundwater concentrations as high as those reported in HSU-1 at the Site were identified; and, 2) no natural hydrogeologic or geochemical variations that could potentially explain the HSU-1 Cr(VI) variability were identified.
- Natural Cr(VI) mobilization: This hypothesis requires that significant naturally-generated Cr(VI) is sorbed or otherwise bound to the soil matrix and is variably released due to anthropogenic or natural influences. As discussed in Section 1.1.1, competing oxyanions such of phosphate, sulfate or nitrate could displace

Cr(VI) from the solid phase. However, Data Gaps and previous results indicate that very little if any Cr(VI) is bound to the soil anywhere at the Site, so this mechanism is considered unlikely. Another potential effect of nitrate is that it may provide a more thermodynamically favorable electron acceptor than Cr(VI) and thereby inhibit Cr(VI) reduction to Cr(III). However, the natural redox conditions of HSU-1 and HSU-2 suggest that very little Cr(VI) reduction occurs naturally, so it is unlikely that nitrate inhibition of Cr(VI) reduction is a significant process at the Site.

1.3.2 Comparative Analysis of Potential Chromium Source Mechanisms

Based on the screening assessment of potential Cr(VI) source mechanisms presented in Section 1.3.1 above, four mechanisms are considered possible: 1) disposed organic matter enhanced natural Cr oxidation through one of three specific mechanisms (Hypotheses 1A, 1B and 1C); 2) Cr(VI) is entirely natural, with variability due to natural hydrogeochemical heterogeneity (Hypothesis 2); 3) naturally-occurring Cr(VI) on soil is variably released to groundwater by competing anions; and, 4) mobilization of disposed Cr(VI) or Cr(III) that has been re-oxidized (Hypothesis 4). A detailed evaluation of these potential source mechanisms is presented below and summarized in Table 1-5.

<u>Hypothesis 1A: Manganese reduction, mobilization and re-oxidation with Cr(VI) generation.</u>

This source mechanism is considered one of the more likely source mechanisms for Cr "hot spot" concentrations at the Site. Disposal of wastewater sewage sludge and/or other organic wastes in the Site landfills or septic systems would have introduced considerable amounts of organic material that is readily available for degradation by soil biota, thereby creating localized reducing conditions. When reducing leachate from a landfill contacts manganese and iron oxide minerals in the soil, the minerals will dissolve since they are more soluble in a reducing environment than in the natural oxidizing environment. Because Mn(IV) is reduced at a higher Eh than Fe(III), the oxidized manganese minerals will dissolve before the iron minerals as reducing conditions develop beneath the landfill. This manganese reduction and mobilization mechanism by landfill leachate is a well-established process (Deutsch, 1997). These conditions would have reduced manganese oxides and solubilized manganese as Mn(II), which then migrated downgradient within the anaerobic zone. Once subsurface conditions downgradient of the landfill reverted back to aerobic conditions, it is believed that Mn(II) reoxidized to form very reactive fresh manganese oxide coatings which oxidized native Cr(III) to Cr(VI) in the process. A conceptual model of this Cr source mechanism is shown on Figure 1-7. As described in Section 1.2.5, the easily reducible manganese test conducted on Site soils estimates that approximately 40% of total manganese in soils is composed of manganese oxides, and that these manganese oxides are able to oxidize significant amounts of Cr(III) to Cr(VI). Since subsurface conditions downgradient of the landfill are oxic with a neutral to alkaline pH, the generated Cr(VI) is believed to have moved nearly unretarded (no adsorptive retardation) through sediments of the vadose and saturated zone. This mechanism is supported by the location of the area of highest groundwater Cr(VI), which is downgradient of the Site landfill and septic systems at a distance consistent with the age of operation (generally 30 to 50 years ago) and the range of

calculated HSU-1 groundwater flow velocities (estimated at three to 40 ft per year). This potential source mechanism has not been documented at other sites, although it might explain elevated Cr concentrations in water supply wells at nearby and off-site agricultural locations. This mechanism is reportedly being evaluated at the Hinkley site in California as a potential concern associated with reductive *in situ* remediation.

Hypothesis 1B: Organic complexation of Cr(III), downgradient oxidation to Cr(VI).

Another of the more likely Cr source mechanisms is organic complexation of Cr(III) with downgradient oxidation of complexed Cr(III) to Cr(VI) by manganese oxides. The disposal of wastewater sewage sludge and/or other organic wastes in the landfill or septic systems would have introduced considerable amounts of organic acids such as citric and fulvic acids, which potentially could have chelated and solubilized Cr(III). This chelated Cr(III) could have remained stable and soluble in solution at a higher pH than unbound Cr(III). As described in Section 1.2.5, the available amount of Cr(III) that can be leached from Site soil by low concentrations of organic chelating substances was determined by a leaching test with sodium citrate. Results indicate that significant amounts of Cr(III) can be chelated and mobilized from the solid phase (Table 1-4). It is well know that non-chelated aqueous Cr(III) can be quickly oxidized to Cr(VI) by manganese oxides, however, the fate of organically chelated Cr(III) is yet not fully understood. Laboratory studies by others have shown that Cr(III) can be mobile if it is in an organically complexed form, however, the existence of Cr(III) complexes has not been documented under field conditions (Guertin et al., 2005). These organically chelating complexes form slowly and once formed, are difficult to break. It is therefore not known if chelated Cr(III) can be oxidized to Cr(VI) once it comes into contact with immobile manganese oxides. As with Hypothesis 1A, this mechanism is supported by the location of the Cr "hot spots" downgradient of the landfill/septic systems at a distance consistent with Site operation dates and HSU-1 calculated groundwater flow velocities. This potential Cr release mechanism has not been documented at other sites, although it might also explain elevated Cr concentrations in water supply wells at nearby and off-site agricultural locations.

Hypothesis 1C: Organic complexation of manganese, downgradient oxidation of Cr(VI).

Another potential Cr source mechanism is organic complexation of manganese oxides with downgradient oxidation of native Cr(III) to Cr(VI). This mechanism is similar to the Cr(III) complexation mechanism described under Hypothesis 1B, with the difference that the organic acids from the landfill or septic systems might have chelated and solubilized manganese oxides, rather than Cr(III). The available amount of manganese that can be leached by low concentrations of organic chelating substances in Site soils was determined by a leaching test with sodium citrate. As described in Section 1.2.5, significant differences in organically available manganese were detected between the "hot spot" and background soil samples, suggesting that more chelated manganese may be present in soils from the Cr anomaly area. These laboratory tests also showed a significant correlation between chelated manganese and the Cr(VI) generated during the standard Cr oxidation test for "hot spot" and background soil samples. However, the redox state of the chelated manganese is not known and it is also not known if manganese has been chelated as a manganese oxide. Manganese might be chelated in a non-reactive form, in a reduced form, or even in an oxic form, without being able to oxidize Cr(III) to Cr(VI). As mentioned for Hypotheses 1A and 1B, the current

location of elevated Cr(VI) is consistent with the timing of potential organic acid releases and calculated HSU-1 groundwater velocities, and this hypothesis could also explain elevated Cr concentrations in water supply wells at nearby and off-site agricultural locations.

Hypothesis 2: Occurrence of Cr(VI) is entirely natural.

The hypothesis that the source of elevated Cr(VI) in Site groundwater is entirely naturally occurring, and that the variability in concentration is due to hydrogeologic and/or natural biogeochemical variability, is considered possible but less likely than Hypothesis 1. No significant hydrogeologic or biogeochemical differences between the "hot spot" and background areas were observed that could explain the elevated Cr concentrations in the Cr anomaly areas. Cr concentrations in the "hot spot" anomaly area exceed natural Cr(VI) concentrations reported for other sites with similar geochemistry. The only other known sites where ultramafic rocks have contributed to the formation of Cr(VI) at similar levels are in New Caledonia, where pore-water concentrations are as high as 700 µg/L, and in Western Australia, where groundwater concentrations are as high as 430 µg/L. However, at these sites the water was within ultramafic rocks, with significantly higher Cr concentrations than those at the Site. Declining Cr concentration trends in many Site HSU-1 wells also suggest that the Cr source has been depleted, which would not be expected with a purely natural source.

Hypothesis 3: Competing anions displace Cr(VI) from mineral surfaces.

The source mechanism that involves significant amounts of naturally-generated Cr(VI) adhering to soil and then being released to groundwater by competing anion replacement is believed to be less likely than Hypotheses 1 and 2. The landfill or septic systems and manure or fertilizer applications could have provided a source of competing anions such as phosphate or sulfate. However, no significant correlations have been observed in groundwater that would support this mechanism. Cr(VI) concentrations in background and "hot spot" soils were non-detect and Cr(VI) concentrations measured during the exchangeable Cr leach tests are also too low the explain the several hundred µg/L of Cr concentrations in Site groundwater wells.

Hypothesis 4: Cr release from the landfill.

This hypothesis is believed to be the least likely of the four hypotheses. If Cr had been disposed of in wastewater sludge or laboratory waste in the landfill, it is likely that the organic matter in the landfill quickly created reducing conditions, leading to the reduction of Cr(VI) to Cr(III). It is unlikely that the reduced Cr(III) would have then come in close enough proximity to manganese oxides for significant re-oxidation. Disposal of Cr(VI) in the landfills through any other mechanism is considered very unlikely based on historical records and investigation findings.

1.4 Chromium Investigation Conclusions and Recommendations

Key conclusions and recommendations based on the Data Gaps Cr tasks are:

- The geology, hydrogeology, and geochemistry of HSU-1 at the Site provide the conditions necessary to potentially generate and maintain Cr(VI) in groundwater, including: 1) soil very high in Cr and manganese (Mn) oxides; 2) groundwater with positive oxidation-reduction potential (ORP), high dissolved

oxygen (DO) and high alkalinity (bicarbonate); and 3) slow groundwater velocities resulting in relatively long groundwater resident times.

- Although a definitive source and an explanation for the distribution of elevated Cr(VI) have not been identified, it appears that: 1) the Site hydrogeology and natural geochemistry cannot account for the observed Cr(VI) distribution; 2) it is likely that an anthropogenic effect is enhancing the oxidation of the naturally-occurring Cr; 3) organic carbon waste is the most likely anthropogenic effect causing this enhanced oxidation, through one of three possible mechanisms; and, 4) this organic carbon waste was probably not disposed in the area(s) of current elevated Cr groundwater concentrations.
- The "source" of the elevated Cr(VI) appears to be depleting or depleted based on declining or stable Cr concentrations in most HSU-1 wells. If the "source" was organic carbon from onsite waste disposal, its depletion is also indicated by the highest Cr groundwater concentrations being located significantly downgradient from disposal area(s). For example, the elevated Cr area centered on well UCD1-28 is approximately 600 ft downgradient of LFU-1, where wastewater sludge was reportedly disposed. If this elevated Cr(VI) area originated near LFU-1 and migrated with groundwater at a rate of 30 ft/yr, this would suggest that the source started to deplete approximately 20 years ago.
- Bench tests were performed (July to September 2009) to evaluate whether Cr(VI) concentrations in Site groundwater could be reduced to Cr(III) through the addition of various reducing agents. The results of these bench tests were used to begin evaluating whether the Cr(VI) can be reduced without undesirable groundwater impacts. These tests also included a "re-oxidation" phase to evaluate whether the reduced Cr(III) is readily oxidized back to Cr(VI) once natural, baseline conditions are restored. Bench test results indicated that: 1) calcium polysulfide (CaSx) effectively reduced groundwater Cr(VI); 2) although groundwater arsenic and other metal concentrations increased due to reduction by CaSx, these concentrations were restored to near baseline levels during the re-oxidation test; 3) no significant Cr re-oxidation was observed in the initial bench tests; and, 4) although CaSx treatment increased groundwater sulfate concentrations in the initial bench tests, additional bench testing indicates that the CaSx dose can be reduced, thereby reducing sulfate generation. Based on preliminary findings, the LEHR Team regulators (i.e., US EPA, CVRWQCB, California Department of Toxic Substances Control [DTSC], and California Department of Public Health Radiologic Health Branch) agreed during an August 25, 2009, conference call that a field test of CaSx could be performed. Therefore, a pilot test work plan for in situ reduction of chromium, including the laboratory bench-test results, was submitted, approved by the LEHR Team, and finalized on January 7, 2010 (Weiss, 2010a). The CaSx field pilot-scale test is currently underway.

- With the completion of the Data Gaps investigations and based on the results, the current Site groundwater monitoring well network may be adequate for long-term monitoring of elevated Cr. Following the Data Gaps work, one additional HSU-1 well (UCD1-67) was installed north of the Site to improve definition of Cr and other constituents in this area (Weiss, 2009). This new well and the three new HSU-1 Cr definition monitoring wells (UCD1-61, UCD1-62, and UCD1-63) and two new HSU-2 Cr definition monitoring wells (UCD2-59 and UCD2-60) have been added to Site groundwater monitoring program, with specific monitoring recommendations included in the recently submitted *Draft Work Plan for 2010 Well Monitoring* (Weiss, 2010b).

2 SOIL TO GROUNDWATER IMPACT EVALUATION

2.1 Background and Introduction

Section 2 of this report presents the results for the Data Gaps investigations and evaluations conducted to assess the current and potential future impact to groundwater by constituents of potential concern (COPCs) identified in the UC Davis DUs. These investigations and evaluations were conducted to provide information needed to complete the FS for the UC Davis areas of responsibility at the Site. The primary purpose of the Data Gaps investigations related to the DU soil-to-groundwater impact evaluation was to enhance existing data on COPC distribution in the vadose zone soil and soil gas and vadose zone soil properties. These data comprise the key parameters for vadose zone modeling to predict potential impact to underlying groundwater. An additional purpose of these investigations was to improve the monitoring well network for HSU-1 groundwater immediately downgradient of the DUs.

This section of the document provides a brief background on the soil-to-groundwater impact evaluation methodology and the UC Davis DUs, and a summary of the Data Gaps DU tasks, purpose and scope, as defined in the *Feasibility Study Data Gaps Work Plan* (Weiss, 2008a) and modified during implementation. Section 2.2 presents a summary of current groundwater impact from the DUs based on historical and Data Gaps groundwater monitoring results, and the Data Gaps hydropunch sampling. Section 2.3 presents the soil-to-groundwater impact evaluation including data used, methodology, and results. Section 2.4 presents conclusions based on this evaluation and discusses how this information will be used in the FS.

2.1.1 Soil-to-Groundwater Impact Evaluation Overview

To evaluate remedial options for the UC Davis DUs, protection of groundwater from COCs in these units must be addressed. This pathway had not been thoroughly addressed prior to the Data Gaps work, in part because the previously assumed remedy (i.e., capping) involves engineered controls to protect groundwater from landfill leaching (UC Davis, 2006). A preliminary evaluation of potential groundwater impacts was conducted in early 2008 (Brown and Caldwell, 2008b), however, this evaluation had limitations, including: 1) the initial elevated vadose zone COPCs were assumed to be constrained to the interval from 15 to 16 ft bgs; 2) lithologies and soil properties for the vadose zone soil columns were generalized and based on limited data; 3) depth-to-water was assumed to be 40 feet, while the minimum depth can be as little as 20 feet; 4) VOC distribution in vadose zone soil was based on limited and potentially non-representative soil data; 5) a 15-foot thick

groundwater mixing zone was assumed; and 6) the lateral extent and overall mass of COPCs in the vadose zone was not considered.

To augment this previous groundwater impact evaluation, new data and methods previously approved and applied at LEHR/SCDS were used in these Data Gaps investigations (Figures 2-1 and 2-2). These methods are:

1. Use the approved screening process (Figure 2-2) for developing the list of COPCs that warrant evaluation. In the Data Gaps Work Plan (Weiss, 2008a), the COPC lists previously generated for each UC Davis disposal area were updated using more conservative soil-water partitioning coefficients (K_ds). These lists were further refined based on the new analytic data generated during the Data Gaps investigations.
2. Conduct Designated Level (DL) modeling using the same general methods and procedures used for United States Department of Energy (DOE) areas at LEHR/SCDS (Weiss, 2005). This modeling was used to develop DU-specific groundwater impact screening levels for each soil and soil gas COPC.
3. Employ a three-step procedure that uses groundwater monitoring data, DU characterization data, and the DL modeling results to screen COPCs and identify "constituents of potential groundwater concern" (COPGWCs) for each DU.
4. Conduct a risk evaluation for each COPGWC, taking into account its distribution in the vadose zone, existing groundwater data, data reliability and representativeness, and other factors (Figure 2-1), using the same methods previously approved for DOE areas (Weiss, 2005).

The UC Davis disposal areas that were evaluated following this process in the Data Gaps investigation and that will be addressed in the FS are (Figure 2-3): LFUs 1, 2, and 3; the Southern Trenches; the Eastern Trenches; and the Waste Burial Holes (WBHs). LFU1, LFU2, and LFU3 were three distinct disposal areas for the landfill used by UC Davis for general campus and municipal-type waste disposal from the 1940s until the late 1960s. LFU1 was the oldest unit and was used in the 1940s and 1950s (UC Davis, 2004). General campus wastes were reportedly disposed of in LFU1, and glass, metal, and burned materials including ash, charcoal, and melted glass were identified in LFU1 during investigations of the area (UC Davis, 2004). Sludge from the adjacent former sewage treatment plant was also reportedly disposed at LFU1. Typical waste depths range from 3.5. to six ft bgs (UC Davis, 2004), with a maximum of eight ft bgs. LFU2 was operated from 1956 to 1967. Based on investigations of the area, wastes in LFU2 include general municipal refuse similar to LFU1, animal parts, and laboratory waste (UC Davis, 2004). Waste was disposed of in 12 east-west disposal pits, with average maximum depths of approximately 10 ft bgs, although some waste was as deep as 14 ft bgs. Waste materials were disposed at LFU3 from 1963 to 1967. Based on investigations in LFU3, the waste placed in this area was general municipal and campus waste, construction debris, and minor quantities of laboratory waste including pipettes, gloves, and plastic containers, buried at a maximum depth of at least 11 ft bgs (UC Davis, 2004).

Pits and trenches around the UC Davis landfill were used for disposal of chemical and radioactive wastes associated with LEHR activities. The Eastern Trenches were used from 1957 to 1965 for disposal of general laboratory waste, pesticide containers, and gravel. The Eastern Trenches consist of five north-south trending trenches and six east-west trending trenches with typical bottom depths of approximately 6 ft bgs. From 1956 to 1974, waste materials including low-level radioactive materials, laboratory chemicals, vials, syringes, laboratory glassware, and animal carcasses were disposed in the WBHs. In 1999, the area was excavated to 12 ft bgs, waste materials were sorted from soil and the sorted soil was returned as backfill. The Southern Trenches are two east-west oriented trenches that were operated between 1957 and 1965 (UC Davis, 2004). Waste materials identified in the trenches during investigation activities include gravel, bones, animal feces, and small amounts of laboratory waste. The trench bottoms were generally approximately 3.5 ft bgs, with maximum depths of up to six ft bgs.

2.1.2 Soil-to-Groundwater Impact Evaluation Tasks, Purpose and Scope

The following summarizes the soil-to-groundwater impact evaluation tasks proposed in the Work Plan and describes each task's intended purpose. Section 2.1.3 below and Table 2-1 summarize the scope of work for each of the tasks and discuss variances from the proposed work and the reasons for these variances.

Task DU1: Disposal Unit Hydropunch Investigation. The purpose of this task was to provide additional data on COPCs in groundwater downgradient of disposal units to determine the need for and location(s) of new HSU-1 monitoring well(s).

Task DU2: Disposal Unit New Well Installation. This task was designed to provide new, ongoing HSU-1 groundwater monitoring points for the area of elevated chloroform in LFU2/Eastern Trenches, immediately downgradient of LFU1 and LFU3, and, if necessary, immediately downgradient of the WBHs.

Task DU3: Disposal Unit New Well Sampling and Analysis. This task provided baseline analytic data for the full suite of COPCs for groundwater in the newly-installed DU monitoring wells. These data were used to establish the analyte list for ongoing monitoring of these wells and for comparison with the predicted groundwater impact based on the vadose zone modeling.

Task SGI1/DU4: Vadose Zone to Groundwater Characterization. The purpose of this task was to provide the soil, soil gas, first groundwater, and soil physical property data needed for evaluation of the potential impact of DU vadose zone COPCs on groundwater. Some of the hydropunch locations for Task DU1 were also used for this task. The soil gas data collected for this task were also used for the evaluation of potential vapor intrusion risk.

Task SGI2: Groundwater Impact Evaluation. The purpose of this task was to develop vadose zone screening levels for groundwater protection based on the new and existing Site data and using the previously-approved modeling approach (Weiss, 2005), and to use these vadose zone screening

levels and other information to conduct risk characterization and identify groundwater impact COCs for each DU using approved methods (Weiss, 2005).

2.1.3 Soil-to-Groundwater Impact Data Gaps Investigation Activities

With the exception of the four quarters of monitoring of the four new DU downgradient monitoring wells, the DU Data Gaps field work was conducted from mid-September through early October 2008. The quarterly sampling events were conducted in early October 2008 (summer event), early December 2008 (fall), February 2009 (winter), and May 2009 (spring). With a few minor exceptions, the field and laboratory activities for the DU Data Gaps tasks were conducted accordance with the FS Data Gaps Work Plan (Weiss, 2008a), including compliance with the HSP (Weiss, 2008b) and QAPP (Dames & Moore, 1998, as revised by Weiss, 2008c). Table 2-1 summarizes the work as it was proposed in the Work Plan, and describes all deviations from the proposed work and the rationale for these changes. None of these changes has a significant negative impact on meeting the DU investigation DQOs that were presented in the Work Plan (Weiss, 2008a).

In addition to the field work specifically described in the Work Plan tasks, two other activities were performed as part of the DU Data Gaps work:

1. Well Resurveying: While the groundwater mean flow direction in HSU-1 is generally to the northeast, the groundwater flow direction based on water level data collected for the 2001 through 2004 fall seasons was interpreted to exhibit a south or southeast flow direction in some areas of the Site, and these results raised some LEHR Team regulator concern that groundwater monitoring downgradient of LFU2 and the Eastern Trenches may not be adequate due to variable flow directions. To assess whether inaccurate water level measurements may play a role in this, several wellhead elevations were resurveyed as proposed in the Work Plan (Weiss, 2008a). In the process of this evaluation, it was discovered that there were discrepancies and some confusion regarding the measuring points and surveyed elevations for Site wells, so the entire monitoring well network was resurveyed in May 2009.

2. Disposal Unit Extent: To confirm that the previously-defined boundaries of the DUs are appropriate and encompass all of the relevant waste, aerial photographs, historical maps, and the geophysical anomaly coordinates from previous investigations were reviewed. No disposal unit boundaries were changed based on this review. Because geophysical surveying of the LFU2 area underlying the former DOE Eastern Dog Pens had apparently not been previously conducted, a surface geophysical survey using ground penetrating radar, metal-detection, and electromagnetic detection was included as part of the Data Gaps investigations. The results of this survey were used in combination with aerial photographs showing LFU2 disposal trenches and boring logs to refine the definition of potential disposal in this area.

2.2 Current Disposal Unit Impact to Groundwater

HSU-1 groundwater flow at the Site is predominantly to the northeast at an approximate velocity of three to 30 feet per year (ft/yr) based on previous slug test results (UC Davis, 2004). As discussed in Section 2.1.3 above and in the Data Gaps Work Plan, some historical groundwater level contour maps for the fall season indicated a component of southerly flow towards Putah Creek in the vicinity of wells UCD1-24, UCD1-23, and UCD1-4. It was hypothesized that this may have been due to a measuring error associated with wellhead elevations; however, measuring points for each well were recently re-established and resurveyed, and the water level contour map for December 2008 using these confirmed wellhead elevations shows the same pattern of HSU-1 hydraulic gradient. This pattern occurs for a short period in some years during the time after agricultural pumping stops and before significant rainfall has fallen, apparently because water levels in most HSU-1 wells rise quickly in response to the end of the agricultural pumping season while a few (notably UCD1-4 and UCD1-23) respond less quickly. This may be due to differences in the vertical hydraulic conductivities of the soil within or below the wells' screened intervals. Well UCD1-4 is screened from 45 to 55 ft bgs while wells UCD1-23 and UCD1-24 are screened from 57 to 72 ft bgs, which is typical of HSU-1 wells at the Site. Site HSU-1 deposits are predominantly low permeability silts and clays, and boring logs for UCD1-23 and UCD1-24 show silts/clays consistently from 55 to 72, so it is not evident from the geologic logs why the wells seem to respond differently when pumping ends. However, laboratory permeability tests of similarly described silt and clay samples from the Site showed a wide range of permeabilities (10E-05 to 10E-09 cm/s range; DB Stephens, 2008), so there may actually be significant differences in vertical conductivities between these well locations. Regardless, this apparent transient area of southerly gradient clearly has little impact on the predominant northeast contaminant transport direction, as is evident by the chemistry in the two wells closest to Putah Creek, i.e., UCD1-4 and UCD1-34, both of which have been consistently free of Site contaminants.

The groundwater downgradient of each DU has been previously investigated and the impact of the DUs on groundwater has been characterized. However, additional groundwater investigation (Data Gaps Tasks DU1 through DU3) was implemented to augment the current understanding. These characterization activities focused on:

1) <u>Better delineation of the HSU-1 elevated chloroform associated with LFU2 and the Eastern Trenches</u>. Groundwater data were lacking for areas of high chloroform in soil gas in parts of these DUs.

2) <u>Enhanced downgradient monitoring of the LFUs, as required, to help ensure that appropriate remedial alternatives are developed and properly evaluated in the FS.</u> The LEHR Team regulators requested that the monitoring network be improved along the eastern boundaries of LFU1, LFU2, LFU3, and the WBHs. Investigation activities were therefore implemented to address HSU-1 groundwater in these areas. For LFU1 and LFU2, these activities were combined with the anomalous Cr area delineation (see Section 1.1) and the elevated chloroform area delineation, respectively, for efficiency.

The following summarizes the known groundwater impact suspected to originate, at least in part, from the UC Davis DUs. The UC Davis Remedial Investigation (RI) report (UC Davis, 2004) discusses the groundwater impact in more detail and summarizes monitoring data collected through 2002, and the distribution of these constituents in HSU-1 and HSU-2 based on the recent monitoring data is presented on figures in the *2008 Comprehensive Annual Water Monitoring Report* (UC Davis, 2009b), which are also included on CD in Appendix F of this report. In addition, the potential impact on groundwater of these constituents in the vadose zone of each DU is discussed in Appendix D to this report. Based on the distribution in groundwater as well as the soil-to-groundwater impact evaluation presented in this section and Appendix D, the UC Davis DUs with the greatest historical and predicted future impact on groundwater are LFU2, the Eastern Trenches, and the WBHs. The impact to groundwater from disposal in LFU1 and LFU3 appears to be small compared with that of the upgradient LFU2, Eastern Trenches, and WBHs area. There is no evidence that the Southern Trenches have significantly impacted groundwater.

Chloroform: The highest concentrations of chloroform in HSU-1 are in the area of the density-driven convection (DDC) interim remedial system near the northeast corner of LFU2 and north end of the Eastern Trenches. Although the DDC system has significantly reduced groundwater concentrations, elevated concentrations (e.g., 750 µg/L in UCD1-51 in 2008) remain. Data Gaps and previous soil gas investigations indicate that vadose zone chloroform remains in the northern LFU2/Eastern Trench area. Chloroform has impacted HSU-2 at low concentrations over a large area (UC Davis, 2004).

Tritium: The highest tritium activities in HSU-1 groundwater are associated with the WBHs and Eastern Trenches, with well UCD1-13 in the Eastern Trenches area (also downgradient of the WBHs) having the highest historical and current concentrations. Tritium concentrations have decreased dramatically, probably due to the WBH removal action. Tritium was measured at close to 30,000 picoCuries per liter (pCi/L) in the early 1990s and was only 270 pCi/L (reported below the 300 pCi/L detection limit) in 2008. Although tritium appeared to have some impact on HSU-2 in this immediate area in the early 1990s (UC Davis, 2004), no ongoing impact to HSU-2 is evident based on recent data (UC Davis, 2009b).

Carbon-14 (C-14): The highest C-14 is also associated with the WBH/Eastern Trench area. As with tritium, the WBH removal action appears to have greatly diminished the ongoing impact on HSU-1 groundwater, as concentrations in well UCD1-13 have declined from approximately 2,000 pCi/L in the early 1990s (UC Davis, 2004) to 179 pCi/L in 2008 (UC Davis, 2009b). C-14 levels in HSU-2 groundwater immediately underlying well UCD1-13 appear to be slightly above background (measured at 44 pCi/L in well UCD2-14 in 2008; UC Davis, 2009b). C-14 levels in upgradient "background" well UCD2-17 have been less than the detection limit, which has consistently been 20 pCi/L in recent years.

Nitrate: Areas of above-background HSU-1 nitrate (defined as 27 milligrams per liter [mg/L] in the RI; UC Davis, 2004) were historically found in well UCD1-24 at the eastern side of the DOE's Western Dog Pens and in the current DDC area (UC Davis, 2004). Currently, areas of above background nitrate in HSU-1 are centered on the DDC area (78

mg/L in well UCD1-50 and 73 mg/L in well UCD1-51 in 2008; UC Davis, 2009b) and the UCD1-28 area (67 mg/L in well UCD1-28 and 63 mg/L in well UCD1-52 in 2008; UC Davis, 2009b). It is suspected that activities in the Western Dog Pens and LFU2 resulted in nitrate impact to HSU-1 groundwater, and other Site activities may have also caused nitrate impact. Nitrate levels in HSU-2 do not appear to be significantly elevated above background based on groundwater monitoring data.

Cr(VI): As discussed in detail in Section 1, Cr levels in HSU-1 appear to be elevated above the local background level under parts of the Site, with the highest concentrations found east of the Site in the well UD1-28 vicinity. Cr levels in HSU-2 also appear to be above the local background level under and to the east of the Site. As discussed in Section 1, the Cr in groundwater is believed to be from natural sources, although secondary, anthropogenic factors associated with Site activities appear to have enhanced the oxidation/mobilization of the naturally-occurring Cr. As discussed in Section 1, Cr concentrations in HSU-1 have generally declined over time and these anthropogenic factors are believed to be no longer active at the Site.

Total Dissolved Solids (TDS): The distribution of TDS at the Site is similar to that of nitrate, with the highest levels found in the DDC system and well UCD1-28 areas. TDS in Site groundwater ranges up to approximately 1400 mg/L based on recent results (UC Davis, 2009b), while levels are typically 300 to 600 mg/L upgradient of the Site. TDS concentrations in HSU-2 are more consistent, and are approximately 400 mg/L upgradient of the Site and approximately 600 mg/L near the downgradient edge of the Site based on recent data (UC Davis, 2009b). The source(s) of elevated TDS in groundwater are not identified, but are suspected to be related to Site activities.

1,4-dioxane: This constituent was identified as a potential COC in groundwater by the community group technical advisor in August 2008 (Lee, 2008), and was sampled and analyzed for in selected HSU-1 and HSU-2 wells during the four quarterly sampling events from October 2008 through May 2009. The highest 1,4-dioxane concentrations were detected in new wells UCD1-66, which had reported concentrations ranging from 3 µg/L to 14 µg/L, and UCD1-65, which had from <1 µg/L to 14 µg/L reported. Concentrations showed a decreasing trend over the four quarters of monitoring, and in the May 2009 all 1,4-dioxane results for HSU-1 were non-detect at a 1 µg/L detection limit, except for a detection of 5.3 µg/L in well UCD1-66. In HSU-2, only trace (1.3 µg/L or less) 1,4-dioxane was detected in well UCD2-14 in December 2008 and February 2009. In May 2009, all 1,4-dioxane results for HSU-2 wells were below the 1 µg/L detection limit.

Other constituents that have been analyzed for, but have been determined to not significantly impact Site groundwater include: organochlorine pesticides, polychlorinated biphenyls, other semi-volatile organic compounds (SVOCs), other metals, other radionuclides, and perchlorate. Potential future groundwater impact due to UC Davis disposal areas is discussed in the next section.

2.3 Soil-to-Groundwater Impact Designated Level Modeling

2.3.1 Summary of Data Evaluated

The data used in the soil-to-groundwater impact evaluation are as follows:

Non-volatile COPCs: During preparation of the *Data Gaps Work Plan*, all soil data for non-volatile constituents that were considered representative of current UC Davis DU conditions (i.e., valid data for all areas not affected by removal actions) were evaluated using the approved screening process (Figure 2-2) to determine COPCs for each disposal area. The results of this screening were presented in Appendix C of the Work Plan (Weiss, 2008a). For the Data Gaps investigations, additional vadose soil samples were collected from each DU and analyzed for the specific non-volatile COPCs identified for that area (as described under Task DU4 in Section 2.1.2 and 2.1.3 above). These samples were located to target the areas expected to have the highest concentrations of COPCs based on previous investigations. The data from these new samples (Appendix F) were incorporated into the previous screening evaluation (Table 2-2) to determine if: 1) any of the previously-identified COPCs should be dropped based on similarity to background levels; and 2) the previously-identified maximum concentration for each COPC in each DU was a reasonable representation of the maximum. In addition, the new data for non-volatile COPCs was used to help define the contaminant distribution over depth for use in establishing conservative contamination intervals for the vadose zone modeling.

Volatile COPCs: Due to LEHR Team regulator concern about the reliability and representativeness of VOC data for Site soil samples, the decision was made to use new soil gas data to represent VOCs in the vadose zone in the UC Davis disposal areas (Weiss, 2008a). For the Data Gaps investigations, soil gas was sampled at five, ten and 15 ft bgs in each DU and analyzed for VOCs, including formaldehyde. These data (Table 2-3) were used to identify COPCs and appropriate contaminated depth intervals for the vadose zone modeling and to calculate theoretical maximum soil concentrations for each COPC for comparison with modeled screening levels. These new soil gas data were also used in evaluating potential vapor intrusion concerns, as discussed in Section 3 of this report.

Soil Properties: Soil properties had been previously measured in vadose zone soils from DOE areas of the Site (DB Stephens, 1996). For the Data Gaps investigations, additional soil samples were collected to represent various soil types in each of the UC Davis disposal areas, and were analyzed for soil parameters. These data sets were used to assign appropriate soil parameter values for use in the soil-to-groundwater impact vadose zone modeling.

Groundwater: In addition to the Data Gaps hydropunch groundwater data for samples collected within each DU and the data for the new DU monitoring wells (Table 2-4), all the COPC monitoring data for wells downgradient of each DU was considered in the risk evaluation for soil-to-groundwater impact COPCs.

2.3.2 COPC Identification

Table 2-2 shows the non-volatile soil-to-groundwater impact COPCs identified for each UC Davis disposal area. This table has been modified from the tables presented in Appendix C of the Data Gaps Work Plan to show only those constituents identified as COPCs and to update the data summary for each COPC based on the new Data Gaps data. As a result of this review, hexavalent chromium was eliminated as a COPC for LFU2 and the WBHs based on Data Gaps investigation results, which indicate that hexavalent chromium is not present above detection limits in Site soil. Similarly, a review of past and Data Gaps investigation results for uranium-235 indicate that it is not present above detection limits, so it was dropped as a COPC for LFU1 and the WBHs. Aside from these changes, the new data did not change the non-volatile COPC list, nor did any of the maximum concentrations change. As described in more detail in Appendix D, a number of VOCs were added as COPCs based on their detection in Data Gaps soil gas samples. With the exception of isopropanol, hexane, and ethanol, all VOCs detected in soil gas (Table 2-3) were retained as soil-to-groundwater COPCs for evaluation through vadose zone modeling.

2.3.3 NUFT Modeling and Designated Levels

This section summarizes the methodology used to develop soil cleanup levels protective of groundwater quality. As described in Section 2.4 below, these soil cleanup levels are a key component of the process used to conduct risk characterization for each COPGWC. A detailed description of this soil cleanup level development and risk characterization process and its results are presented in Appendix D.

The modeled DLs were determined according to *The Designated Level Methodology for Waste Classification and Cleanup Level Determination* (CVRWQCB, 1989). Initial vadose zone model development and parameter selection/justification was as presented in the *Draft Final One Dimensional Vadose Zone Modeling for the US Department of Energy Areas at the Laboratory for Energy-Related Health Research* (Weiss, 1997). One-dimensional modeling calculations to simulate contaminant transport from the vadose zone to groundwater were performed using the Non-Isothermal Unsaturated Flow and Transport (NUFT) (Nitao, 1996) numerical code developed and validated by Lawrence Livermore National Laboratory. The results of this vadose zone modeling were used to estimate the time required for UC Davis area source material to migrate through the vadose zone and to determine soil cleanup levels protective of groundwater quality (DLs).

Model parameters and assumptions include (see Appendix D for additional detail):

<u>Hydrogeologic Parameters:</u> Conservative representative soil profiles were developed for each DU, with soil parameters assigned to each soil type based on the results of laboratory analyses performed on Site soil samples. The same conservative hydrogeologic parameter assumptions that were established in the DL calculations performed by DOE for their areas at LEHR were used, i.e., 20 ft depth to groundwater, 10.8 centimeter per year (cm/yr) infiltration rate, no dispersion for any constituent, and negligible dilution in the saturated zone.

Chemical Parameters: Because of the potential unreliability of soil VOC data as a representative measure of spatial distribution, soil gas data were used to calculate soil concentrations based on Henry's Law and soil adsorption/partitioning coefficient (K_d). Contaminated depth interval assumptions were made from soil and soil gas sample concentration data according to depth. The lowest chemical-specific K_d values from literature review were selected, and tritium and carbon-14 were assumed to partition completely into water in the form of tritiated water and methanol, respectively ($K_d = 0$). Other chemical properties were obtained from literature review, as described in Appendix D.

Groundwater Goals: The primary source of groundwater goals was the California Maximum Contaminant Levels (MCLs) for drinking water (DPH, 2009). If MCLs were unavailable, the United States Environmental Protection Agency, Region 9, Regional Screening Levels (RSLs) for tap water were used (US EPA, 2008). The California Environmental Protection Agency risk-based target of 1.1 ug/L for groundwater was used for chloroform. California notification levels (CNLs) were used as goal concentrations for carbon disulfide, 1,4-dioxane and formaldehyde (DPH, 2009). Background levels for inorganic constituents and sample detection limits for organic constituents were also used to provide baseline goals.

2.4 Soil-to-Groundwater Impact Risk Characterization

Risk characterization is intended to provide risk managers with an understanding of the uncertainties and technical basis of estimated risks and help them formulate appropriate remedial strategies. To facilitate risk management decisions, the risk characterization evaluates and makes recommendations on whether COPGWCs should be evaluated as a COCs in the FS. As summarized below and described in detail in Appendix D, COPGWCs were examined on an individual basis to evaluate the lines of evidence indicating whether a threat to groundwater resources exists.

Once the NUFT modeling was completed, the resultant DLs were used, along with Site groundwater monitoring data and DU soil/soil gas characterization data, to conduct a three-step risk estimate procedure for each DL COPC in each DU. The first step consisted of comparing DL COPC groundwater concentrations downgradient of each DU to background. DL COPCs with maximum groundwater concentrations above background were automatically identified as a COPGWC for risk characterization. DL COPCs with maximum groundwater concentrations below background were evaluated in Step 2. This second step was to compare soil or soil gas concentrations to the NUFT model DLs for each area (see Tables D-6 through D-11 in Appendix D). DL COPCs with maximum concentrations above background and above at least one DL were carried forward to Step 3, while others were eliminated. The third step consisted of evaluating DL COPCs based on their time to peak groundwater impact predicted by the model. DL COPCs whose peak impact was predicted to occur in less than 500 years were identified as COPGWCs and carried forward into the risk characterization, while those with longer "peak times" were eliminated. This three-step process is discussed in more detail in Appendix D, with results for each DU presented in Tables D-12 through D-17.

The risk characterization used multiple lines of evidence to evaluate COPGWCs uncertainties and identify the final COCs that will be the basis of remedial action decisions in the FS. These lines of evidence include:

- Percentage and spatial distribution of COPGWC concentrations in soil/soil gas samples exceeding background.
- Expected degradation and decay of the COPGWC.
- Uncertainties related to COPGWC laboratory analytical issues and data representativeness issues.
- Relation of COPGWC to Site operations (i.e., likelihood of its use at the Site).

These risk characterization lines of evidence are discussed in detail for each COPGWC in each DU in Appendix D, with results summarized in Tables D-18 through D-23.

2.5 Chemicals of Concern and Preliminary Cleanup Goals

Based on the results of the risk characterization (Appendix D), the following groundwater impact COCs were identified for the UC Davis DUs:

- Eastern Trenches: C-14; tritium; chloroform; 1,1-dichloroethane (1,1-DCA); 1,2-DCA; 1,2-dichloropropane; 1,4-dioxane
- LFU1: copper; selenium; C-14
- LFU2: cadmium; C-14; acetone; chloroform; 1,1-DCA; 1,2-dichloropropane; 1,4-dioxane
- LFU3: barium; cadmium; copper; C-14, formaldehyde
- WBHs: C-14; tritium; 1,4-dioxane
- Southern Trenches: none identified.

As presented on Table 2-5, preliminary soil cleanup levels for these COCs are set at the highest value amongst the calculated screening DL, the Site background value, and the lowest available practical quantitation limit (PQL). Based on this, the proposed preliminary soil cleanup levels are the PQLs for VOCs, and background levels for the metals and radionuclides, with the exception of those for C-14 and tritium in the WBHs, which are the screening DLs.

2.6 Soil-to-Groundwater Impact Conclusions and Recommendations

Key conclusions and recommendations based on the Data Gaps soil-to-groundwater impact evaluation are:

- With the completion of the Data Gaps investigations, sufficient vadose zone soil and soil gas data and HSU-1 groundwater data were available to meet the DQOs specified in the Data Gaps Work Plan and adequately assess the current and potential future impact of the UC Davis DUs on groundwater.
- The soil-to-groundwater impact evaluation was conducted following the same conservative and LEHR Team-approved approach and parameters used by DOE, so the results provide results that are valid and sufficiently conservative for use in the FS.
- The identified groundwater impact COCs and preliminary soil cleanup levels for each COC in each DU are presented in Table 2-5.
- It is recommended that these preliminary cleanup levels, along with human health-based preliminary cleanup levels (see Section 3), be used in developing and evaluating remedial alternatives in the FS.
- With the completion of the Data Gaps investigations and based on the results, the current Site groundwater monitoring well network is adequate for long-term monitoring of potential impact immediately down-gradient of the UC Davis DUs. The four new HSU-1 DU Data Gaps monitoring wells (i.e., UCD1-62, UCD1-64, UCD1-65, and UCD1-66) have been added to the Site groundwater monitoring program, with specific monitoring recommendations included in the recently submitted *Draft Work Plan for 2010 Well Monitoring* (Weiss, 2010b).

3 VAPOR INTRUSION EVALUATION

3.1 Introduction and Background

This section of the report presents the results for the Data Gaps investigations and evaluations conducted to assess the potential future risks associated with the intrusion of VOCs emanating from the UC Davis DUs into indoor air. These investigations and evaluations were conducted to provide information needed to complete the FS for the UC Davis areas of responsibility at the Site. The primary purpose of this evaluation was to reassess the potential vapor intrusion risk associated with VOCs present in the disposal areas, and to then determine whether revisions to the Human Health Risk Characterization Report (UC Davis, 2006) are warranted based on that assessment. In addition, the potential presence of methane in the landfill areas and its associated risks were evaluated.

This subsection (Section 3.1) of the document provides a brief background on the vapor intrusion evaluation methodology, and a summary of the Data Gaps tasks conducted for this evaluation. Section 3.2 presents the results of the evaluation and Section 3.3 presents conclusions based on this evaluation, and discusses how this information will be used in an update to the previous Human Health Risk Characterization Report (UC Davis, 2006) and in the FS.

3.1.1 Vapor Intrusion Evaluation Overview

Potential risks due to VOC vapor inhalation were evaluated in the Human Health Risk Characterization Report for UC Davis areas (UC Davis, 2006). The Human Health Risk Characterization Report identified chloroform and tetrachloroethene (PCE) in vadose zone soil in LFU-2 and co-located areas (i.e., the Eastern Trenches and Waste Burial Holes) as “preliminary COCs” based on estimated excess cancer risks above 1×10^{-6} for vapor intrusion into indoor air under future use scenarios that were modeled (UC Davis, 2006). A number of other VOCs have also been detected in previous soil gas sampling (PNL, 1995; Dames & Moore, 1999), but were not include in the risk characterization based on significantly lower estimated cancer risks. To supplement the evaluation conducted in the Risk Characterization Report, the LEHR Team regulators requested that the potential risk associated with VOC vapor intrusion under future use scenarios be further evaluated based on new, depth-discrete Data Gaps soil gas data and following DTSC methodology (DTSC, 2007), as described below.

3.1.2 Vapor Intrusion Evaluation Scope

As described in Table 2-1, the soil gas and soil property analyses conducted for the evaluation of potential soil-to-groundwater impact during this investigation (see Section 2 of this document) also provided data for evaluating potential vapor intrusion risks. Using the DTSC vapor intrusion model (DTSC, 2007) and representative soil properties, area- and depth-specific vapor intrusion screening levels were calculated for each VOC of potential concern in each UC Davis disposal area. These screening levels were then compared with the new Data Gaps soil gas results to determine if any of the VOCs detected present a potential vapor intrusion risk.

In addition to VOCs, each soil gas sample was also screened for methane to evaluate whether it is present at significant levels in any of the DUs. No methane was detected in any of the samples at a 0.1% detection limit, which is below 10% of the lower explosive limit of 5% methane. Based on these results, no additional methane evaluation was conducted.

3.2 Soil Vapor Screening Values Determination

3.2.1 Methodology

Risk-based screening values were determined for VOCs in soil vapor in each of the six UC Davis disposal areas (i.e., LFU1, LFU2, LFU3, Eastern Trenches, WBHs, and Southern Trenches). The screening values were determined using the US EPA version of the Johnson and Ettinger model (J&E, 1991) as modified by the California DTSC to include California-specific toxicity factors. The model software (spreadsheet) was downloaded from DTSC's Johnson and Ettinger Model Website (DTSC, 2007). This model simulates the transport of soil vapors through subsurface soil into indoor air by both diffusion and advection. The model contains a health risk component added by US EPA to calculate the risk from inhaling a specific chemical at the concentration estimated in indoor air. Soil vapor screening values were determined based on a target risk level of 10^{-6} for carcinogens and a hazard quotient of 1.0 for non-carcinogens.

Where appropriate, site-specific parameters were used in the screening value determinations. Site-specific parameters used include soil properties and potential future use scenarios. Additional details on the parameters used in developing the soil vapor screening levels are presented in Appendix E and its associated Table E-1.

3.2.2 Results

The calculated soil vapor screening values for hypothetical future onsite residents and onsite indoor researchers are presented in Table 3-1 and Table 3-2, respectively. Maximum detected concentrations of VOCs in each area at five, 15 and 25 ft bgs are shown next to the screening values for comparison. Soil vapor concentrations are presented in bold on the tables if they exceeded the

screening values. Detection limits (non-detect results) are shown in bold if they exceeded the screening value by more than a factor of two.

As shown in Tables 3-1 and 3-2, most of the soil vapor concentrations were below the screening values. Concentrations of chloroform in soil gas were above resident and researcher screening values for the Eastern Trenches and LFU2. Concentrations of 1,2-dichloropropane in soil gas were above resident screening values for the Eastern Trenches and LFU2 and above the researcher screening value in the Eastern Trenches at five ft bgs. Tetrachloroethene (PCE) was above resident and researcher screening values at five ft bgs in LFU2. 1,2-Dichloroethane (1,2-DCA) was above the resident screening value at 15 ft bgs in the Eastern Trenches and 1,3-butadiene was above the resident screening value at 15 ft bgs in LFU1.

With the exception of 1,3-butadiene, these constituents have been detected previously in Site soil gas and/or groundwater samples. Although 1,3-butadiene is not on the standard analyte list for VOCs in soil gas (by US EPA Methods TO-14 and TO-15) or groundwater (by US EPA Method 8260B or similar), Air Toxics Ltd. (one of the two laboratories used for Data Gaps investigations air analyses) reports results for this compound because it has been identified as a toxic air contaminant under California's air toxics program. This constituent’s presence in ambient air in California and elsewhere is believed to be primarily the result of incomplete combustion of gasoline and diesel (U.S. Department of Health and Human Services, 2005). Incomplete combustion of wood and other organic matter can also generate 1,3-butadiene (U.S. Department of Health and Human Services, 2005), which may explain its presence in LFU1 and other UC Davis DUs. Prior to the Data Gaps investigations, the only 1,3-butadiene results reported in the UC Davis LEHR/SCDS database are for vapor samples from the DDC system, and therefore represent HSU-1 groundwater. No 1,3-butadiene was detected in any of these samples. Because 1,3-butadiene is a gas under most environmental conditions and is reportedly insoluble in water (U.S. Department of Health and Human Services, 2005), it is not expected to be present in groundwater (see also Appendix D). To confirm that 1,3-butadiene is restricted to the vadose zone, analyses for this constituent will be conducted on groundwater samples collected from selected Site wells during the next monitoring event.

3.3 Vapor Intrusion Conclusions and Recommendations

The results of this vapor intrusion screening evaluation indicate that several VOCs (most notably chloroform, PCE and 1,2-dichloropropane) in the LFU2/ET area are at high enough concentrations to be of potential concern for vapor intrusion under potential future Site use scenarios. This conclusion is consistent with the previous Risk Characterization Report for the UC Davis areas (UC Davis, 2006). Still, a reassessment of the human health risk for these areas is recommended to account for the new soil gas data collected during the Data Gaps investigations and recent revisions to the State’s model for assessing vapor intrusion risk. In addition, potential human health risks associated with 1,3-butadiene in soil gas at LFU1 and other UC Davis areas have not been evaluated.

Therefore, the human health risks previously calculated and the risk characterization previously conducted for the UC Davis disposal areas (UC Davis, 2006) will be updated to include these new soil gas results and evaluation tool, and incorporating toxicity values agreed upon by the

LEHR Team. In addition, the soil and groundwater preliminary COC lists developed in the UC Davis Risk Characterization Report (UC Davis, 2006) will be re-evaluated in light of new soil and groundwater data collected and any toxicity values changed since the UC Davis risk estimate (UC Davis, 2005) was completed. Preliminary cleanup goal concentrations for each soil and soil gas COC will also be presented based on the total risk across pathways. Cumulative risks associated with multiple COCs, media and exposure pathways will also be discussed . This risk characterization update and resultant preliminary cleanup levels will be presented in an upcoming LEHR Team meeting and will be included as an appendix to the FS.

4 REFERENCES

Asikainen, J.M. and Nikolaidis, N.P., 1994, "Sequential extraction of chromium from contaminated aquifer sediments." *Ground Water Monitoring and Remediation*, Spring 1994, pp. 185-191.

Barcelona, M.J. and Helom, T.J., 1991, "Oxidation-reduction capacities of aquifer solids," *Environ. Sci. Technol.*, vol. 25, pp. 1565-1572.

Bartlett, R.J., 1991, "Chromium cycling in soils and water: Links, gaps, and methods," *Environ. Health Perspect.*, vol. 92, pp. 17-24.

Bartlett, R. and James, B., 1979, "Behavior of chromium in soils: III Oxidation," *J. Environ. Qual.*, 8: 31-35.

Brown and Caldwell, 2008a, *2007 Comprehensive Annual Water Monitoring Report, LEHR/SCDS Environmental Restoration, University of California, Davis*, April.

Brown and Caldwell, 2008b, "Selection of COCs for Protection of Groundwater for Draft FS, South Campus Disposal Site/Laboratory for Energy-related Health Research, University of California, Davis," presentation at Remedial Project Manager (RPM) meeting, March 17.

California Department of Toxic Substances Control (DTSC), 2007, Johnson and Ettinger Models Website http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm

California Environmental Protection Agency, 2003, *Advisory - Active Soil Gas Investigations*, submitted jointly by the Department of Toxic Substances Control and Los Angeles Regional Water Quality Control Board, January 28.

State Water Resources Control Board (SWRCB), 1996, *1995 AIP Summary Report*, Laboratory for Energy-related Health Research, prepared for United States Department of Energy, Oakland Operations, by Dennis Parfitt, Associate Engineering Geologist, March.

Central Valley Regional Water Quality Control Board (CVRWQCB), 1986, *The Designated Level Methodology for Waste Classification and Cleanup Level Determination*, October.

CVRWQCB, 2009, "Request to Establish Hexavalent Chromium Background Levels in Groundwater", Laboratory for Energy-related Health Resarch, University of California, Davis, Solano County, letter to Ms. Susan Fields, May 29.

Chung, J., Burau, R.G., and Zasoski, R.J., 2001. "Chromate generation by chromate depleted subsurface materials", *Water, Air, and Soil Pollution* 128: 407-417.

Daia, R., Liua, J., Yua, C., Suna, R., Lana, Y., and Mao, J.-D., 2009, "A Comparative Study of Oxidization of Cr(III) in Aqueous Ions, Complex Ions and Insoluble Compounds by Managanese-bearing Mineral (Birnessite)", Chemosphere Volume 76, Issue 4, Pages 536-541.

Dames & Moore, 1997, *Environmental Evaluation/Cost Analysis Groundwater Interim Removal Action, LEHR Environmental Restoration, Davis, California*, April.

Dames & Moore, 1998, *Revised Quality Assurance Project Plan, UC Davis Additional Field Investigations, LEHR/SCDS Environmental Restoration, Davis, California*, Vol. 1, Revision 1, December.

Dames & Moore, 1999, *Groundwater Source Investigation and Data Evaluation Report, SCDS/LEHR Environmental Restoration, Davis*, California, March.

DB Stephens, 2008, Laboratory Report for Weiss Associates (Project 388-1856-1-32), December 12.

Deutsch, W.J., 1997, *Groundwater Geochemistry: Fundamentals and Applications to Contamination*, CRC Press LLC, Boca Raton, FL.

Johnson, P. C., and R. A. Ettinger (J&E). 1991. *Heuristic Model for Predicting the Intrusion of Contaminant Vapors into Buildings*, Environmental Science and Technology, v. 25, n. 8, p. 1445 – 1452.

Gambrell, R.P., 1996, "Manganese," In D.L. Sparks (ed.) *Methods of Soil Analysis*. Part 3, Soil Science Society of America Books Series, No. 5, Madison, WI, p 665-682.

Geomatrix, 2005, *Appendix B, Draft Technical Memorandum, Supplemental Chromium Characterization – HSU-1, LEHR/SCDS, University of California, Davis*, February.

Goldhaber M.B., Morrison J.M., Plulmee G.S., Wanty R.B., Helsel D.R., Wolf R.E., Smith D.B., Hageman P.L., Morman S.A. and Holloway J.M., 2006a, "Regional-scale soil geochemistry in northern California: Natural and anthropogenic sources of soil constituents: Abstracts of the 18th World Congress of Soil Science," July 9-15, 2006, Philadelphia, PA (CD-ROM).

Goldhaber, M.B., Smith, D.B., Morrison, J.M., Wanty, R.B., and Plumlee, G.S., 2006b, "A soil geochemical transect in Northern California: Links to human health," Goldschmidt Conference Abstract, A207.

Goldhaber, M.B., Morrison, J.M., Holloway, J.M., Wanty, R.B., Helsel, D. R. and Smith, D.B. 2009, *A regional soil and sediment geochemical study in northern California*. Applied Geochemistry, Vol. 24, pp. 1482-1499.

Gray, David J., 2003, Naturally occurring Cr6+ in shallow groundwaters of the Yilgarn Craton Western Australia, Co-operative Research Centre for Landscape, Environments and Mineral

Exploration, Wembley, Western Australia, Australia. Geochemistry: Exploration, Environment, Analysis, 3(4), 359-368.

Guertin, J., Jacobs, J.A., Avakian, C.P., eds., 2005, *Chromium (VI) Handbook*. Boca Raton: CRC.

Hoffner, L. R., Loeppert R. H., Newton, R. J., Szaniszlo, P. J., Attrep, M. Jr., 1998, *Literature Review: Phytoaccumulation of Chromium, Uranium, and Plutonium in Plant Systems*, Amarillo National Resource Center for Plutonium, Amarillo, TX 79101, May 1998.

Izbicki, J.A, Kulp, T.R., Bullen, T.D., Ball, J.W., and D.R. O'Leary, in press, *Chromium mobilization from the unsaturated zone*, abstract submitted to Geochimica.

Izbicki, J.A., Ball, J.W., Bullen, T.D., and Sutley, S.J., 2008, *Chromium, chromium isotopes and selected trace elements, western Mojave Desert, USA*, Applied Geochemistry 23 (2008) 1325–1352.

Larssen, D., 2008, personal communication between David Larssen of Westbay Technical Services, Vancouver BC and Bill McIlvride of Weiss Associates, May 15.

Lee, G. Fred, 2008, email to Bob Devany, Weiss Associates, regarding potential for 1,4 dopxane in scintillation waste, August 4.

Middleton, S.S., Latmani, R.B., Mackey, M.R., Ellisman, M.H., Tebo, B.M., and Criddle, C.S., 2003, *Cometabolism of Cr(VI) by Shewanella oneidensis MR-1 produces cell-associated reduced chromium and inhibits growth*. Published online 23 June 2003 in Wily InterScience (www.interscience.wiley.com).

Negra, C., Ross, D.S., and Lanzirotti, A., 2005. "Oxidizing Behavior of Soil Manganese: Interactions among Abundance, Oxidation State, and pH." *Soil Sci. Soc. Am. J.* 69:87-95.

Nitao, J., 1998, *Reference Manual for the NUFT Flow and Transport Code*, Version 2.0, UCRL-MA-130651, Livermore, CA: Lawrence Livermore National Laboratory.

Nriagu, J. O., Nieboer, E., eds., 1988, *Chromium in the Natural and Human Environments*, New York: John Wiley & Sons.

Oze, C., Bird, D.K., and Fendorf, S., 2007, "Genesis of hexavalent chromium from natural sources in soil and groundwater," *Proceedings of the National Academy of Sciences Online*, www.pnas.org, vol. 104, no. 16, pp. 6544-6549.

Pacific Northwest National Laboratory (PNNL), 1995, *Data Needs for Detailed Evaluation of Presumptive Remedial Actions at the Laboratory for Energy-Related Health Research, University of California*, Davis, October.

PNNL, 1996, *Ground-Water Characterization Field Activities for 1995-1996 Laboratory for Energy-Related Health Research, University of California, Davis*, May.

Post, J.E. 1999. *Manganese oxide minerals: Crystal structures and economic and environmental significance*. Proc. Natl. Acad. Sci. USA, Vol.96, pp.3447-3454.

Qafoku, N.P., Dresel, P.E., McKinley, J.P., Liu, C., Heald, S.M., Ainsworth, C.C., Phillips, J.L., and Fruchter, J.S. 2009. *Pathways of aqueous Cr(VI) attenuation in a slightly alkaline oxic surface*. Environ. Sci. Technol., Vo. 43, No. 4.

San Francisco Regional Water Quality Control Board (SFRWQCB), 2007, *Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater*, Interim Final, November.

Schroeder, D., and Lee, G. F., 1975, "Potential Transformations of Chromium in Natural Waters," *Water, Air, and Soil Pollution*, 4:355-365

United States Department of Agriculture, 2005, HYDRUS-1D (software), Version 3.01, http://www .ars.usda.gov/Services/docs.htm?docid=8921, April, accessed June 18, 2008.

U.S. Department of Health and Human Services, Public Health Service, 2005, *Report on Carcinogens, Eleventh Edition*, National Toxicology Program, February.

United States Environmental Protection Agency (US EPA), 1994, *Natural Attenuation of Hexavalent Chromium in Groundwater and Soils*, EPA/540/5-94/505, October.

US EPA, 2000, *In Situ Treatment of Soil and Groundwater Contaminated with Chromium*, EPA/625/R-00/004, October.

US EPA, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, EPA/240/B-06/001, February.

United States Geological Survey (USGS), 2008, *Chromium Concentrations, Chromium Isotopes, and Nitrate in the Unsaturated Zone and at the Water-Table Interface, El Mirage, California*. Letter report submitted to California Regional Water Quality Control Board, Lahontan Region 6, December 24.

USGS, 2006, *Regional-Scale Soil Geochemistry in Northern California: Natural and Anthropogenic Sources of Soil Constituents*, Power Point presentation, November.

University of California, Davis (UC Davis), 2003, *Technical Memorandum – Regional and Site Specific Occurrence of Hexavalent Chromium in Soil and Groundwater*, July 7.

UC Davis, 2004, *Final Remedial Investigation Report, LEHR/SCDS Environmental Restoration, University of California, Davis*, December.

UC Davis, 2005, *Site-wide Risk Assessment, Volume I, Human Health Risk Assessment (Part A – Risk Estimate*), prepared for LEHR/SCDS Environmental Restoration, April.

UC Davis, 2006, *Site-wide Risk Assessment, Volume I, Human Health Risk Assessment (Part C – Risk Characterization for UC Davis Landfill Units*), prepared for LEHR/SCDS Environmental Restoration, April.

UC Davis, 2009a, Final Revised *Groundwater Modeling Work Plan*, Laboratory for Energy-related Health Research/South Campus Disposal Site, Unicersity of California, Davis, letter report, October 23.

UC Davis, 2009b, *2008 Comprehensive Annual Water Monitoring Report for the Laboratory for Energy-related Health Research/South Campus Disposal Site*, University of California, Davis, July.

UC Davis, 2009c, *2009 Semi-Annual Water Monitoring Report for the Laboratory for Energy-related Health Research/South Campus Disposal Site*, University of California, Davis, September.

Vengosh, A. and A. J. Spivak, 1999, "Boron Isotopes in Groundwater" In P.G. Cook and A.L. Herczeg (eds.) *Environmental Tracers in Subsurface Hydrology*, Chapter 16.1, Springer.

Weiss Associates (Weiss), 1997, *Draft Final One Dimensional Vadose Zone Modeling for the US Department of Energy Areas at the Laboratory for Energy-Related Health Research.*

Weiss, 2005, *Site-Wide Risk Assessment, Volume 1, Human Health Risk Assessment (Part B – Risk Characterization for DOE Areas).*

Weiss, 2008a, *Feasibility Study Data Gaps Work Plan for the Laboratory for Energy-related Health Research / South Campus Disposal Site at the University of California at Davis*, September 16.

Weiss, 2008b, *Project Health and Safety Plan for the Laboratory for Energy-related Health Research*, University of California, Davis, Rev. 1, October 13.

Weiss, 2008c, *Quality Assurance Project Plan Revisions for the Laboratory for Energy-Related Health Research / South Campus Disposal Site (LEHR/SCDS)*, University of California, Davis, California, Rev. 1, September 4.

Weiss, 2009, *Addendum to Feasibility Study Data Gaps Work Plan, Proposed Monitoring Well Installation, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis*, November 13.

Weiss, 2010a, *Final Pilot Test Workplan for In Situ Reduction of Chromium for the Laboratory for Energy-related Health Research / South Campus Disposal Site at the University of California at Davis*, January 7.

Weiss, 2010b, *Draft Workplan for 2010 Well Monitoring for the Laboratory for Energy-related Health Research / South Campus Disposal Site at the University of California at Davis*, January 18.

TABLES

Table 1-1. Data Gaps Chromium Investigation – Scope of Work, Modifications, and Rationale, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Work Plan Scope	Modifications / Additional Evaluations	Rationale for Modification
Task CR1. Records Review and Analysis The proposed work included additional geochemical correlation analysis, and records review/interviews focused on the Old Wastewater Treatment Plant and manure management in the area of elevated Cr.	No significant modifications were made, although no interviews or additional research related to manure management were conducted.	As discussed in this report, the placement of manure in the area of elevated Cr (i.e., near wells UCD1-28 and UCD1-53) was eliminated as a likely source of the elevated Cr. Therefore, this modification has no significant impact on meeting DQOs.
Task CR2. Well UCD2-27 Investigation Rehabilitation of this Westbay MP55 Multi-Level Groundwater Monitoring System was proposed to collect aquifer-representative samples from discrete intervals. This included multiple steps of reconditioning to verify the well's proper functioning.	Reconditioning methods were applied according to the scope of work, except for deflating the packers that separate the different sampling zones.	It was determined that the well packers cannot be deflated without their destruction, at significant cost for replacement and reinstallation. It was therefore decided to indefinitely suspend the packer deflation and proposed subsequent steps (i.e., well purging, groundwater ORP readings and analytical parameter analysis, and well redevelopment). Reliable information on the variability with depth of groundwater Cr and other geochemical parameters may have provided some insight into Cr fate and transport; however, not obtaining this information does not have a significant impact on achieving DQOs.
Task CR3. Discrete Interval Soil and Groundwater Geochemical Sampling Soil Sampling and Analysis: Continuous core soil sample collection from two background locations and two hotspot locations was proposed.	Soil samples were collected according to the scope of work, except that hollow-stem auger was used instead of a direct-push rig due to difficulties encountered with both drilling and HSU-1 groundwater collection using direct-push. A total of 28 soil samples from different depths were collected from two hotspot and two background locations and analyzed for parameters specified in the workplan. As an extra scope, these soil samples were analyzed for ORP.	The change in drilling method had no impact on achieving DQOs. The sorption/desorption of chromium is pH/ORP dependent. ORP data were included to demonstrate the stability of hexavalent chromium in Site soil samples, as described in EPA Method 3060A. These additional data enhanced DQO achievement.

Table 1-1. Data Gaps Chromium Investigation – Scope of Work, Modifications and Rationale, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Work Plan Scope	Modifications / Additional Evaluations	Rationale for Modification
Task CR3. Discrete Interval Soil and Groundwater Geochemical Sampling Soil Geochemical Analyses: Geochemical bench test analyses were proposed for a total of 30 soil samples from one hotspot and one background location.	Soil samples were analyzed according to the scope of work. As an extra scope, ten soil samples from the hotspot and background locations were reanalyzed for exchangeable chromium using a higher soil to extractant ratio.	Previous soil investigations by Chung et al. (2001) indicated that a higher soil to extractant ratio yielded detectable chromium concentrations, whereas the ratio used for the initial Data Gaps samples did not. These additional analyses enhanced achievement of DQOs.
Task CR3. Discrete Interval Soil and Groundwater Geochemical Sampling Groundwater: The collection of groundwater samples from two background locations and two hotspot locations was proposed. Sampling was to include two depths within HSU-1 and one at the top of HSU-2.	Because the groundwater level was lower than expected (approximately 60 ft bgs instead of 50 ft bgs) and the groundwater was very slow to come into the open borehole, only one depth interval (approximately 60 to 70 ft bgs) within HSU-1 was sampled. Groundwater samples were analyzed according to the scope of work, except that pH and ORP were not measured.	Hydropunch groundwater samples recharged very slowly in the low yielding HSU-1 water-bearing zone, making it infeasible to sample more than one interval and resulting in potentially unreliable ORP and pH data. Sufficient ORP and pH data are available from nearby HSU-1 monitoring wells; therefore this modification had no significant impact on meeting DQOs.
Task CR4. Chromium HSU-1 Hydropunch Investigation The collection of six HSU-1 hydropunch groundwater samples with analysis for Cr was proposed to improve the definition of Cr distribution and optimally locate two new HSU-1 monitoring wells.	No modifications were made. Samples were collected according to the proposed scope of work and two new wells were installed as planned.	NA
Task CR5. Cr New Well Installation The work plan proposed the installation of three new HSU-1 wells: one north and one south of the elevated Cr area based on the hydropunch results (Task CR4), and one background location south of Putah Creek. The work plan also proposed two new HSU-2 wells down-gradient of the Site.	No modifications were made.	NA

Table 1-1. Data Gaps Chromium Investigation – Scope of Work, Modifications and Rationale, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Work Plan Scope	Modifications / Additional Evaluations	Rationale for Modification
Task CR6. Well Water Geochemical Analyses Groundwater sampling was proposed from selected HSU-1 and HSU-2 wells with analysis for chromium and other key geochemical parameters on a quarterly basis for the duration of one year.	Groundwater samples were collected according to the scope of work, with the first and second quarterly sampling completed in October and December 2008, respectively, and the third and fourth quarterly sampling completed in February and May 2009, respectively. During the October 2008 sampling event, field measurements for DO, ORP, pH, and SC were collected using a Hydrolab downhole probe. However, during the second, third, and fourth quarterly monitoring events, these field measurements were collected above ground using a micropurge flow-through cell. During the May 2009 sampling event, groundwater samples were not collected from wells UCD1-63 and UCD2-46 for Cr analysis and field measurements. Cr and field data will be collected during the next groundwater monitoring event. As an extra scope, selected groundwater samples collected during the second quarterly sampling event were analyzed for silica, vanadium, uranium, aluminum, arsenic, and carbon dioxide.	DO, ORP, and pH data collected with the downhole probe were suspected to be unreliable, therefore a micropurge flow-through cell was used to collect representative measurements. Access to well UCD2-46 was blocked during the May 2009 sampling event. Inadvertently, no sample was collected from well UCD1-63. The additional parameters were measured during the second quarterly sampling event to aid in the evaluation of the redox geochemistry by comparing chromium to other oxyanions. None of these modifications to Task CR6 had any significant impact on meeting DQOs.
Task CR7. Data Evaluation Data evaluation, including the spatial and temporal distribution of Cr and related parameters, was proposed.	No modifications were made.	NA

Note:
Chung, J-B., Burau, R., and Zasoski, R., 2001. *Chromate Generation by Chromate Depleted Subsurface Materials*. Water, Air, and Soil Pollution 128:407-417.

Abbreviations:

Cr	chromium	ft bgs	feet below ground surface	SC	specific conductance
DO	dissolved oxygen	HSU	hydrostratigraphic unit		
DQO	data quality objective	NA	not applicable		
EPA	Environmental Protection Agency	ORP	oxidization reduction potential		

Table 1-2. Chromium Data Gaps Investigation, Summary of Parameters in Groundwater, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Location ID	Sample ID	Sample Date	Lab	Screened Interval	Cr	Cr VI	Mn	Fe	Fe (II)	Ni	B	Fluoride	Cl	Na	K	Mg	Ca	Ortho-phosphate (as P)	Phos-phorous	Nitrate	Sulfate	Carbonate	Bi-carbonate	DOC	DO	ORP	pH	SC
			Units:	ft bgs	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mV	pH Units	mS/cm
BGCR-1	BGCR-1-55	09/22/08	CTB	54-65	13	11 J	6.0	<100	<0.10 UJ	<5.0	610	0.42	19	28,000	1,300	98,000	35,000	---	0.10	7.7	47	<6.7	490	2.3	---	---	---	---
	BGCR-1-85	09/22/08	CTB	80-85	7.3	<0.50 UJ	17,000	<100	0.34 J	710	450	<0.50	21	44,000	3,500	260,000	200,000	---	0.091	5.7	1,300	<6.7 /<6.7 R*	1,400/450 J*	5.3	---	---	---	---
BGCR-2	GWGW2300	09/23/08	CTB	65-70	6.4	9.0	170	<100 UJ	<0.10 UJ	6.9	760	0.36	11	64,000	1,600	69,000	43,000	---	0.33	45	40	<6.7	830	2.7	---	---	---	---
	GWGW2301	09/24/08	CTB	95-98	<5.0	<0.50	480	<100	<0.10	5.6	500	0.51	13	48,000	2,000	53,000	28,000	---	<0.030	2.0	49	<6.7 /9.3 J*	4,900/340 J*	5.7	---	---	---	---
	GWGW2302-DUP	09/24/08	CTB	95-98	<5.0	<0.50	480	<100	<0.10	5.7	500	0.50	13	47,000	2,000	51,000	27,000	---	<0.030	2.0	48	<6.7	4,900	7.1	---	---	---	---
HSCR-1	GWGW2294	09/29/08	CTB	61-70	82	82	43	<100	<0.10	<5.0	800	0.42	82	82,000	<5,000	130,000	53,000	0.12	---	39	43	<6.7	560	4.5	---	---	---	---
	GWGW2295	09/29/08	CTB	85-91.5	<5.0	<1.0	300	150	<0.10	<5.0	700	0.31	78	78,000	<5,000	130,000	45,000	0.046	---	36	46	<6.7 /<6.7 R*	4,500/500 J*	5.0	---	---	---	---
HSCR-2	GWGW2296	09/30/08	CTB	57.5-69.5	530	510	8.2	<100	<0.10	<5.0	1,000	0.59	44	97,000	6,300	81,000	34,000	---	0.096 J	17	81	39	410	3.8	---	---	---	---
	GWGW2297	09/30/08	CTB	80-85	44	41	<5.0	<100	<0.10	<5.0	650	0.17	47	76,000	3,900	44,000	22,000	---	0.14 J	20	84	130 /35 J*	950/130 J*	5.1	---	---	---	---
HP-1	GWGW2273	09/03/08	CTB	72-75	60	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP-2	GWGW2274	09/05/08	CTB	72-75	71	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP-3	GWGW2275	09/05/08	CTB	72-75	38	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP-4	GWGW2277	09/10/08	CTB	72-75	130	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP-5	GWGW2278	09/10/08	CTB	72-75	6.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.3	---	---	---	---	---	---	---	---
HP-6	GWGW2279	09/10/08	CTB	72-75	190	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LF1-2	GWGW2287	09/16/08	CTB	62-75	17	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LF2-4	GWGW2288	09/18/08	CTB	63-75	---	26	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WBH-2	GWGW2292	09/16/08	CTB	65-75	8.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WBH-3	GWGW2293	09/16/08	CTB	64-75	---	42	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
WBH-4	GWGW2286	09/15/08	CTB	63-75	38	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4.5	---	---	---	---	---	---	---	---
UCD1-004**	GWGW2475	05/22/09	CELG	45-55	16.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5.28	194	7.34	927
UCD1-011	GWGW2307	10/08/08	CTB	50-65	160	150	<5.0	<100	<0.10	<5.0	870	0.30	63	84,000	790	140,000	59,000	0.16	---	37	40	<6.7	630	1.1	---	---	7.55	1,208
	GWGW2307	10/16/08	CTB	50-65	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.16	---	---	---	---	---	---	---	---	---
	GWGW2368A	12/03/08	CELG	50-65	145	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.91	723	7.50	1,318
	GWGW2368B-DUP	12/03/08	CELG	50-65	150	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.91	723	7.50	1,318
	GWGW2409	02/09/09	CELG	50-65	153	---	---	---	---	---	---	---	---	---	---	---	---	---	---	48 J	---	---	---	---	3.17	118	7.46	1,377
	GWGW2410-DUP	02/09/09	CELG	50-65	159	---	---	---	---	---	---	---	---	---	---	---	---	---	---	48 J	---	---	---	---	3.17	118	7.46	1,377
	GWGW2476	05/20/09	CELG	50-65	152	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.52	185	7.45	1,560
UCD1-012	GWGW2308	10/09/08	CTB	49.5-64.5	130	120	<5.0	<100	<0.10	<5.0	970	0.36	130	100,000	1,000	170,000	45,000	0.27	---	66	170	<6.7	450	1.9	---	---	8.14	1,769
	GWGW2308	10/16/08	CTB	49.5-64.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.25	---	---	---	---	---	---	---	---	---
	GWGW2369	12/03/08	CELG	49.5-64.5	139	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5.64	688	8.02	1,551
	GWGW2411	02/12/09	CELG	49.5-64.5	138	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	7.95	107	7.99	1,422

Table 1-2. Chromium Data Gaps Investigation, Summary of Parameters in Groundwater, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Location ID	Sample ID	Sample Date	Lab	Screened Interval	Cr	Cr VI	Mn	Fe	Fe (II)	Ni	B	Fluoride	Cl	Na	K	Mg	Ca	Ortho-phosphate (as P)	Phos-phorous	Nitrate	Sulfate	Carbonate	Bi-carbonate	DOC	DO	ORP	pH	SC
				Units: ft bgs	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mV	pH Units	mS/cm
UCD1-012	GWGW2477-DUP	05/19/09	CELG	49.5-64.5	129	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6.68	155	8.31	1,761
	GWGW2478	05/19/09	CELG	49.5-64.5	126	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6.68	155	8.31	1,761
UCD1-018	GWGW2310	10/08/08	CTB	54-69	8.0	8.0	<5.0	<100	<0.10	<5.0	460	0.38	11	32,000	520	74,000	29,000	0.20	---	3.6	31	<6.7	370	<1.0	---	---	8.01	587
	GWGW2310	10/16/08	CTB	54-69	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.17	---	---	---	---	---	---	---	---	---
	GWGW2371	12/05/08	CELG	54-69	7.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6.23	551	7.66	596
	GWGW2413	02/05/09	CELG	54-69	5.35	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5.20	130	7.67	723
	GWGW2414-DUP	02/05/09	CELG	54-69	5.23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5.20	130	7.67	723
	GWGW2480	05/22/09	CELG	54-69	9.78	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5.14	200	7.77	801
UCD1-028	GWGW2317	10/08/08	CTB	53-68	490	450	<5.0	<100	<0.10	<5.0	1,200	0.30	---	100,000	1,300	180,000	59,000	0.12	---	---	---	<6.7	770	1.5	---	---	7.41	1,515
	GWGW2317	10/14/08	CTB	53-68	---	---	---	---	---	---	---	---	48	---	---	---	---	---	---	67	44	---	---	---	---	---	---	---
	GWGW2317	10/16/08	CTB	53-68	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.12	---	---	---	---	---	---	---	---	---
	GWGW2373	12/04/08	CELG	53-68	425	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.81	630	7.39	1,616
	GWGW2423	02/06/09	CELG	53-68	455	---	---	---	---	---	---	---	---	---	---	---	---	---	---	67	---	---	---	---	7.61	261	7.51	1,469
	GWGW2486	05/21/09	CELG	53-68	424	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4.01	177	7.46	1,699
UCD1-058	GWGW2325	10/15/08	CTB	5 -70	63	61	<5.0	<100	<0.10	<5.0	1,600	0.33	26	140,000	1,200	60,000	29,000	0.18	0.19	16	59	<6.7	500	1.4	---	---	7.79	943
	GWGW2376	12/04/08	CELG	5 -70	64.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5.16	197	7.86	1,141
	GWGW2431	02/04/09	CELG	5 -70	63.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	20	---	---	---	---	5.03	125	7.70	1,185
	GWGW2487	05/21/09	CELG	5 -70	74.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5.17	228	7.73	1,092
UCD1-061	GWGW2326	10/14/08	CTB	56-71	65	65	<5.0	<100	<0.10	<5.0	1,100	0.24	43	88,000	4,100	120,000	33,000	0.17	0.19	9.3	59	<6.7	660	1.2	---	---	7.66	1,300
	GWGW2377	12/04/08	CELG	56-71	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	9.5 J	---	---	646	---	1.49	116	7.69	1,242
	GWGW2432	02/04/09	CELG	56-71	45.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	10	---	---	---	---	0.93	193	7.60	1,277
UCD1-062	GWGW2327	10/16/08	CTB	56-71	120	120	9.3	<100	<0.10	<5.0	1,100	0.28	56	91,000	2,800	180,000	70,000	0.17	0.18	27	160	<6.7	740	1.1	---	---	7.29	1,695
	GWGW2378	12/03/08	CELG	56-71	123	---	---	---	---	4.12	---	---	---	---	---	---	---	---	---	28 J	---	---	722	---	4.08	149	7.59	1,678
	GWGW2433	02/09/09	CELG	56-71	155	---	---	---	---	3.25 J	---	---	---	---	---	---	---	---	---	25	---	---	---	---	3.62	210	7.34	1,517
	GWGW2489	05/20/09	CELG	56-71	122	---	---	---	---	1.56	---	---	---	---	---	---	---	---	---	23	---	---	---	---	3.47	231	7.4	1,383
UCD1-063	GWGW2328A	10/14/08	CTB	65-80	29	30	<5.0	<100	<0.10	<5.0	650	0.39	18	58,000	1,700	49,000	26,000	0.14	0.14	1.2	35	<6.7	360	<1.0	---	---	7.97	726
	GWGW2328B-DUP	10/14/08	CTB	65-80	29	30	<5.0	<100	<0.10	<5.0	650	0.37	18	57,000	1,700	49,000	26,000	0.14	0.12	1.3	35	<6.7	360	<1.0	---	---	7.97	726
	GWGW2379A	12/03/08	CELG	65-80	25.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	334	---	6.89	125	8.07	653
	GWGW2379B-DUP	12/03/08	CELG	65-80	24.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	338	---	6.89	125	8.07	653
	GWGW2434	02/03/09	CELG	65-80	23.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	7.64	142	7.96	659
UCD2-040	GWGW2359	10/13/08	CTB	86-106	47	46	<5.0	<100	<0.10	14	580	0.42	19	46,000	590	82,000	49,000	0.096	0.099	12	47	<6.7	490	<1.0	---	---	7.66	818
	GWGW2384	12/05/08	CELG	86-106	46.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.00	570	7.53	876
	GWGW2447	02/11/09	CELG	86-106	51.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.29	144	7.61	911
	GWGW2497	05/22/09	CELG	86-106	46.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.82	170	7.64	1,009
UCD2-046	GWGW2360	10/13/08	CTB	84.5-104.5	58	55	<5.0	<100	<0.10	<5.0	1,200	0.32	37	84,000	1,100	100,000	64,000	0.10	0.11	15	75	<6.7	570	1.1	---	---	7.64	1,029
	GWGW2385	12/05/08	CELG	84.5-104.5	63.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.30	573	7.54	1,123
	GWGW2449	02/03/09	CELG	84.5-104.5	73.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5.03	110	7.67	1,122
UCD2-048	GWGW2361	10/14/08	CTB	90-100	34	34	5.0	<100	<0.10	<5.0	660	0.29	21	46,000	710	85,000	51,000	0.10	0.10	11	48	<6.7	470	<1.0	---	---	7.71	803
	GWGW2386	12/05/08	CELG	90-100	32.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.20	501	7.69	827
	GWGW2450	02/12/09	CELG	90-100	28.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6.7 J	---	---	---	---	2.87	149	7.68	771

Table 1-2. Chromium Data Gaps Investigation, Summary of Parameters in Groundwater, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Location ID	Sample ID	Sample Date	Lab	Screened Interval	Cr	Cr VI	Mn	Fe	Fe (II)	Ni	B	Fluoride	Cl	Na	K	Mg	Ca	Ortho-phosphate (as P)	Phos-phorous	Nitrate	Sulfate	Carbonate	Bi-carbonate	DOC	DO	ORP	pH	SC
			Units:	ft bgs	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mV	pH Units	mS/cm
UCD2-048	GWGW2499	05/19/09	CELG	90-100	25.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	193	176	7.8	821
UCD2-056	GWGW2362	10/15/08	CTB	78-88	88	88	<5.0	<100	<0.10	<5.0	870	0.26	30	72,000	910	97,000	56,000	0.10	0.11	12	50	<6.7	590	<1.0	---	---	7.69	1,182
	GWGW2387	12/05/08	CELG	78-88	92.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.30	360	7.75	1,150
	GWGW2451	02/06/09	CELG	78-88	83.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	13	---	---	---	---	3.65	151	7.64	1,191
	GWGW2500	05/20/09	CELG	78-88	66.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.77	137	7.7	1,194
UCD2-059	GWGW2364	10/15/08	CTB	92-112	61	58	23	<100	<0.10	<5.0	940	0.26	27	74,000	1,400	95,000	58,000	0.098	0.096	11	53	<6.7	530	<1.0	---	---	7.66	907
	GWGW2389	12/05/08	CELG	92-112	58.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	525	---	6.31	190	7.76	1,092
	GWGW2453	02/03/09	CELG	92-112	63.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4.25	128	7.59	1,099
	GWGW2501	05/19/09	CELG	92-112	58.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.35	345	7.63	941
UCD2-060	GWGW2365A	10/15/08	CTB	92-112	47	45	<5.0	<100	<0.10	<5.0	940	0.28	20	77,000	1,200	94,000	57,000	0.10	0.10	5.9	49	<6.7	540	<1.0	---	---	7.70	863
	GWGW2365B-DUP	10/15/08	CTB	92-112	47	46	<5.0	<100	<0.10	<5.0	930	0.28	20	73,000	1,100	90,000	55,000	0.10	0.11	5.9	49	<6.7	540	<1.0	---	---	7.70	863
	GWGW2390	12/04/08	CELG	92-112	46.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	546	---	2.80	116	7.84	1,040
	GWGW2454	02/04/09	CELG	92-112	41.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3.11	221	7.70	1,077
	GWGW2502	05/19/09	CELG	92-112	47.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2.27	241	7.67	926

Parameter Abbreviations:

B = Boron
Ca = Calcium
Cl = Chloride
Cr = Chromium
Cr VI = Hexavalent chromium
DO = Dissolved Oxygen
DOC = Dissolved Organic Carbon
K = Potassium
Fe = Iron
Fe (II) = Ferrous iron
Mg = Magnesium
Mn = Manganese
Na = Sodium
Ni = Nickel
ORP = Oxidation Reduction Potential
P = Phosphorous
pH = Concentration of hydrogen ions
SC = Specific conductance
TOC = Total Organic Carbon

Location Abbreviations:

BGCR-1 = Background chromium location 1
BGCR-2 = Background chromium location 2
HSCR-1 = Hot spot chromium location 1
HSCR-2 = Hot spot chromium location 2
HP-1 = Chromium definition hydropunch location 1
LF1-2 = Landfill 1, location 2
LF2-4 = Landfill 2, location 4
LF3-2 = Landfill 3, location 2
WBH-2 = Waste burial hole, location 2
WBH-3 = Waste burial hole, location 3

Notes:

--- = Not analyzed
** = Well UCD1-004 dry for sampling events in 10/08, 12/08 and 2/09
CELG = California Environmental Laboratories, Inc., Garden Grove, California
CTB = Curtis and Tompkins Laboratory, Berkeley, California
DUP = Blind duplicate for field sample
ft bgs = Feet below ground surface
J = Result is qualified as an estimated concentration or amount
mg/L = Milligrams per liter
mV = Millivolts
R = Rejected result
µg/L = Micrograms per liter
mS/cm = MilliSiemen per centimeter
UJ = Result is not detected at an estimated detection limit
1,400/450* = Result with asterisk (*) was filtered prior to analysis
DO, ORP, pH and SC measured with field instruments

Table 1-3. Chromium Data Gaps Investigation, Summary of Parameters in Soil, LEHR/South Campus Disposal Site, University of California, Davis

Location ID	Sample ID	Sample Date	Lab	Sample Depth	Cr	Cr VI	Fe	Mn	B	pH	ORP	Nitrate	Sulfate	Ortho-phosphate (as P)	Phos-phorous	Moisture	TOC
				Units: ft bgs:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	pH Units	mV	mg/kg	mg/kg	mg/kg	mg/kg	%	%
BGCR-1	SSBGCR-1-5	09/22/08	CTB	5	96	<0.045	40,000	680	<5.7	8.2	370	<0.6	<5.7	<2.3	<11	13	0.11
	SSBGCR-1-19	09/22/08	CTB	19	160	<0.045	36,000	420	<5.7	7.8	330	<0.6	8.0	1.3	<11	13	0.16
	SSBGCR-1-31	09/22/08	CTB	31	52	<0.047	32,000	1,000	<6.0	7.8	290	<0.6	9.4	0.81	---	16	0.03
	SSBGCR-1-42	09/22/08	CTB	42	100	<0.048	32,000	350	6.1	8.2	300	0.6	8.3	<0.60	---	16	0.06
	SSBGCR-1-58.5	09/22/08	CTB	58.5	170	<0.047	26,000	340	<5.9	8.4	260	<0.6	6.6	<0.59	---	15	0.03
	SSBGCR-1-65.5	09/22/08	CTB	65.5	73	<0.049	25,000	350	<6.1	8.3	280	0.9	14	<0.61	---	18	0.02
	SSBGCR-1-85	09/22/08	CTB	85	42	<0.044	14,000	320	<5.6	8.3	250	0.6	7.7	<0.56	---	10	<0.02
BGCR-2	SSBGCR-2-5	09/23/08	CTB	5	150	<0.044	34,000	570	<5.5	7.9	220	3.7	6.7	0.91	<11	9	0.30
	SSBGCR-2-13	09/23/08	CTB	13	120	<0.044	32,000	590	6.6	8.6	210	2.9	13	2.5	<11	9	0.05
	SSBGCR-2-37	09/23/08	CTB	37	83	<0.048	35,000	660	7.0	8.1	330	1.1	15	1.4	---	15	0.03
	SSBGCR-2-46	09/23/08	CTB	46	96	<0.048	38,000	330	8.3	8.3	310	0.6	24	1.3	---	17	0.03
	SSBGCR-2-63	09/23/08	CTB	63	99	<0.047	37,000	1,100	6.3	8.5	270	<0.6	9.6	<0.59	---	15	0.03
	SSBGCR-2-87	09/23/08	CTB	87	85	<0.051	40,000	670	7.5	8.5	270	<0.6	12	0.68	---	21	0.06
	SSBGCR-2-95	09/23/08	CTB	95	230	<0.050	29,000	430	<6.3	8.2	270	0.6	11	<0.63	---	20	0.19
HSCR-1	HSCR-1-5	09/23/08	CTB	5	150	<0.042	33,000	570	<5.2	8.2	210	11	55	2.0	<10	4	0.35 R
	HSCR-1-20	09/23/08	CTB	20	90	<0.049	31,000	340	7.1	8.310	250	4.7	11	1.4	<13	20	0.06
	HSCR-1-32.5	09/22/08	CTB	32.5	66	<0.048	34,000	520	7.8	8.2	270	5.7	22	<0.61	---	18	0.04
	SSHSCR-1-42	09/30/08	CTB	42	69	<0.047	36,000	410	17	7.7	320	5.3 J	15	2.4 J	---	14	0.02
	SSHSCR-1-56	09/30/08	CTB	56	48	<0.047	25,000	380	7.8	8.1	290	3.0 J	15	1.5 J	---	14	<0.02
	SSHSCR-1-73	09/30/08	CTB	73	66	<0.046	24,000	420	8.2	8.0	260	4.3 J	10	1.6 J	---	13	<0.02
	SSHSCR-1-90	09/30/08	CTB	90	150	<0.047	25,000	340	9.8	8.3	260	1.1 J	12	0.76 J	---	13	<0.02
HSCR-2	SSHSCR-2-5	09/30/08	CTB	5	120	<0.045	30,000	460	11	8.2	250	6.7 J	41	1.8 J	<11	11.55	0.19
	SSHSCR-2-17	09/30/08	CTB	17	65	<0.049	28,000	660	9.2	8.3	260	12 J	53	4.9 J	<12	18	0.07
	SSHSCR-2-27	09/30/08	CTB	27	61	<0.049	35,000	1,500	12	8.1	250	4.7 J	34	3.9 J	---	18	0.02
	SSHSCR-2-39	09/30/08	CTB	39	70	<0.047	38,000	1,900	12	8.3	250	2.8 J	17	2.2 J	---	15	<0.02
	SSHSCR-2-53	09/30/08	CTB	53	92	<0.047	16,000	130	8.0	8.3	230	2.1 J	19	1.3 J	---	16	<0.02
	SSHSCR-2-63	09/30/08	CTB	63	73	<0.047	28,000	750	9.7	8.2	230	1.7 J	14	1.4 J	---	14	<0.02
	SSHSCR-2-83	09/30/08	CTB	83	150	<0.047	24,000	370	8.2	9.240	192.9	2.9 J	30	0.57 J	---	14	<0.02
LF1-2	SSLF1-2-15.5	09/15/08	CTB	15.5	---	---	---	---	---	---	---	---	---	---	---	20	---
	SSLF1-2-20	09/15/08	CTB	20	---	---	---	---	---	---	---	---	---	---	---	23	---
	SSLF1-2-27.5	09/15/08	CTB	27.5	---	---	---	---	---	---	---	---	---	---	---	19	---
	SSLF1-2-37.5	09/15/08	CTB	37.5	---	---	---	---	---	---	---	---	---	---	---	17	---

Table 1-3. Chromium Data Gaps Investigation, Summary of Parameters in Soil, LEHR/South Campus Disposal Site, University of California, Davis

Location ID	Sample ID	Sample Date	Lab	Sample Depth	Cr	Cr VI	Fe	Mn	B	pH	ORP	Nitrate	Sulfate	Ortho-phosphate (as P)	Phos-phorous	Moisture	TOC
				Units: ft bgs:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	pH Units	mV	mg/kg	mg/kg	mg/kg	mg/kg	%	%
LF2-4	SSLF2-4-12.5	09/17/08	CTB	12.5	---	<0.024 UJ	---	---	---	8.1 J	220	---	---	---	---	16	---
	SSLF2-4-20	09/17/08	CTB	20	---	<0.023 UJ	---	---	---	7.8 J	220	---	---	---	---	14	---
	SSLF2-4-25	09/17/08	CTB	25	---	<0.022 UJ	---	---	---	7.7 J	220	---	---	---	---	8	---
	SSLF2-4-32.5	09/17/08	CTB	32.5	---	<0.021 UJ	---	---	---	7.9 J	240	---	---	---	---	5	---
LF3-2	SSLF3-2-12.5	09/18/08	CTB	12.5	---	---	---	370	---	---	---	---	---	---	---	15	---
	SSLF3-2-20	09/18/08	CTB	20	---	---	---	330	---	---	---	---	---	---	---	18	---
	SSLF3-2-27.5	09/18/08	CTB	27.5	---	---	---	560	---	---	---	---	---	---	---	16	---
	SSLF3-2-32.5	09/18/08	CTB	32.5	---	---	---	340	---	---	---	---	---	---	---	18.69	---
WBH-2	SSWBH-2-15	09/16/08	CTB	15	---	<0.024 UJ	---	---	---	8.2 J	220	---	---	---	---	18	---
	SSWBH-2-20	09/16/08	CTB	20	---	<0.025 UJ	---	---	---	8.1 J	210	---	---	---	---	18	---
	SSWBH-2-30	09/16/08	CTB	30	---	<0.021 UJ	---	---	---	7.9 J	190	---	---	---	---	5	---
	SSWBH-2-35	09/16/08	CTB	35	---	<0.021 UJ	---	---	---	8.3 J	200	---	---	---	---	5	---
WBH-3	SSWBH-3-7.5	09/16/08	CTB	7.5	---	<0.024 UJ	---	---	---	7.5 J	240	---	---	---	---	15	---
	SSWBH-3-20	09/16/08	CTB	20	---	<0.024 UJ	---	---	---	8.0 J	220	---	---	---	---	17	---
	SSWBH-3-27.5	09/16/08	CTB	27.5	---	<0.023 UJ	---	---	---	8.0 J	220	---	---	---	---	12	---

Parameter Abbreviations:

B = Boron
Cr = Chromium
Cr VI = Hexavalent chromium
Fe = Iron
Mn = Manganese
ORP = Oxidation Reduction Potential
P = Phosphorous
pH = Concentration of hydrogen ions
TOC = Total Organic Carbon

Location Abbreviations:

BGCR-1 = Background chromium location 1
BGCR-2 = Background chromium location 2
HSCR-1 = Hot spot chromium location 1
HSCR-2 = Hot spot chromium location 2
LF1-2 = Landfill 1, location 2
LF2-4 = Landfill 2, location 4
LF3-2 = Landfill 3, location 2
WBH-2 = Waste burial hole, location 2
WBH-3 = Waste burial hole, location 3

Notes:

--- = Not analyzed
% = Percent
CTB = Curtis and Tompkins Laboratory, Berkeley, California
ftbgs = Feet below ground surface
J = Result is qualified as an estimated concentration or amount
mg/L = Milligrams per liter
mV = Millivolt
R = Rejected result
UJ = Result is not detected at an estimated detection limit

Table 1-4. Bench Test Results of Data Gaps Samples Evaluating the Ability of Soils to Release Cr(VI) Into Groundwater, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

					Chromium (Cr) Extraction				Manganese (Mn) Extraction		
Sample ID	**Sample Date**	**Extraction Date**	**Sample Depth**	**Water-bearing zone**	**DI Extractable Cr**	**Exchangeable Cr**	**Available Cr(III)**	**Oxidation of Cr(III) to Cr(VI)**	**DI Extractable Mn**	**Easily Reducible Mn**	**Available Mn**
			ft bgs		<<---------- milligram per kilogram (mg/kg) ---------->>						
Hotspot Soil Sample Location SSHS-Cr-2											
SSHS-Cr-2-2	9/30/2008	10/27-11/12/08	2	HSU-1	0.12	< 0.10	0.14	8.0	0.16	240	180
SSHS-Cr-2-2 LD	9/30/2008	Feb-09	2	HSU-1	n.a.	n.a.	0.37	n.a.	n.a.	n.a.	n.a.
SSHS-Cr-2-5	9/30/2008	10/27-11/12/08	5	HSU-1	< 0.10	< 0.10	0.81	9.3	< 0.10	250	280
SSHS-Cr-2-5*	9/30/2008	3/30/2009	5	HSU-1	n.a.	0.019*	n.a.	n.a.	n.a.	n.a.	n.a.
SSHS-Cr-2-10	9/30/2008	10/27-11/12/08	10	HSU-1	0.11	< 0.10	2.01	8.3	0.11	150	340
SSHS-Cr-2-10 LD	9/30/2008	Feb-09	10	HSU-1	n.a.	n.a.	1.40	n.a.	n.a.	n.a.	n.a.
SSHS-Cr-2-17	9/30/2008	10/27-11/12/08	17	HSU-1	0.12	< 0.10	0.41	12.9	< 0.10	240	260
SSHS-Cr-2-17*	9/30/2008	3/10/2009	17	HSU-1	n.a.	0.044*	n.a.	n.a.	n.a.	n.a.	n.a.
SSHS-Cr-2-25.5	9/30/2008	10/27-11/12/08	25.5	HSU-1	0.15	< 0.10	0.31	9.4	< 0.10	290	320
SSHS-Cr-2-27	9/30/2008	10/27-11/12/08	27	HSU-1	0.20	< 0.10	0.26	6.4	0.11	370	250
SSHS-Cr-2-27*	9/30/2008	3/30/2009	27	HSU-1	n.a.	0.003*	n.a.	n.a.	n.a.	n.a.	n.a.
SSHS-Cr-2-30	9/30/2008	10/27-11/12/08	30	HSU-1	0.17	< 0.10	0.41	7.2	< 0.10	290	310
SSHS-Cr-2-39	9/30/2008	10/27-11/12/08	39	HSU-1	0.13	< 0.10	0.46	6.8	< 0.10	490	400
SSHS-Cr-2-45	9/30/2008	10/27-11/12/08	45	HSU-1	0.24	< 0.10	1.86	2.9	< 0.10	130	160
SSHS-Cr-2-45*	9/30/2008	3/30/2009	45	HSU-1	n.a.	<0.005*	n.a.	n.a.	n.a.	n.a.	n.a.
SSHS-Cr-2-53	9/30/2008	10/27-11/12/08	53	HSU-1	0.15	< 0.10	0.66	2.1	< 0.10	140	160
SSHS-Cr-2-58	9/30/2008	10/27-11/12/08	58	HSU-1	0.14	< 0.10	0.51	0.1	< 0.10	55	95
SSHS-Cr-2-63	9/30/2008	10/27-11/12/08	63	HSU-1	0.15	< 0.10	1.71	5.6	< 0.10	260	240
SSHS-Cr-2-69.5	9/30/2008	10/27-11/12/08	69.5	HSU-1	0.16	< 0.10	0.86	4.5	< 0.10	250	200
SSHS-Cr-2-77	9/30/2008	10/27-11/12/08	77	HSU-1	0.16	< 0.10	1.31	2.7	< 0.10	150	130
SSHS-Cr-2-77*	9/30/2008	3/10/2009	77	HSU-1	n.a.	0.021*	n.a.	n.a.	n.a.	n.a.	n.a.
SSHS-Cr-2-83	9/30/2008	10/27-11/12/08	83	HSU-2	0.14	< 0.10	0.71	0.4	< 0.10	110	65
Background Soil Sample Location SSBG-Cr-2											
SSBG-Cr-2-2	9/23/2008	10/27-11/12/08	2	HSU-1	0.14	< 0.10	0.36	9.9	0.15	290	180
SSBG-Cr-2-5	9/23/2008	10/27-11/12/08	5	HSU-1	0.18	< 0.10	0.51	9.4	0.17	260	230
SSBG-Cr-2-5	9/30/2008	3/30/2009	5	HSU-1	n.a.	<0.005*	n.a.	n.a.	n.a.	n.a.	n.a.
SSBG-Cr-2-9	9/23/2008	10/27-11/12/08	9	HSU-1	0.16	< 0.10	0.46	4.8	< 0.10	110	44
SSBG-Cr-2-13	9/23/2008	10/27-11/12/08	13	HSU-1	0.13	< 0.10	0.10	12.5	< 0.10	300	200
SSBG-Cr-2-13*	9/23/2008	3/10/2009	13	HSU-1	n.a.	< 0.005*	n.a.	n.a.	n.a.	n.a.	n.a.
SSBG-Cr-2-25	9/23/2008	10/27-11/12/08	25	HSU-1	0.20	< 0.10	0.31	5.5	0.12	200	23
SSBG-Cr-2-37	9/23/2008	10/27-11/12/08	37	HSU-1	0.11	< 0.10	0.16	7.4	< 0.10	320	240
SSBG-Cr-2-37 LD	9/23/2008	Feb-09	37	HSU-1	< 0.10	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SSBG-Cr-2-37 LD	9/23/2008	Feb-09	37	HSU-1	< 0.10	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SSBG-Cr-2-37-FD	9/23/2008	10/27-11/12/08	37	HSU-1	0.98	< 0.10	0.21	5.7	1.90	340	270
SSBG-Cr-2-37-FD/LD	9/23/2008	Feb-09	37	HSU-1	0.11	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SSBG-Cr-2-37-FD/LD	9/23/2008	Feb-09	37	HSU-1	< 0.10	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SSBG-Cr-2-40	9/23/2008	10/27-11/12/08	40	HSU-1	< 0.10	< 0.10	0.46	2.5	< 0.10	120	80
SSBG-Cr-2-46	9/23/2008	10/27-11/12/08	46	HSU-1	0.11	< 0.10	0.81	1.9	< 0.10	130	85
SSBG-Cr-2-46*	9/30/2008	3/30/2009	46	HSU-1	n.a.	0.001*	n.a.	n.a.	n.a.	n.a.	n.a.
SSBG-Cr-2-57	9/23/2008	10/27-11/12/08	57	HSU-1	0.12	< 0.10	0.86	2.6	< 0.10	250	210
SSBG-Cr-2-63	9/23/2008	10/27-11/12/08	63	HSU-1	0.11	< 0.10	0.36	7.1	< 0.10	400	160
SSBG-Cr-2-65	9/23/2008	10/27-11/12/08	65	HSU-1	0.12	< 0.10	0.31	5.9	< 0.10	290	270
SSBG-Cr-2-75	9/23/2008	10/27-11/12/08	75	HSU-1	< 0.1	< 0.10	0.06	4.3	< 0.10	240	170
SSBG-Cr-2-75*	9/30/2008	3/30/2009	75	HSU-1	n.a.	0.018*	n.a.	n.a.	n.a.	n.a.	n.a.
SSBG-Cr-2-87	9/23/2008	10/27-11/12/08	87	HSU-2	0.14	< 0.10	0.56	2.2	< 0.10	160	55
SSBG-Cr-2-95	9/23/2008	10/27-11/12/08	95	HSU-2	< 0.1	0.13	0.21	2.2	< 0.10	130	55
SSBG-Cr-2-95*	9/23/2008	3/10/2009	95	HSU-2	n.a.	<0.005*	n.a.	n.a.	n.a.	n.a.	n.a.

Notes and Abbreviations:

DI = deionized water
FD = field duplicate
LD = laboratory duplicate
ft bgs = feet below ground surface
n.a. = not analyzed
SSBG-Cr = Soil Sample Background
SSHS-Cr = Soil Sample Hotspot

Available Cr and Mn = ratio of 3 g soil: 150 mL sodium citrate
DI extractable Cr and Mn = ratio of 7.5 g soil: 150 mL DI water
Easily reducible Mn = ratio of 15 g soil: 150 mL ammonium acetate-hydroquinone solution
Exchangeable Cr = ratio of 7.5 g soil: 150 mL potassium phosphate
Results with asterisk (*) = Exchangeable Cr re-run on ratio of 100 g soil: 100 mL potassium phosphate
Cr oxidation test (Bartlett and James, 1979) = ratio of 15 g soil: 150 mL chromium chloride
At the time of sampling in September 2008, first water was encountered at depths greater than 60 ft bgs.

Table 1-5. Evaluation of Potential Source Mechanisms for Chromium in Groundwater, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis.

HYPOTHESIS	EVIDENCE	COUNTER EVIDENCE	COMPARATIVE PROBABILITY ASSESSMENT
1A. Mn reduction and mobilization in anaerobic zone, with subsequent Mn re-oxidation and resultant Cr(III) oxidation in downgradient aerobic zone.	• Likely organic matter disposal (landfill/septic system) • Mn reduction/mobilization: process well-established in landfills • ~40% of total Mn in Site soils composed of Mn oxides • Cr GW hot spots downgradient of landfill/septic systems, distance consistent with GW flow velocity range • Could explain elevated Cr in supply wells in nearby agricultural locations (e.g., south of Putah Creek)	• Post-1988 TOC/DOC and COD data generally show no correlation with GW Mn (earlier data not available) • Mechanism not yet documented at other sites (although reportedly being evaluated currently at Hinkley, California, Cr site).	More Likely
1B. Organic complexation of Cr(III), with downgradient oxidation by Mn oxides.	• Likely organic matter disposal (landfill/septic system) • Cr GW hot spots downgradient of landfill/septic systems, distance consistent with GW flow velocity range • Could explain elevated Cr in supply wells in nearby agricultural locations (e.g., south of Putah Creek) • Site Cr(III) available for complexation (PRIMA bench tests) • Other lab studies show significant Cr(III) complexation (Guertin, J., Jacobs, J.A., Avakian, C.P., eds., 2005)	• Post-1988 TOC/DOC and COD data generally show no or negative correlation with GW Mn (earlier data not available) • Organically chelated complexes very stable (Daia, R. et al., 2009) • Mechanism not yet documented at other sites	More Likely
1C. Organic complexation of Mn oxides, with downgradient oxidation of Cr(III).	• Likely organic matter disposal (landfill/septic system) • Cr GW hot spots downgradient of landfill/septic systems, distance consistent with GW flow velocity range • Site Mn available for complexation (PRIMA bench tests) • Correlation between "available Mn" and Cr(VI) generation	• Post-1988 TOC/DOC and COD data generally show no or negative correlation with GW Mn (earlier data not available) • Chelated Mn might not be able to oxidize Cr(III) • Mechanism not yet documented at other sites	More likely
2. Natural, localized hydrogeologic or biogeochemical anomaly.	• Site soils have strong Cr oxidation potential (PRIMA bench tests) • Other sites show similar pore water Cr levels • Long residence time of HSU-1 could explain high Cr concentration buildup • Could explain elevated Cr in supply wells in other nearby locations (e.g., south of Putah Creek)	• Cr GW hot spots downgradient of known/suspected contaminant sources • Only one other known site (Western Australia) has similar high Cr in GW wells • Only one other known site (New Caledonia) has similar high Cr levels in pore water • No significant hydrogeologic/biogeochemical differences identified between hot spots and other areas • Declining Cr level trends in many wells not correlated with other known hydrogeologic/biogeochemical changes	Less likely
3. Competing anions displace natural Cr(VI) from mineral surfaces.	• Likely organic matter disposal (landfill/septic system, manure/fertilizer) provides competing anions (e.g., sulfate, phosphate) • Cr GW hot spots downgradient of landfill/septic systems, distance consistent with GW flow velocity range • Could explain elevated Cr in supply wells in nearby agricultural locations (e.g., south of Putah Creek) • Site natural system is capable of creating Cr(VI) and soils show some "exchangeable" Cr(VI) (PRIMA bench tests, Chung et al., 2001) • Mechanism hypothesized for Mojave Desert observations (Izbicki et al., in press)	• Measured "exchangeable" Cr levels too low to explain elevated Cr in hotspots • No significant correlations for Cr and anions observed in GW • Discrepancy between "exchangeable" Cr results (PRIMA bench tests) and Cr(VI) results by standard method EPA 3060A (i.e., Cr(VI) generally not detected in soil using EPA Method 3060A)	Less likely
4. Cr release from landfill.	• Potential source of Cr (wastewater sludge, lab wastes) • Cr GW hot spots downgradient of landfill/septic systems, distance consistent with GW flow velocity range	• Does not explain elevated Cr in supply wells in nearby agricultural locations (e.g., south of Putah Creek) • Cr in waste most likely reduced to Cr(III) • Reduced Cr(III) unlikely in close proximity to Mn oxides for reoxidation	Less likely

Note: Full citations for references cited in this table are included in References section of the main document.

Abbreviations:

COD	chemical oxygen demand	GW	groundwater
Cr	chromium	HSU	hydrostratigraphic units
DOC	dissolved organic carbon	Mn	manganese
EPA	Environmental Protection Agency	TOC	total organic carbon

Table 2-1. Data Gaps Disposal Unit Investigation – Scope of Work, Modifications and Rationale, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Work Plan Scope	Modification – Additional Evaluations	Rationale for Modification
Task DU1. Disposal Unit Hydropunch Investigation The proposed work included: 1) two locations to evaluate impact downgradient of LFU1 (these locations were also for chromium definition); 2) five locations in LFU2/Eastern Trenches area for chloroform definition (these were also for soil-to-groundwater impact evaluation); and 3) two locations at east end of WBH area (one of these two was also for soil-to-groundwater impact evaluation).	Sampling in LFU1 and WBH areas was conducted as proposed. For the LFU2/Eastern Trenches area, a total of six hydropunch locations were sampled for groundwater: four locations were sampled for chloroform and other VOC definition (soil gas was also sampled at these locations for soil-to-groundwater impact and vapor intrusion evaluation), and two locations were sampled for definition of other groundwater impact COPCs (vadose zone soil was also sampled for soil-to-groundwater impact evaluation in these locations).	One of the five LFU2/Eastern Trenches locations identified in work plan Section 5.1.2 as being sampled for chloroform in groundwater was actually designated for evaluation of non-volatile groundwater impact COPCs, and therefore the groundwater was not analyzed for chloroform. Groundwater from this location and one other in the LFU2/Eastern Trenches area was analyzed for non-volatile COPCs. These modifications do not significantly impact the achievement of the DQOs.
Task DU2. Disposal Unit New Well Installation Two or three new HSU-1 wells were proposed to monitor potential DU impact, including: 1) eastern edge of LFU3; 2) area of elevated chloroform in or near eastern boundary of LFU2/Eastern Trenches area, if needed based on hydropunch results; and 3) downgradient edge of the WBHs, if needed based on hydropunch results. In addition, a new monitoring well proposed for defining the southwest extent of elevated chromium would also serve as a monitoring well for LFU1. Four quarters of quarterly monitoring for the full suite of groundwater COPCs was proposed for these new wells.	No significant modifications were made. A total of four new wells were installed for DU monitoring: 1) eastern edge of LFU3 as proposed; 2) east of Eastern Trenches based on chloroform soil gas and hydropunch groundwater results; 3) immediately east of WBHs; and 4) northeast corner of LFU1 (also serves as chromium definition monitoring well). In addition to the COPCs identified in the Data Gaps Work Plan, groundwater samples from these new wells and selected existing wells were also analyzed for 1,4-dioxane, perchlorate, and formaldehyde in one or more of the quarterly sampling events.	NA

Table 2-1. Data Gaps Disposal Unit Investigation – Scope of Work, Modifications and Rationale, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Work Plan Scope	Modification – Additional Evaluations	Rationale for Modification
Task SGI1. Vadose Zone to Groundwater Characterization (Non-volatile COCs) Seven soil/groundwater borings (one each in LFU1, LFU2, LFU3, Eastern Trenches, and Southern Trenches and two in WBHs) were proposed. Borings adjacent to waste cells were to be angled up to 20 degrees off vertical to target under the waste cells. Up to eight soil samples and one grab groundwater sample per boring were proposed, with analysis for identified non-volatile potential groundwater impact COPCs or soil properties.	No significant modifications were made. The borings in LFU1 and LFU3 were angled 15 degrees off vertical to target beneath the waste cells. The remaining borings were drilled vertically. Depth to groundwater was expected to be approximately 50 ft bgs, but was actually approximately 60 ft bgs, so borings had to be drilled deeper than planned.	Borings were drilled vertically instead of at an angle based on previous data and information on disposal cell configuration (i.e., targeted disposal cells were too small laterally, too deep, and/or too closely spaced to make angled boring useful and/or practical). The impact of this modification on achieving DQOs is believed to be insignificant.
Task SGI1. Vadose Zone to Groundwater Characterization (Volatile COCs), and **Task DU4. Disposal Unit COC Data Gaps** Eight soil gas/groundwater borings (one each in LFU1, LFU3, Eastern Trenches, Southern Trenches, and WBHs and three in LFU2) were proposed. Soil gas was to be collected at five, 15 and 25 ft bgs following methodology in *Advisory – Active Soil Gas Investigations*, with minor modifications. Proposed analyses included methane measured in the field and VOCs analyzed in a laboratory by EPA Method TO-14 or TO-15.	Sampling and analysis were conducted as proposed, with the following additions: 1) Following collection of VOC samples at all locations except those in the Southern Trenches, samples were collected in lab-supplied tubes for formaldehyde analysis by EPA Method TO-11A. 2) One of the two laboratories reported compounds not included on the Method TO-15 list, resulting in 1,3-butadiene being identified as a COPC in several of the disposal areas.	Formaldehyde was identified as a COPC for groundwater impact and vapor intrusion after the work plan was finalized and was added to the field protocol. The standard TO-15 reporting list for one of the two laboratories used included additional compounds not on the standard TO-15 list. Of these additional compounds, this laboratory reported detections of 1,3-butadiene, hexane, and ethanol; therefore, the other laboratory was requested to also report these constituents. These changes had a positive effect on achieving DQOs in that they enhanced the DU characterization.

Table 2-1. Data Gaps Disposal Unit Investigation – Scope of Work, Modifications and Rationale, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Work Plan Scope	Modification – Additional Evaluations	Rationale for Modification
Task SGI2. Groundwater Impact Evaluation, and **Task DU5. New Data Evaluation** The proposed work included: 1) developing screening levels and conducting risk characterization to identify groundwater impact COCs for each DU; and 2) evaluating potential vapor intrusion to indoor air and methane risk, if any.	No modifications were made.	NA

Abbreviations:

COC	Constituent of Concern
COPC	Constituent of Potential Concern
DQO	Data Quality Objective
DU	Disposal Unit
EPA	Environmental Protection Agency
ft bgs	feet below ground surface
LFU	Landfill Unit
NA	not applicable
SGI	soil-to-groundwater impact
VOC	volatile organic compound
WBH	Waste Burial Holes

Table 2-2. Non-volatile Constituents of Potential Concern for Groundwater Impact in Each Disposal Unit, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis [1]

	Step 1							Step2				Step 3		
Constituents	**Units**	**Number of Detections**	**Number of Samples**	**Number of Solid Waste Samples**	**Frequency of Detection (FD)**	**Maximum Detection**	**Background Screening Level**	**Is Maximum Concentration > 1.5 x Background Concentrations and FD > 5%?**	**Do Site Concentrations Rank Differently than Background Concentrations?[2]**	**Number of Detections Above Background Screening Level**	**Percent of Data Above Background Screening Level**	**Partitioning Coefficient (K_d) (mL/g)**	**Half-Life (years)**	**Does the Analyte Fail the K_d or half-Life Test ?**
EASTERN TRENCHES														
RADIONUCLIDES														
CARBON-14	pCi/g	8	44	7	18%	8.3	0.13	Yes	Yes	8	18%	5.15	5,730	Yes
TRITIUM (HYDROGEN-3)	pCi/g	1	17	0	6%	15.5	1.2	Yes	Yes	1	6%	9.9	12.32	Yes
URANIUM-235	pCi/g	10	44	7	23%	0.142	0.038	Yes	Yes	4	9%	15	7.04E+08	Yes
LANDFILL UNIT 1														
METALS														
COPPER	µg/kg	33	33	9	100%	2,690,000	60,000	Yes	Yes	6	18%	4	—	Yes
SELENIUM	µg/kg	21	33	9	64%	13,000	1,200	Yes	Yes	13	39%	5	—	Yes
RADIONUCLIDES														
CARBON-14	pCi/g	9	21	4	43%	4.74	0.13	Yes	Yes	9	43%	5.15	5730	Yes
URANIUM-235	pCi/g	8	21	4	38%	0.13	0.038	Yes	Yes	3	14%	15	7.04E+08	Yes
LANDFILL UNIT 2														
METALS														
CADMIUM	µg/kg	15	40	11	38%	6,700	510	Yes	Yes	13	33%	75	—	Yes
CHROMIUM, HEXAVALENT	µg/kg	2	39	11	5%	190	1300[3]	No	—	—	—	—	—	—
SILVER	µg/kg	8	40	11	20%	38,100	550	Yes	Yes	7	18%	120	—	Yes
RADIONUCLIDES														
CARBON-14	pCi/g	16	40	11	40%	4.2	0.13	Yes	Yes	15	38%	5.15	5730	Yes
STRONTIUM-90	pCi/g	16	40	12	40%	0.34	0.056	Yes	Yes	3	8%	35	29.1	Yes
URANIUM-235	pCi/g	15	39	11	38%	0.14	0.038	Yes	Yes	7	18%	15	7.04E+08	Yes
LANDFILL UNIT 3														
METALS														
ANTIMONY	µg/kg	2	38	9	5%	13,800	1,400	Yes	Yes	2	5%	45	—	Yes
BARIUM	µg/kg	38	38	9	100%	968,000	260,000	Yes	Yes	8	21%	41	—	Yes
CADMIUM	µg/kg	18	38	9	47%	20,000	510	Yes	Yes	15	40%	75	—	Yes
COPPER	µg/kg	38	38	9	100%	1,700,000	60,000	Yes	Yes	11	29%	4	—	Yes
MANGANESE	µg/kg	10	10	0	100%	4,300,000	750,000	Yes	Yes	4	40%	750	—	Yes
SILVER	µg/kg	16	38	9	42%	158,000	550	Yes	Yes	14	37%	120	—	Yes
RADIONUCLIDES														
CARBON-14	pCi/g	23	38	9	61%	3.77	0.13	Yes	Yes	21	55%	5.15	5730	Yes
STRONTIUM-90	pCi/g	25	38	9	66%	5.07	0.056	Yes	Yes	16	42%	35	29.1	Yes
TRITIUM (HYDROGEN-3)	pCi/g	17	21	2	81%	60	1.2	Yes	Yes	5	24%	9.9	12.32	Yes

Table 2-2. Non-volatile Constituents of Concern for Groundwater Impact in Each Disposal Unit, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

	Step 1							Step2				Step 3		
Constituents	**Units**	**Number of Detections**	**Number of Samples**	**Number of Solid Waste Samples**	**Frequency of Detection (FD)**	**Maximum Detection**	**Background Screening Level**	**Is Maximum Concentration > 1.5 x Background Concentrations and FD > 5%?**	**Do Site Concentrations Rank Differently than Background Concentrations?[2]**	**Number of Detections Above Background Screening Level**	**Percent of Data Above Background Screening Level**	**Partitioning Coefficient (K_d) (mL/g)**	**Half-Life (years)**	**Does the Analyte Fail the K_d or half-Life Test ?**
URANIUM-235	pCi/g	24	38	9	63%	0.15	0.038	Yes	Yes	9	24%	15	7.04E+08	Yes
WASTE BURIAL HOLES														
METALS														
CHROMIUM, HEXAVALENT	µg/kg	7	38	8	18%	469	1300[3]	No	—	—	—	—	—	—
RADIONUCLIDES														
CARBON-14	pCi/g	70	117	9	60%	1442	0.13	Yes	Yes	68	58%	5.15	5,730	Yes
STRONTIUM-90	pCi/g	11	32	9	34%	25.5	0.056	Yes	Yes	7	22%	35	29.1	Yes
TRITIUM (HYDROGEN-3)	pCi/g	59	108	0	55%	902	1.2	Yes	Yes	57	53%	9.9	12.32	Yes
URANIUM-235	pCi/g	7	32	9	22%	0.12	0.038	Yes	Yes	2	6%	15	7.04E+08	Yes
URANIUM-238	pCi/g	9	9	0	100%	2.17	0.65	Yes	Yes	2	22%	15	4.46E+09	Yes

Notes:

[1] This table is a revised version of Table C1 from the "Feasibility Study Data Gaps Work Plan at the Laboratory for Energy-Related Health Research/South Campus Disposal Site, University of California, Davis" (Weiss Associates, September 2008a), updated to include the Data Gaps Disposal Unit soil results for metals, radionuclides, other inorganics, and semi-volatile organics (i.e., all potential COCs except for VOCs).

[2] The second field within Step 2 does not include results from the data gap investigation; values in this field reflect those from the original Table C1 in the Data Gaps Work Plan referenced above.

[3] The Background Screening Level for hexavalent chromium reported in the September 2008 Data Gaps Work Plan of 54 µg/kg has been revised to 1,300 µg/kg to reflect the most recently approved background level. This newer background value comes from the *Site Wide Risk Assessment, Volume I: Human Health Risk Assessment (Part B Risk Characterization for DOE Areas)*, Weiss Associates, Sept. 2005. The former value was from the *Work Plan for Removal Actions in the Southwest Trenches, RA/SR Treatment Sytems, and Domestic Septic System Areas*, Weiss Associates, July 2000. As a result of using the revised background, hexavalent chromium is no longer considered a potential groundwater impact COC for any disposal unit.

Abbreviations:

COC	constituent of concern
FD	frequency of detection
K_d	distribution/partitioning coefficient
µg/kg	micrograms per kilogram
mL/g	milliliters per gram
—	not applicable
pCi/kg	picocuries per kilogram
SVOC	semi volatile organic compound
VOC	volatile organic compound

Table 2-3. VOCs in Soil Gas in UC Davis Disposal Units, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Location	LF1-1	LF1-1	LF1-1	LF2-1	LF2-1	LF2-1	LF2-2	LF2-2	LF2-2	LF2-3	LF2-3	LF2-3	LF2-3	LF3-1	LF3-1	LF3-1	ET-1	ET-1	ET-1	ST-1	ST-1	ST-1	WBH-1	WBH-1	WBH-1	LF2-1
Sample Name	SG0001	SG0002	SG0003	SG0004	SG0005	SG0006	SG0007	SG0008	SG0009	SG0010	SG0010 Lab Duplicate	SG0011	SG0012	SG0013	SG0014	SG0015	SG0016	SG0017	SG0018	SG0019	SG0020	SG0021	SG0022	SG0023	SG0024	SG0025
Depth (ft)	5	15	25	5	15	25	5	15	25	5	5	15	25	5	15	25	5	15	25	5	15	25	5	15	25	15
Sample Date 2008	9/16	9/17	9/17	9/11	9/11	9/11	9/11	9/11	9/12	9/15	9/15	9/15	9/15	9/17	9/17	9/17	9/10	9/10	9/10	9/9	9/9	9/9	9/16	9/16	9/16	9/18
Analytic Laboratory	ATL	ATL	ATL	AirTech	AirTech	AirTech	AirTech	AirTech	AirTech	ATL	ATL	ATL	ATL	ATL	ATL	ATL	AirTech	AirTech	AirTech	AirTech	AirTech	AirTech	ATL	ATL	ATL	ATL
Analyte (by EPA Method TO15)	micrograms per cubic meter (µg/m^3)																									
1,1,1-Trichloroethane	<37	<17	<410	58	53	<56	<2.7	<9.3	<6.1	<6.5	<6.5	<320	<210	<86	<320	<13	<12	<89	<8.8	<9.3	0.91	<5.4	<53	<62	<51	<20
1,1-Dichloroethane	<28	<12	<300	890	1,600	58	<2.0	<6.9	<4.5	<4.8	<4.8	<240	<160	<64	<230	<9.4	28	550	19	<6.9	<2.0	<4.0	<39	<46	<38	55
1,1-Dichloroethene	<27	<12	<300	270	390	<41	<2.0	<6.9	<4.5	<4.7	<4.7	<230	<150	<63	<230	<9.2	9.1	240	3.1	<6.9	<2.0	<4.0	<38	<45	<37	<15
1,2,4-Trimethylbenzene	<33	<15	<370	88	16	5.7	1.4	2.7	3.6	<5.8	<5.8	<290	<190	<78	<280	<11	0.96	5.3	2.5	10	3.4	9.8	<48	<56	<46	<18
1,2-Dichloroethane	<28	<12	<300	<67	<130	<41	<2.0	<6.9	<4.5	<4.8	<4.8	<240	<160	<64	<230	<9.4	<9.2	**330**	43	<6.9	<2.0	<4.0	<39	<46	<38	<15
1,2-Dichloropropane	<31	<14	<340	**910**	260	32	<2.3	<7.9	<5.2	<5.5	<5.5	<270	<180	<73	<270	<11	43	**1,900**	220	<7.9	<2.3	<4.6	<45	<53	<43	<17
1,3,5-Trimethylbenzene (Mesitylene)	<33	<15	<370	27	<160	<50	0.31	1.3	0.52	<5.8	<5.8	<290	<190	<78	<280	<11	<11	<81	<8.0	4.0	0.80	2.3	<48	<56	<46	<18
1,3-Butadiene	<15	**74**	**<160**	<187(a)	<363(a)	<110(a)	<5.5(a)	<19(a)	9.1 Jt(a)	4.4	4.6	**<130**	**<86**	**<35**	**<130**	12	17 Jt(a)	<176(a)	6.8 Jt(a)	<19(a)	1.8 Jt(a)	1.9 Jt(a)	43	<25	<20	<8.3
1,3-Dichlorobenzene	<41	<18	<450	<100	<200	<62	<3.0	<10	<6.8	<7.2	<7.2	<350	<230	<95	<350	34	<14	<99	<9.8	<10	<3.0	<6.0	<58	<69	79	<22
1,4-Dichlorobenzene	<41	<18	<450	16	<200	<62	<3.0	<10	<6.8	<7.2	<7.2	<350	<230	<95	<350	<14	<14	<99	<9.8	<10	0.70	1.2	<58	<69	<56	<22
4-Ethyltoluene	<33	<15	<370	62	<160	<50	0.81	1.0	1.4	<5.8	<5.8	<290	<190	<78	<280	<11	<11	<81	<8.0	5.9	1.8	5.0	<48	<56	<46	<18
Acetone	120	150	<710	1,500	3,500	3,900	28	780	370	150	160	<560	<370	160	<550	110	210	170	190	74	63	300	140	<110	140	53
Benzene	<22	13	<240	14	14	5.1	1.9	4.0	3.1	<3.8	<3.8	<190	<120	<51	<180	<7.4	5.6	<53	2.8	2.8	3.0	2.1	<31	<36	<30	<12
Carbon Disulfide	<21	<9.5	<230	72	140	51	0.33	5.8	3.3	<3.7	<3.7	<180	<120	<49	<180	<7.2	2.3	81	2.3	2.4	1.2	2.7	<30	<36	<29	<12
Carbon Tetrachloride	<43	<19	<470	<110	<210	<65	0.42	<11	<7.1	<7.5	<7.5	<370	<240	<100	<360	<15	<14	<100	<10	<11	<3.2	<6.2	<61	<72	<58	<24
Chloroform	<33	<15	<360	**9,600**	**16,000**	920	<2.5	1.6	1.9	<5.8	<5.8	<280	200	<77	<280	<11	1,400	**13,000**	710	12	0.85	0.57	<47	<56	<45	380
Chloromethane	<56	<25	<620	<69	<130	<42	2.3	10	<4.6	<9.8	<9.8	<480	<320	<130	<480	<19	<9.4	<67	<6.7	<7.1	1.9	<4.1	<80	<94	<77	<31
Dichlorodifluoromethane	<34	<15	<370	<82	<160	<50	4.9	3.4	<5.5	<5.9	<5.9	<290	<190	<78	<290	<12	2.6	<81	2.5	2.9	5.0	<4.9	<48	<57	<46	<18
Ethanol	210	77	<560	<160(a)	<310(a)	<94(a)	6.4(a)	7.1 Jt(a)	29(a)	14	14	<440	<290	170	<440	130	<22(a)	<150(a)	6.7 Jt(a)	<16(a)	35(a)	10(a)	210	<86	400	40
Ethylbenzene	<30	<13	<320	88	<140	3.6	0.94	2.6	1.8	<5.2	<5.2	<250	<170	<69	<250	<10	0.95	<71	2.6	5.7	2.0	2.7	<42	<50	<40	<16
Formaldehyde (b)	57.8	68.5	69.7	72	117	120	58.8	123	112 J1	68	NA	120	175	50.2	80.2	121	45.8 J1	58.8 J1	61.7 J1	NA	NA	NA	46.3	70.2	71.2	NA
Hexane	<24	12	<260	<60(a)	<116(a)	<35(a)	1.0Jt(a)	17(a)	11(a)	<4.2	<4.2	<210	<140	<56	<200	<8.2	8.1(a)	<56(a)	10(a)	4.5 Jt(a)	3.4(a)	4.5(a)	<34	<40	<33	<13
Isopropanol	6,100	760	1,200	25	30	37	0.80	11	12	100	100	<580	<380	1,100	570	1,700	47	39	54	3.9	27	500	4,900	400	11,000Jt	320
m,p-Xylenes	<30	<13	<320	220	16	10	3.3	5.3	4.5	<5.2	<5.2	<250	<170	<69	<250	<10	2.3	<71	4.7	12	6.4	11	<42	<50	<40	<16
Methyl ethyl ketone (2-butanone)	<20	18	<220	36	<95	52	1.4	61	43	15	15	<170	<110	<47	<170	11	19	<48	21	7.2	7.4	19	<29	<34	<27	<11
Methyl isobutyl ketone (4-methyl-2-pentanone)	<28	<12	<300	<69	80	23	0.34	3.7	3.7	<4.9	<4.9	<240	<160	<65	<240	<9.5	<9.4	16	<6.7	<7.1	1.6	3.4	<40	<47	<38	<15
Methylene chloride	<24	<11	<260	<59	<110	<36	<1.8	<6.0	<3.9	<4.1	<4.1	<200	<130	<55	<200	<8.1	<8.1	<58	<5.7	<6.0	1.6	<3.5	<34	<40	<32	<13
o-Xylene	<30	<13	<320	100	<140	7.6	1.1	2.7	2.2	<5.2	<5.2	<250	<170	<69	<250	<10	0.79	<71	1.9	5.5	2.4	5.3	<42	<50	<40	<16
Styrene	<29	<13	<320	<72	<140	<44	<2.2	2.2	2.2	<5.1	<5.1	<250	<160	<68	<250	<9.9	<9.9	<71	1.8	1.3	0.79	1.2	<41	<49	<40	<16
Tetrachloroethene (PCE)	<46	24	<500	**2,600**	**1,500**	770	<3.4	6.9	13	11	11	<400	<260	<110	<390	<16	22	130	6.8	5.0	1.6	2.4	<66	<78	<63	67
Toluene	72	120	<280	8,000	1,800	1,800	8.4	590	230	120	120	<220	<150	61	<220	89	70	44	44	34	17	29	110	110	100	78
Trichlorofluoromethane	<38	<17	<420	<94	<180	<58	2.6	2.2	1.4	<6.7	<6.7	<330	<220	<89	<320	<13	<13	<92	1.1	<9.6	2.6	1.2	<54	<64	<52	<21

Note:
Soil gas concentrations that exceed the site-specific screening level for residential scenario are shown in bold. Detection limits shown in bold if greater than twice the screening value.

Abbreviations:

ATL Air Toxics Ltd.
AirTech Air Technology Laboratories, Inc.
(a) not on standard EPA Method TO15 list and not reported initially by AirTech, so QA/QC review could not be completed
(b) analyzed by EPA Method TO11
J estimated value, below reporting limit (Jt) or one day past holding time (J1)
NA not analyzed
< n not detected; detection limit equal to n

Table 2-4. Analytical Results for Grab Groundwater Samples Collected from Locations Adjacent to the UC Disposal Units During the 2008 Data Gaps Investigation
Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Location ID	Sample ID	Sample Date	Lab	Screened Interval	1,1-Dichloro-ethane	1,1-Dichloro-ethene	1,2,3-Trichloro-propane	1,2-Dichloro-ethane	1,2-Dichloro-propane	Acetone	Antimony	Barium	Cadmium	Carbon-14	Chloro-form	Chromium, Total	Chromium, Hexavalent	Copper	Formal-dehyde	Mang-anese	Nitrate	Tetra-chloro-ethene	Selenium	Silver	Strontium-90	Tritium	Uranium-235/236	Uranium-238
			Units:	ft bgs	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	pCi/L	pCi/L	pCi/L	pCi/L
ET-1	GWGW2283	09/12/08	CTB	77-80	**5.1**	<0.5	**0.7**	**8.0**	**2.9**	**22**	---	---	---	---	**40**	---	---	---	---	---	---	<0.5	---	---	---	---	---	---
	GWGW2283	09/12/08	NCL	77-80	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<5.0 UJ	---	---	---	---	---	---	---	---	---
ET-2	GWGW2290	09/18/08	CTB	70-75	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	GWGW2290	09/18/08	STLL	70-75	---	---	---	---	---	---	---	---	---	**46.5 J**	---	---	---	---	---	---	---	---	---	---	---	1,520 J	<1.00	**2.23**
LF1-2	GWGW2287	09/16/08	CTB	62-75	---	---	---	---	---	---	---	---	---	---	---	**17**	---	**5.3**	---	---	---	---	<10	---	---	---	---	---
	GWGW2287	09/16/08	STLL	62-75	---	---	---	---	---	---	---	---	---	<20.0 UJ	---	---	---	---	---	---	---	---	---	---	---	---	<1.00	**1.64**
LF2-1	GWGW2280	09/15/08	CTB	72-75	<0.5	**0.7**	<0.5	<0.5	<0.5	<10	---	---	---	---	**7.4**	---	---	---	---	---	---	<0.5	---	---	---	---	---	---
	GWGW2280	09/15/08	NCL	72-75	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<3.5 UJ	---	---	---	---	---	---	---	---	---
	GWGW2280-DUP	09/15/08	CTB	72-75	<0.5	**0.7**	<0.5	<0.5	<0.5	<10	---	---	---	---	**8.1**	---	---	---	---	---	---	<0.5	---	---	---	---	---	---
LF2-2	GWGW2281	09/15/08	CTB	72-75	<0.5	<0.5	<0.5	<0.5	<0.5	<10	---	---	---	---	<0.5	---	---	---	---	---	---	<0.5	---	---	---	---	---	---
	GWGW2281	09/15/08	NCL	72-75	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**4**	---	---	---	---	---	---	---	---	---
LF2-3	GWGW2282	09/15/08	CTB	72-75	<0.5	<0.5	<0.5	<0.5	<0.5	<10	---	---	---	---	<0.5	---	---	---	---	---	---	<0.5	---	---	---	---	---	---
	GWGW2282	09/15/08	NCL	72-75	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**4 J**	---	---	---	---	---	---	---	---	---
LF2-4	GWGW2288	09/17/08	STLL	63-75	---	---	---	---	---	---	---	---	---	**12.4 J**	---	---	---	---	---	---	---	---	---	---	<1.00 UJ	---	<1.00	**0.78**
	GWGW2288	09/18/08	CTB	63-75	---	---	---	---	---	---	---	---	<5.0	---	---	---	**26**	---	---	---	---	---	---	<5.0	---	---	---	---
LF3-2	GWGW2289	09/19/08	CTB	67-75	---	---	---	---	---	---	<10	**150**	<5.0	---	---	---	---	**6.8**	---	<5.0	---	---	---	<5.0	---	---	---	---
	GWGW2289	09/19/08	STLL	67-75	---	---	---	---	---	---	---	---	---	<20.0 UJ	---	---	---	---	---	---	---	---	---	---	<1.00	<300	<1.00	**2.07**
ST-1	GWGW2284	09/09/08	CTB	72-75	<0.5	<0.5	<0.5	<0.5	<0.5	**18**	---	---	---	---	<0.5	---	---	---	---	---	---	<0.5	---	---	---	---	---	---
ST-2	GWGW2291	09/15/08	CTB	70-75	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
UCD1-062	GWGW2327	10/16/08	CTB	56-71	<0.5	<0.5	**2.8**	<0.5	<0.5	<10	<10	**56**	<5.0	---	<0.5	**120**	**120**	<5.0	---	**9.3**	**27**	<0.5	**12**	<5.0	---	---	---	---
	GWGW2327	10/16/08	STLL	56-71	---	---	---	---	---	---	---	---	---	<20.0 R	---	---	---	---	---	---	---	---	---	---	<1.00	<300	<25	**2.91**
	GWGW2378	12/03/08	CELG	56-71	<0.50	<0.50	---	<0.50	<0.50	<5.0 R	<2.00	**56.7**	<2.00	---	<0.50	**123**	---	**2.75**	---	---	**28 J**	<0.50	**8.97**	<2.00 UJ	---	---	---	---
	GWGW2378	12/03/08	STLL	56-71	---	---	---	---	---	---	---	---	---	<20.0 R	---	---	---	---	---	---	---	---	---	---	<1.0 UJ	**<300 UJ**	**0.43 U**	**2.57**
	GWGW2433	02/09/09	CELG	56-71	<0.50	<0.50	---	<0.50	<0.50	<5.0 R	<5.00 UJ	**62.3**	**0.825 J**	---	**0.12 J**	**155**	---	**3.44 J**	---	---	**25**	<0.50	**13.7**	<5.00	---	---	---	---
	GWGW2433	02/09/09	STLL	56-71	---	---	---	---	---	---	---	---	---	<20.0	---	---	---	---	---	---	---	---	---	---	<1.00	**<300**	**0.51 J**	**3.10**
	GWGW2489	05/20/09	CELG	56-71	<0.50	<0.50	---	<0.50	**0.30 J**	<5.0 R	**0.155 J**	**484**	**0.0298 J**	---	**0.19 J**	**122**	---	**3.43**	---	---	**23**	<0.50	**7.68**	<1.00	---	---	---	---
	GWGW2489	05/20/09	STLL	56-71	---	---	---	---	---	---	---	---	---	<20.0 UJ	---	---	---	---	---	---	---	---	---	---	<1.00	<300	<25 UJ	**2.42**
	GWGW2489	05/20/09	TANC	56-71	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<20	---	---	---	---	---	---	---	---	---
UCD1-064	GWGW2329	10/16/08	CTB	55-70	<0.5	<0.5	<0.5	<0.5	<0.5	<10	<10	**140**	<5.0	---	<0.5	**40**	---	<5.0	---	---	**0.65**	<0.5	<10	<5.0	---	---	---	---
	GWGW2329	10/16/08	STLL	55-70	---	---	---	---	---	---	---	---	---	**11.2 J**	---	---	---	---	---	---	---	---	---	---	<1.00 UJ	**<300**	**0.34 J**	**1.68**
	GWGW2380	12/03/08	CELG	55-70	<0.50	<0.50	---	<0.50	<0.50	<5.0 R	<1.00	**136**	**0.0522**	---	<0.50	**38.2**	---	**2.39**	---	---	**0.74**	<0.50	<1.00	<1.00	---	---	---	---
	GWGW2380	12/03/08	STLL	55-70	---	---	---	---	---	---	---	---	---	**10.8 J**	---	---	---	---	---	---	---	---	---	---	<1.0	**<300 UJ**	**0.50**	**1.97**
	GWGW2435	02/09/09	CELG	55-70	<0.50	<0.50	---	<0.50	<0.50	<5.0 R	<5.00 UJ	**196**	**0.653 J**	---	<0.50	**62.7**	---	**2.84 J**	---	---	**2.1**	<0.50	**4.10 J**	<5.00	---	---	---	---
	GWGW2435	02/09/09	STLL	55-70	---	---	---	---	---	---	---	---	---	<20.0	---	---	---	---	---	---	---	---	---	---	<1.00	<300	<25	**1.89 U**
	GWGW2490	05/20/09	CELG	55-70	<0.50	<0.50	---	<0.50	<0.50	<5.0 R	**0.215 J**	**418**	**0.0198 J**	---	<0.50	**46.3**	---	**1.77 U**	---	---	**4.0**	<0.50	**2.51**	<1.00	---	---	---	---
	GWGW2490	05/20/09	STLL	55-70	---	---	---	---	---	---	---	---	---	<20.0	---	---	---	---	---	---	---	---	---	---	<1.00	<300	<25 UJ	**1.64**
UCD1-065	GWGW2330	10/16/08	CTB	52-72	<0.5	<0.5	<0.5	<0.5	<0.5	<10	<10	**110**	<5.0	---	<0.5	**67**	---	<5.0	---	---	**3.9**	<0.5	<10	<5.0	---	---	---	---

Table 2-4. Analytical Results for Grab Groundwater Samples Collected from Locations Adjacent to the UC Disposal Units During the 2008 Data Gaps Investigation
Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Location ID	Sample ID	Sample Date	Lab	Screened Interval	1,1-Dichloro-ethane	1,1-Dichloro-ethene	1,2,3-Trichloro-propane	1,2-Dichloro-ethane	1,2-Dichloro-propane	Acetone	Antimony	Barium	Cadmium	Carbon-14	Chloro-form	Chromium, Total	Chromium, Hexavalent	Copper	Formal-dehyde	Mang-anese	Nitrate	Tetra-chloro-ethene	Selenium	Silver	Strontium-90	Tritium	Uranium-235/236	Uranium-238
			Units:	ft bgs	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	pCi/L	pCi/L	pCi/L	pCi/L
UCD1-065	GWGW2330	10/16/08	STLL	52-72	---	---	---	---	---	---	---	---	---	10.6 J	---	---	---	---	---	---	---	---	---	---	<1.00	<300	0.34 J	1.32
	GWGW2381	12/03/08	CELG	52-72	<0.50	<0.50	---	<0.50	<0.50	<5.0 R	<1.00	182	0.0464	---	<0.50	79.6	---	2.81	---	---	4.5	<0.50	<1.00	<1.00	---	---	---	---
	GWGW2381	12/03/08	STLL	52-72	---	---	---	---	---	---	---	---	---	32.0 J	---	---	---	---	---	---	---	---	---	---	<1.0	250 J	<25	1.25
	GWGW2436	02/10/09	CELG	52-72	<0.50	<0.50	---	<0.50	<0.50	2.4 J	0.106 J	218	<1.00	---	<0.50	42.5	---	3.07	---	---	3.8	0.073 J	0.884 J	<1.00	---	---	---	---
	GWGW2436	02/10/09	STLL	52-72	---	---	---	---	---	---	---	---	---	19.1 J	---	---	---	---	---	---	---	---	---	---	<1.00	<300	<25 UJ	1.60 U
	GWGW2491	05/20/09	CELG	52-72	<0.50	<0.50	---	<0.50	<0.50	<5.0 R	0.163 J	677	0.0322 J	---	<0.50	42.0	---	3.91	---	---	3.2	0.065 J	<1.00	<1.00	---	---	---	---
	GWGW2491	05/20/09	STLL	52-72	---	---	---	---	---	---	---	---	---	<20.0 UJ	---	---	---	---	---	---	---	---	---	---	<1.00	<300	<25	1.71
	GWGW2491	05/20/09	TANC	52-72	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<20	---	---	---	---	---	---	---	---	---
UCD1-066	GWGW2331A	10/16/08	CTB	57-72	1.2	0.7	<0.5	<0.5	<0.5	<10	<10	56	<5.0	---	52	73	---	<5.0	---	---	13	<0.5	<10	<5.0	---	---	---	---
	GWGW2331A	10/16/08	STLL	57-72	---	---	---	---	---	---	---	---	---	26.7 J	---	---	---	---	---	---	---	---	---	---	<1.00	<300	0.36 J	2.16
	GWGW2331B-DUP	10/16/08	CTB	57-72	1.3	1	<0.5	<0.5	<0.5	<10	<10	55	<5.0	---	54	72	---	<5.0	---	---	13	<0.5	<10	<5.0	---	---	---	---
	GWGW2331B-DUP	10/16/08	STLL	57-72	---	---	---	---	---	---	---	---	---	51.7 J	---	---	---	---	---	---	---	---	---	---	<1.00	<300 UJ	<25 UJ	3.18
	GWGW2382A	12/04/08	CELG	57-72	1.1	0.56	---	<1.0	<1.0	<10 R	<2.00	49.1	<2.00	---	48	69.5	---	4.13	---	---	12 J	<1.0	4.47	<2.00 UJ	---	---	---	---
	GWGW2382A	12/04/08	STLL	57-72	---	---	---	---	---	---	---	---	---	28.6 J	---	---	---	---	---	---	---	---	---	---	<1.00	300 J	<25 UJ	2.99
	GWGW2382B-DUP	12/04/08	CELG	57-72	1.0	0.49	---	<1.0	<1.0	<10 R	<2.00	49.8	<2.00	---	46	71.4	---	4.37	---	---	12 J	<1.0	4.88	<2.00 UJ	---	---	---	---
	GWGW2382B-DUP	12/04/08	STLL	57-72	---	---	---	---	---	---	---	---	---	50.9 J	---	---	---	---	---	---	---	---	---	---	<1.00	<300 UJ	<25	2.85
	GWGW2437	02/12/09	CELG	57-72	0.65 J	0.22 J	---	<1.0	<1.0	<10 R	<5.00 UJ	51.8	0.262 J	---	34	81.9	---	3.32 J	---	---	13 J	<1.0	8.86	<5.00	---	---	---	---
	GWGW2437	02/12/09	STLL	57-72	---	---	---	---	---	---	---	---	---	83	---	---	---	---	---	---	---	---	---	---	<1.00	<300	0.37 J	3.48
	GWGW2438-DUP	02/12/09	CELG	57-72	0.70 J	0.34 J	---	0.26 J	<1.0	3.0 J	0.0918 UJ	51.1	<1.00	---	37	75.0	---	2.35	---	---	13 J	<1.0	6.35	<1.00	---	---	---	---
	GWGW2438-DUP	02/12/09	STLL	57-72	---	---	---	---	---	---	---	---	---	82	---	---	---	---	---	---	---	---	---	---	<1.00	210 J	<25	2.79
	GWGW2492-DUP	05/20/09	CELG	57-72	1.2	0.55	---	<0.50	<0.50	<5.0 R	0.158 J	492	0.0358 J	---	52	73.9	---	3.31	---	---	12	<0.50	5.17	<1.00	---	---	---	---
	GWGW2492-DUP	05/20/09	STLL	57-72	---	---	---	---	---	---	---	---	---	46.5	---	---	---	---	---	---	---	---	---	---	<1.00	<300	0.30 J	2.64
	GWGW2492-DUP	05/20/09	TANC	57-72	---	---	---	---	---	---	---	---	---	---	---	---	---	---	<20	---	---	---	---	---	---	---	---	---
	GWGW2493	05/20/09	CELG	57-72	1.1	0.56	---	0.35 J	<0.50	<5.0 R	0.348 J	563	0.0491 J	---	52	80.8	---	3.67	---	---	12	<0.50	5.12	0.0292 J	---	---	---	---
	GWGW2493	05/20/09	STLL	57-72	---	---	---	---	---	---	---	---	---	53.5	---	---	---	---	---	---	---	---	---	---	<1.00 UJ	<300	0.24 J	2.90
WBH-1	GWGW2285	09/18/08	CTB	65-75	<0.5	<0.5	<0.5	<0.5	<0.5	<10	---	---	---	---	<0.5	---	---	---	---	---	---	0.5	---	---	---	---	---	---
	GWGW2285	09/18/08	NCL	65-75	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5 J	---	---	---	---	---	---	---	---	---
	GWGW2285-DUP	09/18/08	CTB	65-75	<0.5	<0.5	<0.5	<0.5	<0.5	<10	---	---	---	---	<0.5	---	---	---	---	---	---	0.6	---	---	---	---	---	---
WBH-2	GWGW2292	09/16/08	CTB	65-75	---	---	---	---	---	---	---	---	---	---	---	8.4	---	---	---	---	---	---	---	---	---	---	---	---
	GWGW2292	09/17/08	CTB	65-75	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	GWGW2292	09/17/08	STLL	65-75	---	---	---	---	---	---	---	---	---	<20.0	---	---	---	---	---	---	---	---	---	---	<1.00	1,620	<1.00	0.74 J
WBH-3	GWGW2293	09/16/08	CTB	64-75	---	---	---	---	---	---	---	---	---	---	---	---	42	---	---	---	---	---	---	---	---	---	---	---
	GWGW2293	09/16/08	STLL	64-75	---	---	---	---	---	---	---	---	---	12.4 J	---	---	---	---	---	---	---	---	---	---	<1.00 UJ	<300	<1.00	1.99
WBH-4	GWGW2286	09/15/08	CTB	63-75	<0.5	<0.5	<0.5	<0.5	<0.5	<10	---	---	---	---	<0.5	38	---	---	---	---	4.5	<0.5	---	---	---	---	---	---
	GWGW2286	09/15/08	STLL	63-75	---	---	---	---	---	---	---	---	---	10.4 J	---	---	---	---	---	---	---	---	---	---	---	<300	---	---

Table 2-4. Analytical Results for Grab Groundwater Samples Collected from Locations Adjacent to the UC Disposal Units During the 2008 Data Gaps Investigation
Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Location ID	Sample ID	Sample Date	Lab	Screened Interval	1,1-Dichloro-ethane	1,1-Dichloro-ethene	1,2,3-Trichloro-propane	1,2-Dichloro-ethane	1,2-Dichloro-propane	Acetone	Antimony	Barium	Cadmium	Carbon-14	Chloro-form	Chromium, Total	Chromium, Hexavalent	Copper	Formal-dehyde	Mang-anese	Nitrate	Tetra-chloro-ethene	Selenium	Silver	Strontium-90	Tritium	Uranium-235/236	Uranium-238
			Units:	ft bgs	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	pCi/L	pCi/L	pCi/L	pCi/L

Location Abbreviations:

ET-1 = Eastern trenches, location 1
ET-2 = Eastern trenches, location 2
LF1-2 = Landfill 1, location 2
LF2-1 = Landfill 1, location 1
LF2-2 = Landfill 2, location 2
LF2-3 = Landfill 2, location 3
LF2-4 = Landfill 2, location 4
LF3-2 = Landfill 3, location 2
ST-1 = Southern trenches, location 1
ST-2 = Southern trenches, location 2
WBH-1 = Waste burial hole, location 1
WBH-2 = Waste burial hole, location 2
WBH-3 = Waste burial hole, location 3
WBH-4 = Waste burial hole, location 4

Notes:

--- = Not analyzed
BOLD = Analyte detected above reporting limit
CELG = Calscience Environmental Labs, Inc. Garden Grove, California
CTB = Curtis and Tompkins Laboratory, Berkeley, California
DUP = Blind duplicate for field sample
ft bgs = Feet below ground surface
J = Result is qualified as an estimated concentration or amount
mg/L = Milligrams per liter
NCL = North Coast Laboratory, Arcata, California
pCi/L = Picocuries per liter
R = Non-detectable results rejected due to laboratory deficiencies
STLL = Test America Laboratory, St. Louis, Missouri
TANC = Test America Laboratory, North Canton, Ohio
µg/L = Micrograms per liter
UJ = Result is not detected at an estimated detection limit

Analytic methods used for these results: A-01-R, C-01-01, E300.0, E905.0, E906.0, EPA 8315A, SW6010B, SW7199, SW8081A, SW8082, SW8260B, SW8270C

Table 2-5. Proposed Preliminary Soil Cleanup Goals for Ground Water Impact Chemicals of Concern, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Disposal Unit	Groundwater Impact COC	Soil Background (µg/kg or pCi/g)[1]	Best Available Practical Quantitation Limit[2] (µg/kg or pCi/g)	Soil Designated Level for GW Impact at Drinking Water Standard[3] (µg/kg or pCi/g)	Soil Designated Level for GW Impact at Background[4] (µg/kg or pCi/g)	Proposed Preliminary Soil Cleanup Goal[5] (µg/kg or pCi/g)	Maximum Soil Concentration Detected[6] (µg/kg or pCi/g)
Eastern Trenches	Chloroform	0	**5**	0.67	0.30	**<5**	NA
	1,1-dichloroethane	0	**5**	1.12	0.112	**<5**	NA
	1,2-dichloroethane	0	**5**	0.104	0.104	**<5**	NA
	1,2-dichloropropane	0	**5**	1.20	0.120	**<5**	NA
	1,4-dioxane[7]	0	**20**	0.48	0.32	**<20**	NA
	Carbon-14	**<0.13**	0.05	<0.13	<0.13	**<0.13**	8.3
	Tritium	**<1.2**	1.0	<1.2	<1.2	**<1.2**	15.5
Landfill Unit No. 1	Copper	**60,000**	300	43,500	62.2	**60,000**	2,690,000
	Selenium	**1,200**	600	216	18.1	**1,200**	13,000
	Carbon-14	**<0.13**	0.05	<0.13	<0.13	**<0.13**	4.74
Landfill Unit No. 2	Acetone	0	**5**	4,780	1.09	**<5**	NA
	Chloroform	0	**5**	0.64	0.32	**<5**	NA
	1,1-dichloroethane	0	**5**	1.24	0.124	**<5**	NA
	1,2-dichloropropane	0	**5**	1.34	0.134	**<5**	NA
	1,4-dioxane[7]	0	**20**	0.58	0.39	**<20**	NA
	Cadmium	**510**	300	287	11.6	**510**	6,700
	Carbon-14	**<0.13**	0.05	<0.13	<0.13	**<0.13**	4.2
Landfill Unit No. 3	Barium[7]	**260,000**	10,000	35,000	6,920	**260,000**	968,000
	Cadmium	**510**	300	319	12.9	**510**	20,000
	Copper	**60,000**	300	138,000	197	**60,000**	1,700,000
	Carbon-14	**<0.13**	0.05	<0.13	<0.13	**<0.13**	3.77
	Formaldehyde[7]	**0**	**20**	15.2	7.6	**20**	NA
Waste Burial Holes	1,4-dioxane[7]	0	**20**	0.50	0.33	**<20**	NA
	Carbon-14	<0.13	0.05	**0.319**	<0.13	**0.319**	1,442
	Tritium	<1.2	1.0	**3.19**	<1.2	**3.19**	902

Table 2-5. Proposed Preliminary Soil Cleanup Goals for Ground Water Impact Chemicals of Concern, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Abbreviations:

< n	not detected; detection limit equal to n
CNL	California Notification Level, drinking water
CRDL	Contract-required Detection Limit
COC	constituent of concern
GW	groundwater
MCL	State of California Maximum Contaminant Level, drinking water
µg/kg	micrograms per kilogram
NA	not applicable; these volatile constituents were generally not detected in soil, therefore only soil vapor data were used to assess their potential impact on groundwater
pCi/g	picocuries per gram
PQL	practical quantitation limit
PRG	United States Environmental Protection Agency Region 9 Preliminary Remediation Goal, residential tap water
VOCs	volatile organic compounds

Notes:

Bold font indicates numbers that form the basis of proposed preliminary cleanup goals. The goal for a given constituent may vary from one disposal unit to another due to differences in soil types and constituent distribution. See Appendix D of this document for details.

[1] Site-specific soil background as defined in *Work Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas* (Weiss Associates, 2000) and approved by the regulatory agencies. Background values are the 80% lower confidence limit (LCL) on the 95th percentile of data for soil collected from borings drilled in the vicinity of the Site specifically for the purpose of establishing soil background.

[2] Best available PQLs are the current CRDLs; for organics, John Zimmerman, Research Physical Scientist, Characterization and Monitoring Branch, ESD, NERL, US EPA, who is part of the Regional Applied Research Effort (RARE) team working on *Development of a Systematic Approach to Accurately Measure Trace Levels of VOCs in Soils*, was consulted on May 4, 2009, and he confirmed that these are the best available PQLs.

[3] Based on MCL if available, CNL if no MCL available, and PRG if no MCL or CNL available (with the exception of chloroform, for which the 1.1 microgram per liter Cal EPA toxicity value was used instead of the 80 microgram per liter MCL).

[4] Based on groundwater background values determined from well UCD1-018 samples data (hydrostratigraphic unit 1 background) up to October 2008, with groundwater CRDL used for organics.

[5] Proposed goal is highest of background, best available PQL or designated level for groundwater impact at background.

[6] Based on Data Gaps and previous investigations, as shown on Table 2-2.

[7] Constituents retained as COCs for evaluation in the Feasibility Study primarily due to data limitations; i.e., the lack of soil data for 1,4-dioxane and the potential lack of sufficient groundwater data for barium and formaldehyde. These COCs may be dropped during the Feasibility Study based on additional groundwater data collected during 2010.

Table 3-1. Maximum Soil Vapor Concentrations and Risk-Based[1] Screening Values for Hypothetical Future Onsite Residents, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

		5 foot Depth		15 foot Depth		25 foot Depth	
Area / COC	CHHSLs (µg/m^3)	Screening Value (µg/m^3)	Maximum Soil Vapor Concentration (µg/m^3)	Screening Value (µg/m^3)	Maximum Soil Vapor Concentration (µg/m^3)	Screening Value (µg/m^3)	Maximum Soil Vapor Concentration (µg/m^3)
Eastern Trenches							
Acetone	NA	3.00E+07	210	6.80E+07	170	1.05E+08	190
1,3-Butadiene	NA	9.6	17 Jt(a)	18	< 176 J(a)	26	6.8 Jt(a)
Carbon Disulfide	NA	750,000	2.3	1.80E+06	81	2.75E+06	2.3
Chloroform	NA	470	**1,400**	1,150	**13,000**	1,750	710
1,1-Dichloroethane	NA	1,950	28	5,000	550	7,950	19
1,2-Dichloroethane	49.6	120	< 9.2	280	**330**	440	43
1,2-Dichloropropane	NA	300	43	760	**1,900**	1,200	220
Formaldehyde	NA	110	45.8 J1	175	58.8 J1	240	61.7 J1
Styrene	NA	1.25E+06	< 9.9	3.15E+06	< 71	5.00E+06	1.8
Tetrachloroethene	180	540	22	1,400	130	2,200	7
Toluene	135,000	360,000	70	880,000	44	1.40E+06	44
Landfill Unit 1							
Acetone	NA	2.40E+07	120	6.80E+07	150	1.05E+08	< 710
1,3-Butadiene	NA	8.5	< 15	18	**74**	26	**< 160**
Formaldehyde	NA	140	57.8	175	68.5	240	69.7
Toluene	135,000	280,000	72	880,000	120	1.40E+06	< 280
Landfill Unit 2							
Acetone	NA	2.40E+07	1,500	4.80E+07	3,500	1.05E+08	3,900
1,3-Butadiene	NA	8.5	4.4	13.5	**< 130**	26	**< 86**
Carbon Disulfide	NA	585,000	72	1.25E+06	140	2.75E+06	51
Chloroform	NA	370	**9,600**	790	**16,000**	1,750	920
1,1-Dichloroethane	NA	1,500	890	3,300	1,600	7,950	58
1,1-Dichloroethene	NA	62,500	270	140,000	390	320,000	< 41
1,2-Dichloropropane	NA	225	**910**	510	260	1,200	32
Formaldehyde	NA	140	72	280	123	240	175
Methyl Ethyl Ketone	NA	4.75E+06	36	1.10E+07	61	2.50E+07	52
Styrene	NA	920,000	< 72	2.15E+06	2.2	5.00E+06	2.2
Tetrachloroethene	180	400	**2,600**	920	**1,500**	2,200	770
Toluene	135,000	280,000	8,000	600,000	1,800	1.40E+06	1,800
1,1,2-Trichloroethane	NA	145	< 91	330	< 320	780	< 210
Xylenes	315,000	91,000	320	200,000	16	470,000	18
Landfill Unit 3							
Acetone	NA	2.40E+07	160	6.80E+07	< 550	1.05E+08	110
1,3-Butadiene	NA	8.5	**< 35**	18	**< 130**	26	12
Formaldehyde	NA	140	50.2	175	80.2	240	121
Toluene	135,000	280,000	61	880,000	< 220	1.40E+06	89
Southern Trenches							
Acetone	NA	2.40E+07	74	6.80E+07	63	1.05E+08	300
1,3-Butadiene	NA	8.5	< 19 J(a)	18	1.8 Jt(a)	26	1.9 Jt(a)
Carbon Disulfide	NA	585,000	2.4	1.80E+06	1.2	2.75E+06	2.7
Methyl Ethyl Ketone	NA	4.75E+06	7.2	1.55E+07	7.4	2.50E+07	19
Styrene	NA	920,000	1.3	3.15E+06	0.79	5.00E+06	1.2
Toluene	135,000	280,000	34	880,000	17	1.40E+06	29
Waste Burial Holes							
Acetone	NA	1.40E+08	140	6.80E+07	< 110	1.05E+08	140
Benzene	36.2	2,500	< 31	235	< 36	370	< 30
1,3-Butadiene	NA	160	43	18	< 25	26	< 20
Chloroform	NA	11,500	< 47	1,150	< 56	1,750	< 45
Formaldehyde	NA	55	46.3	175	70.2	240	71.2
Methyl Ethyl Ketone	NA	3.50E+07	< 29	1.55E+07	< 34	2.50E+07	< 27
Toluene	135,000	9.50E+06	110	880,000	110	1.40E+06	100
1,3-Dichlorobenzene	NA	4.00E+06	< 58	380,000	< 69	600,000	79

Notes:
Soil vapor concentrations that exceed the screening values are shown in bold. Detection limits shown in bold if greater than twice the screening value.
[1] Based on risk below 1 in 1,000,000 for carcinogens and hazard quotient below 1.0 for non-carcinogens.

Abbreviations:
(a) not on standard EPA Method TO15 list and not reported initially by AirTech, so QA/QC review could not be completed
CHSSLs California Human Health Screening Levels (California Environmental Protection Agency, 2005), based on a residential scenario and assumed soil gas depth of five ft below ground surface; included for comparison with the site-specific five-foot screening levels in the second column
COC constituent of concern
J estimated value, below reporting limit (Jt) or one day past holding time (J1)
< n not detected; detection limit equal to n.
NA not available
µg/m^3 micrograms per cubic meter

Table 3-2. Maximum Soil Vapor Concentrations and Risk-Based[1] Screening Values for Onsite Indoor Researchers[2], Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

	5 foot Depth		15 foot Depth		25 foot Depth	
Area / COC	Screening Value (µg/m^3)	Maximum Soil Vapor Concentration (µg/m^3)	Screening Value (µg/m^3)	Maximum Soil Vapor Concentration (µg/m^3)	Screening Value (µg/m^3)	Maximum Soil Vapor Concentration (µg/m^3)
Eastern Trenches						
Acetone	1.10E+08	210	2.80E+08	170	2.30E+08	190
1,3-Butadiene	39	17 Jt(a)	79	< 176 J(a)	66	6.8 Jt(a)
Carbon Disulfide	2.55E+06	2.3	6.80E+06	81	5.90E+06	2.3
Chloroform	1,600	1,400	4,300	**13,000**	3,750	710
1,1-Dichloroethane	6,000	28	17,000	550	16,000	19
1,2-Dichloroethane	405	< 9.2	1,100	330	935	43
1,2-Dichloropropane	940	43	2,650	1,900	2,450	220
Formaldehyde	425	45.8 J1	720	58.8 J1	650	61.7 J1
Styrene	3.80E+06	< 9.9	1.10E+07	< 71	1.05E+07	1.8
Tetrachloroethene	1,650	22	4,700	130	4,400	7
Toluene	1.15E+06	70	3.20E+06	44	2.90E+06	44
Landfill Unit 1						
Acetone	1.55E+08	120	2.75E+08	150	2.30E+08	< 710
1,3-Butadiene	14	< 15	79	74	66	**< 160**
Formaldehyde	230	57.8	730	68.5	650	69.7
Toluene	460,000	72	3.20E+06	120	2.90E+06	< 280
Landfill Unit 2						
Acetone	4.00E+07	1,500	8.00E+07	3,500	2.30E+08	3,900
1,3-Butadiene	14	4.4	23	**< 130**	66	< 86
Carbon Disulfide	980,000	72	2.05E+06	140	5.90E+06	51
Chloroform	615	**9,600**	1,300	**16,000**	3,750	920
1,1-Dichloroethane	2,450	890	5,600	1,600	16,000	58
1,1-Dichloroethene	105,000	270	230,000	390	660,000	< 41
1,2-Dichloropropane	380	**910**	850	260	2,450	32
Formaldehyde	230	72	460	123	650	175
Methyl Ethyl Ketone	8.00E+06	36	1.80E+07	61	5.00E+07	52
Styrene	1.55E+06	< 72	3.55E+06	2.2	1.05E+07	2.2
Tetrachloroethene	675	**2,600**	1,550	1,500	4,400	770
Toluene	460,000	8,000	1.00E+06	1,800	2.90E+06	1,800
1,1,2-Trichloroethane	240	< 91	535	< 320	1,550	< 210
Xylenes	155,000	320	335,000	16	960,000	18
Landfill Unit 3						
Acetone	4.00E+07	160	2.75E+08	< 550	2.30E+08	110
1,3-Butadiene	14	**< 35**	79	< 130	66	12
Formaldehyde	230	50.2	730	80.2	650	121
Toluene	460,000	61	3.20E+06	< 220	2.90E+06	89
Southern Trenches						
Acetone	4.00E+07	74	2.75E+08	63	2.30E+08	300
1,3-Butadiene	14	< 19 J(a)	79	1.8 Jt(a)	66	1.9 Jt(a)
Carbon Disulfide	980,000	2.4	6.80E+06	1.2	5.90E+06	2.7
Methyl Ethyl Ketone	7.95E+06	7.2	3.50E+07	7.4	5.00E+07	19
Styrene	1.55E+06	1.3	1.10E+07	0.79	1.05E+07	1.2
Toluene	460,000	34	3.20E+06	17	2.90E+06	29
Waste Burial Holes						
Acetone	6.70E+08	140	2.75E+08	< 110	2.30E+08	140
Benzene	5,300	< 31	850	< 36	770	< 30
1,3-Butadiene	480	43	79	< 25	66	< 20
Chloroform	25,500	< 47	4,300	< 56	3,750	< 45
Formaldehyde	140	46.3	730	70.2	650	71.2
Methyl Ethyl Ketone	1.30E+08	< 29	3.50E+07	< 34	5.00E+07	< 27
Toluene	2.05E+07	110	3.20E+06	110	2.90E+06	100
1,3-Dichlorobenzene	8.15E+06	< 58	1.25E+06	< 69	1.20E+06	79

Notes:
Soil vapor concentrations that exceed the screening values are shown in bold. Detection limits shown in bold if greater than twice the screening value.
[1] Based on risk below 1 in 1,000,000 for carcinogens and hazard quotient below 1.0 for non-carcinogens.
[2] Exposure assumptions and parameters for the Onsite Indoor Researcher are the same as for an onsite commercial use scenario.

Abbreviations:
(a) not on standard EPA Method TO15 list and not reported initially by AirTech, so QA/QC review could not be completed
COC constituent of concern
J estimated value, below reporting limit (Jt) or one day past holding time (J1)
µg/m^3 micrograms per cubic meter
< n not detected; detection limit equal to n

FIGURES

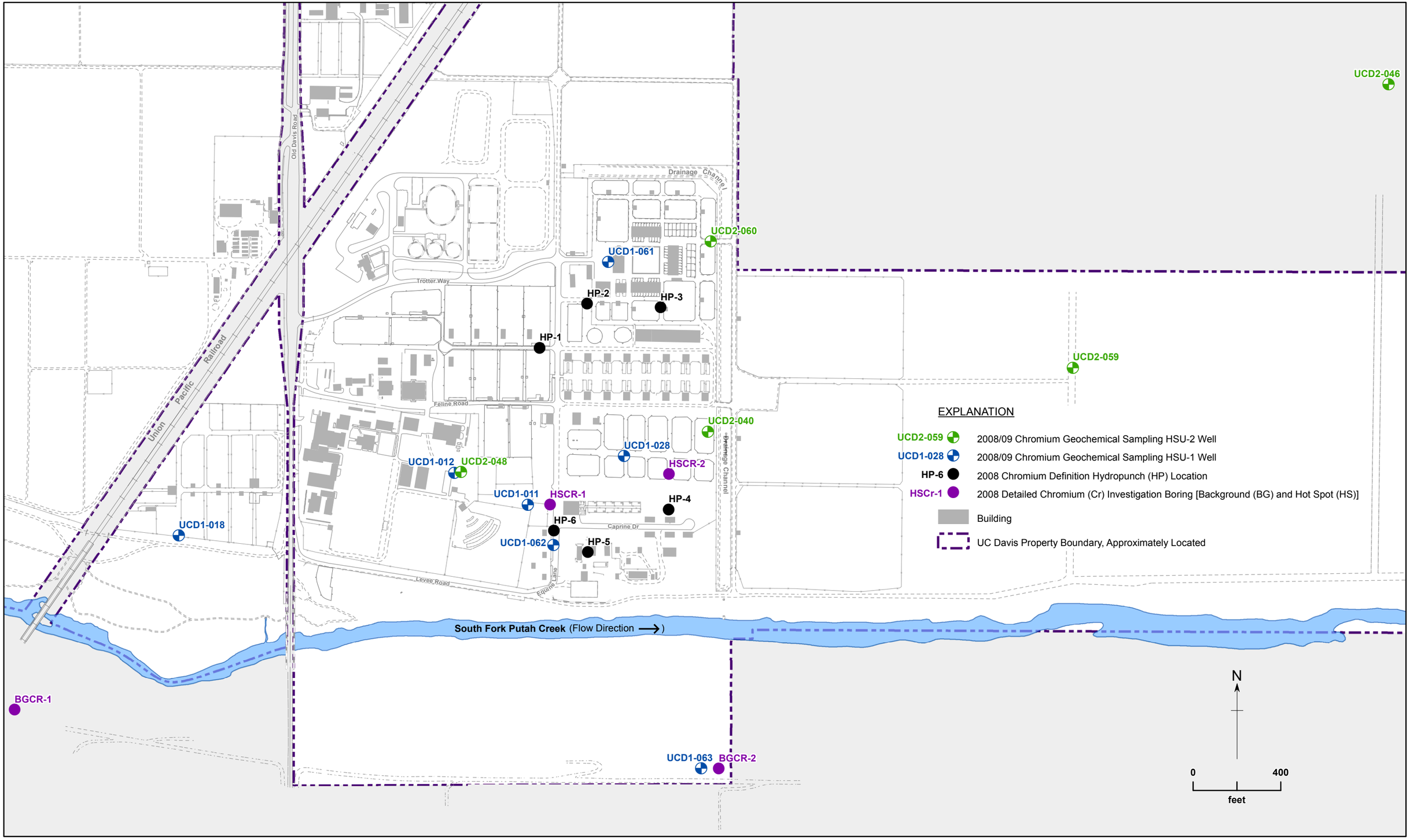


Figure 1-1. Chromium Data Gaps Investigations Sampling Locations - Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

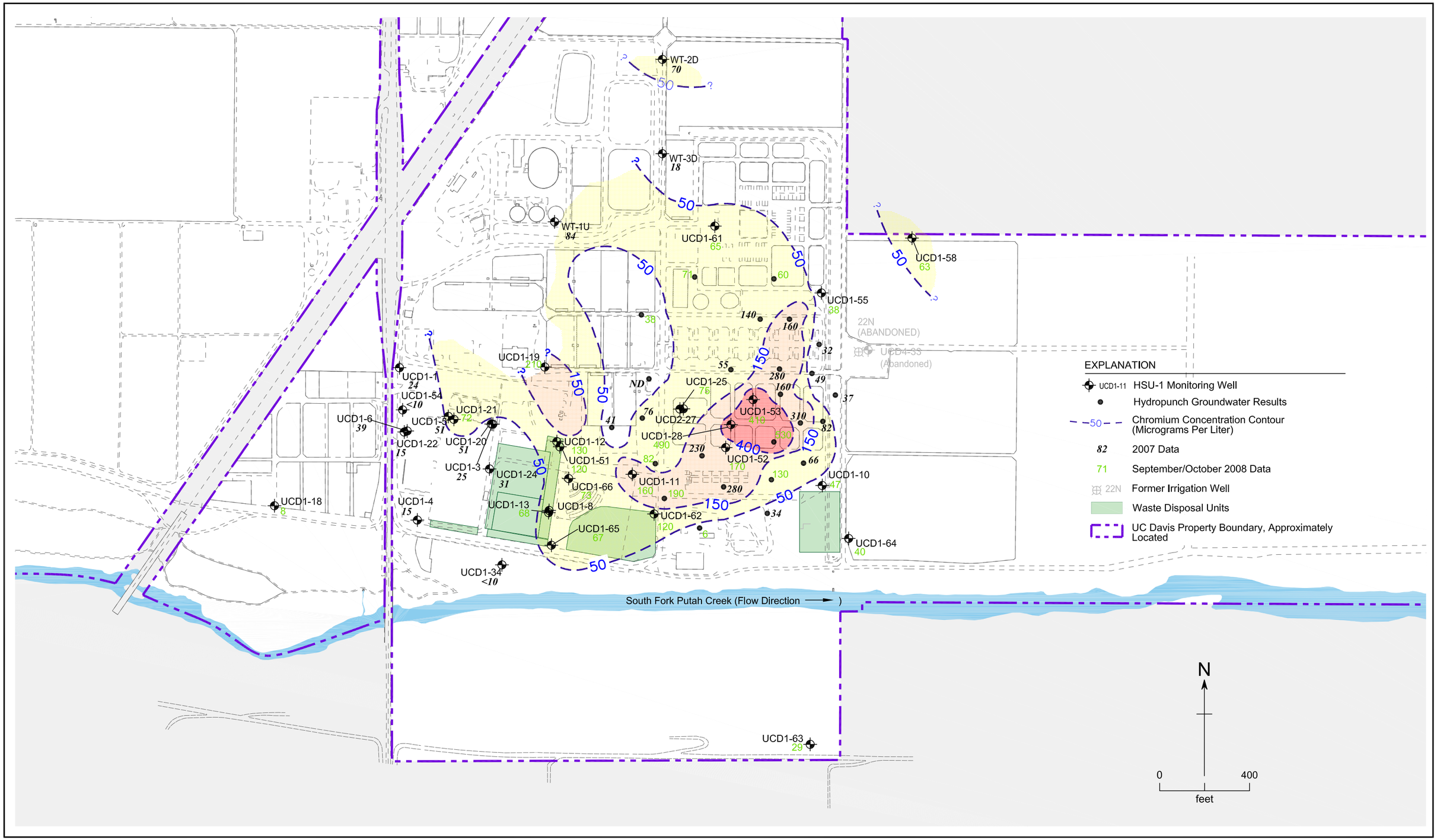


Figure 1-2. Representative Chromium Distribution in HSU-1, 2007 - 2008 Data - Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

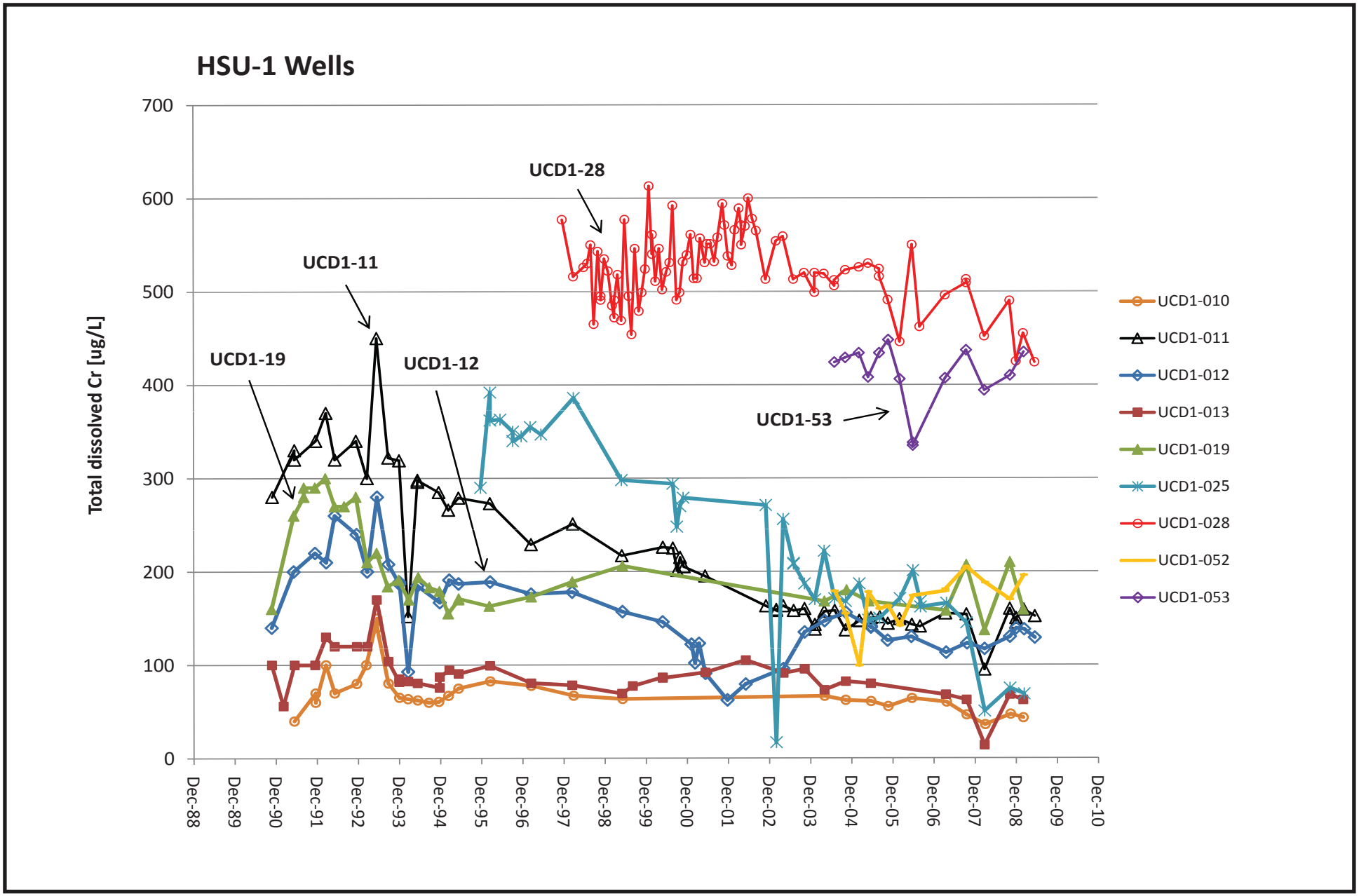


Figure 1-3. Chromium Concentrations in HSU-1 Monitoring Wells Higher Concentration Over Time, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

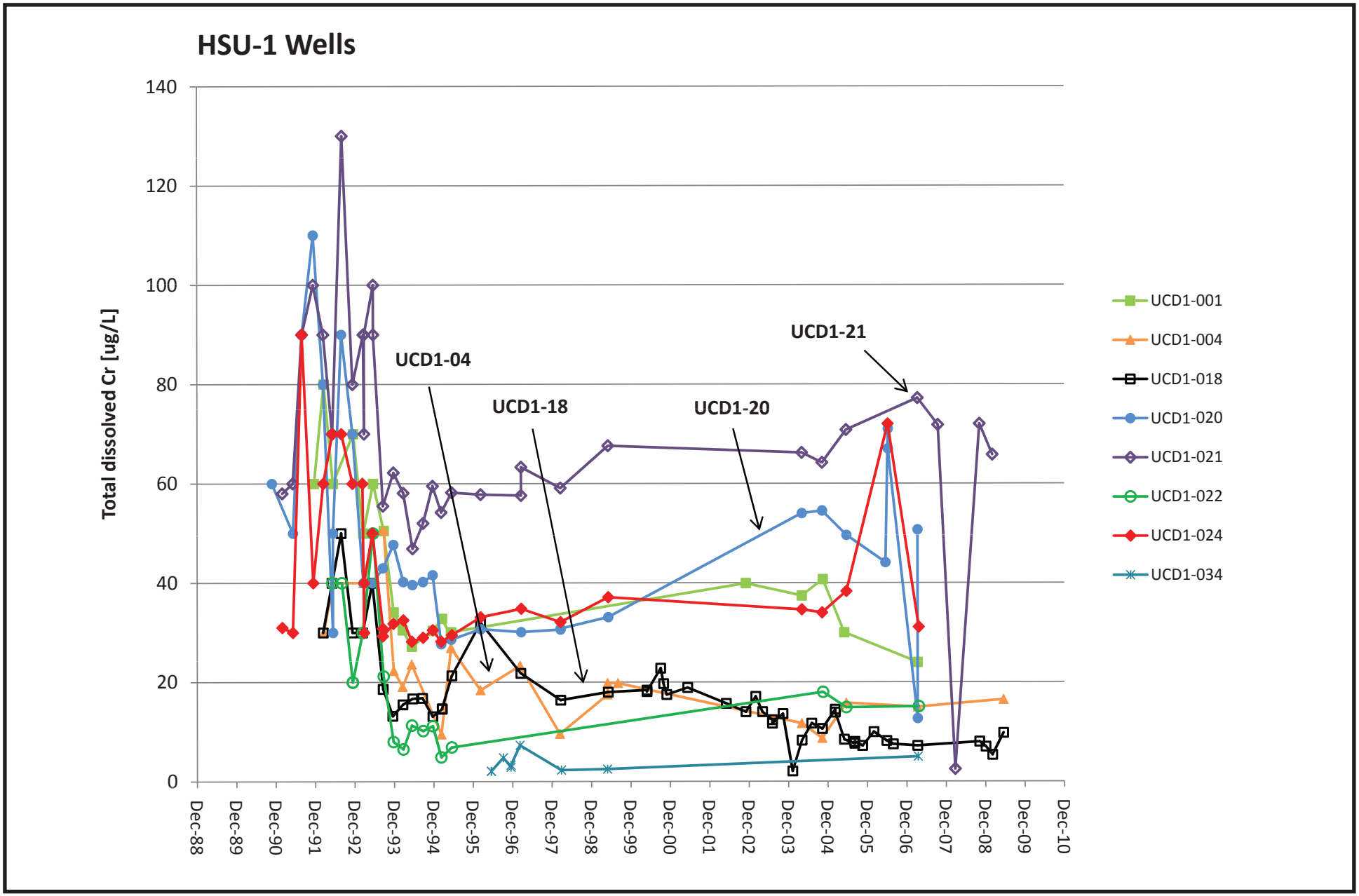


Figure 1-4. Chromium Concentrations in HSU-1 Monitoring Wells Lower Concentration Over Time, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

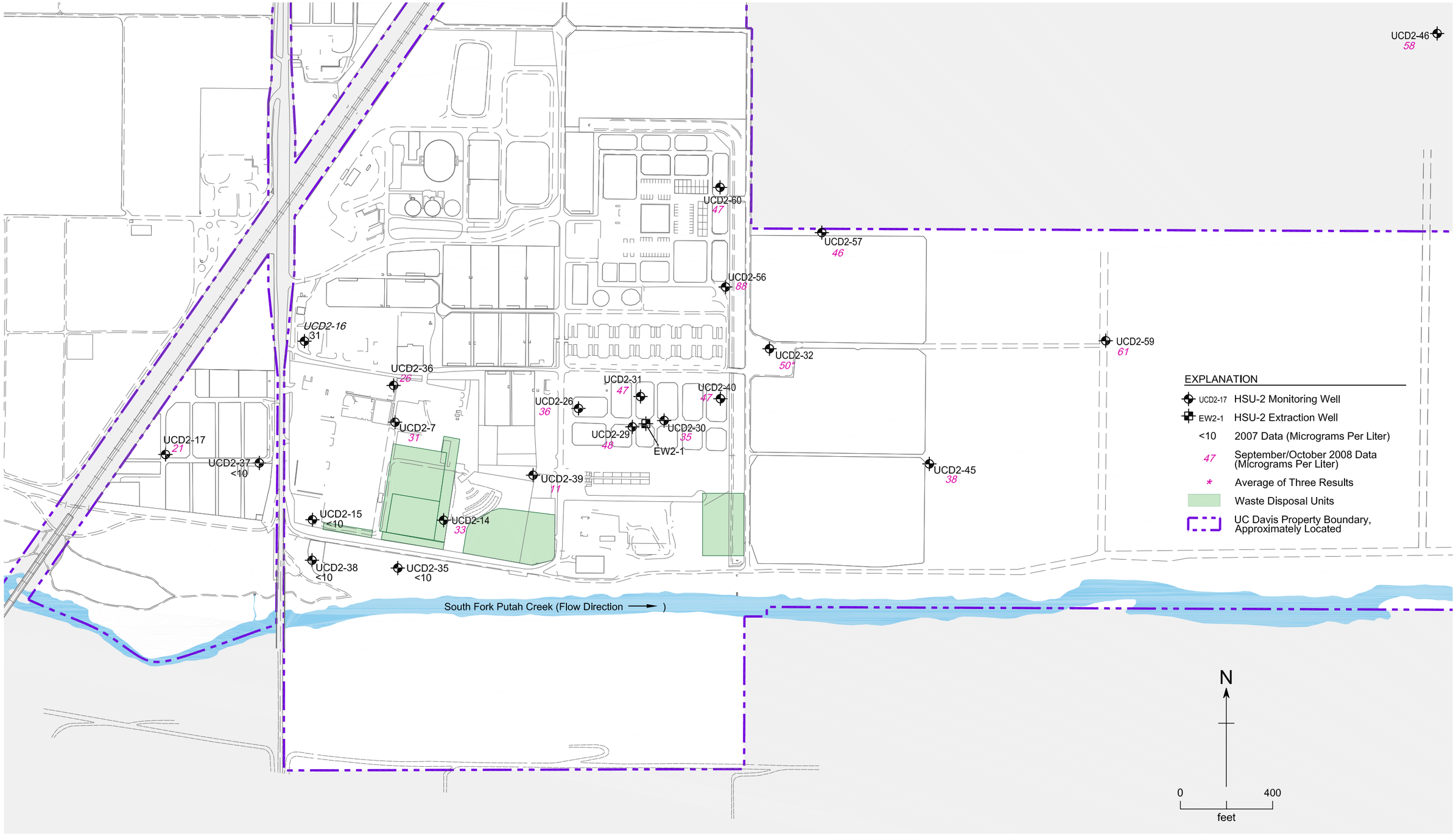


Figure 1-5. Representative Chromium Distribution in HSU-2, 2007 - 2008 Data, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

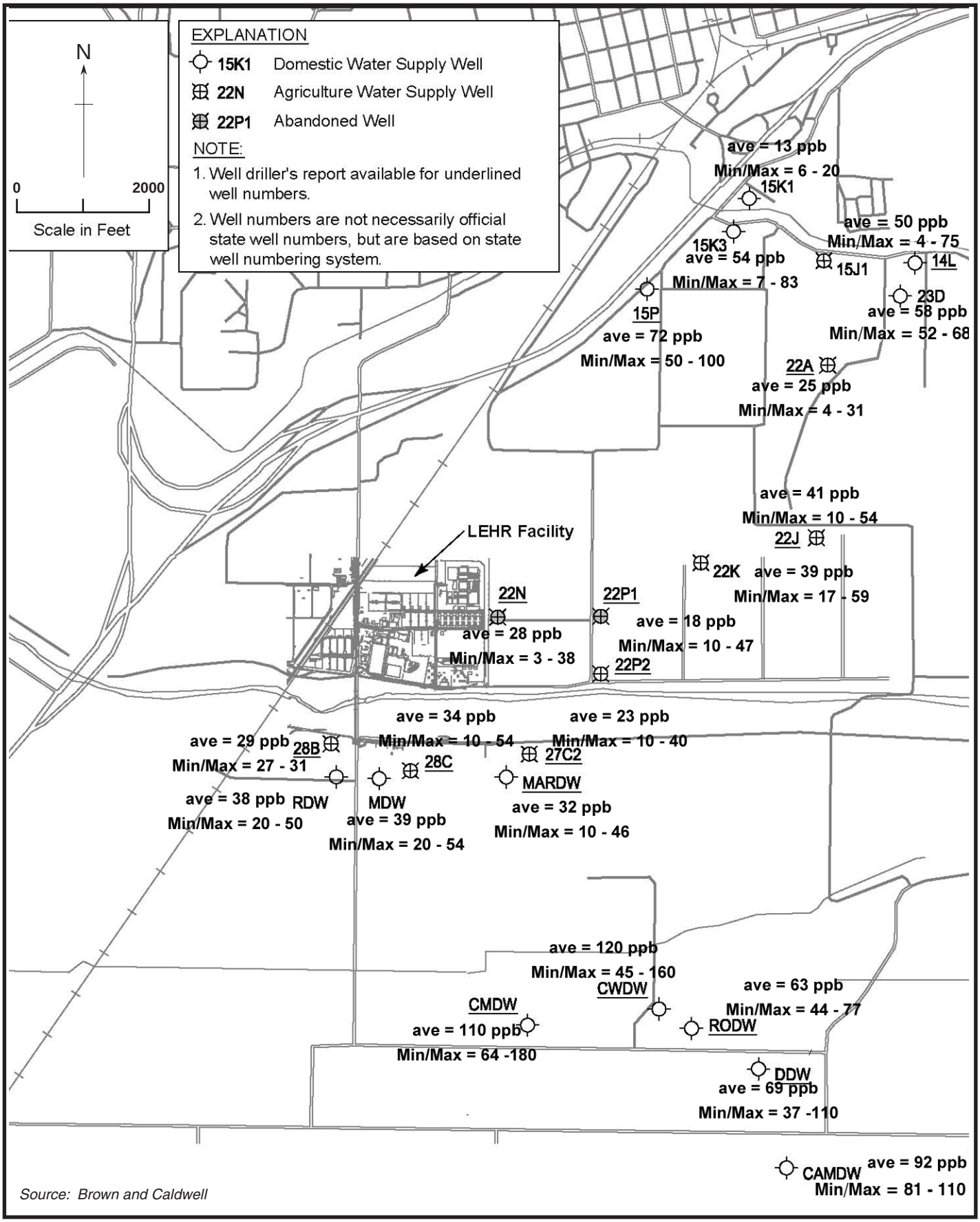


Figure 1-6. Off-site Supply Wells Chromium Concentrations, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

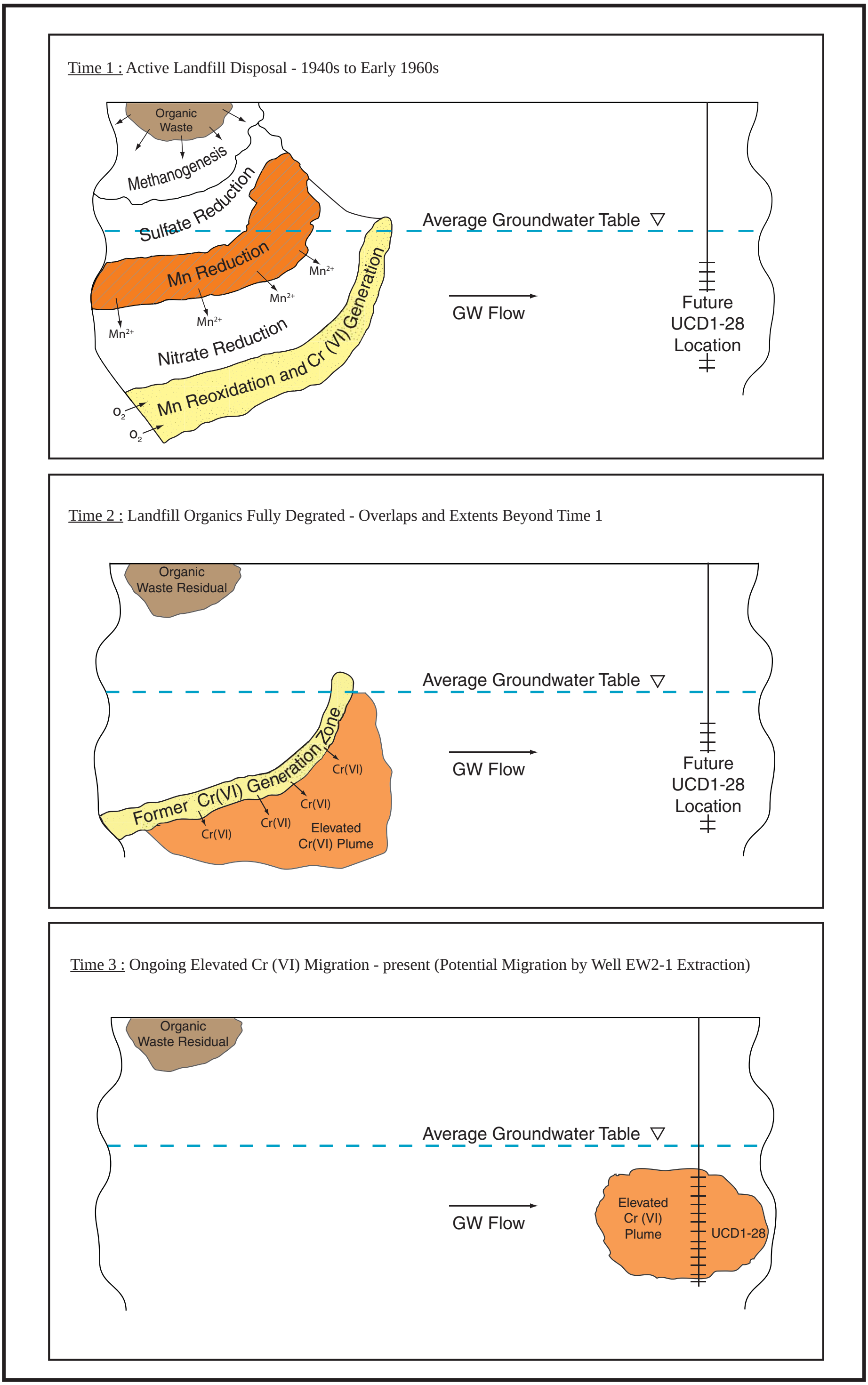


Figure 1-7. Source Mechanism 1A : Manganese Reduction, Mobilization and Reoxidation with Cr (VI) Generation, Laboratory for Energy-related Health Research/SouthCampus Disposal Site, University of California, Davis.

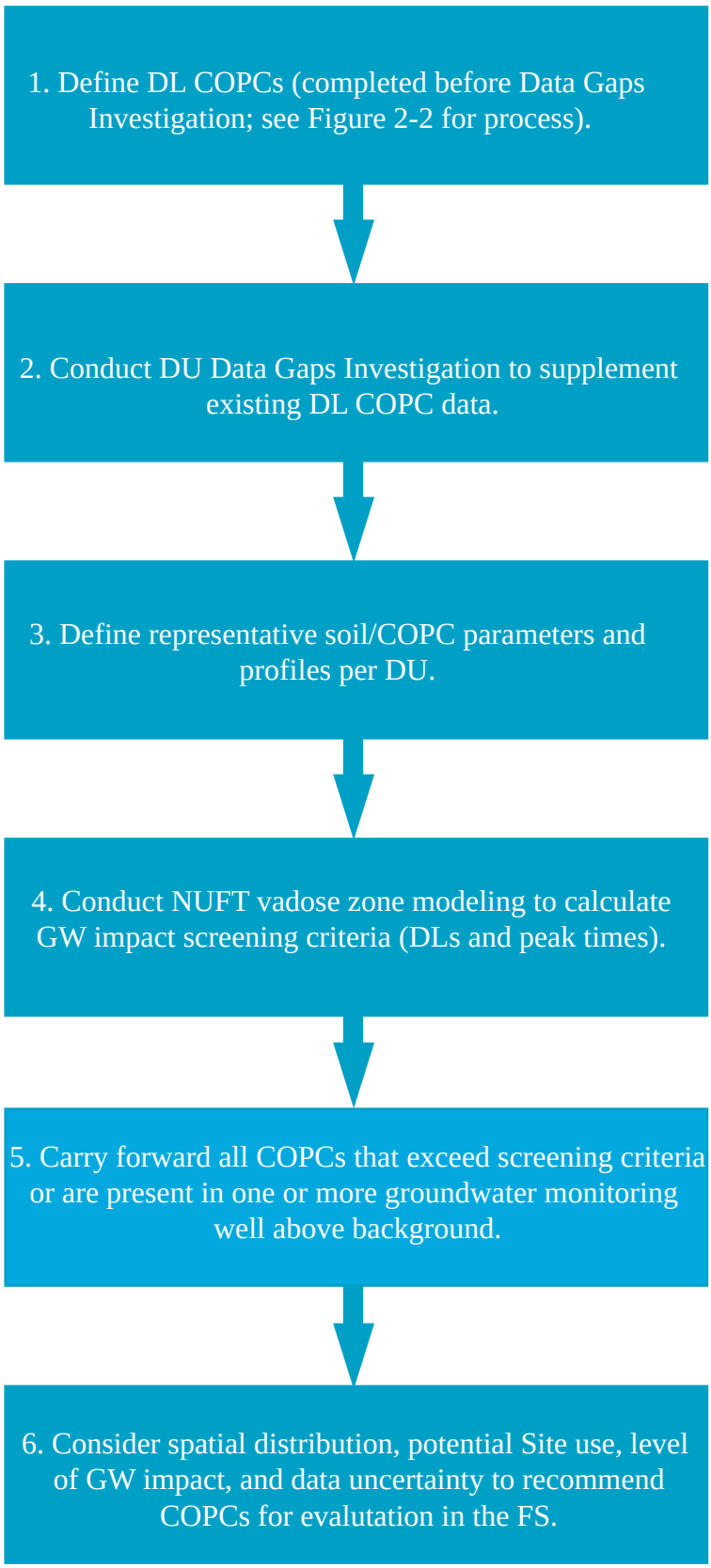


Figure 2-1. Soil-to-Groundwater Impact COPC Risk Characteration Analysis Flow Chart, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

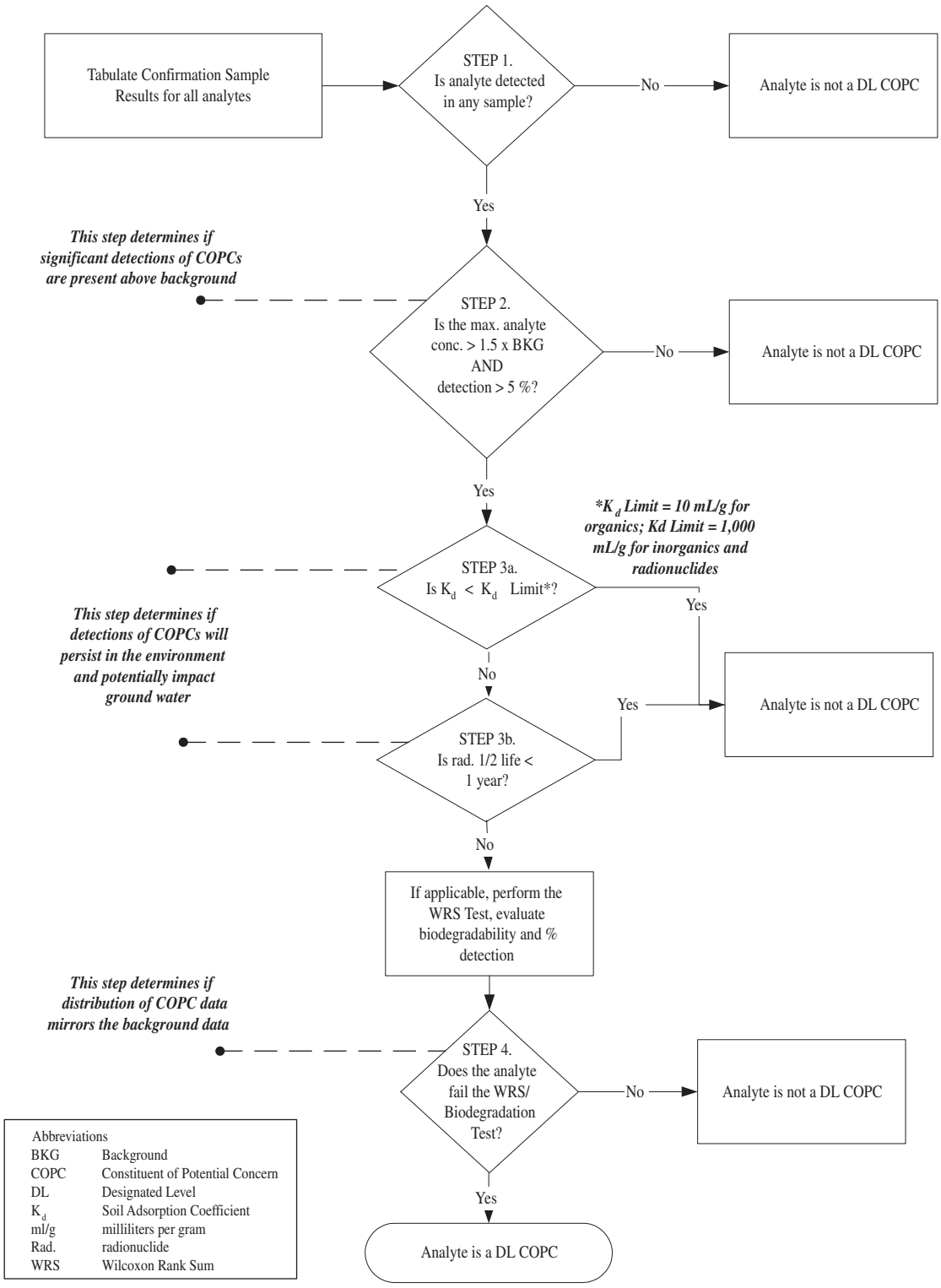


Figure 2-2. Designated-Level COPC Analysis Flow Chart, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

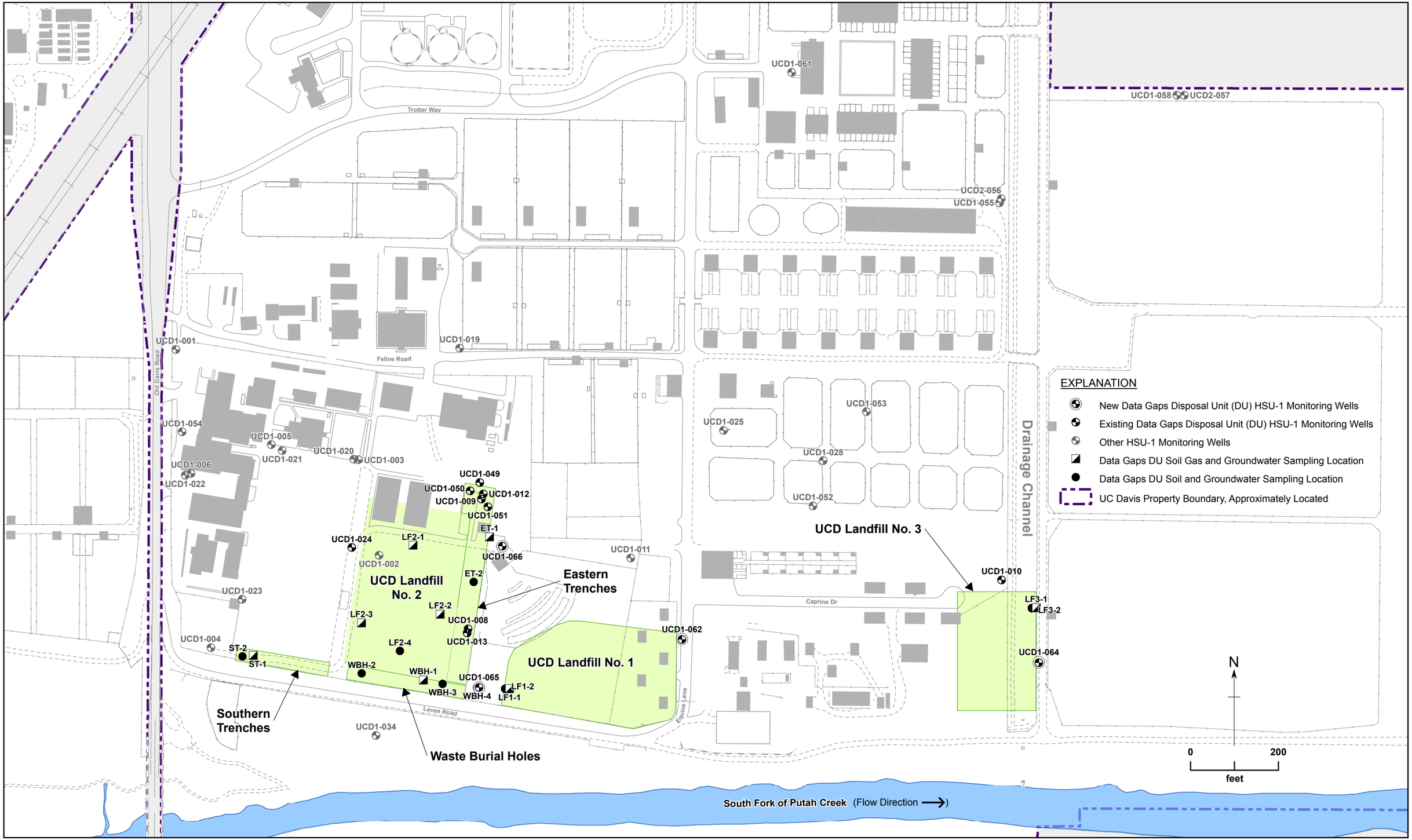


Figure 2-3. Data Gaps Disposal Unit Soil, Soil Gas and Groundwater Sampling and New Monitoring Well Locations, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Figure 2-4. Landfill Unit No. 1 Vadose Zone Sample Locations used in Soil-to-Groundwater Impact Evaluation, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Figure 2-5. Landfill Unit No. 2 and Eastern Trenches Vadose Zone Sample Locations used in Soil-to-Groundwater Impact Evaluation, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

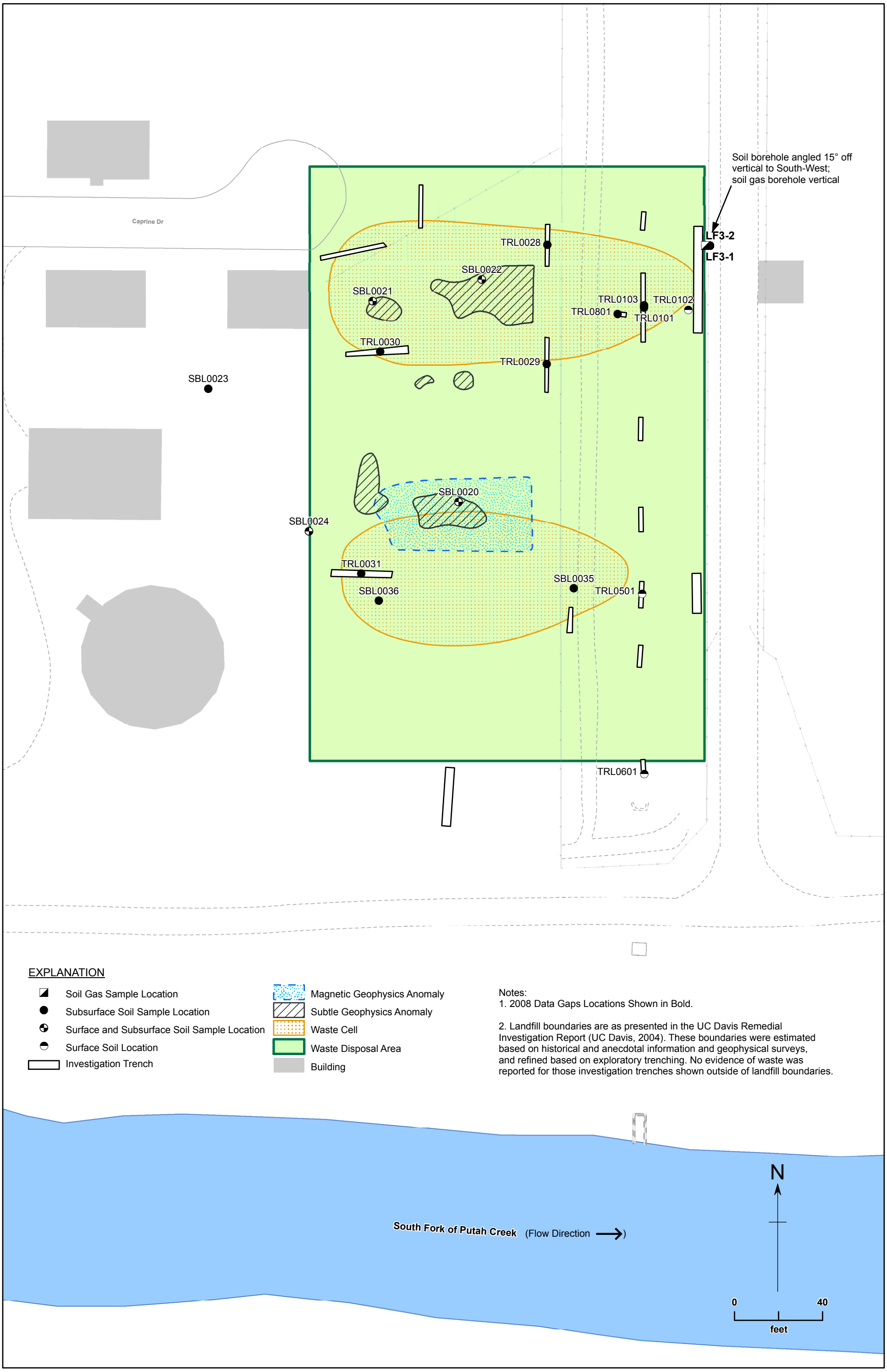


Figure 2-6. Landfill Unit No. 3 Vadose Zone Sample Locations used in Soil-to-Groundwater Impact Evaluation, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Weiss Associates

Southwest Disposal Trenches

Western Dog Pens

Landfill Disposal Unit No. 2

Southern Trenches

Waste Burial Holes

SBL-441
TRL0024
SBL-438
ST-2
ST-1
SBL0038
TRL0025
SBL-439
SBL-442
SBL0037
SBL-444
TRL0026
SBL-440
SBL-443
SBL0034
SBL-445
TRL0027
SBL-424
SSWB0060
SSWB0061
TRL0054
SSWB0062
SSWB0078
SSWB0077
SSWB0076
SSWB0107
SSWB0106
SBL-390

EXPLANATION

- Soil Gas Sample Location
- Subsurface Soil Sample Location
- Surface Soil Location
- Investigation Trench
- Waste Disposal Unit
- Subtle Geophysics Anomaly

Notes:
1. 2008 Data Gaps Locations Shown in Bold.

2. Landfill boundaries are as presented in the UC Davis Remedial Investigation Report (UC Davis, 2004). These boundaries were estimated based on historical and anecdotal information and geophysical surveys, and refined based on exploratory trenching. No evidence of waste was reported for those investigation trenches shown outside of landfill boundaries.

N

0 20 Feet
feet

Figure 2-7. Southern Trenches Vadose Zone Sample Locations used in Soil-to-Groundwater Impact Evaluation, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

T:\LEHR\Maps\UCDavis\DataGaps\SouthernTrenches.mxd

22-Jan-2010

Weiss Associates

Landfill Disposal Unit No. 2

Eastern Dog Pens

Eastern Trenches

Waste Burial Holes

WBH-1

WBH-2

WBH-3

SSWB0061 SSWB0060 TRL0054 SSWB0062 SBL-376B SSWB0063 SSWB0064 SBL-391 SBL-446 SBL-392 SBL-371B SBL-372A SSWB0065 SBL-372B SSWB0077 SSWB0078 SSWB0079 SBL-371A SSWB0076 SSWB0107 SSWB0106 SSWB0081 SSWB0080 SBL-376A SBL-390 SBL-371C SBL-447 SSWB0019 SBL-393 SSWB0066 SBL-448 SSWB0082 SBL-376C SBL-372C SSWB0091 SSWB0105 SSWB0088 SSWB0089 SSWB0090 SBL-377A SSWB0092 SSWB0067 SSWB0069 SSWB0068 SBL-394 SBL-377C SSWB0070 SSWB0071 SSWB0072 SSWB0075 TRL0051 SBL-0032 SSWB0073 SSWB0083 SSWB0093 SSWB0094 SSWB0095 SBL-396 SSWB0018 SSWB0085 SSWB0084 SSWB0086 SBL-397 SBL-375B TRL0050 SBL-449 SSWB0087 SBL-395 SBL-374B SBL-375A SBL-377B SSWB0102 SSWB0104 SSWB0103 SBL-374A SSWB0096 SSWB0097 SBL-451 SBL-375C SBL-373A TRL0052 SSWB0098 SBL-450 SSWB0099 TRL0049 SBL-398 SBL-373B SBL-374C SBL-399 SBL-373C

EXPLANATION

- Soil Gas Sample Location
- Subsurface Soil Sample Location
- Composite Sampling Location
- Clean Imported Soil
- Sorted Soil
- Waste Burial Holes Removed 1999
- Investigation Trench

Notes:
1. See Figure 2-5 for more information within Landfill Unit No. 2 and Eastern Trenches.

2. 2008 Data Gaps Locations Shown in Bold.

3. Landfill boundaries are as presented in the UC Davis Remedial Investigation Report (UC Davis, 2004). These boundaries were estimated based on historical and anecdotal information and geophysical surveys, and refined based on exploratory trenching. No evidence of waste was reported for those investigation trenches shown outside of landfill boundaries.

N

0 20
feet

Figure 2-8. Waste Burial Holes Vadose Zone Sample Locations used in Soil-to-Groundwater Impact Evaluation, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

T:\LEHR\Maps\UCDavis\DataGaps\Waste BurialHoles.mxd

22-Jan-2010

APPENDIX A

CHROMIUM DATA GAPS INVESTIGATION GEOLOGIC AND WELL CONSTRUCTION LOGS

BORING BGCr-1

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			Silt (ML), grayish brown, stiff, damp, ~20% f-m sand, 80% fines, roots, LP, LEK.
2			
4			
6	18/18		
	18/12		
8	18/18		At 7 ft: Unit coarsening downwards.
			Silty Sand (SM), light olive brown (2.5Y, 5/4), medium dense, damp, ~75-80% f. sand.
10	18/18		
12	18/18		At 10-12.7 ft: 65-75% f. sand, 25-35% silt fines, LP, MEK
	24/24		Sandy Silt (ML), lt. olive brown (2.5Y, 5/4), stiff, damp, 15-20% f. sand, root holes, LP, LEK.
14			
	18/6		
16			Silty Sand (SM), dk. brown (7.5Y, 4/4), med. dense, moist, 6% f. sand; up to 40% fines; Fe-ox stained, LP, MEK.
	18/12		
18	18/18		At 18-19.8 ft: Fe-ox staining (in circles and mottling), grayish zone about 3 inches thick at 19-19.3 ft.
	6/6		
20	18/18		
			Silt (ML), lt. olive brown (2.5Y, 5/4), hard, moist, trace to 5% f. sand, root holes, reddish brown mottling, LP, LEK.
22	18/18		
	18/18		
24			At 24-28 ft: Caliche veins and nodules, trace Mn-ox staining and Fe-ox, LP, LEK.
	6/6		
	18/13		
26	18/18		At 26.5 ft: Increasing clay content but still predominantly silt fines.
28	18/18		
	6/6		
30	18/18		At 30-31.5 ft: as above, caliche-nodules, minor Me- and Fe-ox stains, mottling, hard, damp-moist, LP, LEK.
32	18/18		
	18/18		
34			
	6/6		

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. Hand auger used to clear 0-5 feet.
2. Borehole was continuously cored using 2" diameter California Modified split-spoon samplers.
3. Borehole was backfilled to surface with neat cement.

Symbols:
Water level during drilling (first encountered)
Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/22/2008
Date completed:	9/22/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod sampler
Ground-surface elevation:	46.7
Bore-hole diameter:	8"

Figure A-1. Boring Log for Boring BGCr-1, LEHR/SCDS, UC Davis, Davis, California

BORING BGCr-1

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36	18/18		At 35 ft: As above, hard, damp-moist, LEK.
	18/18		
38	18/18		
40	6/6		
	18/18		
42	18/18		At 42 ft: Moist, grayish and lt. olive brown, thin (< 1/2), silty sand dense at 42.2, firm to stiff, LP, LEK.
	18/18		
44	6/6		
	18/18		
46	18/18		
48	18/18		
50	6/6		
	18/18		At 50 ft: As above with minor Fe-ox mottling, firm, moist, LP, LEK.
52	18/9		
54	18/15		Sand (SP), dk. yellowish brown (10YR, 5/2), dense, wet, trace to 5% fine f-m sand, HEK.
	6/0		At 54 ft: Water noted on samples.
56	18/16		Collected GW sample at 55 ft 14:00, 9/22/08 (ID=GWGW2298).
	18/15		
58	18/12		
60	6/3		Sandy SILT (ML) Lt. olive brown (2.5Y, 5/4), to olive (2.5Y, 4/4), hard, moist to wet, 15-25% f-m sand; 75-85% fines (silt % > clay%), dk. reddish brn., Fe-ox veins and whitish caliche veings and nodules, LP, LEK.
	18/15		
62	18/18		
64	18/18		
	6/6		
66	18/18		At 65 ft: Bailed inside of augers w/ 3" diameter bailer (3-4 gallons removed).
	18/18		At 66-70 ft: Increased clay in fines; Fe-ox and Mn-ox stains.
68	18/18		Clayey Silt (ML), yellowish brown (10YR, 5/4), hard, moist to wet, 95% fines (silt% > clay%), 5% v. f. sand, mn-ox specks, grayish mottling scarce, LP, LEK.
70	6/5		
	18/18		
72	18/18		
74	18/18		
	6/6		At 74.5 ft: Unit coarsening downward.
76	18/18		Silty Sand (SM), dk. yellowish brown (10 YR, 4/3), med. dense, wet, 15% silt fines, 85% f. sand, LP, HEK.
	18/18		At 75 ft: Water returned inside augers again.
78	18/18		Silt (ML) lt. olive brown (2.5Y, 5/4), stiff, wet.
80	6/0		Sand (SP), grayish brown, 10 YR, 3/3), medium dense, wet, trace to 5% fines, 85% fine sand; 10% f-c gravel; sub-round.
	18/15		
82	18/9		Gravel (GP), dk. grayish brown (10YR, 3/2), dense, wet, 0-5% fines, 65% f-c gravel, subround to round, 30-35% f-c sand, HEK.
	18/10		Collected GW sample BGCr-1-85 (GWGW2299).
84	6/6		Boring terminated 15:50 9/22/08

Bottom of borehole at 85.0 feet.

Figure A-1. Boring Log for Boring BGCr-1, LEHR/SCDS, UC Davis, Davis, California

BORING BGCr-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			Sandy SILT (ML), lt. grayish brown (10 YR, 3/4), stiff, dry, ~70% fines, ~30% f-c sand, LP, LEK.
2			
4			
6	18/18		SILT (ML), dk. grayish brown (10 YR, 3/2), hard, damp, trace to 5% f. sand, root holes, LP, LEK.
8	18/18		
10	18/18		
12	18/12		Silty SAND (SM), yellowish brown (10YR, 5/4), medium dense, damp to moist, ~60-70% f-m sand; 30-40% fines (silty% > clay%).
14	18/18		SILT (ML), light olive brown (2.5 YR, 5/4), v. stiff to hard, moist, trace to 5% f. sand, 95-100% silt fines; root holes, trace Mn-ox fine specs, LP, LEK.
16	18/18		At 16.5-18.5 ft: Minor Mn-ox specs and caliche veins, damp, LEK.
18	18/18		
20	18/12		
22	18/18		At 21-25 ft: Mn-ox staining (veins and specs), increasing with depth, LP, LEK.
24	18/18		
26	18/18		
28	18/18		Sandy SILT (ML), lt. olive brown (2.5Y, 5/4), hard, moist, ~65% fines (silt % > clay%), 35% f. sand, minor Mn-ox stains, LP, LEK.
30	18/18		SILT (ML), light olive brown (2.5Y, 5/4), hard, damp to moist, trace to 10% f. sand; caliche nodules to 1/8 diameter and whitish veins, Fe-Ox, Mn-ox staining/mottling, LP, LEK.
32	18/18		
34	18/18		

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1.. Hand augered 0-5 feet.
2.. Borehole was continuously cored using 2" diameter California Modified split-spoon samplers.
3.. Borehole was backfilled to surface with neat cement.

Symbols:
▽ Water level during drilling (first encountered)
▨ Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Mike Radakovitz
Date begun:	9/23/2009
Date completed:	9/23/2009
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod sampler
Ground-surface elevation:	47.6
Bore-hole diameter:	8"

Figure A-2. Boring Log for Boring BGCr-2, LEHR/SCDS, UC Davis, Davis, California

BORING BGCr-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36	18/18		SILT (ML), continued.
	18/18		At 34-37 ft: Mn-ox (black) and Fe-ox (orange w/brown) staining, minor caliche as veins, otherwise as above.
38	18/18		At 37-39 ft: Mn-ox staining decreased, rare caliche veins and abundant Fe-ox stains, LP, LEK.
40	18/18		Silty SAND (SM), light olive brown (2.5Y, 5/4), dense, damp, ~15-20% fines, 75-80% f. sand, LP, HEK.
	18/18		SILT (ML), dk. brown, LEK.
42	18/18		Silty SAND (SM) as above at 40-41.2 feet.
44	18/18		Sandy SILT (ML), lt. olive brown (2.5Y, 5/2), hard, moist, Fe-ox stained, ~60-70% silt, 30-40% f. sand, LP, L-MEK.
46	18/18		Silty SAND (SM); olive brwn. (2.5Y, 4/4), ~65% f. sand, 35% silt fines, M-HEK, trace water at 45.5.
48	18/18		Clayey SILT (ML), grayish brown (2.5Y, 5/2), hard, moist, trace f. sand, Fe-ox staining/mottling, caliche nodules strong reaction with hydrochloric acid, silt% > clay %), LP, LEK.
50	18/18		
52	18/18		Silty SAND (SM), olive brown (2.5Y, 4/4), dense, moist, ~65-75% f-m sand, 25-35% fines, LP, M-HEK.
	18/18		
54	18/12		At 54.5-55.5 ft: ~5% F. gravel, moisture observed on tip of samples at 56 feet.
56	18/18		
58	18/14		SAND (SP), dk. grayish brown (10YR, 3/2), dense, wet, trace to 5% fines, 90% f-c sand, 5-10% f. gravel, subround-round, HEK.
	10/7		SILT (ML), lt. olive brown (2.5Y, 5/4), hard, moist, trace to 10% sand; Fe-ox stains and rare caliche veins, LP, LEK.
60	9/9		Note: High% of sloughed sand inside augers impacted sample recovery at 59.5-66.0 feet, sand may be an interbed, but is more likely from the unit at 56.5 feet.
62	8/6		
	18/13		
64			
66	18/16		At 65 ft: Collected GW sample BGCR-2 @ 65', 14:00, 9/23/08.
	18/11		
68	18/18		At 65-70 ft: as above with minor Fe-ox staining, caliche veins and modules common, LP, LEK.
70	18/18		At 70-75 ft: as above, yellowish brown (10 YR, 5/4), moist to wet, stiff, LP, LEK, caliche veins and nodules.
	18/18		
72	18/18		
74	18/17		
76	18/6.5		
	18/12		
78	18/10		
80	18/18		At 80 ft: as above with minor caliche veins, moist to wet, L-MP, LEK.
82	18/5		
	18/15		SILT (ML), as above, caliche rare, increased % plastic (clay) fines, moist to wet, LEK.
84	18/18		
86	18/18		
88	18/18		At 87 ft: Fe-ox stains common again with orange brown mottling and lt. grayish brown patches, caliche veins, LP, LEK.
	18/17		
90	18/15		

Figure A-2. Boring Log for Boring BGCr-2, LEHR/SCDS, UC Davis, Davis, California

BORING BGCr-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
92	18/16		
94	18/12		At 93.5-94.5 ft: Unit coarsening, trace f. gravel, 10% fine sand.
96	18/9		SAND (SP), dk. gry. brn (10YR, 3/2), dense, wet, trace fines, 80% f-c sand, 20% f. gravel, HEK.
98	18/0		At 96.5-98 ft: no recovery, drilled like coarse sand or pea gravel, abundant water recharged inside augers.

Bottom of borehole at 98.0 feet.

Figure A-2. Boring Log for Boring BGCr-2, LEHR/SCDS, UC Davis, Davis, California

BORING HSCr-1

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			Gravel roadbse, FILL, Silty GRAVEL(GW)
2			Silty SAND (SM), pale brown (10YR 6/3); loose; dry; ~65% v.f. sand; 35% silt fines; trace f-c gravel near top of unit; LP; M-HEK.
4			
6	18/18		
8	18/15		At 6.5 ft: dark grayish brown (10YR 4/2); rootholes; damp; ~40-50% fine; 50% vf-m sand; LP; LMEK
10	18/12		Sandy SILT (ML), dark grayish brown (10YR 4/2); hard; damp; ~75% fine; 25% f-m sand; rootholes; LP; LEK.
12	18/14		
14	18/15		
16	18/16		
18	18/18		SILT (ML) dark yellowish brown (10YR, 4/4); firm; moist; 5-10% vf-f. sand 90-95% silt fines; rootholes; rare caliche veins; LP; LEK.
20	18/18		
22	18/18		At 18.5 ft: stiff; moist; as above
24	18/18		
26	18/18		At 20 ft: Fe-ox stained w/dk reddish brn. veins; rootholes
28	18/18		At 21 ft: ~6" thick silty sand (SM) layer; moist; 75% f-c sand; 25 % fines; HEK
30	18/18		At 22 ft; Fe-ox and mn-ox staining.
32	18/18		At 23.5 ft: 6 silty sand layer as above @21 moist; HEK
34	18/18		
	18/18		
	18/11		
	18/13		
	18/18		At 25-28 ft: stiff; moist Fe-ox stains; Mn-ox specs (black); caliche veins and nodules
	18/18		
	18/18		At 30-35 ft: v. stiff to hard; moist; trace to 10% f-c sand; Fe-ox and Mn-ox staining as mottling and Mn-ox specs; caliche nodules and whitish veins increasing w/depth; LP; LEK
	18/18		
	18/18		

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger
2.. Borehole was continuously cored using 2" diameter California Modified split-spoon samplers.
3.. Borehole was backfilled to surface with neat cement.

Symbols:

Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Mike Radakovitz
Date begun:	9/24/2008
Date completed:	9/29/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod sampler
Ground-surface elevation:	48.3
Bore-hole diameter:	8"

Figure A-3. Boring Log for Boring HSCr-1, LEHR/SCDS, UC Davis, Davis, California

BORING HSCr-1

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36	18/18		At 35-40 ft: silt (ML) as above.
	18/18		
38	18/18		
40	18/18		At 40 ft: silt (ML); as above w/ $CaCO_3$ lined rootholes; LP; LEK
	18/18		
42	18/18		
44	12/12		
	18/15		At 45 ft: Silt (ML) as above w/caliche veins & nodules; Fe-ox staining pervasive; LP; LEK
46	18/18		
48	18/18		At 47.5 ft: moisture observed in core.
50	18/18		
	18/18		
52	18/18		
54	12/12		At 53 ft: trace Mn-ox staining; otherwise as above; hard; damp to moist; LP; LEK
	18/18		At 55-60 ft: as above
56	18/18		
58	18/18		
60	18/18		
62	18/18		At 61 ft: moisture visible in core; no recharge inside augers after ~5 min pause. Water stabilized @ 61' after drilling ahead to 70'
	18/18		
64			
66	18/18		At 65 ft: wet on outside of sampler; litholo is as above; hard; moist; LP; LEK
	18/15		
68	18/18		
70	18/18		At 70 ft: collected GW sample from inside augers (HSCr1-70'); 12:45 9/29/08
72	18/18		At 72 ft: dark yellowish brown (10YR, 4/4); hard; damp; low-medium plasticity fines; LP; LEK
	18/18		
74			
	18/18		
76	18/18		Silty SAND (SM), olive brown (2.5 Y, 4/3); dense; wet; ~75-80% f-m sand; 20-25% silt fines; LP; HEK
78	18/18		At 76.8-77.1 ft and 77.7-78.2 ft: clayey silt (ML) interbeds; LP; LEK
			At 78.2-80 ft: Silty SAND (SM) as above
80	18/18		SAND (SP), dk. grayish brown (10YR, 3/2); dense; wet; trace to 10% fines; 90-100% f-m sand; HEK
82	18/18		
	18/18		
84			
86	18/8		At 83-91.5 ft: limited true recovery in spl spoon sampler due to flowing sands;
	18/6		
88	18/7		
90	18/8		GRAVEL (GP), dark grayish brown (10YR, 3/2); dense; wet; ~5-10% fines; 35% f-c sand; 55-60% f-c gravel, rounded; HEK Boring terminated 15:40, 9/29/08

Figure A-3. Boring Log for Boring HSCr-1, LEHR/SCDS, UC Davis, Davis, California

BORING HSCr-1

RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
		Boring Terminated 15:40, 9/28/09
		Bottom of borehole at 91.5 feet.

DEPTH BELOW GROUND SURFACE (FEET)

Figure A-3. Boring Log for Boring HSCr-1, LEHR/SCDS, UC Davis, Davis, California

BORING HSCr-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0, 2, 4, 6	18/18, 18/18, 18/15		Silty SAND (SM), light olive brown (2.5x, 5/4), medium dense, damp, ~20-25% fines, 75-80% f-m sand, LP, HEK.
8, 10, 12, 14	18/18, 18/17, 18/18		SILT (ML), dark grayish brown (10YR, 4/2), very stiff, damp, trace to 5% f. sand, low plasticity silt fines, root holes, LP, LEK. Silt (ML) continued. At 11 ft: hue changes to light olive brown (2.5Y, 5/4) ~10% f. sand, LP, LEK.
16, 18, 20, 22, 24	18/18, 18/18, 18/18, 18/18, 18/18, 18/12		Sandy SILT (ML), light olive brown (2.5Y, 5/4), very stiff, damp, ~70-75% fines (silty% > clay%), 25-30% f. sand, LP, LEK. At 16ft : Moist, rootholes, LEK. At 20-25 ft: Sandy SILT (ML) as above, damp, LEK.
26, 28, 30, 32, 34	18/18, 18/18, 18/18, 18/12, 18/12, 18/18		At 25.5 ft: Fe-ox and Mn-ox staining appears, Mn-ox specs to ~1/4 dia.. LP, moist, LEK. At 30 ft: SILT (ML), continued. Light olive brown (2.5Y, 5/4), hard, damp, Caliche veins and modules common, Fe-ox staining, LP, LEK.

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger
2.. Borehole was continuously cored using 2" diameter California Modified split-spoon samplers.
3.. Borehole was backfilled to surface with neat cement.

Symbols:
▽ Water level during drilling (first encountered)
▨ Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/30/2008
Date completed:	9/30/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod sampler
Ground-surface elevation:	47.2
Bore-hole diameter:	8"

Figure A-4. Boring Log for Boring HSCr-2, LEHR/SCDS, UC Davis, Davis, California

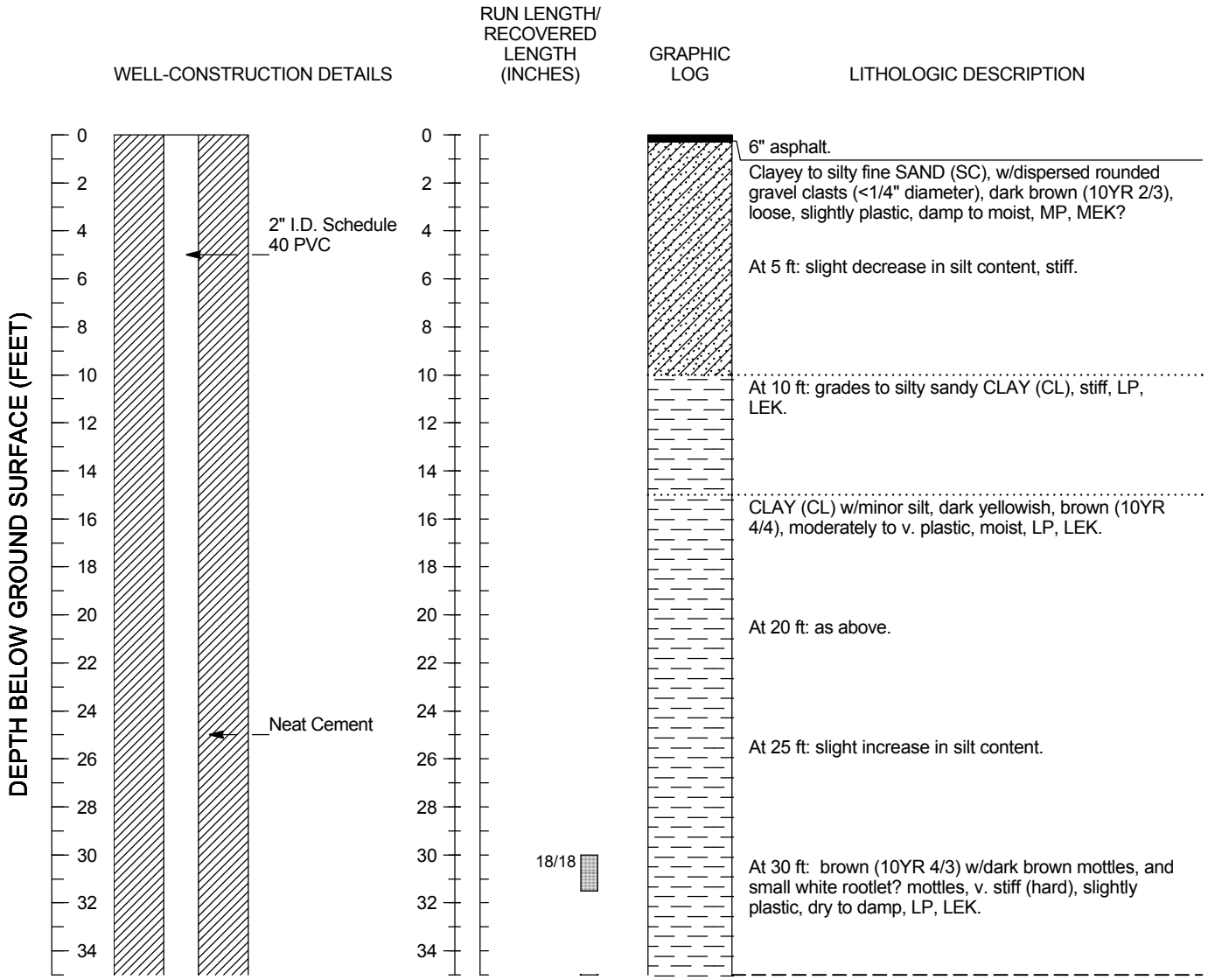
BORING HSCr-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36	18/18		At 30-40 ft: SILT (ML) as above, dark brown mottling and MN-ox specs increasing in frequency with depth.
	18/18		
38	18/18		
40	18/18		
	18/18		
42	18/18		At 42 ft: Sandy SILT (ML) as above, but Mn-ox specs are infrequent. CaCO3 nodules common to ~3/8 inch diameter.
44	18/18		At 45-50 ft: Caliche absent, otherwise sandy silt (ML) as above w/ Fe-ox stains/mottling, hard, damp, LP, LEK.
46	18/18		
	18/18		
48	18/18		
50	18/18		At 49.5 ft: Moisture observed in core sample.
	18/18		
52	18/18		At 52.5 ft: Fe-ox staining and mottling, caliche veins and nodules common, hard, moist, LP, LEK.
54	18/18		At 55 ft: Yellowish brown (10YR 5/3), caliche present as veins, hard, moist, LP, LEK.
56	18/18		
	18/18		
58	18/18		At 57.5 ft: Water level inside auger, 11:20 9/30/08.
60	18/14		At 60 ft: As above, hard, moist, LEK.
	18/18		
62	18/18		
64	18/18		At 63-64.5 ft: Water observed in augers.
66	18/12		At 65 ft: As above, very stiff to hard, moist, LEK.
	18/18		
68	18/18		Silty SAND (SM), light olive brown, (2.5Y, 5/4), medium dense, wet, ~70% f. sand, 30% fines, LP, HEK.
70	18/18		SILT (ML) light yellowish brown (10YR, 5/4), hard, moist to wet, trace f. sand, Fe-ox staining and mottling, LP, LEK. At 69.5 ft: Paused for HSU-1 water sample 11:00AM 9/30/08.
	18/18		
72	18/18		
74	18/17		
76	18/12		At 75.4-79.5 ft: Silty SAND (SM) dark yellowish brown (10YR, 3/4), dense, wet, ~70-80% f-m sand, 15% f. gravel, medium dense, wet, HEK. At 76.5-84.5 ft: Limited true recovery due to loose flowing sands inside augers, rip behavior and driller's observations indicate coarse sand/gravel in this zone.
78	18/6		At 78 ft: Unit coarsening downward, ~15% fines, 70% f-c sand, 15% f. gravel, medium dense, wet, HEK.
80	18/6		At 79.5-84.5 ft: GRAVEL (GP), very dark greyish brown (10YR, 3/2), medium dense, wet, trace to 5% fines, ~35% f-c sand, 60% f-c gravel, subround to round, HEK.
82	18/12		
84	18/3		Boring terminated 12:00 9/30/08.

Bottom of borehole at 84.5 feet.

Figure A-4. Boring Log for Boring HSCr-2, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-61



EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. hand augered 0-5 feet
2. borehole logged by cuttings and limited split spoon sampling

Symbols:
▽ Water level during drilling (first encountered)
▨ Location of cored run

Logged by:	REK
Checked by:	RKD
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Mike Radakovitz
Date begun:	10/2/2008
Date completed:	10/2/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	Split Spoon
Ground-surface elevation:	47.7
Bore-hole diameter:	8"
Well-head completion:	
Well-casing diameter:	2"

Figure A-5. Boring Log and Well-Construction Details for Well UCD1-61, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-61

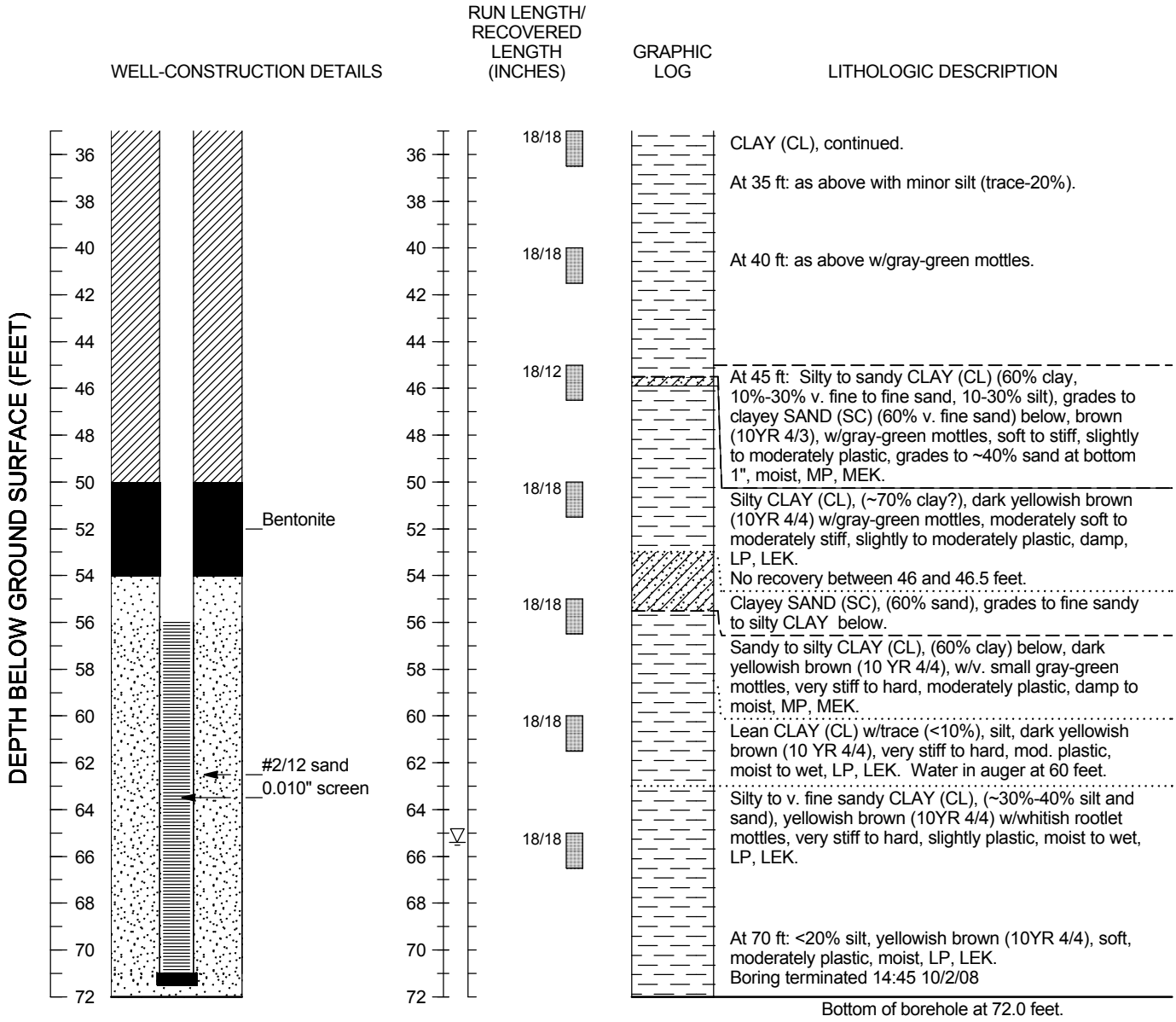
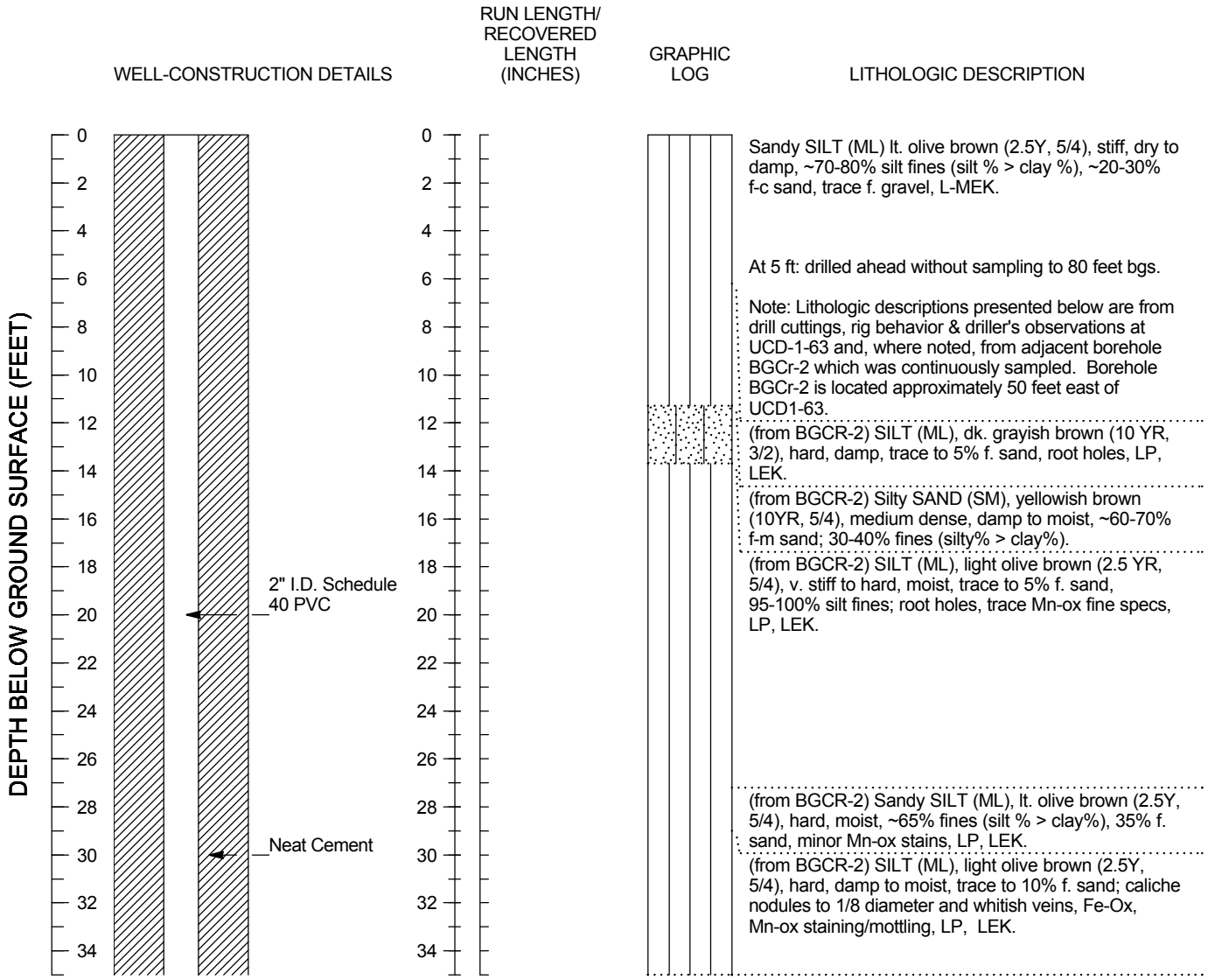


Figure A-5. Boring Log and Well-Construction Details for Well UCD1-61, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-63



EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

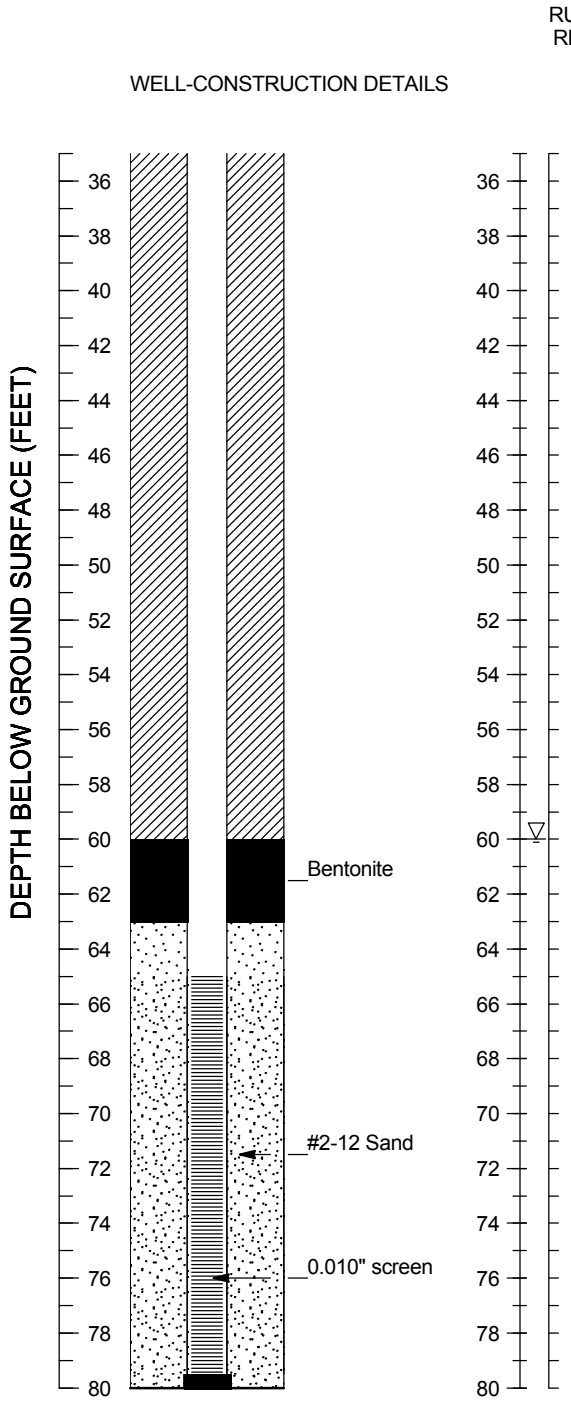
Notes:
1. Hand augered 0-5'
2. Lithologic descriptions are from cuttings, rig behavior, drillers observations and continuous core observed in nearby borehole BGCr-2.

Symbols:
▽ Water level during drilling (first encountered)

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	10/1/2008
Date completed:	10/1/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	Split Spoon
Ground-surface elevation:	47.6
Bore-hole diameter:	8"
Well-head completion:	
Well-casing diameter:	2"

Figure A-7. Boring Log and Well-Construction Details for Well UCD1-63, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-63



LITHOLOGIC DESCRIPTION

SILT (ML), continued.

(from BGCR-2) Silty SAND (SM), light olive brown (2.5Y, 5/4), dense, damp, ~15-20% fines, 75-80% f. sand, LP, HEK.
At 40 ft: cuttings & rig behavior indicates fine grained, silt lithology.

(from BGCR-2) SILT (ML), dk. brown, LEK.

(from BGCR-2) Silty SAND (SM) as above at 40-41.2 feet.

(from BGCR-2) Sandy SILT (ML), lt. olive brown (2.5Y, 5/2), hard, moist, Fe-ox stained, ~60-70% silt, 30-40% f. sand, LP, L-MEK.

(from BGCR-2) Silty SAND (SM); olive brwn. (2.5Y, 4/4), ~65% f. sand, 35% silt fines, M-HEK, trace water at 45.5.

(from BGCR-2) Clayey SILT (ML), grayish brown (2.5Y, 5/2), hard, moist, trace f. sand, Fe-ox staining/mottling, caliche nodules strong reaction with hydrochoric acid, silt% > clay %, LP, LEK.
At 45 to 65 ft: drill cuttings, rig behavior & driller's observations indicate primarily fine-grained silt to clayey silt (ML) lithology with minor silty sand.

(from BGCR-2) Silty SAND (SM), olive brown (2.5Y, 4/4), dense, moist, ~65-75% f-m sand, 25-35% fines, LP, M-HEK.

(from BGCR-2) Sand (SP), dk. grayish brown (10YR, 3/2), dense, wet, trace to 5% fines, 90% f-c sand, 5-10% f. gravel, subround-round, HEK.
At 57 ft: moisture observed on hammer/center bit.

(from BGCR-2) SILT (ML), lt. olive brown (2.5Y, 5/4), hard, moist, trace to 10% sand; Fe-ox stains and rare caliche veins, LP, LEK.
At 60 ft: silty SAND (SM) observed in cuttings and on augers at the conclusion of drilling.

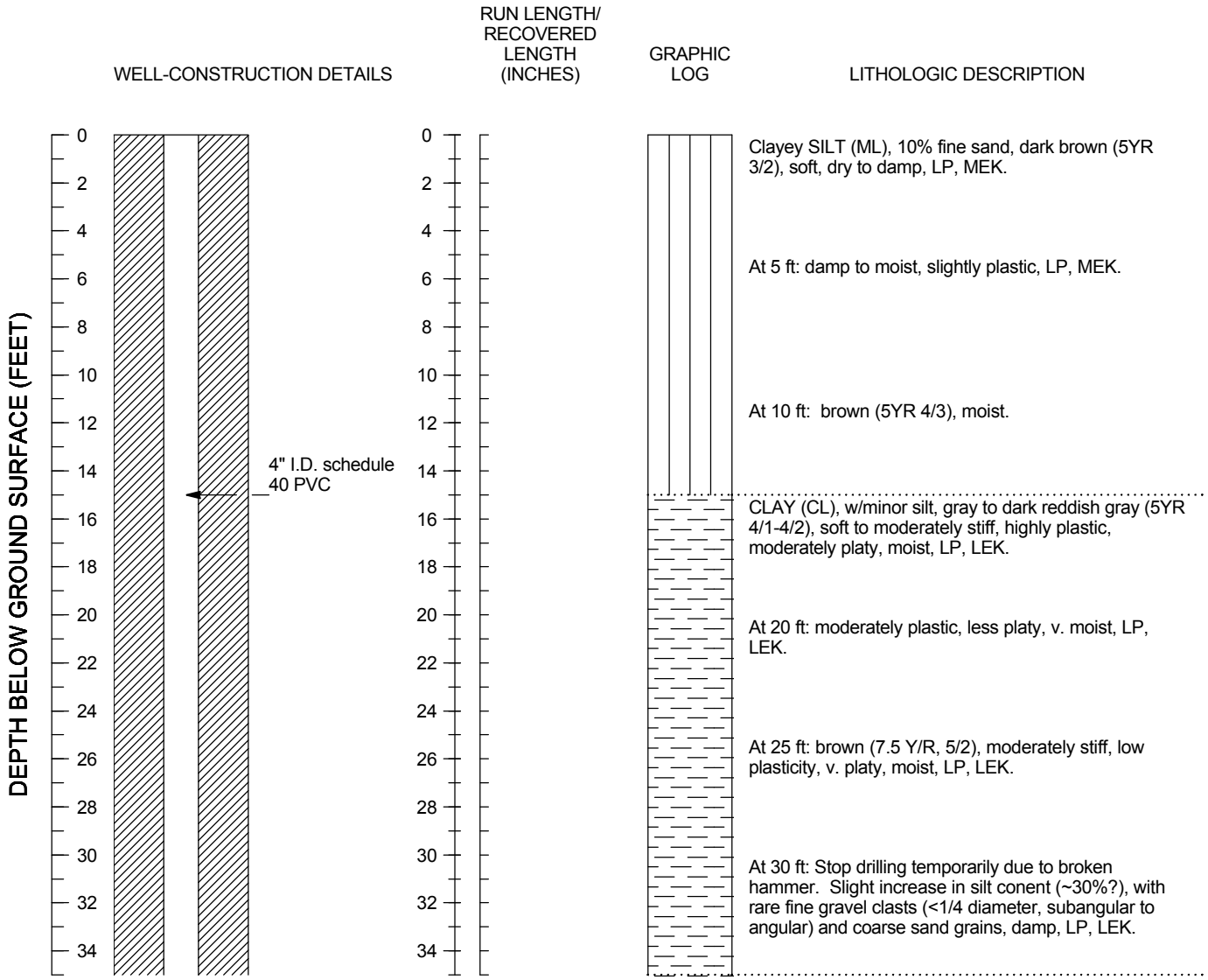
At 65-80ft: Drill cuttings, rig behavior, driller's observations and material observed on auger flights at the conclusion of drilling confirm fine grained units, primarily SILT (ML).

Boring Terminated 14:00 10/1/08

Bottom of borehole at 80.0 feet.

Figure A-7. Boring Log and Well-Construction Details for Well UCD1-63, LEHR/SCDS, UC Davis, Davis, California

WELL UCD2-59



EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. borehole logged by cuttings and limited split spoon sampling.

Symbols:

Location of cored run

Logged by:	REK
Checked by:	RKD
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Victor De Santiago
Date begun:	9/16/2008
Date completed:	9/19/2008
Drilling method:	Air Rotary
Type of sampler:	Split Spoon
Ground-surface elevation:	44.6
Bore-hole diameter:	10"
Well-head completion:	
Well-casing diameter:	4"

Figure A-8. Boring Log and Well-Construction Details for Well UCD2-59, LEHR/SCDS, UC Davis, Davis, California

WELL UCD2-59

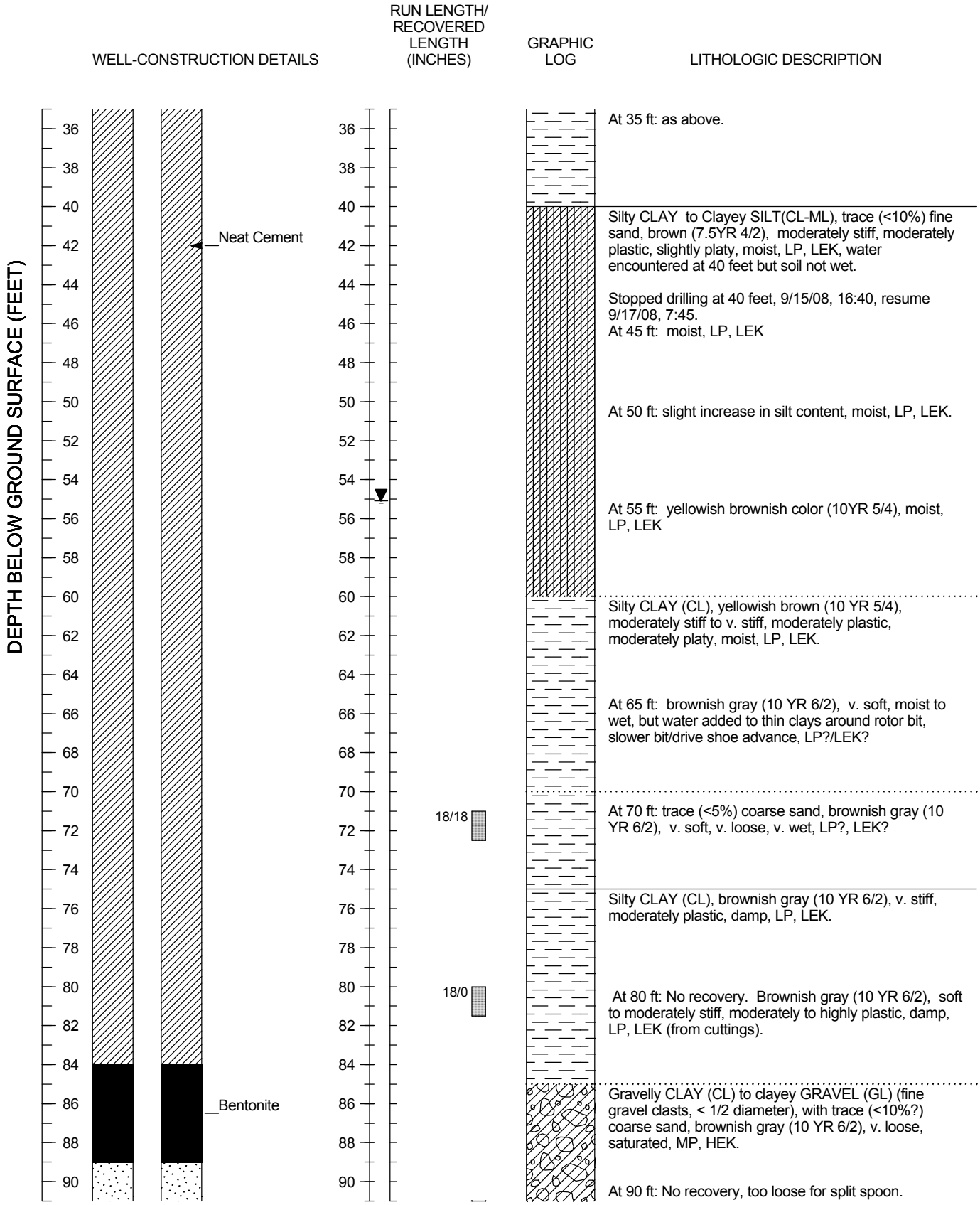


Figure A-8. Boring Log and Well-Construction Details for Well UCD2-59, LEHR/SCDS, UC Davis, Davis, California

WELL UCD2-59

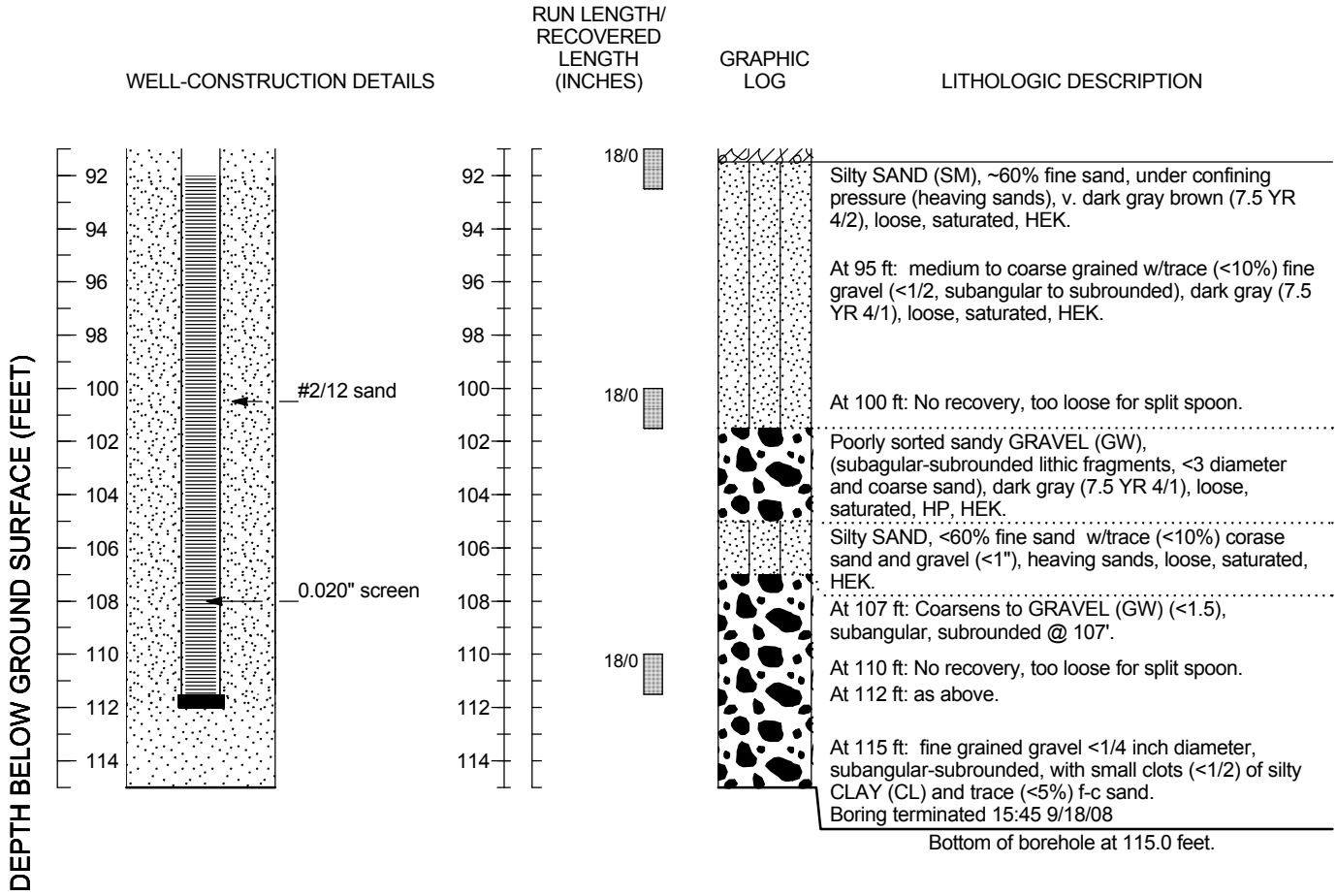
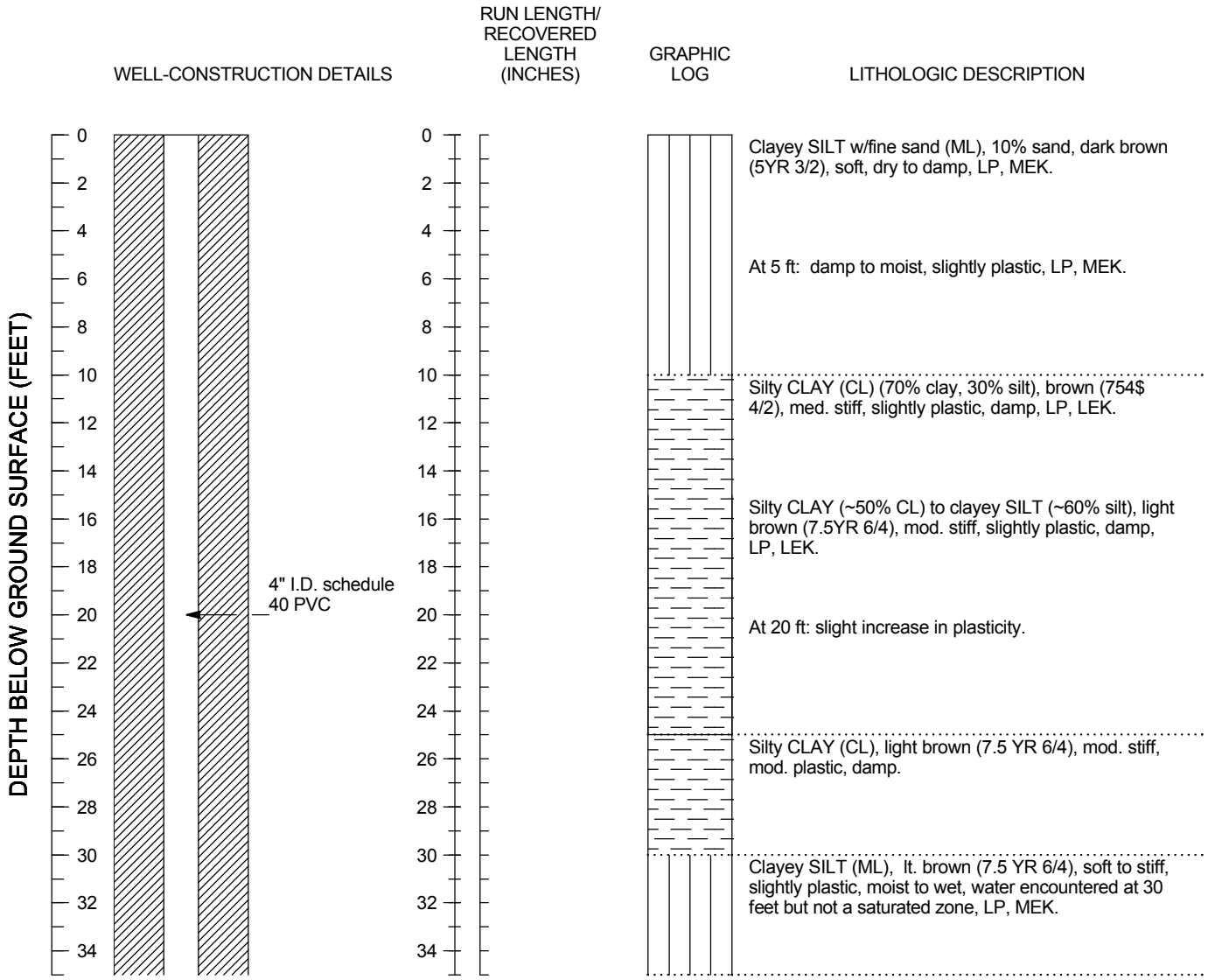


Figure A-8. Boring Log and Well-Construction Details for Well UCD2-59, LEHR/SCDS, UC Davis, Davis, California

WELL UCD2-60



EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. borehole logged by cuttings and limited split spoon sampling.

Symbols:
▽ Water level during drilling (first encountered)
▦ Location of cored run

Logged by:	REK
Checked by:	RKD
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Victor De Santiago
Date begun:	9/19/2008
Date completed:	9/24/2008
Drilling method:	Air Rotary
Type of sampler:	Split Spoon
Ground-surface elevation:	45.5
Bore-hole diameter:	10"
Well-head completion:	
Well-casing diameter:	4"

Figure A-9. Boring Log and Well-Construction Details for Well UCD2-60, LEHR/SCDS, UC Davis, Davis, California

WELL UCD2-60

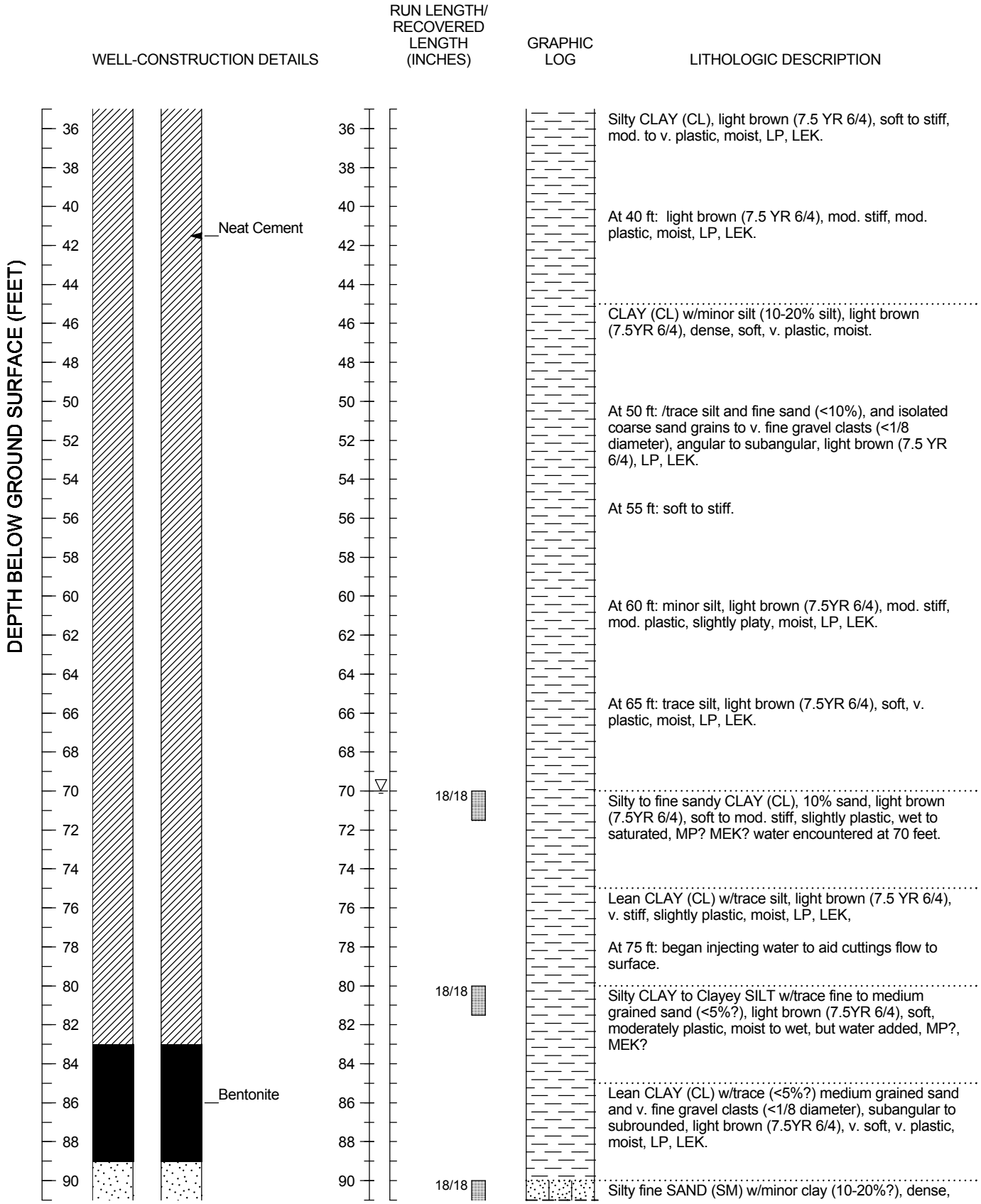


Figure A-9. Boring Log and Well-Construction Details for Well UCD2-60, LEHR/SCDS, UC Davis, Davis, California

WELL UCD2-60

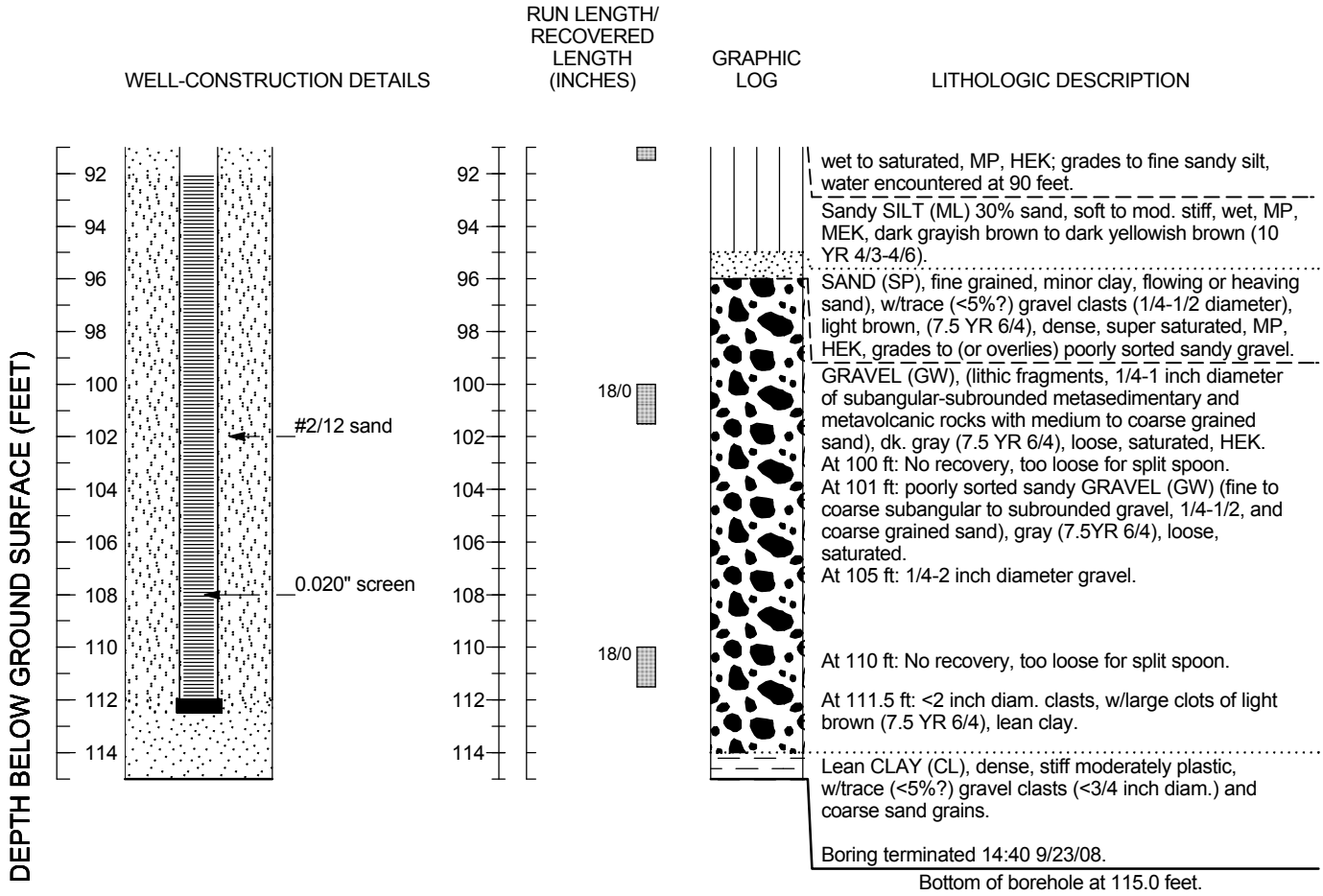


Figure A-9. Boring Log and Well-Construction Details for Well UCD2-60, LEHR/SCDS, UC Davis, Davis, California

BORING LFI-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			Silty gravelly SAND (SM), brown, (10YR, 5/3), medium-dense, dry, 35% f-c sand, 25% f-c gravel, 40% silt fines, LP, MEK.
2			
4			
6			At 5-14.5 ft: Drilled ahead without sampling to first sample interval.
8			
10			
12			
14			
16	18/16		Sandy SILT (ML), dark brown, damp, very stiff, ~65% silt fines, 25% f-c sand, 10% f gravel, rounded, LP, LEK.
18			SILT (ML), light olive brown, (2.5Y, 5/4), stiff, damp to moist, trace to 5%, f. sand, grayish mottling, trace rootholes, LP, LEK.
20	18/18		
22			
24	18/18		At 24 ft: As above with Mn-Ox specs & blotches, Fe-ox staining, trace caliche nodules & veins, stiff, damp, LEK.
26	18/13		At 26.5-28 ft: As above, damp, LEK.
28			
30			
32			
34			

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger
2. Angled borehole 15 degrees off vertical to SW
3. Borehole was sampled using 2" diameter California Modified and SPT samplers.
4.. Borehole was backfilled to surface with neat cement.

Symbols:
Water level during drilling (first encountered)
Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/15/2008
Date completed:	9/15/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod, SPT samplers
Ground-surface elevation:	47.1
Bore-hole diameter:	8"

Figure C-1. Boring Log for Boring LFI-2, LEHR/SCDS, UC Davis, Davis, California

BORING LFI-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36	18/15		Sandy SILT (ML) olive brown, (2.5Y, 4/4), hard, moist, ~55% fines (silt% > clay%), 15% f-m sand, 30% caliche nodules to 3/8 diameter with mild reaction to HCL, Mn-Ox staining and mottling, Fe-Ox staining, caliche veins and nodules, LP, LEK. *(continued)*
38			
40			
42			SILT (ML), yellowish brown (10YR, 5/4), hard, damp, low plasticity, fines, trace f-m sand, grayish mottling, rootholes with black (Mn-Ox?) lining, LEK.
44	18/18		
46			At 45.5-75 ft: Drilled ahead without sampling for HSU-1 grab GW sample.
48			
50			
52			
54			
56			
58			
60			
62			
64			
66			
68			
70			
72			
74			

Boring terminated 15:30, 9/15/08.

Bottom of borehole at 75.0 feet.

Figure C-1. Boring Log for Boring LFI-2, LEHR/SCDS, UC Davis, Davis, California

APPENDIX B

RESULTS OF PRIMA ENVIRONMENTAL CHROMIUM AND MANGANESE BENCH TESTS

PRIMA ENVIRONMENTAL INC.

July 16, 2009

Anja Verce
Weiss Associates
5801 Christie Avenue, Suite 600
Emeryville, CA 94608

RE: Report of Findings for Cr(VI) extractions, UC Davis site

Dear Anja:

Enclosed is the final report of findings "Laboratory Testing in Support of Evaluation of Natural Occurrence of Cr(VI)" that describes bench testing conducted on soil from the UC Davis site. If you have any questions, please give me a call. Thank you for the opportunity to be of service.

Sincerely,
PRIMA Environmental, Inc.

Cindy G. Schreier, Ph.D.
President

5070 Robert J. Mathews Parkway, Suite 300, El Dorado Hills, CA 95762
Ph (916) 939-7300 • Fax (916) 939-7398
www.primaenvironmental.com

Final

Laboratory Testing in Support of Evaluation of Natural Occurrence of Cr(VI)

UC Davis Site

July 16, 2009

Submitted to

Anja Verce
Weiss Associates
5801 Christie Avenue, Suite 600
Emeryville, CA 94608

Submitted by
Cindy G. Schreier, Ph.D.
PRIMA Environmental, Inc.
5070 Robert J Mathews Parkway, Suite 300
El Dorado Hills, CA 95762

Cindy G. Schreier, Ph.D. *President* July 16, 2009
Date

Table of Contents

List of Tables ..... **ii**
1.0 INTRODUCTION **1**
2.0 MATERIALS and METHODS **2**
2.1 Materials 2
2.2 Soil Preparation 2
2.3 DI Extractable Cr and Mn 2
2.4 Exchangeable Cr 3
2.5 Easily Reducible Manganese 3
2.6 Available Cr(III) and Mn in Soil 4
2.7 Standard Chromium Oxidation Tests 4
2.8 Follow-up Tests 4
3.0 RESULTS **5**
3.1 Analysis of Total Cr and Mn in Untreated Soil 5
3.2 Summary Chromium Tests 5
3.2.1 Initial Results 5
3.2.2 Confirmation Testing 7
3.2.2.1 Controls 8
3.2.2.2 DI Extractable Cr—SSBG-CR-2-37 and SSBG-CR-37Dup 8
3.2.2.3 Available Cr—SSHS-CR-2-2 and SSHS-CR-2-10 8
3.3 Summary of Manganese Tests 9
3.4 Follow-Up Tests 9
4.0 CONCLUSIONS **12**
APPENDIX A (Chain of Custody)
APPENDIX B (Analytical Reports)

List of Tables

Table 1. Total Cr and Mn in Untreated Soil 5
Table 2. Chromium Results DI Extractable, Exchangeable, and Available Cr. 6
Table 3. Manganese Results. 10
Table 4. Follow-up Exchangeable Cr and Available Cr Tests..... 11

1.0 INTRODUCTION

Laboratory testing was conducted on thirty (30) soil samples in order to provide data that may be used by Weiss to evaluate the possibility that hexavalent chromium, Cr(VI), at the UC Davis site may be naturally occurring. Testing was conducted by PRIMA Environmental, Inc. Evaluation of the data will be conducted by Weiss Associates.

The tests conducted to evaluate the natural ability of soils to oxidize Cr to Cr(VI), included:

- DI extractable Cr and Mn
- Exchangeable Cr
- Easily reducible Mn
- Available Cr(III) and Mn in soil
- Standard Cr oxidation tests

The specific tests conducted to achieve these objectives are described in Section 2.0 and results are presented in Section 3.0. Interpretation of the data is the responsibility of Weiss Associates.

2.0 MATERIALS and METHODS

2.1 Materials

Nitric acid (HNO_3) – Baker Instra-analyzed® Reagent for trace metals analysis (69-70%) – J.T. Baker.

Potassium dihydrogen phosphate, monobasic (KH_2PO_4) – F.C.C. (98%) – Spectrum.

Potassium phosphate, dibasic (K_2HPO_4) – F.C.C. (99%) – J.T. Baker.

Ammonium acetate ($CH_3CO_2NH_4$) – A.C.S. (99.9%) – EMD.

Hydroquinone (1,4-$(HO)_2C_6H_4$) – (99.95%) – J.T. Baker.

Sodium citrate ($C_6H_8Na_2O_8$) – (99%) – Alfa Aesar.

Chromium chloride ($CrCl_3$) – Fisher Scientific.

2.2. Soil Preparation

Thirty soil samples (one set with ID: SSHS–CR 2, and a second set with ID: SSBG–CR 2, collected from depths ranging from 2-85 feet and 2-95 feet, respectively) were received on October 16, 2008. Two samples—SSHS-CR-2-53 dup, and SSBG-CR-2-50—were replaced with new samples—SSHS-CR–2-2, and SSBG–CR–2-2—on October 27, 2008 as requested by Weiss Associates. Most soil samples were solid cores that appeared to have high clay content and were non-friable. Because the efficiency of the various tests may depend upon surface area, each sample was broken up, sieved to remove large rocks, if necessary and homogenized using a food processor in order to obtain particles less than about 2 mm.

Sixteen of the homogenized soils (depths 2, 10, 25.5, 30, 45, 58, 69.9, and 77 foot depths from the SSHS-CR-2 group, and depths 2, 9, 25, 37, 40, 57, 65, and 75 from the SSBG-CR-2 group) were analyzed for:

- Chromium (Cr)
- Manganese (Mn)

All of the samples were subjected to the tests described in Sections 2.3-2.7.

2.3. DI Extractable Cr and Mn

For each soil, the amount of Cr that can be leached by deionized (DI) water was determined as follows:

1. Place 7.5±0.2 g soil in a 250 mL poly bottle.
2. Add 150 mL DI water to 7.5±0.2 g soil.
3. Mix on shaker table for 16-24 hours.
4. Centrifuge.
5. Filter through 0.45 μm filter.
6. Preserve filtrate with HNO_3, then analyze for total chromium and manganese.

2.4. Exchangeable Cr

This method is based on the procedures described by Asikainen and Nikolaidis (J.M. Asikainen, N.P. Nikolaidis. **Spring 1994**. "Sequential Extraction of Chromium form Contaminated Aquifer Sediments" *GWMR*, 185-191.).

For each soil, the amount of Cr that can be exchanged by phosphate was determined as follows:

1. Place 7.5±0.2 g soil in a 250 mL poly bottle.
2. Add 150 mL 0.1 M KH_2PO_4/K_2HPO_4 (1/1) solution at pH 7.2.
3. Mix on shaker table for 16-24 hours.
4. Centrifuge.
5. Filter through 0.45 μm filter.
6. Preserve filtrate with HNO_3, then analyze for total chromium.

.

2.5. Easily Reducible Manganese

This method is based on the procedure described in A.L. Page, R.H. Miller, D.R. Keeney (eds.) *Methods of Soil Analysis Part 2—Chemical and Microbiological Properties, 2nd ed.,* (American Society of Agronomy, Inc.: Madison) 1982, p. 319.

For each soil, the amount of Mn in soil that can be easily reduced to water-soluble Mn was determined as follows:

1. Place 15 ± 0.2 g soil in a 250 mL poly bottle.
2. Add 150 mL ammonium acetate-hydroquinone solution (1N NH4OAc, 0.2% hydroquinone).
3. Mix on shaker table for 30 minutes, then intermittently for 6 hours.
4. Centrifuge.
5. Filter through 0.45 μm filter.
6. Preserve filtrate with HNO_3 then analyze for total manganese.

2.6. Available Cr(III) and Mn in Soil

This method is based on the procedures described by Bartlett (R.J. Bartlett. **1991**. "Chromium Cycling in Soils and Water: Links, Gaps and Methods," *Environmental Health Perspectives*, **92**, 17-24.).

For each soil, the amount of Cr(III) and possibly Mn in soil that can be leached by low concentrations of organic chelating substances will be determined as follows:

1. Place 3 ± 0.1 g soil in a 250 mL poly bottle.
2. Add 150 mL 10 mM sodium citrate (Na_2H-citrate).
3. Mix on shaker table for 18 hours.
4. Centrifuge.
5. Filter through 0.45 μm filter.
6. Preserve filtrate with HNO_3, then analyze for total chromium and manganese.

2.7 Standard Chromium Oxidation Test

This method is based on the procedures described by Bartlett (R.J. Bartlett. **1991**. "Chromium Cycling in Soils and Water: Links, Gaps and Methods," *Environmental Health Perspectives*, **92**, 17-24).

For each soil, the amount of Cr(III) that can be oxidized by soil was estimated as follows:

1. Place 15 ± 0.2 g soil in a 250 mL poly bottle.
2. Add 150 mL 1 mM chromium chloride ($CrCl_3$).
3. Mix on shaker table for 15 minutes.
4. Add 1.5 mL pH 7.2 phosphate buffer (10 mM KH_2PO_4/K_2HPO_4)
5. Shake by hand for 15 seconds.
6. Centrifuge.
7. Filter through 0.45 μm filter.
8. Preserve filtrate with HNO_3, then analyze for Cr(VI) via Hach spectrophotometer.

2.8 Follow-up Tests

Because Exchangeable Cr was detected in site soil samples previously conducted by Chung et al. (Chung, J., Burau, R.G., and Zasoski, R.J., 2001. "Chromate generation by chromate depleted subsurface materials. *Water, Air, and Soil Pollution* 128: 407-417), additional Exchangeable Cr and also Available Cr tests were preformed on selected soil at a similar soil to extractant ration as presented in Chung et al. The methods were as described in Sections 2.4 and 2.6, except as follows:

- 100 g soil and 100 mL phosphate buffer were used for the Exchangeable Cr tests.
- 15 g soil and 150 mL of citrate solution were used for the Available Cr tests.

3.0 RESULTS

3.1 Analysis of Total Cr and Mn in Untreated Soil

Results from analysis of total chromium and total manganese in untreated soil are summarized in Table 1.

Table 1. Total Cr and Mn in Untreated Soil

Soil Sample	Units	Total Cr	Total Mn
SSHS-CR-2-2	mg/kg	150	550
SSHS-CR-2-10	mg/kg	130	580
SSHS-CR-2-25.5	mg/kg	72	560
SSHS-CR-2-30	mg/kg	94	720
SSHS-CR-2-45	mg/kg	100	510
SSHS-CR-2-58	mg/kg	99	410
SSHS-CR-2-69.5	mg/kg	84	510
SSHS-CR-2-77	mg/kg	170	670
SSBG-CR-2-2	mg/kg	140	580
SSBG-CR-2-9	mg/kg	130	560
SSBG-CR-2-25	mg/kg	98	570
SSBG-CR-2-37	mg/kg	120	520
SSBG-CR-2-40	mg/kg	95	410
SSBG-CR-2-57	mg/kg	250	540
SSBG-CR-2-65	mg/kg	120	590
SSBG-CR-2-75	mg/kg	91	570

3.2 Summary Chromium Tests

3.2.1 Initial Results

The result of the DI Extractable Cr, Exchangeable Cr, Available Cr(III), and Oxidation of Cr(III) tests are show in Table 2. The table includes the aqueous concentrations of Cr or Cr(VI) as well as the concentrations relative to the amount of soil used. Low levels of chromium were observed in the process controls for the DI extraction, exchangeable Cr, and available Cr, but they do not affect interpretation of the data because the concentrations in the process controls can be subtracted out and because the primary goal of the testing is to assess differences between the hotspot soil (the SSHS samples) and the background soil (SSBG samples). The controls are discussed in more detail in Section 3.2.2.

The aqueous concentrations of chromium in the DI extraction test were low. Except for SSBG-CR-37 dup (see Section 3.2.2 for discussion), the concentrations of dissolved

Table 2. Chromium Results DI Extractable, Exchangeable, and Available Cr.

Soil Sample	DI Extractable Cr		Exchangeable Cr		Available Cr(III)		Oxidation of Cr(III) to Cr(VI)	
	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg
Process Control(1)	0.0053	n.a.	0.0210	n.a.	0.0110	n.a.	0.030	n.a.
Process Control(2)	< 0.0050	n.a.	0.0084	n.a.	0.0028 J	n.a.	n.m.	n.m.
SSHS-CR-2-2	0.0059	0.12	0.0064	0.13	0.0096	0.48	0.83	8.3
SSHS-CR-2-5	< 0.0050	< 0.10	< 0.0050	< 0.10	0.0230	1.2	0.96	9.6
SSHS-CR-2-10	0.0053	0.11	< 0.0050	< 0.10	0.047	2.4	0.86	8.6
SSHS-CR-2-17	0.0060	0.12	< 0.0050	< 0.10	0.015	0.75	1.3	13
SSHS-CR-2-25.5	0.0077	0.15	< 0.0050	< 0.10	0.013	0.65	0.97	9.7
SSHS-CR-2-27	0.0100	0.20	< 0.0050	< 0.10	0.012	0.60	0.67	6.7
SSHS-CR-2-30	0.0084	0.17	< 0.0050	< 0.10	0.015	0.75	0.75	7.5
SSHS-CR-2-39	0.0066	0.13	< 0.0050	< 0.10	0.016	0.80	0.71	7.1
SSHS-CR-2-45	0.0120	0.24	< 0.0050	< 0.10	0.044	2.2	0.32	3.2
SSHS-CR-2-53	0.0073	0.15	< 0.0050	< 0.10	0.020	1.0	0.24	2.4
SSHS-CR-2-58	0.0071	0.14	< 0.0050	< 0.10	0.017	0.85	0.039	0.39
SSHS-CR-2-63	0.0074	0.15	< 0.0050	< 0.10	0.041	2.1	0.59	5.9
SSHS-CR-2-69.5	0.0081	0.16	< 0.0050	< 0.10	0.024	1.2	0.48	4.8
SSHS-CR-2-77	0.0081	0.16	0.0054	0.11	0.033	1.7	0.30	3.0
SSHS-CR-2-83	0.0069	0.14	0.0054	0.11	0.021	1.1	0.071	0.71
Process Control(3)	0.0053	n.a.	0.0210	n.a.	0.011	n.a.	0.018	n.a.
SSBG-CR-2-2	0.0071	0.14	< 0.0050	< 0.10	0.014	0.70	1.0	10
SSBG-CR-2-5	0.0089	0.18	< 0.0050	< 0.10	0.017	0.85	0.97	9.7
SSBG-CR-2-9	0.0081	0.16	< 0.0050	< 0.10	0.016	0.80	0.51	5.1
SSBG-CR-2-13	0.0064	0.13	0.0056	0.11	0.0089	0.45	1.3	13
SSBG-CR-2-25	0.0100	0.20	< 0.0050	< 0.10	0.013	0.65	0.58	5.8
SSBG-CR-2-37DUP	0.0490	0.98	< 0.0050	< 0.10	0.011	0.55	0.60	6.0
SSBG-CR-2-37	0.0053	0.11	< 0.0050	< 0.10	0.010	0.50	0.77	7.7
SSBG-CR-2-40	< 0.0050	< 0.10	< 0.0050	< 0.10	0.016	0.80	0.28	2.8
SSBG-CR-2-46	0.0056	0.11	< 0.0050	< 0.10	0.023	1.2	0.22	2.2
SSBG-CR-2-57	0.0061	0.12	0.011	0.22	0.024	1.2	0.29	2.9
SSBG-CR-2-63	0.0056	0.11	< 0.0050	< 0.10	0.014	0.70	0.74	7.4
SSBG-CR-2-65	0.0058	0.12	< 0.0050	< 0.10	0.013	0.65	0.62	6.2
SSBG-CR-2-75	< 0.0050	< 0.1	< 0.0050	< 0.10	0.008	0.41	0.46	4.6
SSBG-CR-2-87	0.0071	0.14	0.0076	0.15	0.018	0.90	0.25	2.5
SSBG-CR-2-95	< 0.0050	< 0.1	0.021	0.42	0.011	0.55	0.25	2.5

Notes:

- SSHS soils were collected from the "hotspot"
- "SSBG" samples are background soils.
- The last number in the sample ID is the depth below ground surface
- "J" indicates that the value is estimated.
- (1) An aliquot of each process control was collected and analyzed immediately after the extraction process. The remaining extraction fluid was stored unpreserved in the poly extraction bottle.
- (2) The remaining extraction fluid (see Note 1) was analyzed after being stored unpreserved for about three months.
- (3) One process control was run for all soils for the DI-Extractable Cr, Exchangeable Cr, and Available Cr(III). For Oxidation of Cr(III), one process control was run for the SSHS soils and one for the SSBG soils.

chromium were less than 0.005 mg/L (< 0.1 mg/kg) to 0.012 mg/L (0.24 mg/kg). Concentrations were slightly different in the hotspot soil (SSHS samples) compared to the background soil (SSBG samples). Specifically, the amount of DI-extractable Cr was slightly higher in the shallower (2-25 feet) background soil compared to the hotspot soil, but was slightly lower in the deeper (37 to 95 feet) background soils compared to the hotspot soils. At all similar depths, the difference between the two soils is small [typically 0.001 to 0.003 mg/L (0.02-0.06 mg/kg)], but because the difference is consistently higher or lower for a given depth range, it is likely that it represents a real difference between the soils.

Dissolved chromium was not detected above 0.005 mg/L in most of the Exchangeable Cr samples. This implies that soils did not contain significant leachable Cr(VI) since the phosphate anion in the extraction fluid displaces chromate anions in soil. (Phosphate buffer is also the extraction fluid used for measurement of Cr(VI) in soil, but the extraction conditions are more vigorous than those used in this study.) Furthermore, because Cr was present in the process control (see below for further discussion), lack of Cr in the extraction fluid implies that chromium sorbed to the soils

The concentration of dissolved chromium in the Available Cr tests ranged from 0.0096 mg/L (0.48 mg/kg) to 0.047 mg/L (2.4 mg/kg). This indicates that the soils contain weakly bound chromium. This chromium is not Cr(VI) since it was not leached in the exchangeable Cr test. Rather, it is probably Cr(III) that is binds more strongly to the chelating agent of the extraction fluid than to the minerals of the soil. (The extraction fluid for this test is citrate, a chelating agent that can solubilize metals.) Chromium concentrations were consistently higher in the hotspot soils than in the background soil, implying that the hotspot soil contains more weakly bound chromium than the background soil.

Both soils were able to oxidize a significant amount of Cr(III) to Cr(VI). The concentration of Cr(VI) in the samples ranged from 0.039 mg/L (0.39 mg/kg) to 1.3 mg/L (13 mg/kg), though there was no obvious trend with depth or difference between the hotspot and background soils. The presence of Cr(VI) in the process control is reasonable since a small amount of Cr(VI) could be present in chromium (III) chloride used to prepare the reagent.

3.2.2 Confirmation Testing

Additional tests were conducted to assess the presence of chromium in the process controls, investigate the variability of the SSBG-CR-2-37 and SSBG-CR-2-37dup DI extraction results, and confirm variability in the Available Cr measurement for selected soils .

3.2.2.1 Controls

As discussed above, chromium was detected in the process controls. The presence of chromium was confirmed in several ways. First, analysis of exchangeable Cr and available Cr extractions fluids that had been stored unpreserved in glass for over one month showed that these extraction fluids contained 0.012 mg/L Cr and approximately 0.0041 mg/L Cr, respectively. Second, re-analysis of the an aliquot of the original process controls that had been stored unpreserved in the original poly extraction bottles for three months found 0.0084 mg/L Cr in the Exchangeable Cr extraction fluid, approximately 0.0028 mg/L in the Available Cr extraction fluid, and < 0.005 mg/L in the DI Extractable Cr fluid. Although all of these values are lower than the originally measured values, they confirm that Cr is present in the Exchangeable Cr and Available Cr extraction fluids. Cr was probably also present in the original DI extraction fluid, but because the concentration was so low, no Cr was detected in subsequent samples. Finally, fresh extractions fluids were prepared and analyzed approximately 3 months after the original fluids. Neither DI water nor the Available Cr extraction fluid contained Cr above the reporting limit of 0.005 mg/L or an estimated value above 0.0025 mg/L. The Exchangeable Cr fluid contained 0.0064 mg/L Cr. The presence of Cr in this sample supports the presence of Cr in the original extraction fluid. The reason for the lower value is unknown.

Because there is no reason to suspect that any of the Cr results in the process controls (or soil extracts) are incorrect, both sets of process control data are reported in Table 2. The results from the extraction fluids stored in glass are not included since they could be low due to sorption of Cr onto the glass. (PRIMA discussed the results extensively with Alpha Analytical, Inc, the California- and NELAC-certified laboratory who performed the chromium analyses and with whom PRIMA has worked for over 10 years. Alpha reviewed the data, but found no analytical irregularities and stands by its results.)

3.2.2.2 DI Extractable Cr—SSBG-CR-2-37 and SSBG-CR-37Dup

Because the SSBG-CR-37Dup DI Extractable Cr was much higher than all other results and was no similar to the SSBG-CR-2-37 sample, both soils were re-extracted twice. The results are: < 0.005 mg/L Cr for both extractions of SSBG-CR-37, and 0.0057 mg/L and < 0.0050 mg/L for the two SSBG-CR-37Dup extractions. These values are more consistent with other DI Extractable Cr results. However, soils are naturally heterogeneous and the high Cr value in the original SSBG-CR-37Dup extraction should not necessarily be discarded.

3.2.2.3 Available Cr—SSHS-CR-2-2 and SSHS-CR-2-10

Because the concentration of Cr in the Available Cr tests was often near the concentration seen in the process control, two sample—SSHS-CR-2-2 and SSHS-CR-2-10— were re-extracted to determine if they were in fact different from each other. SSHS-CR-2-2 was found to contain approximately 0.0073 mg/L Cr, while SSHS-CR-2-10 contained 0.028

mg/L Cr (Cr was not detected above 0.0050 mg/L in the process control). These values are similar to the original values reported in Table 2 and confirm that these two soils are different from each other.

3.3 Summary of Manganese Tests

The results of the DI Extractable Mn, Easily Reducible Mn and Available Mn are shown in Table 3.

The aqueous concentrations of manganese in the DI extraction test were low. Except for SSBG-CR-37 dup, the concentrations of dissolved manganese ranged from less than 0.0050 mg/L (< 0.1 mg/kg) to 0.0083 mg/L (0.17 mg/kg). There was no obvious difference between the hotspot and background soils. Sample SSBG-CR-2-37Dup contained 0.095 mg/L (1.90 mg/kg) DI-extractable Mn. Because this value was higher than all of the other samples, the extraction was repeated twice. The results were 0.0082 mg/L (0.0164 mg/kg) and < 0.0050 mg/L (< 0.1 mg/kg) manganese, which are consistent with other soils and with the SSBG-CR-2-37. However, soils are naturally heterogeneous and the high Mn value in the original SSBG-CR-37Dup extraction should not necessarily be discarded.

The amount of Easily Reducible Manganese ranged from 5.5 mg/L (55 mg/kg) to 49 mg/L (490 mg/kg), with no clear difference between hotspot and background soils. However, the presence of easily reducible manganese implies that soils contain manganese dioxides, which are known to be able to oxidize Cr to Cr(VI).

The concentration of Available Manganese ranged from 0.46 mg/L (23 mg/kg) to 7.9 mg/L (400 mg/kg). This indicates that the soils contain manganese that is weakly bound to the soil and that can easily be solubilized by a chelating agent. Overall, hotspot soil contained higher amounts of available manganese than background soil, especially in the shallower depths.

3.4 Follow-Up Tests

The results of follow-up Exchangeable Cr and Available Cr tests are shown in Table 4.

A small amount of Cr (0.0086 to 0.011 mg/L) was consistently observed in the six Exchangeable Cr process controls confirming that it is present in the phosphate extraction solution. However, the Cr concentrations detected in some extracts of hot spot soils (SSHS samples) were greater than in the process controls indicating that some hot spot soils contain Cr that can be displaced by phosphate. In contrast, Cr concentrations in extracts of background soils were lower than in the process controls, indicating that these soils can sorb Cr.

Table 3. Manganese Results.

Soil Sample	DI Extractable Mn		Easily Reducible Mn		Available Mn	
	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg
Process Control	< 0.0050	n.a.	< 0.010	n.a.	< 0.0050	n.a.
SSHS-CR-2-2	0.0080	0.16	24	240	3.6	180
SSHS-CR-2-5	< 0.0050	< 0.10	25	250	5.5	280
SSHS-CR-2-10	0.0056	0.11	15	150	6.7	340
SSHS-CR-2-17	< 0.0050	< 0.10	24	240	5.2	260
SSHS-CR-25.5	< 0.0050	< 0.10	29	290	6.3	320
SSHS-CR-2-27	0.0056	0.11	37	370	4.9	250
SSHS-CR-2-30	< 0.0050	< 0.10	29	290	6.1	310
SSHS-CR-2-39	< 0.0050	< 0.10	49	490	7.9	400
SSHS-CR-2-45	< 0.0050	< 0.10	13	130	3.2	160
SSHS-CR-2-53	< 0.0050	< 0.10	14	140	3.1	160
SSHS-CR-2-58	< 0.0050	< 0.10	5.5	55	1.9	95
SSHS-CR-2-63	< 0.0050	< 0.10	26	260	4.8	240
SSHS-CR-2-69.5	< 0.0050	< 0.10	25	250	3.9	200
SSHS-CR-2-77	< 0.0050	< 0.10	15	150	2.5	130
SSHS-CR-2-83	< 0.0050	< 0.10	11	110	1.3	65
SSBG-CR-2-2	0.0074	0.15	29	290	3.5	180
SSBG-CR-2-5	0.0083	0.17	26	260	4.6	230
SSBG-CR-2-9	< 0.0050	< 0.10	11	110	0.87	44
SSBG-CR-2-13	< 0.0050	< 0.10	30	300	4.0	200
SSBG-CR-2-25	0.0062	0.12	20	200	0.46	23
SSBG-CR-2-37DUP	0.0950	1.90	34	340	5.3	270
SSBG-CR-2-37	< 0.0050	< 0.10	32	320	4.7	240
SSBG-CR-2-40	< 0.0050	< 0.10	12	120	1.6	80
SSBG-CR-2-46	< 0.0050	< 0.10	13	130	1.7	85
SSBG-CR-2-57	< 0.0050	< 0.10	25	250	4.1	210
SSBG-CR-2-63	< 0.0050	< 0.10	40	400	3.1	160
SSBG-CR-2-65	< 0.0050	< 0.10	29	290	5.4	270
SSBG-CR-2-75	< 0.0050	< 0.10	24	240	3.4	170
SSBG-CR-2-87	< 0.0050	< 0.10	16	160	1.1	55
SSBG-CR-2-95	< 0.0050	< 0.10	13	130	1.1	55

Notes:

- SSHS soils were collected from the "hotspot"
- "SSBG" samples are background soils.
- The last number in the sample ID is the depth below ground surface

No Cr was detected in process controls of the Available Cr tests. However, Cr was detected in most extracts, indicating that both hotspot and background soils contain Cr that can be complexed (and thereby mobilized) by citrate.

Table 4. Follow-up Exchangeable Cr and Available Cr Tests.

Soil Sample	Exchangeable Cr		Available Cr(III)	
	mg/L	mg/kg	mg/L	mg/kg
Follow-up Set 1				
Process Control 1	0.013	n.a.	< 0.0050	n.a.
Process Control 2	0.012	n.a.	< 0.0050	n.a.
Process Control 3	0.010	n.a.	< 0.0050	n.a.
SSHS-CR-2-10	n.m.	n.m.	0.012	0.12
SSHS-CR-2-17	0.056	0.0560	n.m.	n.m.
SSHS-CR-2-69.5	n.m.	n.m.	0.025	0.25
SSHS-CR-2-77	0.033	0.0330	n.m.	n.m.
SSBG-CR-2-13	0.0066	0.0066	n.m.	n.m.
SSBG-CR-2-25	n.m.	n.m.	0.0069	0.07
SSBG-CR-2-57	n.m.	n.m.	0.021	0.21
SSBG-CR-2-95	<0.0050	< 0.005	n.m.	n.m.
Follow-up Set 2				
Process Control 1	0.0093	n.a.	n.m.	n.m.
Process Control 2	0.0086	n.a.	n.m.	n.m.
Process Control 3	0.011	n.a.	n.m.	n.m.
SSHS-CR-2-5	0.029	0.029	n.m.	n.m.
SSHS-CR-2-27	0.013	0.013	n.m.	n.m.
SSHS-CR-2-45	0.0057	0.0057	n.m.	n.m.
SSBG-CR-2-5	0.0055	0.0055	n.m.	n.m.
SSBG-CR-2-46	0.011	0.011	n.m.	n.m.
SSBG-CR-2-75	0.028	0.028	n.m.	n.m.

4.0 CONCLUSIONS

Background soil and hotspot soils were similar with respect to most of the parameters measured, but showed differences in others. The amount of Exchangeable Cr, DI-Extractable Mn, Easily Reducible Mn, and ability to oxidize Cr(III) to Cr(VI) were similar between the soils in the initial tests. In follow-up tests, which used larger amounts of soil and a lower soil to liquid ratio to ensure measurable amounts of Cr, hotspot soils contained more Exchangeable Cr than background soils. The amount of DI-Extractable Cr seemed slightly higher for shallow background soils and slightly higher for deeper hotspot soils, though the differences were small in all cases. Hotspot soil contained more Available Cr than the background soil, especially at deeper depths. This implies that the hotspot soil contains more mobile Cr. Finally, the hotspot soil contained more Available Mn than the background soil, but there was no clear trend with depth.

APPENDIX A
(Chain of Custody)

Chain of Custody Record

Please send analytic results, EDD, EDF, and the original chain-of-custody form to:
Anja Verce (av@weiss.com)

INSTRUCTIONS FOR LAB PERSONNEL:
GeoTracker EDF required? ☒ Yes ☐ No
Include laboratory QA/QC data with report.
Specify analytic/prep method and detection limit in report.
Notify us of any anomalous peaks in GC or other scans.
Call immediately with any questions or problems.

Weiss Associates
Environmental Science, Engineering and Management Services
5801 Christie Avenue, Suite 600, Emeryville, CA 94608
Phone: 510-450-6000 Fax: 510-547-5043
A grafiania Associates Incorporated, DBA

Prima Environmental
5070 Robert J. Mathews Parkway, Suite 300
El Dorado Hills, CA 95762
phone: (916) 939-7300

Project ID: 388-1856-1-32a
Protocol No.:

Client Contact	Project Manager: Bob Devany	Sampled by: RKD / REY	Date: 10-16-09	COC Number: UCD
Weiss Associates	Tel: 510-450-6144	Lab Contact: Cindy Schreier	Carrier:	Page 1 of 4
5801 Christie Avenue, Suite 600	Analysis Turnaround Time			Job No.
Emeryville, CA 94608	Calendar (C) or Work Days (W) ---			
(510) 450-6000 Phone	TAT if different from Below _____			
(510) 547-5043 FAX	☐ 2 weeks			SDG No.
	☐ 1 week			
Job Name: UC Davis	☐ 2 days			
Address: One Shields Ave, Davis	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Easily Reducible Mn	Available Cr(III)	Standard Cr Oxidation Test	DI extraction	Exchangeable fraction extraction	Sample Specific Notes:
SSHSCR-2-58	10-16-09	14:45	~~Soil~~	Soil	1 bag	X	X	X	X	X	
SSHSCR-2-5	↓	↓		↓	↓	X	X	X	X	X	
SSHSCR-2-10						X	X	X	X	X	
SSHSCR-2-17						X	X	X	X	X	
SSHSCR-2-25.5						X	X	X	X	X	
SSHSCR-2-27						X	X	X	X	X	
SSHSCR-2-30						X	X	X	X	X	
SSHSCR-2-39						X	X	X	X	X	
SSHSCR-2-45	↓	↓		↓	↓	X	X	X	X	X	
Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____						1	1	1	1	1	

Possible Hazard Identification
Non-Hazard *Flammable* *Skin Irritant* *Poison B* *Unknown*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
Return To Client *Disposal By Lab* *Archive For* _____ *Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Randy R. Hurley	Weiss Associates	17:45 10-16-09			
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company: PRIMA	Date/Time: 10/16/08 17:45

Chain of Custody Record

Please send analytic results, EDD, EDF, and the original chain-of-custody form to:
Anja Verce (av@weiss.com)

INSTRUCTIONS FOR LAB PERSONNEL:
GeoTracker EDF required? ☒ Yes ☐ No
Include laboratory QA/QC data with report.
Specify analytic/prep method and detection limit in report.
Notify us of any anomalous peaks in GC or other scans.
Call immediately with any questions or problems.

Weiss Associates
Environmental Science, Engineering and Management Services
5801 Christie Avenue, Suite 600, Emeryville, CA 94608
Phone: 510-450-6000 Fax: 510-547-5043
A Geotechnical Associates Incorporated, DBA

Prima Environmental
5070 Robert J. Mathews Parkway, Suite 300
El Dorado Hills, CA 95762
phone: (916) 939-7300

Project ID: 388-1856-1-32a
Protocol No.:

Client Contact	Project Manager: Bob Devany	Sampled by: RDK / REK	Date: 10-16-08	COC Number: UCD
Weiss Associates	Tel: 510-450-6144	Lab Contact: Cindy Schreier	Carrier:	Page 2 of 4
5801 Christie Avenue, Suite 600	Analysis Turnaround Time			Job No.
Emeryville, CA 94608	Calendar (C) or Work Days (W) ---			
(510) 450-6000 Phone	TAT if different from Below _____			
(510) 547-5043 FAX	☐ 2 weeks			SDG No.
	☐ 1 week			
Job Name: UC Davis	☐ 2 days			
Address: One Shields Ave, Davis	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Easily Reducible Mn	Available Cr(III)	Standard Cr Oxidation Test	DI extraction	Exchangeable fraction extraction	Sample Specific Notes:
SSHSCR-2-53	10-16-08	14:45		Soil	1 bag	X	X	X	X	X	
SSHSCR-2-53 Dup						X	X	X	X	X	
SSHSCR-2-63						X	X	X	X	X	
SSHSCR-2-69.5						X	X	X	X	X	
SSHSCR-2-77						X	X	X	X	X	
SSHSCR-2-83						X	X	X	X	X	
Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____						1	1	1	1	1	

Possible Hazard Identification
Non-Hazard *Flammable* *Skin Irritant* *Poison B* *Unknown*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
Return To Client *Disposal By Lab* *Archive For* _____ *Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Randy E. Kirby / [signature]	WEISS ASSOCIATES	10-16-08 17:45			
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by: [signature]	Company: PRIMA	Date/Time: 10/16/08 1745

Chain of Custody Record

Please send analytic results, EDD, EDF, and the original chain-of-custody form to:
Anja Verce (av@weiss.com)

INSTRUCTIONS FOR LAB PERSONNEL:
GeoTracker EDF required? ☒ Yes ☐ No
Include laboratory QA/QC data with report.
Specify analytic/prep method and detection limit in report.
Notify us of any anomalous peaks in GC or other scans.
Call immediately with any questions or problems.

Weiss Associates
Environmental Science, Engineering and Management Services
5801 Christie Avenue, Suite 600, Emeryville, CA 94608
Phone: 510-450-6000 Fax: 510-547-5043
A Joint Venture Associates Incorporated, 1984

Prima Environmental
5070 Robert J. Mathews Parkway, Suite 300
El Dorado Hills, CA 95762
phone: (916) 939-7300

Project ID: 388-1856-1-32a
Protocol No.:

Client Contact	Project Manager: Bob Devany	Sampled by: RKD / REK	Date: 10-16-08	COC Number: UCD
Weiss Associates	Tel: 510-450-6144	Lab Contact: Cindy Schreier	Carrier:	Page 3 of 4
5801 Christie Avenue, Suite 600	Analysis Turnaround Time			Job No.
Emeryville, CA 94608	Calendar (C) or Work Days (W) ---			
(510) 450-6000 Phone	TAT if different from Below _____			
(510) 547-5043 FAX	☐ 2 weeks			SDG No.
	☐ 1 week			
Job Name: UC Davis	☐ 2 days			
Address: One Shields Ave, Davis	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Easily Reducible Mn	Available Cr(III)	Standard Cr Oxidation Test	DI extraction	Exchangeable fraction extraction	Sample Specific Notes:
SSBGCR-2-37 Dup	10-16-08	14:45		Soil	1 bag	X	X	X	X	X	
SSBGCR-2-5						X	X	X	X	X	
SSBGCR-2-9						X	X	X	X	X	
SSBGCR-2-13						X	X	X	X	X	
SSBGCR-2-25						X	X	X	X	X	
SSBGCR-2-37						X	X	X	X	X	
SSBGCR-2-40						X	X	X	X	X	
SSBGCR-2-46						X	X	X	X	X	
SSBGCR-2-57						X	X	X	X	X	
Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____						1	1	1	1	1	

Possible Hazard Identification
Non-Hazard *Flammable* *Skin Irritant* *Poison B* *Unknown*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
Return To Client *Disposal By Lab* *Archive For* _____ *Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
[signature]	WEISS ASSOCIATES	10/16-08, 17:45			
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by: [signature]	Company: PRIMA	Date/Time: 10/16/08 1745

4 of 4

Chain of Custody Record

Please send analytic results, EDD, EDF, and the original chain-of-custody form to:
Anja Verce (av@weiss.com)

INSTRUCTIONS FOR LAB PERSONNEL:
GeoTracker EDF required? ☒ Yes ☐ No
Include laboratory QA/QC data with report.
Specify analytic/prep method and detection limit in report.
Notify us of any anomalous peaks in GC or other scans.
Call immediately with any questions or problems.

Weiss Associates
Environmental Science, Engineering and Management Services
5801 Christie Avenue, Suite 600, Emeryville, CA 94608
Phone: 510-450-6000 Fax: 510-547-5043
A Geofirma Associates Incorporated, GIA

Prima Environmental
5070 Robert J. Mathews Parkway, Suite 300
El Dorado Hills, CA 95762
phone: (916) 939-7300

Project ID: 388-1856-1-32a
Protocol No.: 081015_Chrom detail_Prima Lab

Client Contact	Project Manager: Bob Devany	Sampled by: RDK/EEK	Date: 10-16-08	COC Number: UCD
Weiss Associates	Tel: 510-450-6144	Lab Contact: Cindy Schreier	Carrier:	Page 4 of 4
5801 Christie Avenue, Suite 600	Analysis Turnaround Time			Job No.
Emeryville, CA 94608	Calendar (C) or Work Days (W) ---			
(510) 450-6000 Phone	TAT if different from Below _____			
(510) 547-5043 FAX	☐ 2 weeks			SDG No.
	☐ 1 week			
Job Name: UC Davis	☐ 2 days			
Address: One Shields Ave, Davis	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Easily Reducible Mn	Available Cr(III)	Standard Cr Oxidation Test	DI extraction	Exchangeable fraction extraction	Sample Specific Notes:
SSBGCR-2-63	10-16-08	14:45		soil	1 bag	X	X	X	X	X	
SSBGCR-2-65	↓	↓		↓	↓	X	X	X	X	X	
SSBGCR-2-75						X	X	X	X	X	
SSBGCR-2-87						X	X	X	X	X	
SSBGCR-2-50						X	X	X	X	X	
SSBGCR-2-95						X	X	X	X	X	
Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____						1	1	1	1	1	

Possible Hazard Identification
Non-Hazard *Flammable* *Skin Irritant* *Poison B* *Unknown*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
Return To Client *Disposal By Lab* *Archive For* _____ *Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Ramon R. Kirby / [signature]	WEISS ASSOCIATES	10-16-08, 17:45			
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by: [signature]	Company: PRIMA	Date/Time: 10/16/08

Chain of Custody Record

Please send analytic results, EDD, EDF, and the original chain-of-custody form to:
Anja Verce (av@weiss.com)

INSTRUCTIONS FOR LAB PERSONNEL:
GeoTracker EDF required? ☒ Yes ☐ No
Include laboratory QA/QC data with report.
Specify analytic/prep method and detection limit in report.
Notify us of any anomalous peaks in GC or other scans.
Call immediately with any questions or problems.

Weiss Associates
Environmental Science, Engineering and Management Services
5801 Christie Avenue, Suite 600, Emeryville, CA 94608
Phone: 510-450-6000 Fax: 510-547-5043

Prima Environmental
5070 Robert J. Mathews Parkway, Suite 300
El Dorado Hills, CA 95762
phone: (916) 939-7300

Project ID: 388-1856-2-32a
Protocol No.: 081023_Chrom detail_Prima Lab

Client Contact	Project Manager: Bob Devany	Sampled by: R. Davis	Date: 10/27/08	COC Number: UCD 2008 1027-4
Weiss Associates	Tel: 510-450-6144	Lab Contact: Cindy Schreier	Carrier: —	Page 1 of 1
5801 Christie Avenue, Suite 600	Analysis Turnaround Time			Job No. 0388-1856-1-32a
Emeryville, CA 94608	Calendar (C) or Work Days (W) ---			
(510) 450-6000 Phone	TAT if different from Below _____			
(510) 547-5043 FAX	☐ 2 weeks			SDG No.
	☐ 1 week			
Job Name: UC Davis	☐ 2 days			
Address: One Shields Ave, Davis	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Easily Reducible Mn	Available Cr(III)	Standard Cr Oxidation Test	DI extraction	Exchangeable fraction extraction	Sample Specific Notes:
SSHSCR-2-2	10/27/08		grab soil	SOIL	1	X	X	X	X	X	
SSBGCR-2-2	↓		grab soil	SOIL	1	X	X	X	X	X	
Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____						1	1	1	1	1	

Possible Hazard Identification
Non-Hazard *Flammable* *Skin Irritant* *Poison B* *Unknown*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
Return To Client *Disposal By Lab* *Archive For* _____ *Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Robert R. [illegible]	Weiss Associates	10/27/08 15:20	Kelly Tripp/Prima	Prima	10/27/08 15:20
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:

APPENDIX B
(Analytical Reports)

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

ANALYTICAL REPORT

Prima Environmental
5070 Robert J. Mathews Parkway
El Dorado Hills, CA 95762

Attn: Cindy Schreier
Phone: (916) 939-7300
Fax: (916) 393-7398
Date Received : 10/30/08

Job#: Weiss Assoc - UC Davis

Metals by ICPMS
EPA Method SW6020 / SW6020A

		Parameter	Concentration	Reporting Limit	Date Sampled	Date Analyzed
Client ID :	**Weiss-Diextr-Control**					
Lab ID :	PES08103003-01A	Chromium (Cr)	0.0053	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-5**					
Lab ID :	PES08103003-02A	Chromium (Cr)	0.0089	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	0.0083	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-9**					
Lab ID :	PES08103003-03A	Chromium (Cr)	0.0081	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-13**					
Lab ID :	PES08103003-04A	Chromium (Cr)	0.0064	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-25**					
Lab ID :	PES08103003-05A	Chromium (Cr)	0.010	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	0.0062	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-37 DUP**					
Lab ID :	PES08103003-06A	Chromium (Cr)	0.049	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	0.095	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-37**					
Lab ID :	PES08103003-07A	Chromium (Cr)	0.0053	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-40**					
Lab ID :	PES08103003-08A	Chromium (Cr)	ND	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-46**					
Lab ID :	PES08103003-09A	Chromium (Cr)	0.0056	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-57**					
Lab ID :	PES08103003-10A	Chromium (Cr)	0.0061	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-63**					
Lab ID :	PES08103003-11A	Chromium (Cr)	0.0056	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-65**					
Lab ID :	PES08103003-12A	Chromium (Cr)	0.0058	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Client ID :	**Weiss-Diextr-BGCR-75**					
Lab ID :	PES08103003-13A	Chromium (Cr)	ND	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-87**					
Lab ID :	PES08103003-14A	Chromium (Cr)	0.0071	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-95**					
Lab ID :	PES08103003-15A	Chromium (Cr)	ND	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-BGCR-2**					
Lab ID :	PES08103003-16A	Chromium (Cr)	0.0071	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	0.0074	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-5**					
Lab ID :	PES08103003-17A	Chromium (Cr)	ND	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-10**					
Lab ID :	PES08103003-18A	Chromium (Cr)	0.0053	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	0.0056	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-17**					
Lab ID :	PES08103003-19A	Chromium (Cr)	0.0060	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-25-5**					
Lab ID :	PES08103003-20A	Chromium (Cr)	0.0077	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-27**					
Lab ID :	PES08103003-21A	Chromium (Cr)	0.010	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	0.0056	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-30**					
Lab ID :	PES08103003-22A	Chromium (Cr)	0.0084	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-39**					
Lab ID :	PES08103003-23A	Chromium (Cr)	0.0066	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-45**					
Lab ID :	PES08103003-24A	Chromium (Cr)	0.012	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-53**					
Lab ID :	PES08103003-25A	Chromium (Cr)	0.0073	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-58**					
Lab ID :	PES08103003-26A	Chromium (Cr)	0.0071	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-63**					
Lab ID :	PES08103003-27A	Chromium (Cr)	0.0074	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-69-5**					
Lab ID :	PES08103003-28A	Chromium (Cr)	0.0081	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Client ID :	**Weiss-Diextr-HSCR-77**					
Lab ID :	PES08103003-29A	Chromium (Cr)	0.0081	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-83**					
Lab ID :	PES08103003-30A	Chromium (Cr)	0.0069	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	ND	0.0050 mg/L	10/28/08	11/03/08
Client ID :	**Weiss-Diextr-HSCR-2**					
Lab ID :	PES08103003-31A	Chromium (Cr)	0.0059	0.0050 mg/L	10/28/08	11/03/08
		Manganese (Mn)	0.0080	0.0050 mg/L	10/28/08	11/06/08

ND = Not Detected

Roger Scholl Randy Gardner Walter Hinchman

Roger L. Scholl, Ph.D., Laboratory Director • • Randy Gardner, Laboratory Manager • • Walter Hinchman, Quality Assurance Officer

Sacramento, CA • (916) 366-9089 / Las Vegas, NV • (702) 736-7522 / info@alpha-analytical.com

Alpha Analytical, Inc. currently holds appropriate and available California (#2019) and NELAC (01154CA) certifications for the data reported. Test results relate only to reported samples.

11/12/08

Report Date

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *09-Nov-08*

QC Summary Report

Work Order: 08103003

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A075SMPL.D** Batch ID: **20920** Analysis Date: **11/03/2008 18:07**

Sample ID: **MB-20920** Units : **mg/L** Run ID: **ICP/MS_081103C** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	ND	0.005								
Manganese (Mn)	ND	0.005								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A076_LCS.D** Batch ID: **20920** Analysis Date: **11/03/2008 18:13**

Sample ID: **LCS-20920** Units : **mg/L** Run ID: **ICP/MS_081103C** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.248	0.005	0.25		99	80	124			
Manganese (Mn)	2.48	0.005	2.5		99	83	120			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A083SMPL.D** Batch ID: **20920** Analysis Date: **11/03/2008 18:53**

Sample ID: **08103003-01AMS** Units : **mg/L** Run ID: **ICP/MS_081103C** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.259	0.005	0.25	0.005322	102	70	133			
Manganese (Mn)	2.48	0.005	2.5	0	99	70	130			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A084SMPL.D** Batch ID: **20920** Analysis Date: **11/03/2008 18:58**

Sample ID: **08103003-01AMSD** Units : **mg/L** Run ID: **ICP/MS_081103C** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.259	0.005	0.25	0.005322	101	70	133	0.2593	0.2(20)	
Manganese (Mn)	2.46	0.005	2.5	0	99	70	130	2.478	0.6(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *09-Nov-08*

QC Summary Report

Work Order: 08103003

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A114SMPL.D** Batch ID: **20923** Analysis Date: **11/03/2008 21:51**

Sample ID: **MB-20923** Units : **mg/L** Run ID: **ICP/MS_081103D** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	ND	0.005								
Manganese (Mn)	ND	0.005								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A115_LCS.D** Batch ID: **20923** Analysis Date: **11/03/2008 21:57**

Sample ID: **LCS-20923** Units : **mg/L** Run ID: **ICP/MS_081103D** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.262	0.005	0.25		105	80	124			
Manganese (Mn)	2.45	0.005	2.5		98	83	120			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A118SMPL.D** Batch ID: **20923** Analysis Date: **11/03/2008 22:13**

Sample ID: **08103003-20AMS** Units : **mg/L** Run ID: **ICP/MS_081103D** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.259	0.005	0.25	0.007681	101	70	133			
Manganese (Mn)	2.41	0.005	2.5	0	96	70	130			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A119SMPL.D** Batch ID: **20923** Analysis Date: **11/03/2008 22:19**

Sample ID: **08103003-20AMSD** Units : **mg/L** Run ID: **ICP/MS_081103D** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.271	0.005	0.25	0.007681	105	70	133	0.2594	4.4(20)	
Manganese (Mn)	2.42	0.005	2.5	0	97	70	130	2.41	0.3(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103003

Report Due By : 5:00 PM On : 13-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT/ CR

PO :

Client's COC # : 23867, 23868, 23865 Job : Weiss Assoc - UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	30-Oct-08	30-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08103003-01A	Weiss-Diextr-Control	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-02A	Weiss-Diextr-BGCR-5	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-03A	Weiss-Diextr-BGCR-9	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-04A	Weiss-Diextr-BGCR-13	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-05A	Weiss-Diextr-BGCR-25	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-06A	Weiss-Diextr-BGCR-37 DUP	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-07A	Weiss-Diextr-BGCR-37	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-08A	Weiss-Diextr-BGCR-40	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-09A	Weiss-Diextr-BGCR-46	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-10A	Weiss-Diextr-BGCR-57	AQ	10/28/08 13:00	1	0	10	Cr, Mn								

Comments: Security seals intact. Frozen ice. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Elizabeth Adcox	Elizabeth Adcox	Alpha Analytical, Inc.	10-30-08 1116

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103003

Report Due By : 5:00 PM On : 13-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT/ CR

PO :

Client's COC # : 23867, 23868, 23865 Job : Weiss Assoc - UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	30-Oct-08	30-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08103003-11A	Weiss-Diextr-BGCR-63	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-12A	Weiss-Diextr-BGCR-65	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-13A	Weiss-Diextr-BGCR-75	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-14A	Weiss-Diextr-BGCR-87	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-15A	Weiss-Diextr-BGCR-95	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-16A	Weiss-Diextr-BGCR-2	AQ	10/28/08 13:00	1	0	10	Cr, Mn								
PES08103003-17A	Weiss-Diextr-HSCR-5	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-18A	Weiss-Diextr-HSCR-10	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-19A	Weiss-Diextr-HSCR-17	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-20A	Weiss-Diextr-HSCR-25-5	AQ	10/28/08 15:30	1	0	10	Cr, Mn								

Comments: Security seals intact. Frozen ice. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Elizabeth Adcox	Elizabeth Adcox	Alpha Analytical, Inc.	10.30.08 1116

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103003

Report Due By : 5:00 PM On : 13-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT/ CR

PO :

Client's COC # : 23867, 23868, 23865 Job : Weiss Assoc - UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	30-Oct-08	30-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08103003-21A	Weiss-Diextr-HSCR-27	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-22A	Weiss-Diextr-HSCR-30	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-23A	Weiss-Diextr-HSCR-39	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-24A	Weiss-Diextr-HSCR-45	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-25A	Weiss-Diextr-HSCR-53	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-26A	Weiss-Diextr-HSCR-58	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-27A	Weiss-Diextr-HSCR-63	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-28A	Weiss-Diextr-HSCR-69-5	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-29A	Weiss-Diextr-HSCR-77	AQ	10/28/08 15:30	1	0	10	Cr, Mn								
PES08103003-30A	Weiss-Diextr-HSCR-83	AQ	10/28/08 15:30	1	0	10	Cr, Mn								

Comments: Security seals intact. Frozen ice. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Elizabeth Adcox	Elizabeth Adcox	Alpha Analytical, Inc.	10-30-08 1116

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103003

Report Due By : 5:00 PM On : 13-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT/ CR

PO :

Client's COC # : 23867, 23868, 23865 Job : Weiss Assoc - UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	30-Oct-08	30-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08103003-31A	Weiss-Diextr-HSCR-2	AQ	10/28/08 15:30	1	0	10	Cr, Mn								

Comments: Security seals intact. Frozen ice. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Elizabeth Adcox	Elizabeth Adcox	Alpha Analytical, Inc.	10.30.08 1116

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information:

Name
Ad
Cit
Ph
Cl
Ac

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

P.O. #
EMail Address
Phone #

Job # Weiss Assoc. UC Davis
data@primaenvironmental.com
Fax #

Samples Collected From Which State? AZ ___ CA ___ NV ___ WA ___ ID ___ OR ___ OTHER ___

23867

Page # 1 of 3

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID # ___

Sampled by KT/CR

Report Attention CINDY SCHREIER

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	Cr	Mn						REMARKS
1300	10/28	AQ	PES08103003 -01	Weiss, DIEXTR. CONTROL	STD	X	1-Poly	X	X						
			-02	BGCR-5		X	1-P	X	X						
			-03	BGCR-9		X	1-P	X	X						
			-04	BGCR-13		X	1-P	X	X						
			-05	BGCR-25		X	1-P	X	X						
			-06	BGCR-37 Dup		X	1-P	X	X						
			-07	BGCR-37		X	1-P	X	X						
			-08	BGCR-40		X	1-P	X	X						
			-09	BGCR-46		X	1-P	X	X						
			-10	BGCR-57		X	1-P	X	X						
			-11	BGCR-63		X	1-P	X	X						
			-12	BGCR-65		X	1-P	X	X						
			-13	BGCR-75		X	1-P	X	X						

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Trupp	K. Trupp	Prima	10/29/08	1035
Received by	[illegible]	Lisa deSilva	ALPHA	10/29/08	1035
Relinquished by					
Received by	Elizabeth Adcox	Elizabeth Adcox	Alpha	10-30-08	1116
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Billing Information:

Name

Addr

City

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State? AZ ___ CA ___ NV ___ WA ___ ID ___ OR ___ OTHER ___

23868

Page # 2 of 3

P.O. #

Job # Weiss Assoc. UC Davis

EMail Address data@primaenvironmental.com

Phone #

Fax #

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID #

Sampled by KT/CR

Report Attention Cindy Schreier

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	CR	MN						REMARKS
1300	10/28	AQ	-14	Weiss- DI EXTR. BGCR-87	STD	X	1-P	X	X						
			-15	. BGCR-95		X	1-P	X	X						
			-16	. BGCR-2		X	1-P	X	X						
1530	10/28	AQ	-17	Weiss. DI EXTR. HSCR-5	STD	X	1-P	X	X						
			-18	. HSCR. 10		X	1-P	X	X						
			-19	. HSCR. 17		X	1-P	X	X						
			-20	. HSCR. 25-5		X	1-P	X	X						
			-21	. HSCR. 27		X	1-P	X	X						
			-22	. HSCR. 30		X	1-P	X	X						
			-23	. HSCR. 39		X	1-P	X	X						
			-24	. HSCR. 45		X	1-P	X	X						
			-25	. HSCR. 53		X	1-P	X	X						
			-26	. HSCR. 58		X	1-P	X	X						

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Trupp	K Trupp	Prima	10/29/08	10:35
Received by	Lisa deSilva	Lisa deSilva	Alpha	10-29-08	10:35
Relinquished by					
Received by	Elizabeth Adcox	Elizabeth Adcox	Alpha	10:30:08	1116
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Billing Information:

Name
A
C PRIMA ENVIRONMENTAL, Inc.
F 5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398
City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State? AZ ___ CA ___ NV ___ WA ___ ID ___ OR ___ OTHER ___

23865

Page # 3 of 3

P.O. # Weiss Assoc. UC Davis

EMail Address data@primaenvironmental.com

Phone # Fax #

Report Attention Cindy Schreier

Sampled by KJ/CR

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID # ___

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	CR	MN						REMARKS
1530	10/28	AQ	-26	weiss.DIEXTR.HSCR.63	STD	X	1-P	X	X						
			-28	.HSCR.69.5		X	1-P	X	X						
			-29	.HSCR.77		X	1-P	X	X						
			-30	.HSCR.83		X	1-P	X	X						
1530			-31	.HSCR-2		X	1-P	X	X						

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelley Tripp	K Tripp	Prima	10/29/08	10-35
Received by	[illegible]	Lisa deSilva	ALPHA	10-29-08	1035
Relinquished by					
Received by	Elizabeth Adcox	Elizabeth Adcox	Alpha	10-30-08	1116
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

ANALYTICAL REPORT

Prima Environmental
5070 Robert J. Mathews Parkway
El Dorado Hills, CA 95762

Attn: Cindy Schreier
Phone: (916) 939-7300
Fax: (916) 393-7398
Date Received : 10/30/08

Job#: Weiss-UC Davis

Metals by ICPMS
EPA Method SW6020 / SW6020A

		Parameter	Concentration	Reporting Limit	Date Sampled	Date Analyzed
Client ID :	**Weiss-HSCR-10(soil)**					
Lab ID :	PES08103054-01A	Chromium (Cr)	130	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	580	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-HSCR-25.5(soil)**					
Lab ID :	PES08103054-02A	Chromium (Cr)	72	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	560	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-HSCR-30(soil)**					
Lab ID :	PES08103054-03A	Chromium (Cr)	94	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	720	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-HSCR-45(soil)**					
Lab ID :	PES08103054-04A	Chromium (Cr)	100	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	510	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-HSCR-58(soil)**					
Lab ID :	PES08103054-05A	Chromium (Cr)	99	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	410	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-HSCR-69.5(soil)**					
Lab ID :	PES08103054-06A	Chromium (Cr)	84	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	510	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-HSCR-77(soil)**					
Lab ID :	PES08103054-07A	Chromium (Cr)	170	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	670	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-HSCR-2(soil)**					
Lab ID :	PES08103054-08A	Chromium (Cr)	150	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	550	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-BGCR-9(soil)**					
Lab ID :	PES08103054-09A	Chromium (Cr)	130	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	560	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-BGCR-25(soil)**					
Lab ID :	PES08103054-10A	Chromium (Cr)	98	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	570	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-BGCR-37(soil)**					
Lab ID :	PES08103054-11A	Chromium (Cr)	120	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	520	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-BGCR-40(soil)**					
Lab ID :	PES08103054-12A	Chromium (Cr)	95	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	410	1.0 mg/Kg	10/27/08	11/03/08

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Client ID :	**Weiss-BGCR-57(soil)**					
Lab ID :	PES08103054-13A	Chromium (Cr)	250	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	540	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-BGCR-65(soil)**					
Lab ID :	PES08103054-14A	Chromium (Cr)	120	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	590	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-BGCR-75(soil)**					
Lab ID :	PES08103054-15A	Chromium (Cr)	91	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	570	1.0 mg/Kg	10/27/08	11/03/08
Client ID :	**Weiss-BGCR-2(soil)**					
Lab ID :	PES08103054-16A	Chromium (Cr)	140	1.0 mg/Kg	10/27/08	11/03/08
		Manganese (Mn)	580	1.0 mg/Kg	10/27/08	11/03/08

Sample results were calculated on a wet weight basis.

Roger Scholl Randy Gardner Walter Hinchman

Roger L. Scholl, Ph.D., Laboratory Director • • Randy Gardner, Laboratory Manager • • Walter Hinchman, Quality Assurance Officer

Sacramento, CA • (916) 366-9089 / Las Vegas, NV • (702) 736-7522 / info@alpha-analytical.com

Alpha Analytical, Inc. currently holds appropriate and available California (#2019) and NELAC (01154CA) certifications for the data reported. Test results relate only to reported samples.

11/12/08

Report Date

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *09-Nov-08*

QC Summary Report

Work Order: 08103054

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A024SMPL.D** Batch ID: **20912** Analysis Date: **11/03/2008 13:13**

Sample ID: **MB-20912** Units : **mg/Kg** Run ID: **ICP/MS_081030F** Prep Date: **10/30/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	ND	1								
Manganese (Mn)	ND	1								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A025_LCS.D** Batch ID: **20912** Analysis Date: **11/03/2008 13:18**

Sample ID: **LCS-20912** Units : **mg/Kg** Run ID: **ICP/MS_081030F** Prep Date: **10/30/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	24.9	1	25		99.7	75	120			
Manganese (Mn)	265	1	250		106	79	121			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A028SMPL.D** Batch ID: **20912** Analysis Date: **11/03/2008 13:35**

Sample ID: **08103054-01AMS** Units : **mg/Kg** Run ID: **ICP/MS_081030F** Prep Date: **10/30/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	137	1	10	130.9	62	50	150			
Manganese (Mn)	701	1	100	580.7	120	50	146			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\A029SMPL.D** Batch ID: **20912** Analysis Date: **11/03/2008 13:41**

Sample ID: **08103054-01AMSD** Units : **mg/Kg** Run ID: **ICP/MS_081030F** Prep Date: **10/30/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	131	1	10	130.9	-4	50	150	137.1	4.9(20)	M3
Manganese (Mn)	714	1	100	580.7	133	50	146	701	1.8(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

M3 = The accuracy of the spike recovery value is reduced since the analyte concentration in the sample is disproportionate to the spike level. The method control sample recovery was acceptable.

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103054

Report Due By : 5:00 PM On : 13-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : K. Tripp

PO :

Client's COC # : 23860 Job : Weiss-UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	30-Oct-08	30-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_SO								Sample Remarks
PES08103054-01A	Weiss-HSCR-10(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-02A	Weiss-HSCR-25.5(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-03A	Weiss-HSCR-30(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-04A	Weiss-HSCR-45(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-05A	Weiss-HSCR-58(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-06A	Weiss-HSCR-69.5(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-07A	Weiss-HSCR-77(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-08A	Weiss-HSCR-2(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-09A	Weiss-BGCR-9(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-10A	Weiss-BGCR-25(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								

Comments: Security seals intact. Frozen ice. One voa provided per soil sample. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Jane Dickinson	Jane Dickinson	Alpha Analytical, Inc.	10/30/08 1050

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103054

Report Due By : 5:00 PM On : 13-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : No

Sampled by : K. Tripp

PO :

Client's COC # : 23860 Job : Weiss-UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	30-Oct-08	30-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_SO								Sample Remarks
PES08103054-11A	Weiss-BGCR-37(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-12A	Weiss-BGCR-40(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-13A	Weiss-BGCR-57(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-14A	Weiss-BGCR-65(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-15A	Weiss-BGCR-75(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								
PES08103054-16A	Weiss-BGCR-2(soil)	SO	10/27/08 13:00	1	0	10	Cr, Mn								

Comments: Security seals intact. Frozen ice. One voa provided per soil sample. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tara Dickinson	Tara Dickinson	Alpha Analytical, Inc.	10/30/08 1050

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information:

Name

Ar

C PRIMA ENVIRONMENTAL, Inc.

P 5070 Robert J. Mathews Pkwy, Ste 300

(El Dorado Hills, CA 95762

PH: 916-939-7300

FAX: 916-939-7398

City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State? AZ ___ CA ___ NV ___ WA ___ ID ___ OR ___ OTHER ___

23860

Page # 1 of 2

P.O. #

Job # Weiss. UC DAVIS

EMail Address data@primaenvironmental.com

Phone # Fax #

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID #

Sampled by K Tripp

Report Attention Cindy Schreier

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	Total Cr	Manganese						REMARKS
1300	10/27	SO	PES08103054-01	Weiss. HSCR. 10 (soil)	Std		1-VOA	X	X						
			-02	. HSCR. 25.5 (soil)			1-V	X	X						
			-03	. HSCR. 30 (soil)			1-V	X	X						
			-04	. HSCR. 45 (soil)			1-V	X	X						
			-05	. HSCR. 58 (soil)			1-V	X	X						
			-06	. HSCR. 69.5 (soil)			1-V	X	X						
			-07	. HSCR. 77 (soil)			1-V	X	X						
			-08	. HSCR. 2 (soil)			1-V	X	X						
			-09	Weiss. BGCR. 9 (soil)	Std		1-V	X	X						
			-10	. BGCR. 25 (soil)			1-V	X	X						
			-11	. BGCR. 37 (soil)			1-V	X	X						
			-12	. BGCR 40 (soil)			1-V	X	X						
			-13	. BGCR 57 (soil)			1-V	X	X						

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	K. TRIPP	Prima	10/29/08	1035
Received by	Lisa deSilva	Lisa deSilva	ALPHA	10-29-08	1035
Relinquished by					
Received by	Tara Jackson	Tara Jackson	alpha	10/30/08	1050
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Billing Information:

Name

A

C PRIMA ENVIRONMENTAL, Inc.

F 5070 Robert J. Mathews Pkwy, Ste 300

El Dorado Hills, CA 95762

PH: 916-939-7300

FAX: 916-939-7398

City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State? AZ ___ CA ___ NV ___ WA ___ ID ___ OR ___ OTHER ___

23863

Page # 2 of 2

P.O. #

Job# Weiss. UC Davis

EMail Address data@primaenvironmental.com

Phone #

Fax #

Sampled by RT

Report Attention Cindy SCHREIER

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID # ___

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	Total Cr	Manganese							REMARKS
1300	10/21	SO	PESO8103054-14	Weiss. BGCR. 65 (soil)	Std		1-V	X	X							
↓	↓	↓	-15	BGCR. 75 (soil)	↓		↓	X	X							
↓	↓	↓	-16	BGCR. 2 (soil)	↓		↓	X	X							

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	Kelly Tripp	Prima	10/29/08	1035
Received by	Lisa de Silva	Lisa de Silva	ALPHA	10-29-08	1035
Relinquished by					
Received by	Jane Jackson	Jane Jackson	Alpha	10/30/08	1050
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

ANALYTICAL REPORT

Prima Environmental
5070 Robert J. Mathews Parkway
El Dorado Hills, CA 95762

Attn: Cindy Schreier
Phone: (916) 939-7300
Fax: (916) 393-7398
Date Received : 10/31/08

Job#: Weiss-UCD

Metals by ICPMS
EPA Method SW6020 / SW6020A

	Parameter	Concentration	Reporting Limit	Date Sampled	Date Analyzed
Client ID :	**Weiss-EXCHCR-BGCR-2**				
Lab ID :	PES08103154-01A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-5**				
Lab ID :	PES08103154-02A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-9**				
Lab ID :	PES08103154-03A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-13**				
Lab ID :	PES08103154-04A Chromium (Cr)	0.0056	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-25**				
Lab ID :	PES08103154-05A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-37**				
Lab ID :	PES08103154-06A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-37DUP**				
Lab ID :	PES08103154-07A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-40**				
Lab ID :	PES08103154-08A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-46**				
Lab ID :	PES08103154-09A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-57**				
Lab ID :	PES08103154-10A Chromium (Cr)	0.011	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-63**				
Lab ID :	PES08103154-11A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-65**				
Lab ID :	PES08103154-12A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-75**				
Lab ID :	PES08103154-13A Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-87**				
Lab ID :	PES08103154-14A Chromium (Cr)	0.0076	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-BGCR-95**				
Lab ID :	PES08103154-15A Chromium (Cr)	0.021	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-Control**				
Lab ID :	PES08103154-16A Chromium (Cr)	0.021	0.0050 mg/L	10/29/08	11/04/08

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Client ID :	**Weiss-EXCHCR-HSCR-2**					
Lab ID :	PES08103154-17A	Chromium (Cr)	0.0064	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-5**					
Lab ID :	PES08103154-18A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-10**					
Lab ID :	PES08103154-19A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-17**					
Lab ID :	PES08103154-20A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-25.5**					
Lab ID :	PES08103154-21A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-27**					
Lab ID :	PES08103154-22A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-30**					
Lab ID :	PES08103154-23A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-39**					
Lab ID :	PES08103154-24A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-45**					
Lab ID :	PES08103154-25A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-53**					
Lab ID :	PES08103154-26A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-58**					
Lab ID :	PES08103154-27A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-63**					
Lab ID :	PES08103154-28A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-69.5**					
Lab ID :	PES08103154-29A	Chromium (Cr)	ND	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-77**					
Lab ID :	PES08103154-30A	Chromium (Cr)	0.0054	0.0050 mg/L	10/29/08	11/04/08
Client ID :	**Weiss-EXCHCR-HSCR-83**					
Lab ID :	PES08103154-31A	Chromium (Cr)	0.0054	0.0050 mg/L	10/29/08	11/04/08

This replaces the report originally signed 11/13/08, due to a change in the Client ID for -12A.

ND = Not Detected

Roger Scholl Randy Gardner Walter Hinchman

Roger L. Scholl, Ph.D., Laboratory Director • • Randy Gardner, Laboratory Manager • • Walter Hinchman, Quality Assurance Officer
Sacramento, CA • (916) 366-9089 / Las Vegas, NV • (702) 736-7522 / info@alpha-analytical.com

Alpha Analytical, Inc. currently holds appropriate and available California (#2019) and NELAC (01154CA) certifications for the data reported. Test results relate only to reported samples.

11/14/08
Report Date

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *13-Nov-08*

QC Summary Report

Work Order: 08103154

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**
File ID: **110308.B\A172SMPL.D** Batch ID: **20924** Analysis Date: **11/04/2008 03:21**
Sample ID: **MB-20924** Units : **mg/L** Run ID: **ICP/MS_081104E** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	ND	0.005								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**
File ID: **110308.B\A173_LCS.D** Batch ID: **20924** Analysis Date: **11/04/2008 03:27**
Sample ID: **LCS-20924** Units : **mg/L** Run ID: **ICP/MS_081104E** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.254	0.005	0.25		102	80	124			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**
File ID: **110308.B\A180SMPL.D** Batch ID: **20924** Analysis Date: **11/04/2008 04:06**
Sample ID: **08103154-01AMS** Units : **mg/L** Run ID: **ICP/MS_081104E** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.234	0.005	0.25	0	94	70	133			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**
File ID: **110308.B\A181SMPL.D** Batch ID: **20924** Analysis Date: **11/04/2008 04:12**
Sample ID: **08103154-01AMSD** Units : **mg/L** Run ID: **ICP/MS_081104E** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.224	0.005	0.25	0	90	70	133	0.2344	4.6(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *13-Nov-08*

QC Summary Report

Work Order: 08103154

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\C004SMPL.D** Batch ID: **20925** Analysis Date: **11/04/2008 14:01**

Sample ID: **MB-20925** Units : **mg/L** Run ID: **ICP/MS_081104A** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	ND	0.005								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\C005_LCS.D** Batch ID: **20925** Analysis Date: **11/04/2008 14:07**

Sample ID: **LCS-20925** Units : **mg/L** Run ID: **ICP/MS_081104A** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.257	0.005	0.25		103	80	124			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\C008SMPL.D** Batch ID: **20925** Analysis Date: **11/04/2008 14:24**

Sample ID: **08103154-20AMS** Units : **mg/L** Run ID: **ICP/MS_081104A** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.278	0.005	0.25	0	111	70	133			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **110308.B\C009SMPL.D** Batch ID: **20925** Analysis Date: **11/04/2008 14:29**

Sample ID: **08103154-20AMSD** Units : **mg/L** Run ID: **ICP/MS_081104A** Prep Date: **10/31/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.289	0.005	0.25	0	116	70	133	0.2778	4.1(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

AMENDED

CA

Billing Information :

CHAIN-OF-CUSTODY RECORD

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103154

Report Due By : 5:00 PM On : 14-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : C.S.

PO :

Client's COC # : 23870, 23869, 23866 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	31-Oct-08	14-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08103154-01A	Weiss-EXCHCR-BGCR-2	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-02A	Weiss-EXCHCR-BGCR-5	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-03A	Weiss-EXCHCR-BGCR-9	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-04A	Weiss-EXCHCR-BGCR-13	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-05A	Weiss-EXCHCR-BGCR-25	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-06A	Weiss-EXCHCR-BGCR-37	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-07A	Weiss-EXCHCR-BGCR-37DUP	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-08A	Weiss-EXCHCR-BGCR-40	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-09A	Weiss-EXCHCR-BGCR-46	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-10A	Weiss-EXCHCR-BGCR-57	AQ	10/29/08 11:00	1	0	10	Cr								

Comments: Security seals intact. Frozen ice. Amended 11/14/08 to change sample ID on sample -12A to end in 65 instead of 63, per Kathy w/ PES. TD. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tara Dickinson	Tara Dickinson	Alpha Analytical, Inc.	11/14/08 922

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

AMENDED

CA

Billing Information :

CHAIN-OF-CUSTODY RECORD

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103154

Report Due By : 5:00 PM On : 14-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : C.S.

PO :

Client's COC # : 23870, 23869, 23866 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	31-Oct-08	14-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08103154-11A	Weiss-EXCHCR-BGCR-63	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-12A	Weiss-EXCHCR-BGCR-65	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-13A	Weiss-EXCHCR-BGCR-75	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-14A	Weiss-EXCHCR-BGCR-87	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-15A	Weiss-EXCHCR-BGCR-95	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-16A	Weiss-EXCHCR-Control	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-17A	Weiss-EXCHCR-HSCR-2	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-18A	Weiss-EXCHCR-HSCR-5	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-19A	Weiss-EXCHCR-HSCR-10	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-20A	Weiss-EXCHCR-HSCR-17	AQ	10/29/08 14:00	1	0	10	Cr								

Comments: Security seals intact. Frozen ice. Amended 11/14/08 to change sample ID on sample -12A to end in 65 instead of 63, per Kathy w/ PES. TD. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Ione Dickinson	Ione Dickinson	Alpha Analytical, Inc.	11/14/08 922

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

AMENDED

CA

Billing Information :

CHAIN-OF-CUSTODY RECORD

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103154

Report Due By : 5:00 PM On : 14-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : C.S.

PO :

Client's COC # : 23870, 23869, 23866 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	31-Oct-08	14-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08103154-21A	Weiss-EXCHCR-HSCR-25.5	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-22A	Weiss-EXCHCR-HSCR-27	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-23A	Weiss-EXCHCR-HSCR-30	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-24A	Weiss-EXCHCR-HSCR-39	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-25A	Weiss-EXCHCR-HSCR-45	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-26A	Weiss-EXCHCR-HSCR-53	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-27A	Weiss-EXCHCR-HSCR-58	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-28A	Weiss-EXCHCR-HSCR-63	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-29A	Weiss-EXCHCR-HSCR-69.5	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-30A	Weiss-EXCHCR-HSCR-77	AQ	10/29/08 14:00	1	0	10	Cr								

Comments: Security seals intact. Frozen ice. Amended 11/14/08 to change sample ID on sample -12A to end in 65 instead of 63, per Kathy w/ PES. TD. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tara Dickinson	Tara Dickinson	Alpha Analytical, Inc.	11/14/08 922

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

AMENDED

CA

Billing Information :

CHAIN-OF-CUSTODY RECORD

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103154

Report Due By : 5:00 PM On : 14-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : C.S.

PO :

Client's COC # : 23870, 23869, 23866 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	31-Oct-08	14-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08103154-31A	Weiss-EXCHCR-HSCR-83	AQ	10/29/08 14:00	1	0	10	Cr								

Comments: Security seals intact. Frozen ice. Amended 11/14/08 to change sample ID on sample -12A to end in 65 instead of 63, per Kathy w/ PES. TD. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Jane Dickinson	Jane Dickinson	Alpha Analytical, Inc.	11/14/08 922

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103154

Report Due By : 5:00 PM On : 14-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : C.S.

PO :

Client's COC # : 23870, 23869, 23866 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	31-Oct-08	31-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08103154-01A	Weiss-EXCHCR-BGCR-2	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-02A	Weiss-EXCHCR-BGCR-5	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-03A	Weiss-EXCHCR-BGCR-9	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-04A	Weiss-EXCHCR-BGCR-13	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-05A	Weiss-EXCHCR-BGCR-25	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-06A	Weiss-EXCHCR-BGCR-37	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-07A	Weiss-EXCHCR-BGCR-37DUP	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-08A	Weiss-EXCHCR-BGCR-40	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-09A	Weiss-EXCHCR-BGCR-46	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-10A	Weiss-EXCHCR-BGCR-57	AQ	10/29/08 11:00	1	0	10	Cr								

Comments: Security seals intact. Frozen ice. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tara Jickinson	Tara Jickinson	Alpha Analytical, Inc.	10/31/08 1215

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103154

Report Due By : 5:00 PM On : 14-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : C.S.

PO :

Client's COC # : 23870, 23869, 23866 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	31-Oct-08	31-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08103154-11A	Weiss-EXCHCR-BGCR-63	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-12A	Weiss-EXCHCR-BGCR-63	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-13A	Weiss-EXCHCR-BGCR-75	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-14A	Weiss-EXCHCR-BGCR-87	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-15A	Weiss-EXCHCR-BGCR-95	AQ	10/29/08 11:00	1	0	10	Cr								
PES08103154-16A	Weiss-EXCHCR-Control	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-17A	Weiss-EXCHCR-HSCR-2	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-18A	Weiss-EXCHCR-HSCR-5	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-19A	Weiss-EXCHCR-HSCR-10	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-20A	Weiss-EXCHCR-HSCR-17	AQ	10/29/08 14:00	1	0	10	Cr								

Comments: Security seals intact. Frozen ice. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tara Dickinson	Tara Dickinson	Alpha Analytical, Inc.	10/31/08 1215

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103154

Report Due By : 5:00 PM On : 14-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : C.S.

PO :

Client's COC # : 23870, 23869, 23866 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	31-Oct-08	31-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08103154-21A	Weiss-EXCHCR-HSCR-25.5	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-22A	Weiss-EXCHCR-HSCR-27	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-23A	Weiss-EXCHCR-HSCR-30	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-24A	Weiss-EXCHCR-HSCR-39	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-25A	Weiss-EXCHCR-HSCR-45	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-26A	Weiss-EXCHCR-HSCR-53	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-27A	Weiss-EXCHCR-HSCR-58	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-28A	Weiss-EXCHCR-HSCR-63	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-29A	Weiss-EXCHCR-HSCR-69.5	AQ	10/29/08 14:00	1	0	10	Cr								
PES08103154-30A	Weiss-EXCHCR-HSCR-77	AQ	10/29/08 14:00	1	0	10	Cr								

Comments: Security seals intact. Frozen ice. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Jana Dickinson	Jana Dickinson	Alpha Analytical, Inc.	10/31/08 1215

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08103154

Report Due By : 5:00 PM On : 14-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : C.S.

PO :

Client's COC # : 23870, 23869, 23866 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	31-Oct-08	31-Oct-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08103154-31A	Weiss-EXCHCR-HSCR-83	AQ	10/29/08 14:00	1	0	10	Cr								

Comments: Security seals intact. Frozen ice. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tara Dickinson	Tara Dickinson	Alpha Analytical, Inc.	10/31/08 1215

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information:

Name
Address
C
F PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State? AZ ___ CA ___ NV ___ WA ___ ID ___ OR ___ OTHER ___

23870

Page # 1 of 3

P.O. #
Job # Weiss: UCD
EMail Address
data@primaenvironmental.com
Phone #
Fax #

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID #

Report Attention Cindy Schreier

Sampled by CL

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	CV							REMARKS
1100	10/30/08	AQ	PES08103154-01	Weiss • EXCHCR • BGCR • 2	STD	X	1-P	X							
			-02	• 5		X		X							
			-03	• 9		X		X							
			-04	• 13		X		X							
			-05	• 25		X		X							
			-06	• 37		X		X							
			-07	• 37 DUP		X		X							
			-08	• 40		X		X							
			-09	• 46		X		X							
			-10	• 57		X		X							
			-11	• 63		X		X							
			-12	• 65		X		X							
			-13	• 75		X		X							

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	K. TRIPP	PRIMA	10/30/08	1105
Received by	Lisa de Silva	Lisa de Silva	ALPHA	10-30-08	1105
Relinquished by	Lisa de Silva	Lisa de Silva	ALPHA	10-30-08	1500
Received by	Tara Dickinson	Tara Dickinson	Alpha	10/31/08	1222
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Billing Information:

Name

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398
City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State? AZ ___ CA ___ NV ___ WA ___ ID ___ OR ___ OTHER ___

23869

Page # 2 of 3

P.O. #

Job # Weiss - UCD

EMail Address

data@primaenvironmental.com

Phone #

Fax #

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID # ___

Sampled by CR

Report Attention Cindy Schreier

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	CJ							REMARKS
1100	10/29/08	AQ	PESD810354-14	weiss · ~~EXCHR~~ EXCHCR · BGCR · 87	STD	X	1-P	X							
↓	↓	↓	-15	↓ · 95		X		X							
1400	10/29/08	AQ	-16	weiss, EXCHCR · [redacted] Control		X		X							
			-17	weiss, EXCHCR · HSCR · 2		X		X							
			-18	· 5		X		X							
			-19	· 10		X		X							
			-20	· 17		X		X							
			-21	· 25.5		X		X							
			-22	· 27		X		X							
			-23	· 30		X		X							
			-24	· 39		X		X							
			-25	· 45		X		X							
↓	↓	↓	-26	↓ · 53	↓	X	↓	X							

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	K. Tripp	Prima	10/30/08	1105
Received by	Lisa de Silva	Lisa de Silva	ALPHA	10-30-08	1105
Relinquished by	Lisa de Silva	Lisa de Silva	ALPHA	10-30-08	1500
Received by	Dave Dickinson	Dave Dickinson	Alpha	10/31/08	1227
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Billing Information:

Name
A
C PRIMA ENVIRONMENTAL, Inc.
P 5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398
City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State? 23866
AZ ___ CA ___ NV ___ WA ___
ID ___ OR ___ OTHER ___

Page # 3 of 3

P.O. #
Job # Weiss • UCD
EMail Address
data@primaenvironmental.com
Phone #
Fax #

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID # ___

Sampled by CR

Report Attention Cindy Schreier

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	CR							REMARKS
1400	10/23/08	AQ	PES08103154 27	Weiss • ExCHCR • HSCR • 58	STD	X	1-P	X							
			-28	• 63		X		X							
			-29	• 69,5		X		X							
			-30	• 77		X		X							
			-31	• 83		X		X							

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	K. Tripp	Prima	10/30/08	1105
Received by	Lisa de Silva	Lisa de Silva	ALPHA	10-30-08	1105
Relinquished by	Lisa de Silva	Lisa de Silva	ALPHA	10-30-08	1500
Received by	Tara Jickinson	Tara Jickinson	Alpha	10/31/08	1207
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

ANALYTICAL REPORT

Prima Environmental
5070 Robert J. Mathews Parkway
El Dorado Hills, CA 95762

Attn: Cindy Schreier
Phone: (916) 939-7300
Fax: (916) 393-7398
Date Received : 11/07/08

Job#: Weiss Assoc - UC Davis

Metals by ICPMS
EPA Method SW6020 / SW6020A

	Parameter	Concentration		Reporting Limit	Date Sampled	Date Analyzed
Client ID :	**Weiss-MANG-BGCR-Contol**					
Lab ID :	PES08110703-01A Manganese (Mn)	ND	X	0.010 mg/L	11/05/08	11/14/08
Client ID :	**Weiss-MANG-BGCR-2**					
Lab ID :	PES08110703-02A Manganese (Mn)	29		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-5**					
Lab ID :	PES08110703-03A Manganese (Mn)	26		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-9**					
Lab ID :	PES08110703-04A Manganese (Mn)	11		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-13**					
Lab ID :	PES08110703-05A Manganese (Mn)	30		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-25**					
Lab ID :	PES08110703-06A Manganese (Mn)	20		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-37**					
Lab ID :	PES08110703-07A Manganese (Mn)	32		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-37 (dup)**					
Lab ID :	PES08110703-08A Manganese (Mn)	34		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-40**					
Lab ID :	PES08110703-09A Manganese (Mn)	12		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-46**					
Lab ID :	PES08110703-10A Manganese (Mn)	13		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-57**					
Lab ID :	PES08110703-11A Manganese (Mn)	25		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-63**					
Lab ID :	PES08110703-12A Manganese (Mn)	40		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-65**					
Lab ID :	PES08110703-13A Manganese (Mn)	29		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-75**					
Lab ID :	PES08110703-14A Manganese (Mn)	24		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-87**					
Lab ID :	PES08110703-15A Manganese (Mn)	16		0.10 mg/L	11/05/08	11/13/08
Client ID :	**Weiss-MANG-BGCR-95**					
Lab ID :	PES08110703-16A Manganese (Mn)	13		0.10 mg/L	11/05/08	11/13/08

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

X = Reporting Limits were increased due to sample matrix interferences.

ND = Not Detected

Roger Scholl Randy Gardner Walter Hinchman

Roger L. Scholl, Ph.D., Laboratory Director • • Randy Gardner, Laboratory Manager • • Walter Hinchman, Quality Assurance Officer

Sacramento, CA • (916) 366-9089 / Las Vegas, NV • (702) 736-7522 / info@alpha-analytical.com

Alpha Analytical, Inc. currently holds appropriate and available California (#2019) and NELAC (01154CA) certifications for the data reported. Test results relate only to reported samples.

11/20/08

Report Date

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *19-Nov-08*

QC Summary Report

Work Order: 08110703

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **111308.B\019SMPL.D** Batch ID: **20996** Analysis Date: **11/13/2008 17:08**

Sample ID: **MB-20996** Units : **mg/L** Run ID: **ICP/MS_081113B** Prep Date: **11/12/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Manganese (Mn)	ND	0.005								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **111308.B\020_LCS.D** Batch ID: **20996** Analysis Date: **11/13/2008 17:14**

Sample ID: **LCS-20996** Units : **mg/L** Run ID: **ICP/MS_081113B** Prep Date: **11/12/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Manganese (Mn)	2.69	0.005	2.5		108	83	120			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **111308.B\MS.D** Batch ID: **20996** Analysis Date: **11/14/2008 18:52**

Sample ID: **08110703-01AMS** Units : **mg/L** Run ID: **ICP/MS_081113B** Prep Date: **11/12/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Manganese (Mn)	2.49	0.005	2.5	0	99	70	130			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **111308.B\MSD.D** Batch ID: **20996** Analysis Date: **11/14/2008 18:58**

Sample ID: **08110703-01AMSD** Units : **mg/L** Run ID: **ICP/MS_081113B** Prep Date: **11/12/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Manganese (Mn)	2.49	0.005	2.5	0	99	70	130	2.487	0.0(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

AMENDED

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.

255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08110703

Report Due By : 5:00 PM On : 21-Nov-08

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 23873, 23874 Job : Weiss Assoc - UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	07-Nov-08	12-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	METALS_AQ								Sample Remarks
							Requested Tests								
PES08110703-01A	Weiss-MANG-BGCR-Contol	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-02A	Weiss-MANG-BGCR-2	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-03A	Weiss-MANG-BGCR-5	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-04A	Weiss-MANG-BGCR-9	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-05A	Weiss-MANG-BGCR-13	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-06A	Weiss-MANG-BGCR-25	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-07A	Weiss-MANG-BGCR-37	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-08A	Weiss-MANG-BGCR-37 (dup)	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-09A	Weiss-MANG-BGCR-40	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-10A	Weiss-MANG-BGCR-46	AQ	11/05/08 17:00	1	0	10	Mn								

Comments: Security seals intact. Frozen ice. Samples received filtered and preserved. Samples are highly buffered. Amended 11/12/08 @ 15:43: Corrected comment of preservation, samples were received unpreserved due to login error. EA :

	Signature	Print Name	Company	Date/Time
Logged in by:	Elizabeth Adcox	Elizabeth Adcox	Alpha Analytical, Inc.	11-12-08 1552

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

AMENDED

CA

CHAIN-OF-CUSTODY RECORD

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08110703

Report Due By : 5:00 PM On : 21-Nov-08

Billing Information :

,

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 23873, 23874 Job : Weiss Assoc - UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	07-Nov-08	12-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	METALS_AQ								Sample Remarks
PES08110703-11A	Weiss-MANG-BGCR-57	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-12A	Weiss-MANG-BGCR-63	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-13A	Weiss-MANG-BGCR-65	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-14A	Weiss-MANG-BGCR-75	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-15A	Weiss-MANG-BGCR-87	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-16A	Weiss-MANG-BGCR-95	AQ	11/05/08 17:00	1	0	10	Mn								

Comments: Security seals intact. Frozen ice. Samples received filtered and preserved. Samples are highly buffered. Amended 11/12/08 @ 15:43: Corrected comment of preservation, samples were received unpreserved due to login error. EA :

	Signature	Print Name	Company	Date/Time
Logged in by:	Elizabeth Adcox	Elizabeth Adcox	Alpha Analytical, Inc.	11-12-08 1552

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08110703

Report Due By : 5:00 PM On : 21-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 23873, 23874 Job : Weiss Assoc - UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	07-Nov-08	07-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08110703-01A	Weiss-MANG-BGCR-Contol	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-02A	Weiss-MANG-BGCR-2	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-03A	Weiss-MANG-BGCR-5	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-04A	Weiss-MANG-BGCR-9	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-05A	Weiss-MANG-BGCR-13	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-06A	Weiss-MANG-BGCR-25	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-07A	Weiss-MANG-BGCR-37	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-08A	Weiss-MANG-BGCR-37 (dup)	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-09A	Weiss-MANG-BGCR-40	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-10A	Weiss-MANG-BGCR-46	AQ	11/05/08 17:00	1	0	10	Mn								

Comments: Security seals intact. Frozen ice. Samples received filtered and preserved. Samples are highly buffered. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Elizabeth Adcox	Elizabeth Adcox	Alpha Analytical, Inc.	11-7-08 1257

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08110703

Report Due By : 5:00 PM On : 21-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 23873, 23874 Job : Weiss Assoc - UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	07-Nov-08	07-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08110703-11A	Weiss-MANG-BGCR-57	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-12A	Weiss-MANG-BGCR-63	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-13A	Weiss-MANG-BGCR-65	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-14A	Weiss-MANG-BGCR-75	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-15A	Weiss-MANG-BGCR-87	AQ	11/05/08 17:00	1	0	10	Mn								
PES08110703-16A	Weiss-MANG-BGCR-95	AQ	11/05/08 17:00	1	0	10	Mn								

Comments: Security seals intact. Frozen ice. Samples received filtered and preserved. Samples are highly buffered. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Elizabeth Adcox	Elizabeth Adcox	Alpha Analytical, Inc.	11-7-08 1257

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information:

Name
Adr
Cit
Ph
C
A
City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State? AZ ___ CA ___ NV ___ WA ___ ID ___ OR ___ OTHER ___

23873

Page # 1 of 2

Rev-BB

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

P.O. #
Job # Weiss Assoc. UC Davis
EMail Address data@primaenvironmental.com
Phone #
Fax #

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID # ___

Sampled by RT

Report Attention CINDY SCHREIER

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	Total Mn							REMARKS
1700	11/5/08	AQ	PES0811 0703 -01	Weiss: MANG: BGCR-Control	Std	✓	1-P	X							Filtered & Unpreserved Samples
			-02	BGCR-2		✓	1-P	X							
			-03	BGCR-5		✓	1-P	X							
			-04	BGCR-9		✓	1-P	X							
			-05	BGCR-13		✓	1-P	X							Samples are highly Buffered
			-06	BGCR-25		✓	1-P	X							
			-07	BGCR-37		✓	1-P	X							
			-08	BGCR-37 (dup)		✓	1-P	X							
			-09	BGCR-40		✓	1-P	X							
			-10	BGCR-46		✓	1-P	X							
			-11	BGCR-57		✓	1-P	X							
			-12	BGCR-63		✓	1-P	X							
			-13	BGCR-65		✓	1-P	X							

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	K. TRIPP	PRIMA	11-6-08	1350
Received by	Lisa deSilva	LISA deSilva	ALPHA	11-6-08	1350
Relinquished by	Lisa deSilva	LISA deSilva	ALPHA	11-6-08	1600
Received by	Elizabeth Adcox	Elizabeth Adcox	Alpha	11-7-08	1257
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Billing Information:

Name
Address
Cit
Pr PRIMA ENVIRONMENTAL, Inc.
C 5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
A PH: 916-939-7300
C FAX: 916-939-7398

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State?
AZ ___ CA ___ NV ___ WA ___
ID ___ OR ___ OTHER ___

23874
Page # 2 of 2

Rev. BB

P.O. #
Job # Weiss Assoc. UC DAVIS
EMail Address data@primaenvironmental.com
Phone #
Fax #

Required QC Level? I II III IV
EDD / EDF? YES ___ NO ___
Global ID # ___

Sampled by R Tripp
Report Attention Cindy SCHREIER

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	Total Mn							REMARKS
1700	10/5	AQ	-14	Weiss: MANG. BGCR-75	std	✓		X							Filtered & Unpreserved Samples
↓	↓	↓	-15	· BGCR-87	↓	✓		X							
↓	↓	↓	-16	· BGCR-95	STD	✓		X							
															Samples are highly Buffered

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	K. TRIPP	PRIMA	11-6-08	13:50
Received by	Lisa de Silva	Lisa de Silva	ALPHA	11-6-08	13:50
Relinquished by	Lisa de Silva	Lisa de Silva	ALPHA	11-6-08	1600
Received by	Elizabeth Adcox	Elizabeth Adcox	Alpha	11-7-08	1257
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

ANALYTICAL REPORT

Prima Environmental
5070 Robert J. Mathews Parkway
El Dorado Hills, CA 95762

Attn: Cindy Schreier
Phone: (916) 939-7300
Fax: (916) 393-7398
Date Received : 11/11/08

Job#: Weiss-Assoc-UCD

Metals by ICPMS
EPA Method SW6020 / SW6020A

	Parameter	Concentration		Reporting Limit	Date Sampled	Date Analyzed
Client ID : **Weiss-Mang-HSCR-CON**						
Lab ID : PES08111156-01A	Manganese (Mn)	ND	X	0.010 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-2**						
Lab ID : PES08111156-02A	Manganese (Mn)	24		0.10 mg/L	11/10/08	11/13/08
Client ID : **Weiss-Mang-HSCR-5**						
Lab ID : PES08111156-03A	Manganese (Mn)	25		0.10 mg/L	11/10/08	11/13/08
Client ID : **Weiss-Mang-HSCR-10**						
Lab ID : PES08111156-04A	Manganese (Mn)	15		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-17**						
Lab ID : PES08111156-05A	Manganese (Mn)	24		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-25.5**						
Lab ID : PES08111156-06A	Manganese (Mn)	29		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-27**						
Lab ID : PES08111156-07A	Manganese (Mn)	37		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-30**						
Lab ID : PES08111156-08A	Manganese (Mn)	29		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-39**						
Lab ID : PES08111156-09A	Manganese (Mn)	49		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-45**						
Lab ID : PES08111156-10A	Manganese (Mn)	13		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-53**						
Lab ID : PES08111156-11A	Manganese (Mn)	14		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-58**						
Lab ID : PES08111156-12A	Manganese (Mn)	5.5		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-63**						
Lab ID : PES08111156-13A	Manganese (Mn)	26		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-69.5**						
Lab ID : PES08111156-14A	Manganese (Mn)	25		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-77**						
Lab ID : PES08111156-15A	Manganese (Mn)	15		0.10 mg/L	11/10/08	11/14/08
Client ID : **Weiss-Mang-HSCR-83**						
Lab ID : PES08111156-16A	Manganese (Mn)	11		0.10 mg/L	11/10/08	11/14/08

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

X = Reporting Limits were increased due to sample matrix interferences.

ND = Not Detected

Roger Scholl Randy Gardner Walter Hinchman

Roger L. Scholl, Ph.D., Laboratory Director • • Randy Gardner, Laboratory Manager • • Walter Hinchman, Quality Assurance Officer

Sacramento, CA • (916) 366-9089 / Las Vegas, NV • (702) 736-7522 / info@alpha-analytical.com

Alpha Analytical, Inc. currently holds appropriate and available California (#2019) and NELAC (01154CA) certifications for the data reported. Test results relate only to reported samples.

11/24/08

Report Date

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *20-Nov-08*

QC Summary Report

Work Order: 08111156

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **111308.B\075SMPL.D** Batch ID: **21007** Analysis Date: **11/13/2008 22:27**

Sample ID: **MB-21007** Units : **mg/L** Run ID: **ICP/MS_081113C** Prep Date: **11/13/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Manganese (Mn)	ND	0.005								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **111308.B\076_LCS.D** Batch ID: **21007** Analysis Date: **11/13/2008 22:33**

Sample ID: **LCS-21007** Units : **mg/L** Run ID: **ICP/MS_081113C** Prep Date: **11/13/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Manganese (Mn)	2.66	0.005	2.5		106	83	120			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **111308.B\079SMPL.D** Batch ID: **21007** Analysis Date: **11/13/2008 22:49**

Sample ID: **08111157-15AMS** Units : **mg/L** Run ID: **ICP/MS_081113C** Prep Date: **11/13/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Manganese (Mn)	3.77	0.005	2.5	1.365	96	70	130			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **111308.B\084SMPL.D** Batch ID: **21007** Analysis Date: **11/13/2008 23:17**

Sample ID: **08111157-15AMSD** Units : **mg/L** Run ID: **ICP/MS_081113C** Prep Date: **11/13/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Manganese (Mn)	3.61	0.005	2.5	1.365	90	70	130	3.774	4.4(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08111156

Report Due By : 5:00 PM On : 25-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT, CS

PO :

Client's COC # : 024765 Job : Weiss-Assoc-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	11-Nov-08	11-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08111156-01A	Weiss-Mang-HSCR-CON	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-02A	Weiss-Mang-HSCR-2	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-03A	Weiss-Mang-HSCR-5	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-04A	Weiss-Mang-HSCR-10	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-05A	Weiss-Mang-HSCR-17	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-06A	Weiss-Mang-HSCR-25.5	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-07A	Weiss-Mang-HSCR-27	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.

Comments: Security seals intact. Frozen ice. Samples rec'd filtered and unpreserved. Samples are highly buffered. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tara Dickinson	Tara Dickinson	Alpha Analytical, Inc.	11/11/08 1303

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08111156

Report Due By : 5:00 PM On : 25-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT, CS

PO :

Client's COC # : 024765 Job : Weiss-Assoc-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	11-Nov-08	11-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08111156-08A	Weiss-Mang-HSCR-30	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-09A	Weiss-Mang-HSCR-39	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-10A	Weiss-Mang-HSCR-45	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-11A	Weiss-Mang-HSCR-53	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-12A	Weiss-Mang-HSCR-58	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-13A	Weiss-Mang-HSCR-63	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-14A	Weiss-Mang-HSCR-69.5	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.

Comments: Security seals intact. Frozen ice. Samples rec'd filtered and unpreserved. Samples are highly buffered. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tara Dickinson	Tara Dickinson	Alpha Analytical, Inc.	11/11/08 1303

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08111156

Report Due By : 5:00 PM On : 25-Nov-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT, CS

PO :

Client's COC # : 024765 Job : Weiss-Assoc-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	11-Nov-08	**11-Nov-08**

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08111156-15A	Weiss-Mang-HSCR-77	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.
PES08111156-16A	Weiss-Mang-HSCR-83	AQ	11/10/08 15:00	1	0	10	Mn								Samples rec'd filtered and unpreserved. Samples are highly buffered.

Comments: Security seals intact. Frozen ice. Samples rec'd filtered and unpreserved. Samples are highly buffered. :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tare Dickinson	Tare Dickinson	Alpha Analytical, Inc.	11/11/08 1303

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information:

Name

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

Address

City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State?
AZ ___ **CA** ___ **NV** ___ **WA** ___
ID ___ **OR** ___ **OTHER** ___

024765

Page # 1 of 2

P.O. #

Job # Weiss. Assoc. UCD

EMail Address: data@primaenvironmental.com

Phone #

Fax #

Sampled by KT/CR

Report Attention Cindy Schreier

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID # ___

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	Total Mn							REMARKS
1500	11/10/08	AQ	PES081111156-01	Weiss. Mang. HSCR. CON	Std	✓		X							Filtered &
			-02	. 2		✓		X							Unpreserved
			-03	. 5		✓		X							samples
			-04	. 10		✓		X							
			-05	. 17		✓		X							
			-06	. 25.5		✓		X							samples are
			-07	. 27		✓		X							highly buffered
			-08	. 30		✓		X							
			-09	. 39		✓		X							
			-10	. 45		✓		X							
			-11	. 53		✓		X							
			-12	. 58		✓		X							
			-13	. 63		✓		X							

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	Kelly Tripp	Prima	11/10/08	~1600
Received by		Federal Express	Airbill 8667-8445-9136		
Relinquished by					
Received by	Tara Dickinson	Tara Dickinson	Alpha	11/11/08	1303
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Billing Information:

Name

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

Address

City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State?
AZ ___ CA ___ NV ___ WA ___
ID ___ OR ___ OTHER ___

024766

Page # 2 of 2

P.O. #

Job # Weiss. Assoc. JCD

data@primaenvironmental.com

Phone #

Fax #

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID # ___

Report Attention Cindy Schreier

Sampled by KT/CL

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	Total Mn							REMARKS
1500	11/10/08	AQ	PES081111156-14	Weiss-Mary-HSCR-69.5	Std	✓		X							Filtered & unpreserved samples
↓	↓	↓	-15	↓ : 77	↓	✓		X							
↓	↓	↓	-16	↓ : 83	↓	✓		X							
															Samples are highly buffered

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	Kelly Tripp	Prima	11-10-08	~1600
Received by		Federal Express	Airbill 8667-8445-9136		
Relinquished by					
Received by	Jane Jackinson	Jane Jackinson	Alpha	11/11/08	1303
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

ANALYTICAL REPORT

Prima Environmental
5070 Robert J. Mathews Parkway
El Dorado Hills, CA 95762

Attn: Cindy Schreier
Phone: (916) 939-7300
Fax: (916) 393-7398
Date Received : 11/14/08

Job#: Weiss-UC Davis

Metals by ICPMS
EPA Method SW6020 / SW6020A

		Parameter	Concentration	Reporting Limit	Date Sampled	Date Analyzed
Client ID :	**Weiss-sodcit-BGCR-Con**					
Lab ID :	PES08111429-01A	Chromium (Cr)	0.011	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	ND	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-2**					
Lab ID :	PES08111429-02A	Chromium (Cr)	0.014	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	3.5	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-9**					
Lab ID :	PES08111429-03A	Chromium (Cr)	0.016	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	0.87	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-13**					
Lab ID :	PES08111429-04A	Chromium (Cr)	0.0089	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	4.0	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-25**					
Lab ID :	PES08111429-05A	Chromium (Cr)	0.013	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	0.46	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-37**					
Lab ID :	PES08111429-06A	Chromium (Cr)	0.010	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	4.7	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-37dup**					
Lab ID :	PES08111429-07A	Chromium (Cr)	0.011	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	5.3	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-40**					
Lab ID :	PES08111429-08A	Chromium (Cr)	0.016	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	1.6	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-46**					
Lab ID :	PES08111429-09A	Chromium (Cr)	0.023	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	1.7	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-57**					
Lab ID :	PES08111429-10A	Chromium (Cr)	0.024	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	4.1	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-63**					
Lab ID :	PES08111429-11A	Chromium (Cr)	0.014	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	3.1	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-65**					
Lab ID :	PES08111429-12A	Chromium (Cr)	0.013	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	5.4	0.0050 mg/L	11/12/08	11/25/08

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Client ID :	**Weiss-sodcit-BGCR-75**					
Lab ID :	PES08111429-13A	Chromium (Cr)	0.0081	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	3.4	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-87**					
Lab ID :	PES08111429-14A	Chromium (Cr)	0.018	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	1.1	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-95**					
Lab ID :	PES08111429-15A	Chromium (Cr)	0.011	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	1.1	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-sodcit-BGCR-5**					
Lab ID :	PES08111429-16A	Chromium (Cr)	0.017	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	4.6	0.0050 mg/L	11/12/08	11/25/08

ND = Not Detected

Roger Scholl Randy Gardner Walter Hinchman

Roger L. Scholl, Ph.D., Laboratory Director • • Randy Gardner, Laboratory Manager • • Walter Hinchman, Quality Assurance Officer

Sacramento, CA • (916) 366-9089 / Las Vegas, NV • (702) 736-7522 / info@alpha-analytical.com

Alpha Analytical, Inc. currently holds appropriate and available California (#2019) and NELAC (01154CA) certifications for the data reported. Test results relate only to reported samples.

11/28/08

Report Date

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *01-Dec-08*

QC Summary Report

Work Order: 08111429

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **112408.B\B111SMPL.D** Batch ID: **21045** Analysis Date: **11/24/2008 23:54**

Sample ID: **MB-21045** Units : **mg/L** Run ID: **ICP/MS_081124A** Prep Date: **11/18/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	ND	0.005								
Manganese (Mn)	ND	0.005								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **112408.B\B112_LCS.D** Batch ID: **21045** Analysis Date: **11/25/2008 00:00**

Sample ID: **LCS-21045** Units : **mg/L** Run ID: **ICP/MS_081124A** Prep Date: **11/18/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.278	0.005	0.25		111	80	124			
Manganese (Mn)	2.6	0.005	2.5		104	83	120			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **112408.B\B115SMPL.D** Batch ID: **21045** Analysis Date: **11/25/2008 00:17**

Sample ID: **08111429-01AMS** Units : **mg/L** Run ID: **ICP/MS_081124A** Prep Date: **11/18/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.268	0.005	0.25	0.01094	103	70	133			
Manganese (Mn)	2.48	0.005	2.5	0	99	70	130			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **112408.B\B116SMPL.D** Batch ID: **21045** Analysis Date: **11/25/2008 00:23**

Sample ID: **08111429-01AMSD** Units : **mg/L** Run ID: **ICP/MS_081124A** Prep Date: **11/18/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.269	0.005	0.25	0.01094	103	70	133	0.2682	0.4(20)	
Manganese (Mn)	2.51	0.005	2.5	0	100	70	130	2.482	1.0(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08111429

Report Due By : 5:00 PM On : 01-Dec-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 024768,024769 Job : Weiss-UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	14-Nov-08	14-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08111429-01A	Weiss-sodcit-BGCR-Con	AQ	11/12/08 10:00	1	0	10	Cr,Mn								Poly labeled Weiss-potcit-BGCR-Con, logged in per client chain.
PES08111429-02A	Weiss-sodcit-BGCR-2	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-03A	Weiss-sodcit-BGCR-9	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-04A	Weiss-sodcit-BGCR-13	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-05A	Weiss-sodcit-BGCR-25	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-06A	Weiss-sodcit-BGCR-37	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-07A	Weiss-sodcit-BGCR-37dup	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-08A	Weiss-sodcit-BGCR-40	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-09A	Weiss-sodcit-BGCR-46	AQ	11/12/08 10:00	1	0	10	Cr,Mn								

Comments: Security seals intact. Frozen ice. Logged in samples according to client chain, per Kathy at Prima. :

	Signature	Print Name	Company	Date/Time
Logged in by:	K Murray	K Murray	Alpha Analytical, Inc.	11/14/08 1415

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08111429

Report Due By : 5:00 PM On : 01-Dec-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 024768,024769 Job : Weiss-UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	14-Nov-08	14-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08111429-10A	Weiss-sodcit-BGCR-57	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-11A	Weiss-sodcit-BGCR-63	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-12A	Weiss-sodcit-BGCR-65	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-13A	Weiss-sodcit-BGCR-75	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-14A	Weiss-sodcit-BGCR-87	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-15A	Weiss-sodcit-BGCR-95	AQ	11/12/08 10:00	1	0	10	Cr,Mn								
PES08111429-16A	Weiss-sodcit-BGCR-5	AQ	11/12/08 10:00	1	0	10	Cr,Mn								

Comments: Security seals intact. Frozen ice. Logged in samples according to client chain, per Kathy at Prima. :

	Signature	Print Name	Company	Date/Time
Logged in by:	K Murray	K Murray	Alpha Analytical, Inc.	11/14/08 1415

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information:

Name _____

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State?
AZ ___ ***CA*** ___ ***NV*** ___ ***WA*** ___
ID ___ ***OR*** ___ ***OTHER*** ___

024768

Page # 1 ***of*** 1

P.O. #

Job # Weiss. UC Davis

EMail data@primaenvironmental.com

City, State, Zip

Phone #

Fax #

Sampled by KT

Report Attention Cindy Schreier

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ ***NO*** ___

Global ID # _____

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	MN-6020	Cr-6020						REMARKS
10:00	11/12	AQ	PES08111429-01	Weiss. sodcit. BGCR.Con	STD	F	1-P	X	X						poly labeled-potcit-
			02	· BGCR-2		F		X	X						
			03	· BGCR-9		✓		X	X						
			04	· BGCR-13		✓		X	X						
			05	· BGCR-25		✓		X	X						
			06	· BGCR-37		✓		X	X						
			07	· BGCR.37dup		✓		X	X						
			08	· BGCR. 40		✓		X	X						
			09	· BGCR-46		✓		X	X						
			10	· BGCR. 57		✓		X	X						
			11	· BGCR., 63		✓		X	X						
			12	· BGCR 65		✓		X	X						
			13	· BGCR 75		✓		X	X						

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Trupp	K Trupp	Prima	11/12/08	1220
Received by	Lisa deSilva	Lisa deSilva	ALPHA	11/13/08	1220
Relinquished by					
Received by	K Murray	K Murray	AAI	11/14/08	1410
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Billing Information:

Name

Address

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State?
AZ ___ ***CA*** ___ ***NV*** ___ ***WA*** ___
ID ___ ***OR*** ___ ***OTHER*** ___

024769

Page # 2 *of* 2

P.O. #

Job # Weiss - UCDavis

EMail data@primaenvironmental.com

Phone #

Fax #

Sampled by KT

Report Attention Cindy Schreier

Analyses Required

Required QC Level?
I *II* *III* *IV*

EDD / EDF? YES ___ *NO* ___

Global ID # ___

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	MNS	CU						REMARKS
1000	11/12	AQ	PES0811429-14	Weiss. Sodcit. BGCR. 87	STD	✓	1-P	✓	✓						
↓	↓	↓	15	. BGCR. 95	↓	✓	1-P	✓	✓						
↓	↓	↓	16	BGCR. 5	↓	✓	1-P	✓	✓						

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	K Trupp	Kelly Trupp	Prima	11/12/08	1220
Received by	Lisa deSilva	Lisa deSilva	ALPHA	11/13/08	1220
Relinquished by					
Received by					
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

ANALYTICAL REPORT

Prima Environmental
5070 Robert J. Mathews Parkway
El Dorado Hills, CA 95762

Attn: Cindy Schreier
Phone: (916) 939-7300
Fax: (916) 393-7398
Date Received : 11/14/08

Job#: Weiss-UC Davis

Metals by ICPMS
EPA Method SW6020 / SW6020A

		Parameter	Concentration	Reporting Limit	Date Sampled	Date Analyzed
Client ID :	**Weiss-Potcit-HSCR-2**					
Lab ID :	PES08111430-01A	Chromium (Cr)	0.0096	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	3.6	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-5**					
Lab ID :	PES08111430-02A	Chromium (Cr)	0.023	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	5.5	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-10**					
Lab ID :	PES08111430-03A	Chromium (Cr)	0.047	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	6.7	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-17**					
Lab ID :	PES08111430-04A	Chromium (Cr)	0.015	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	5.2	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-25.5**					
Lab ID :	PES08111430-05A	Chromium (Cr)	0.013	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	6.3	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-27**					
Lab ID :	PES08111430-06A	Chromium (Cr)	0.012	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	4.9	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-39**					
Lab ID :	PES08111430-07A	Chromium (Cr)	0.016	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	7.9	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-45**					
Lab ID :	PES08111430-08A	Chromium (Cr)	0.044	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	3.2	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-30**					
Lab ID :	PES08111430-09A	Chromium (Cr)	0.015	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	6.1	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-53**					
Lab ID :	PES08111430-10A	Chromium (Cr)	0.020	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	3.1	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-58**					
Lab ID :	PES08111430-11A	Chromium (Cr)	0.017	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	1.9	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-63**					
Lab ID :	PES08111430-12A	Chromium (Cr)	0.041	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	4.8	0.0050 mg/L	11/12/08	11/25/08

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Client ID :	**Weiss-Potcit-HSCR-69.5**					
Lab ID :	PES08111430-13A	Chromium (Cr)	0.024	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	3.9	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-77**					
Lab ID :	PES08111430-14A	Chromium (Cr)	0.033	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	2.5	0.0050 mg/L	11/12/08	11/25/08
Client ID :	**Weiss-Potcit-HSCR-83**					
Lab ID :	PES08111430-15A	Chromium (Cr)	0.021	0.0050 mg/L	11/12/08	11/25/08
		Manganese (Mn)	1.3	0.0050 mg/L	11/12/08	11/25/08

This replaces the report originally signed 11/28/08, due to to a change in the Client I.D., per client request.

Roger Scholl Randy Gardner Walter Hinchman

Roger L. Scholl, Ph.D., Laboratory Director • • Randy Gardner, Laboratory Manager • • Walter Hinchman, Quality Assurance Officer

Sacramento, CA • (916) 366-9089 / Las Vegas, NV • (702) 736-7522 / info@alpha-analytical.com

Alpha Analytical, Inc. currently holds appropriate and available California (#2019) and NELAC (01154CA) certifications for the data reported. Test results relate only to reported samples.

C

12/11/08

Report Date

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *28-Nov-08*

QC Summary Report

Work Order: 08111901

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **112108.B\101SMPL.D** Batch ID: **21076** Analysis Date: **11/22/2008 04:23**

Sample ID: **MB-21076** Units : **µg/L** Run ID: **ICP/MS_081121B** Prep Date: **11/20/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Lead (Pb)	ND	5								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **112108.B\102_LCS.D** Batch ID: **21076** Analysis Date: **11/22/2008 04:28**

Sample ID: **LCS-21076** Units : **µg/L** Run ID: **ICP/MS_081121B** Prep Date: **11/20/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Lead (Pb)	259	5	250		104	85	120			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **112108.B\105SMPL.D** Batch ID: **21076** Analysis Date: **11/22/2008 04:45**

Sample ID: **08111921-01AMS** Units : **µg/L** Run ID: **ICP/MS_081121B** Prep Date: **11/20/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Lead (Pb)	259	5	250	0	104	70	130			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **112108.B\106SMPL.D** Batch ID: **21076** Analysis Date: **11/22/2008 04:51**

Sample ID: **08111921-01AMSD** Units : **µg/L** Run ID: **ICP/MS_081121B** Prep Date: **11/20/2008**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Lead (Pb)	271	5	250	0	108	70	130	258.8	4.5(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

Reported in micrograms per Liter, per client request.

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08111430

Report Due By : 5:00 PM On : 01-Dec-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 024770,024771 Job : Weiss-UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	14-Nov-08	11-Dec-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests METALS_AQ								Sample Remarks
PES08111430-01A	Weiss-Potcit-HSCR-2	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-02A	Weiss-Potcit-HSCR-5	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-5, logged in per client chain.
PES08111430-03A	Weiss-Potcit-HSCR-10	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-04A	Weiss-Potcit-HSCR-17	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-05A	Weiss-Potcit-HSCR-25.5	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-06A	Weiss-Potcit-HSCR-27	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-07A	Weiss-Potcit-HSCR-39	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-08A	Weiss-Potcit-HSCR-45	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-09A	Weiss-Potcit-HSCR-30	AQ	11/12/08 11:00	1	0	10	Cr,Mn								

Comments: Security seals intact. Frozen ice. Logged in samples according to client chain, per Kathy at Prima. Amended 12/11/08 13:50 to change sample ID for 09A from Weiss-Potcit-HSCR-50 to Weiss-Potcit-HSCR-30, per Corinne at Prima.KM :

	Signature	Print Name	Company	Date/Time
Logged in by:	K Murray	K Murray	Alpha Analytical, Inc.	12/11/08 1350

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08111430

Report Due By : 5:00 PM On : 01-Dec-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 024770,024771 Job : Weiss-UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	14-Nov-08	**11-Dec-08**

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08111430-10A	Weiss-Potcit-HSCR-53	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-11A	Weiss-Potcit-HSCR-58	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-58, logged in per client chain.
PES08111430-12A	Weiss-Potcit-HSCR-63	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-63, logged in per client chain.
PES08111430-13A	Weiss-Potcit-HSCR-69.5	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-69.5, logged in per client chain.
PES08111430-14A	Weiss-Potcit-HSCR-77	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-77, logged in per client chain.
PES08111430-15A	Weiss-Potcit-HSCR-83	AQ	11/12/08 11:00	1	0	10	Cr,Mn								

Comments: Security seals intact. Frozen ice. Logged in samples according to client chain, per Kathy at Prima. Amended 12/11/08 13:50 to change sample ID for 09A from Weiss-Potcit-HSCR-50 to Weiss-Potcit-HSCR-30, per Corinne at Prima.KM :

	Signature	Print Name	Company	Date/Time
Logged in by:	K Murray	K Murray	Alpha Analytical, Inc.	12/11/08 1350

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES08111430

Report Due By : 5:00 PM On : 01-Dec-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 024770,024771 Job : Weiss-UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	14-Nov-08	14-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08111430-01A	Weiss-Potcit-HSCR-2	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-02A	Weiss-Potcit-HSCR-5	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-5, logged in per client chain.
PES08111430-03A	Weiss-Potcit-HSCR-10	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-04A	Weiss-Potcit-HSCR-17	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-05A	Weiss-Potcit-HSCR-25.5	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-06A	Weiss-Potcit-HSCR-27	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-07A	Weiss-Potcit-HSCR-39	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-08A	Weiss-Potcit-HSCR-45	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-09A	Weiss-Potcit-HSCR-50	AQ	11/12/08 11:00	1	0	10	Cr,Mn								

Comments: Security seals intact. Frozen ice. Logged in samples according to client chain, per Kathy at Prima. :

	Signature	Print Name	Company	Date/Time
Logged in by:	K Murray	K Murray	Alpha Analytical, Inc.	11/14/08 1425

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

CA

WorkOrder : PES08111430

Report Due By : 5:00 PM On : 01-Dec-08

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : KT

PO :

Client's COC # : 024770,024771 Job : Weiss-UC Davis

Cooler Temp	Samples Received	Date Printed
4 °C	14-Nov-08	14-Nov-08

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES08111430-10A	Weiss-Potcit-HSCR-53	AQ	11/12/08 11:00	1	0	10	Cr,Mn								
PES08111430-11A	Weiss-Potcit-HSCR-58	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-58, logged in per client chain.
PES08111430-12A	Weiss-Potcit-HSCR-63	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-63, logged in per client chain.
PES08111430-13A	Weiss-Potcit-HSCR-69.5	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-69.5, logged in per client chain.
PES08111430-14A	Weiss-Potcit-HSCR-77	AQ	11/12/08 11:00	1	0	10	Cr,Mn								Poly labeled Weiss-sodcit-HSCR-77, logged in per client chain.
PES08111430-15A	Weiss-Potcit-HSCR-83	AQ	11/12/08 11:00	1	0	10	Cr,Mn								

Comments: Security seals intact. Frozen ice. Logged in samples according to client chain, per Kathy at Prima. :

	Signature	Print Name	Company	Date/Time
Logged in by:	K Murray	K Murray	Alpha Analytical, Inc.	11/14/08 1425

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information:

Name

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

Address

City, State, Zip

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State?
AZ ___ CA ___ NV ___ WA ___
ID ___ OR ___ OTHER ___

024770

Page # 1 of 2

P.O. #

Job # Weiss. UC Davis

EMAIL: data@primaenvironmental.com

Phone #

Fax #

Report Attention: C. Schreier

Analyses Required

Required QC Level? I II III IV

EDD / EDF? YES ___ NO ___

Global ID # ___

Time Sampled	Date Sampled	Matrix* See Key Below	Sampled by KT / Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	MN-6020	CR-6020						REMARKS
11:00	11/12	AQ	PES08111430-01	Weiss. Potcit. HSCR. 2	Std	✓	1-P	✓	✓						
			02	. HSCR-5		✓		✓	✓						Polylabeled - Sodcit -
			03	. HSCR-10		✓		✓	✓						
			04	. HSCR-17		✓		✓	✓						
			05	. HSCR.25.5		✓		✓	✓						
			06	. HSCR. 27		✓		✓	✓						
			07	. HSCR . 39		✓		✓	✓						
			08	. HSCR. 45		✓		✓	✓						
			09	HSCR. 50		✓		✓	✓						
			10	HSCR. 53		✓		✓	✓						
			11	HSCR. 58		✓		✓	✓						poly labeled - sodcit -
			12	HSCR. 63		✓		✓	✓						
			13	HSCR 69.5		✓		✓	✓						

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	K Tripp	Prima	11/13/08	1220
Received by	Lisa de Silva	Lisa de Silva	ALPHA	11/13/08	1220
Relinquished by					
Received by	K Murray	K Murray	AAI	11/14/08	1420
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Billing Information:

Name

A

C

F

PRIMA ENVIRONMENTAL, Inc.
5070 Robert J. Mathews Pkwy, Ste 300
El Dorado Hills, CA 95762
PH: 916-939-7300
FAX: 916-939-7398

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State?
AZ ___ ***CA*** ___ ***NV*** ___ ***WA*** ___
ID ___ ***OR*** ___ ***OTHER*** ___

024771

Page # 2 ***of*** 2

P.O. #

Job # Weiss, UCLWTS

EMa data@primaenvironmental.com

City, State, Zip

Phone #

Fax #

Sampled by KT

Report Attention C Schreier

Analyses Required: Mn-6020, Cr-6020

Required QC Level? I II III IV

EDD / EDF? YES ___ ***NO*** ___

Global ID # ___

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	Mn-6020	Cr-6020						REMARKS
11:00	11/12	AQ	PES08111430-14	Weiss. Potcit. HSCR. 77	STD	✓	1-P	✓	✓						poly labeled-sodcit-
			15	HSCR. 83		✓	1-P	✓	✓						
~~HSCR~~						✓	1-P	✓	✓						

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Kelly Tripp	K Tripp	Prima	11/13/08	1220
Received by	[illegible]	ALPHA	ALPHA	11-13-08	1220
Relinquished by					
Received by	K Murray	K Murray	ASI	11/14/08	1420
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778
(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

ANALYTICAL REPORT

Prima Environmental
5070 Robert J. Mathews Parkway
El Dorado Hills, CA 95762

Attn: Cindy Schreier
Phone: (916) 939-7300
Fax: (916) 393-7398
Date Received : 01/14/09

Job#: Weiss-UCD

Metals by ICPMS
EPA Method SW6020 / SW6020A

	Parameter	Concentration	Reporting Limit	Date Sampled	Date Analyzed
Client ID :	**Weiss-UCD-Disodium Cit.**				
Lab ID : PES09011440-01A	Chromium (Cr)	ND	0.0050 mg/L	12/18/08	01/15/09
Client ID :	**Weiss-UCD-Potassium Phos.**				
Lab ID : PES09011440-02A	Chromium (Cr)	0.012	0.0050 mg/L	12/18/08	01/15/09
Client ID :	**Weiss-UCD-DI**				
Lab ID : PES09011440-03A	Chromium (Cr)	ND	0.0050 mg/L	01/12/09	01/15/09

ND = Not Detected

Roger Scholl Randy Gardner Walter Hinchman

Roger L. Scholl, Ph.D., Laboratory Director • • Randy Gardner, Laboratory Manager • • Walter Hinchman, Quality Assurance Officer
Sacramento, CA • (916) 366-9089 / Las Vegas, NV • (702) 736-7522 / info@alpha-analytical.com

Alpha Analytical, Inc. currently holds appropriate and available California (#2019) and NELAC (01154CA) certifications for the data reported. Test results relate only to reported samples.

1/21/09
Report Date

Alpha Analytical, Inc.

255 Glendale Ave. • Suite 21 • Sparks, Nevada 89431-5778

(775) 355-1044 • (775) 355-0406 FAX • 1-800-283-1183

Date: *21-Jan-09*

QC Summary Report

Work Order: 09011440

Method Blank

Type **MBLK** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **011409.B\086SMPL.D** Batch ID: **21314** Analysis Date: **01/14/2009 23:50**

Sample ID: **MB-21314** Units : **mg/L** Run ID: **ICP/MS_090114C** Prep Date: **01/14/2009**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	ND	0.005								

Laboratory Control Spike

Type **LCS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **011409.B\087_LCS.D** Batch ID: **21314** Analysis Date: **01/14/2009 23:55**

Sample ID: **LCS-21314** Units : **mg/L** Run ID: **ICP/MS_090114C** Prep Date: **01/14/2009**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.23	0.005	0.25		92	80	124			

Sample Matrix Spike

Type **MS** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **011409.B\094SMPL.D** Batch ID: **21314** Analysis Date: **01/15/2009 00:35**

Sample ID: **09011340-01AMS** Units : **mg/L** Run ID: **ICP/MS_090114C** Prep Date: **01/14/2009**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.291	0.005	0.25	0.05765	93	70	133			

Sample Matrix Spike Duplicate

Type **MSD** Test Code: **EPA Method SW6020 / SW6020A**

File ID: **011409.B\095SMPL.D** Batch ID: **21314** Analysis Date: **01/15/2009 00:41**

Sample ID: **09011340-01AMSD** Units : **mg/L** Run ID: **ICP/MS_090114C** Prep Date: **01/14/2009**

Analyte	Result	PQL	SpkVal	SpkRefVal	%REC	LCL(ME)	UCL(ME)	RPDRefVal	%RPD(Limit)	Qual
Chromium (Cr)	0.295	0.005	0.25	0.05765	95	70	133	0.2909	1.5(20)	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

AMENDED

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES09011440

Report Due By : 5:00 PM On : 21-Jan-09

Billing Information :

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : CL

PO :

Client's COC # : 025025 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	14-Jan-09	**19-Jan-09**

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ					Sample Remarks
PES09011440-01A	Weiss-UCD-Disodium Cit.	AQ	12/18/08 17:00	1	0	5	Cr					
PES09011440-02A	Weiss-UCD-Potassium Phos.	AQ	12/18/08 17:00	1	0	5	Cr					
PES09011440-03A	Weiss-UCD-DI	AQ	01/12/09 16:50	1	0	5	Cr					

Comments: Security seals intact. Frozen ice. Amended 1/19/09 9:20 to change date on samples -01 and -02 to 2008, due to login error. TP :

	Signature	Print Name	Company	Date/Time
Logged in by:	Tasha Pascal	Tasha Pascal	Alpha Analytical, Inc.	1/19/09 930

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.

Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Information :

CHAIN-OF-CUSTODY RECORD

CA

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21 Sparks, Nevada 89431-5778
TEL: (775) 355-1044 FAX: (775) 355-0406

WorkOrder : PES09011440

Report Due By : 5:00 PM On : 21-Jan-09

Client:
Prima Environmental
5070 Robert J. Mathews Parkway
Suite 300
El Dorado Hills, CA 95762

Report Attention	Phone Number	EMail Address
Cindy Schreier	(916) 939-7300 x	data@primaenvironmental.com

EDD Required : **No**

Sampled by : CL

PO :

Client's COC # : 025025 Job : Weiss-UCD

Cooler Temp	Samples Received	Date Printed
4 °C	14-Jan-09	**14-Jan-09**

QC Level : S3 = Final Rpt, MBLK, LCS, MS/MSD With Surrogates

Alpha Sample ID	Client Sample ID	Matrix	Collection Date	No. of Bottles Alpha	Sub	TAT	Requested Tests: METALS_AQ								Sample Remarks
PES09011440-01A	Weiss-UCD-Disodium Cit.	AQ	12/18/09 17:00	1	0	5	Cr								
PES09011440-02A	Weiss-UCD-Potassium Phos.	AQ	12/18/09 17:00	1	0	5	Cr								
PES09011440-03A	Weiss-UCD-DI	AQ	01/12/09 16:50	1	0	5	Cr								

Comments: Security seals intact. Frozen ice. :

	Signature	Print Name	Company	Date/Time
Logged in by:	TM Pascal	Tasha Pascal	Alpha Analytical, Inc.	1/14/09 9:30

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.
The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this COC. The liability of the laboratory is limited to the amount paid for the report.
Matrix Type : AQ(Aqueous) AR(Air) SO(Soil) WS(Waste) DW(Drinking Water) OT(Other) Bottle Type: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Billing Inforr

Name _____ PRIMA ENVIRONMENTAL, Inc.
Address _____ 5070 Robert J. Mathews Parkway, Suite 300
City, State, Zip _ El Dorado Hills, CA 95762
Phone Number _ PH: 916-939-7300
FAX: 916-939-7398

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431-5778
Phone (775) 355-1044
Fax (775) 355-0406

Samples Collected From Which State?
AZ ____ ***CA*** ____ ***NV*** ____ ***WA*** ____
ID ____ ***OR*** ____ ***OTHER*** _____

025025

Page # 1 ***of*** 1

Client Name	P.O. #	Job # Weiss - UCD	
Address	EMail Addres data@primaenvironmental.com		
City, State, Zip	Phone #	Fax #	

Sampled by CL
Report Attention Cindy Schreier

Analyses Required: Cr (6020)

Required QC Level? I II III IV

EDD / EDF? YES ____ ***NO*** ____

Global ID # _____

Time Sampled	Date Sampled	Matrix* See Key Below	Lab ID Number (Office Use Only)	Sample Description	TAT	Field Filtered	Total and type of containers ** See below	Cr (6020)							REMARKS
1700	12/18/08	AQ	PES0901144 0-01	Weiss. UCD. Disodium cit.	~~5 Day~~ STD	✓	1-P	✓							
1700	12/18/08	AQ	-02	weiss. UCD - Potassium Phos.	~~5 Day~~ STD	✓	1-P	✓							
1615	1/12/09	AQ	-03	Weiss. UCD. DI	5 Day	✓	1-P	✓							

ADDITIONAL INSTRUCTIONS:

	Signature	Print Name	Company	Date	Time
Relinquished by	Catherine Lignoi	Catherine Lignoi	PRIMA	1/13/09	1215
Received by		Fed Ex 845790173584			
Relinquished by					
Received by	Tasha Pascal	Tasha Pascal	AAI	1/14/09	9:30
Relinquished by					
Received by					

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other AR - Air **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense. The report for the analysis of the above samples is applicable only to those samples received by the laboratory with this coc. The liability of the laboratory is limited to the amount paid for the report.

APPENDIX C

DISPOSAL UNIT DATA GAPS INVESTIGATION GEOLOGIC AND WELL CONSTRUCTION LOGS

BORING LFI-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			Silty gravelly SAND (SM), brown, (10YR, 5/3), medium-dense, dry, 35% f-c sand, 25% f-c gravel, 40% silt fines, LP, MEK.
2			
4			
6			At 5-14.5 ft: Drilled ahead without sampling to first sample interval.
8			
10			
12			
14			
16	18/16		Sandy SILT (ML), dark brown, damp, very stiff, ~65% silt fines, 25% f-c sand, 10% f gravel, rounded, LP, LEK.
18			SILT (ML), light olive brown, (2.5Y, 5/4), stiff, damp to moist, trace to 5%, f. sand, grayish mottling, trace rootholes, LP, LEK.
20	18/18		
22			
24	18/18		At 24 ft: As above with Mn-Ox specs & blotches, Fe-ox staining, trace caliche nodules & veins, stiff, damp, LEK.
26	18/13		At 26.5-28 ft: As above, damp, LEK.
28			
30			
32			
34			

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger
2. Angled borehole 15 degrees off vertical to SW
3. Borehole was sampled using 2" diameter California Modified and SPT samplers.
4.. Borehole was backfilled to surface with neat cement.

Symbols:
Water level during drilling (first encountered)
Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/15/2008
Date completed:	9/15/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod, SPT samplers
Ground-surface elevation:	47.1
Bore-hole diameter:	8"

Figure C-1. Boring Log for Boring LFI-2, LEHR/SCDS, UC Davis, Davis, California

BORING LFI-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36	18/15		Sandy SILT (ML) olive brown, (2.5Y, 4/4), hard, moist, ~55% fines (silt% > clay%), 15% f-m sand, 30% caliche nodules to 3/8 diameter with mild reaction to HCL, Mn-Ox staining and mottling, Fe-Ox staining, caliche veins and nodules, LP, LEK. *(continued)*
38			
40			
42			SILT (ML), yellowish brown (10YR, 5/4), hard, damp, low plasticity, fines, trace f-m sand, grayish mottling, rootholes with black (Mn-Ox?) lining, LEK.
44	18/18		
46			At 45.5-75 ft: Drilled ahead without sampling for HSU-1 grab GW sample.
48			
50			
52			
54			
56			
58			
60			
62			
64			
66			
68			
70			
72			
74			

Boring terminated 15:30, 9/15/08.

Bottom of borehole at 75.0 feet.

Figure C-1. Boring Log for Boring LFI-2, LEHR/SCDS, UC Davis, Davis, California

BORING LF2-4

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			GRAVEL (GP), very dark grayish brown (10YR, 3/2), dense, damp, ~50-55% f-c gravel, 35-40% f-c sand, 5-10% fines, reddish clasts rare.
2			
4			
6			
8			
10			
12	18/14		
14	18/18		SILT (ML), yellowish brown, (10YR, 5/3), hard, moist, trace to 5% f. sand, dark brown mottling, LP, LEK.
16			
18			Silty SAND (SM), olive brown (2.5YR, 4/4), dense, damp, ~80% f-m sand, 20% silt fines, LP, HEK
20	18/17		
22			
24	18/11		Sandy SILT (ML), lt. olive brown (2.5Y, 5/4), hard, damp to moist, ~70% silt fines, ~25% f sand, ~5% f. gravel, Mn-ox specs and mottling, Fe-ox staining, trace caliche, LP, LEK.
26			
28			
30			GRAVEL (GP), dark grey brown (10YR, 4/4), dense, damp, ~55% f-c gravel, 45% f-c sand, clasts are sub-round to round, LP, HEK.
32	18/18		
34	18/18		

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1.. Hand augered 0-5 feet.
2.. Borehole was sampled using 2" diameter California Modified and SPT split-spoon samplers.
3.. Borehole was backfilled to surface with neat cement.

Symbols:

Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/17/2008
Date completed:	9/17/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod, SPT samplers
Ground-surface elevation:	48.4
Bore-hole diameter:	8"

Figure C-2. Boring Log for Boring LF2-4, LEHR/SCDS, UC Davis, Davis, California

BORING LF2-4

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36			SILT (ML), lt. olive brown (2.5Y. 5/4), hard, damp, 90-95% silt fines, 5-10% f. sand, whitish veins.
38			
40			At 35.5 to 75 ft: Drilled ahead without sampling to 75 feet for grab groundwater sampling, cuttings lithology and rig behavior confirm silt to sandy silt (ML) lithology.
42			
44			
46			
48			
50			
52			
54			
56			
58			
60			
62			
64			Groundwater stabilized @ 63 feet just prior to grab GW sample collection.
66			
68			
70			
72			
74			Boring terminated 13:15 9/17/08.

Bottom of borehole at 75.0 feet.

Figure C-2. Boring Log for Boring LF2-4, LEHR/SCDS, UC Davis, Davis, California

BORING LF3-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			Silty SAND (SM), light yellowish brown (10YR, 5/4), dense, dry, ~55% f-c sand, 20% f-c gravel, 25% silt fines, LP, HEK.
2			
4			
6			
8			
10			
12	18/14		
14	18/18		SILT (ML), dark yellowish brown (10YR, 4/4), very stiff, damp to moist, trace to 5% f. sand, LP, LEK.
16			
18			
20	18/16		At 19 ft: As above, hard, moist, LEK.
22			
24	18/18		At 24 ft: As above, with caliche veins & modules, Mn-ox staining as specs and mottling, rootholes, LP, LEK.
26	18/15		At 26.5 ft: Same comments as at 24 ft caliche modules to 1/4 diameter.
28			
30			
32	18/14		At 31.5 ft: As above with Fe-ox staining/mottling, Mn-ox staining less common than above, moist, LP, LEK.
34	18/18		

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger.
2. Angled hole is 15 degrees off vertical to SW.
3. Borehole was sampled w/ 2" diameter California Modified & SPT samplers.
4. Borehole backfilled to surface w/ cement.

Symbols:
Water level after drilling (9/19/2008 8:00:00 AM)
Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/18/2008
Date completed:	9/18/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod, SPT samplers
Ground-surface elevation:	46.8
Bore-hole diameter:	8"

Figure C-3. Boring Log for Boring LF3-2, LEHR/SCDS, UC Davis, Davis, California

BORING LF3-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36			At 34 ft: as above w/Fe-ox and Mn-Ox staining throughout; caliche nodules and veins common, LP, LEK.
			SILT (ML), continued.
38			
40			Drilled ahead from 35.5-75 feet without sampling for collection of HSU-1 grab ground water sample. Cuttings and rig behavior confirm fine-grained lithology (silt to sandy silt [ML]) continues to 75 feet.
42			
44			
46			
48			
50			
52			
54			
56			
58			
60			
62			
64			
66			
68			Collected grab ground water sample at 67 feett bgs, 8:00 AM, 9/19/08.
70			
72			
74			Boring completed 9/08/08, 16:20.

Bottom of borehole at 75.0 feet.

Figure C-3. Boring Log for Boring LF3-2, LEHR/SCDS, UC Davis, Davis, California

BORING ET-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			Silty SAND (SM), yellowish brown (10YR, 5/3), medium dense, dry, ~45% f-c sand, ~10% f-c gravel, subround to round, 45% silt fines, roots, LP, MEK.
2			
4			Sandy SILT (ML), light olive brown (2.5Y, 5/4) to dark grayish brown (10YR, 3/7), stiff, damp, ~15-20% f. sand, rootholes, LP, LEK. At 5 ft: Drilled ahead without sampling to first sample interval at 14 feet.
6			
8			
10			
12			
14	18/15		At 14-15.5 ft: Dry, stiff, LP, LEK
16			
18			Silty SAND (SM), light olive brown (2.5Y, 5/4), dense, slightly damp, ~65% v.f. sand, 35% fines, Mn-ox and Fe-ox stains & mottling, LP, MEK.
20	18/18		
22	18/16		
24			Sandy SILT (ML), light olive brown, (2.5Y, 5/4), hard, dry to damp, ~25% f, 75% silt fines, Fe-ox staining, LP, LEK.
26	18/13		Silty SAND (SM), light brownish grey, (2.5Y, 6/2), hard, dry, ~60% v.f. sand, low plasticity silt fines, caliche veins.
28			
30			
32			
34	18/18		

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger
2.. Borehole was backfilled to surface with neat cement.

Symbols:
Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/17/2008
Date completed:	9/17/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod, SPT samplers
Ground-surface elevation:	49.6
Bore-hole diameter:	8"

Figure C-4. Boring Log for Boring ET-2, LEHR/SCDS, UC Davis, Davis, California

BORING ET-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36			Sandy SILT (ML), light olive brown (2.5Y, 5/4), hard, moist, ~85% fines, (silt > clay %), 15% f-m sand, caliche veins. *(continued)*
38			
40	18/18		Silty SAND (SM), olive brown (2.5Y, 4/4) v. dense, moist, ~80% f. sand, ~20% silt fines, LP, HEK.
			At 40.5 ft: Drilled ahead to 75' for grab GW sample.
42			Cuttings and rig behavior at 40.5 to 75 feet confirm fine-grained lithology (SILT & sandy SILT [ML] with trace amounts of silty SAND [SM] observed.
44			
46			
48			
50			
52			
54			
56			
58			
60			
62			
64			
66			
68			
70			
72			
74			

Bottom of borehole at 75.0 feet.

Figure C-4. Boring Log for Boring ET-2, LEHR/SCDS, UC Davis, Davis, California

BORING ST-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			Sandy SILT (ML),dark brown (10YR, 3/3), stiff, slightly damp, 80% fines (silt% > clay%), 20% f-c sand, sand clasts are subround, LP, LEK.
2			
4			
6			At 5 ft: Drilled ahead to first sample interval at 11.5 feet with 8 inch HSA.
8			
10			
12	18/12		At 11.5-13 ft: As above
14			
16	18/18		At 15 ft: Roots & rootholes, damp, LP, LEK
18			
20	18/18		At 19 ft: Dark grayish brown, ~25-35% f-c sand, damp, LP, LMEK, Mn-Ox specs and mottling below 18.3. At 19.5-20.5 ft:~15% f-m sand, damp, LP, LEK, Mn-Ox specs and mottling.
22			
24	18/18		At 24-25.5 ft: Sandy silt (ML) as above, hard, damp, LP, LEK.
26			
28	18/17		At 27-28.5 ft: Sandy silt as above, hard, damp, LP, LEK
30			
32	18/18		At 32-35.5 ft: Sandy silt (ML) as above, Fe-ox and Mn-ox staining, low plasticity, damp, LEK
34	18/18		

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger
2. Borehole was sampled using 2" diameter California Modified and SPT split-spoon samplers.
3.. Borehole was backfilled to surface with neat cement.

Symbols:
▽ Water level during drilling (first encountered)
▩ Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/12/2008
Date completed:	9/12/2009
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod, SPT samplers
Ground-surface elevation:	48.8
Bore-hole diameter:	8"

Figure C-5. Boring Log for Boring ST-2, LEHR/SCDS, UC Davis, Davis, California

BORING ST-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36			SILT (ML), continued. At 35.5 ft: Drilled ahead without sampling to 75 feet. Drill cuttings indicate fine grained lithology, predominantly silt (ML) with minor silty sand components.
38			
40			
42			
44			
46			
48			
50			
52			
54			
56			
58			
60			
62			Water observed at 61 feett 14:00, 9/12/08 Collected HSU-1 GW grab sample GWW2291, 8:30 9/15/08
64			
66			
68			
70			
72			
74			

Boring Terminated 13:00, 9/12/08

Bottom of borehole at 75.0 feet.

Figure C-5. Boring Log for Boring ST-2, LEHR/SCDS, UC Davis, Davis, California

BORING WBH-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0			Silty GRAVEL (GM), yellowish brown (10YR, 5/4), medium dense, dry to damp, ~45%, f-c gravel, subround to sub-angular, 30% f-c sand, 25% silt fines, LP, MEK.
2, 4, 6, 8			Sandy SILT (ML), light olive brown (2.5Y, 5/4), medium stiff, damp to moist, ~70-80% silt fines, 20-30% f-c sand, trace f. gravel, Fe-ox staining, LP, LEK.
10, 12, 14	18/10		
16, 18			SILT (ML), light olive brown (2.5Y, 5/4), hard, damp, low plasticity, fines, grayish mottling and Mn-ox specs, rootholes, LP, LEK.
20	18/14		
22, 24, 26			
28			Silty SAND (SM), dark grayish brown (10YR, 4/2), dense, damp, ~80% f-m sand, 15% fines (silt % > clay %), 5% f gravel, LP, HEK.
30	18/15		At 30 ft: Driller notes much harder drilling.
32			GRAVEL (GP), dark greyish brown (2.5Y, 4/2), dense, damp, 55% f-c gravel, subround to round, 40% f-c sand, 5% fines, HEK.
34	18/18		

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger
2. Borehole was sampled using SPT split-spoon samplers.
3. Borehole was backfilled to surface with neat cement.

Symbols:
▽ Water level during drilling (first encountered)
▩ Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/16/2008
Date completed:	9/16/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod, SPT samplers
Ground-surface elevation:	49.3
Bore-hole diameter:	8"

Figure C-6. Boring Log for Boring WBH-2, LEHR/SCDS, UC Davis, Davis, California

BORING WBH-2

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36			Note: Drilled ahead from 35.5 to 75 feet for HSU-1 grab ground water sampling.
38			At 35.5 to 75 ft: Cuttings and rig behavior indicate fine grained units (silt, sandy SILT [ML] with traces of silty SAND [SM]).
40			
42			
44			
46			
48			
50			
52			
54			
56			
58			
60			
62			
64			
66			At 65 ft: Water level stabilized 16:50, 9/16/08
68			
70			
72			
74			Boring terminated 16:45, 9/16/08

Bottom of borehole at 75.0 feet.

Figure C-6. Boring Log for Boring WBH-2, LEHR/SCDS, UC Davis, Davis, California

BORING WBH-3

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
0, 2, 4	18/18		Silty GRAVEL (GM), light yellowish brown (10YR, 5/3), medium dense, dry to damp, ~35% f-c gravel, 30-35% f-c sand, 30-35% fines, trace plastic and glass, LP, MEK-HEK
6, 8	18/13		Sandy SILT (ML), olive brown (2.5Y, 4/4), med. stiff, damp, ~30% f-c sand, 5-10% f. gravel, plastic and glass fragments, LP, L-MEK.
10, 12, 14, 16, 18, 20	18/18		SILT (ML), olive brown (2.5Y, 4/4) hard, damp to moist, Fe-ox mottling and Mn-ox specs, rootholes, low plasticity fines, LEK.
22, 24, 26	18/18		At 24 ft: as above, yellowish brown (10YR, 5/3), increased Fe-ox mottling/staining, Mn-ox staining absent, LP, LEK. At 26.5 ft: Same comments as above.
28, 30, 32, 34	18/18		At 28 ft: Drilled ahead to 75 feet for HSU-1 grab groundwater sample. Drill cuttings and rig behavior between 28 and 75 feet indicate fine grained lithology (silt to sandy SILT [ML] w/minor silty SAND [SM] percentage).

EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger
2. Borehole was sampled using 2" diameter California Modified and SPT split-spoon samplers.
3. Borehole was backfilled to surface with neat cement.

Symbols:
▽ Water level during drilling (first encountered)
▨ Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Izzy Sapien
Date begun:	9/16/2008
Date completed:	9/16/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod, SPT samplers
Ground-surface elevation:	49.3
Bore-hole diameter:	8"

Figure C-7. Boring Log for Boring WBH-3, LEHR/SCDS, UC Davis, Davis, California

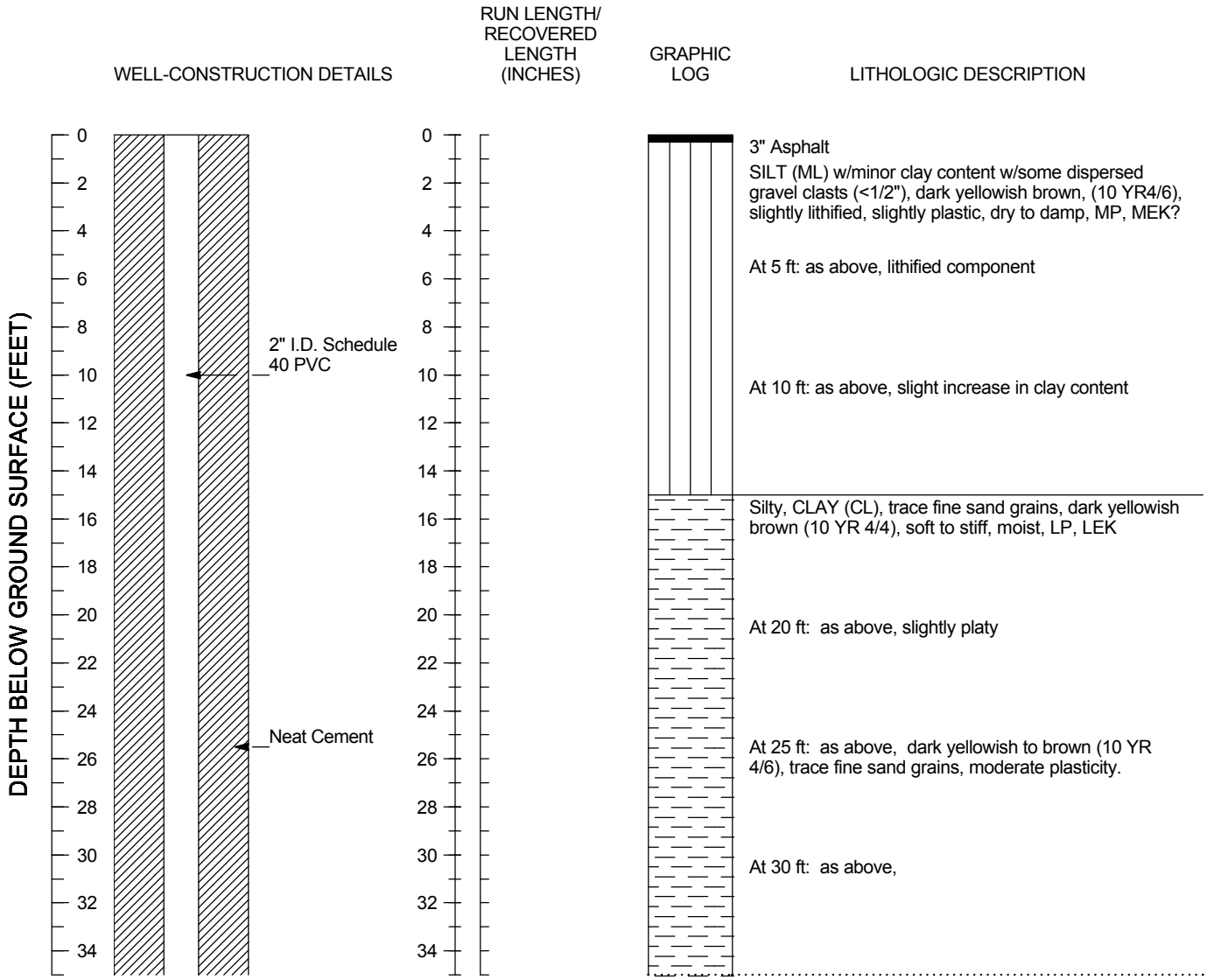
BORING WBH-3

DEPTH BELOW GROUND SURFACE (FEET)	RUN LENGTH/ RECOVERED LENGTH (INCHES)	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
36			SILT to Sandy SILT (ML), continued.
38			
40			
42			
44			
46			
48			
50			
52			
54			
56			
58			
60			
62			
64	▽		At 64 ft: Collected grab HSU-1 groundwater sample 14:30, 9/16/08.
66			
68			
70			
72			
74			Boring terminated 12:30, 9/16/08.

Bottom of borehole at 75.0 feet.

Figure C-7. Boring Log for Boring WBH-3, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-62



EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. Hand augered 0-5 feet.
2. Borehole logged by cuttings.

Symbols:
▽ Water level during drilling (first encountered)

Logged by:	REK
Checked by:	RKD
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Mike Radakovitz
Date begun:	10/1/2008
Date completed:	10/1/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	none
Ground-surface elevation:	49.5
Bore-hole diameter:	8"
Well-head completion:	
Well-casing diameter:	2"

Figure C-8. Boring Log and Well-Construction Details for Well UCD1-62, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-62

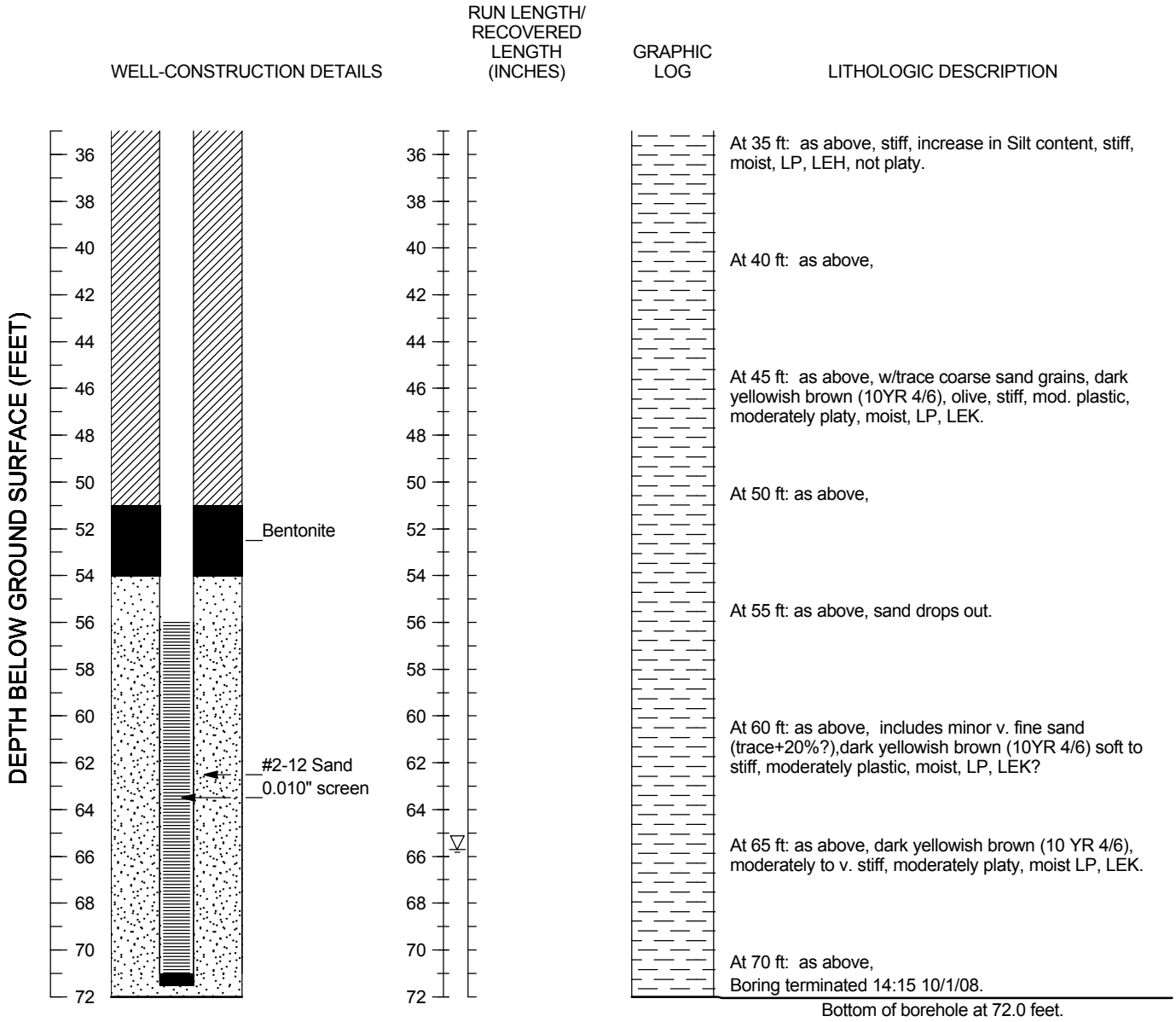
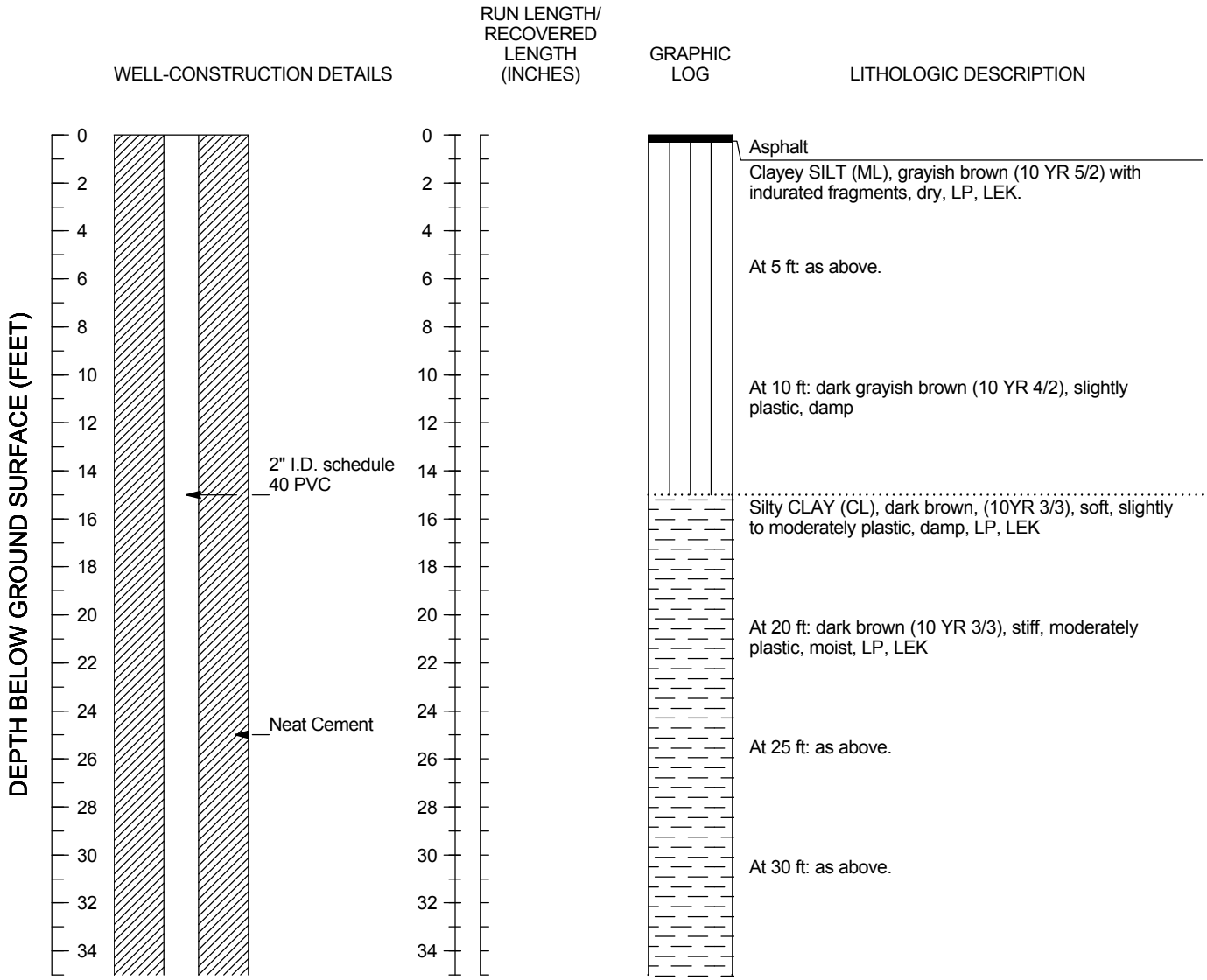


Figure C-8. Boring Log and Well-Construction Details for Well UCD1-62, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-64



EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. Hand augered 0-5 feet.
2. Borehole logged by cuttings.

Symbols:
▽ Water level during drilling (first encountered)

Logged by:	REK
Checked by:	RKD
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Mike Radakovitz
Date begun:	9/30/2008
Date completed:	10/1/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	n/a - logged by cuttings
Ground-surface elevation:	47.4
Bore-hole diameter:	8"
Well-head completion:	
Well-casing diameter:	2"

Figure C-9. Boring Log and Well-Construction Details for Well UCD1-64, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-64

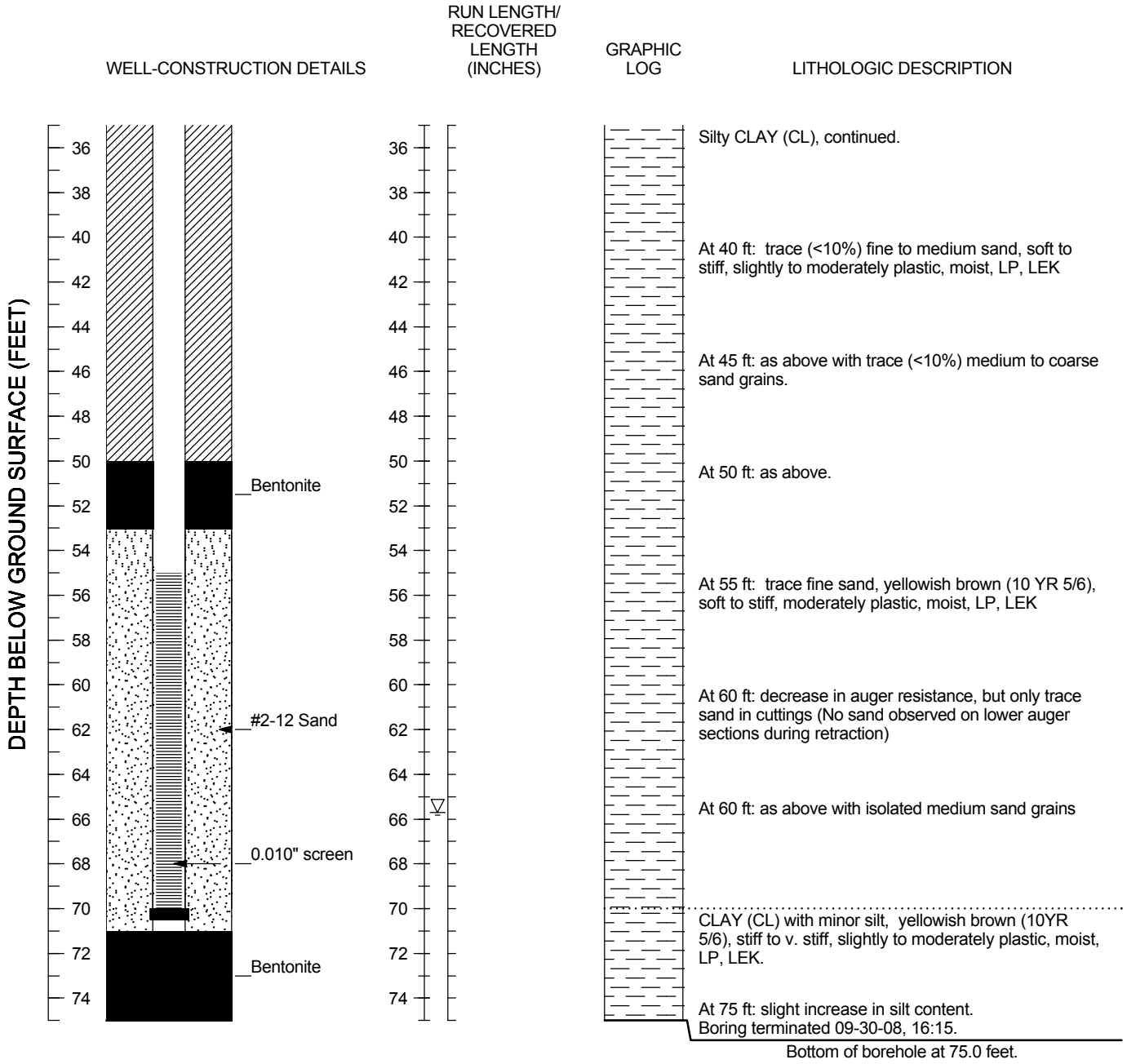
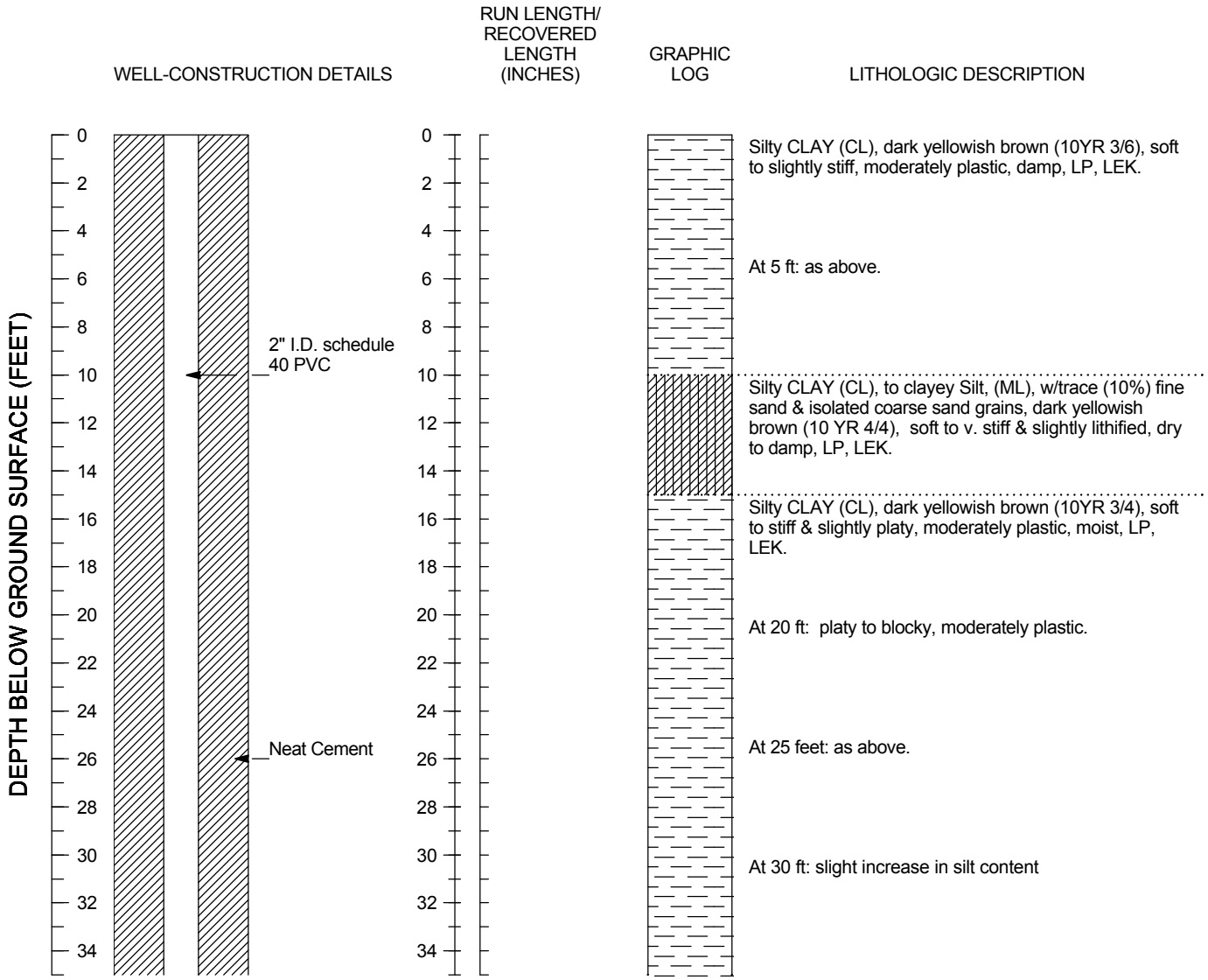


Figure C-9. Boring Log and Well-Construction Details for Well UCD1-64, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-65



EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. hand augered 0-5 feet
2. borehole logged by cuttings

Symbols:
Water level after drilling (9/30/2008 11:35:00 AM)

Logged by:	REK
Checked by:	RKD
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	Mike Radakovitz
Date begun:	9/30/2008
Date completed:	9/30/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	n/a - logged by cuttings
Ground-surface elevation:	47.5
Bore-hole diameter:	8"
Well-head completion:	
Well-casing diameter:	2"

Figure C-10. Boring Log and Well-Construction Details for Well UCD1-65, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-65

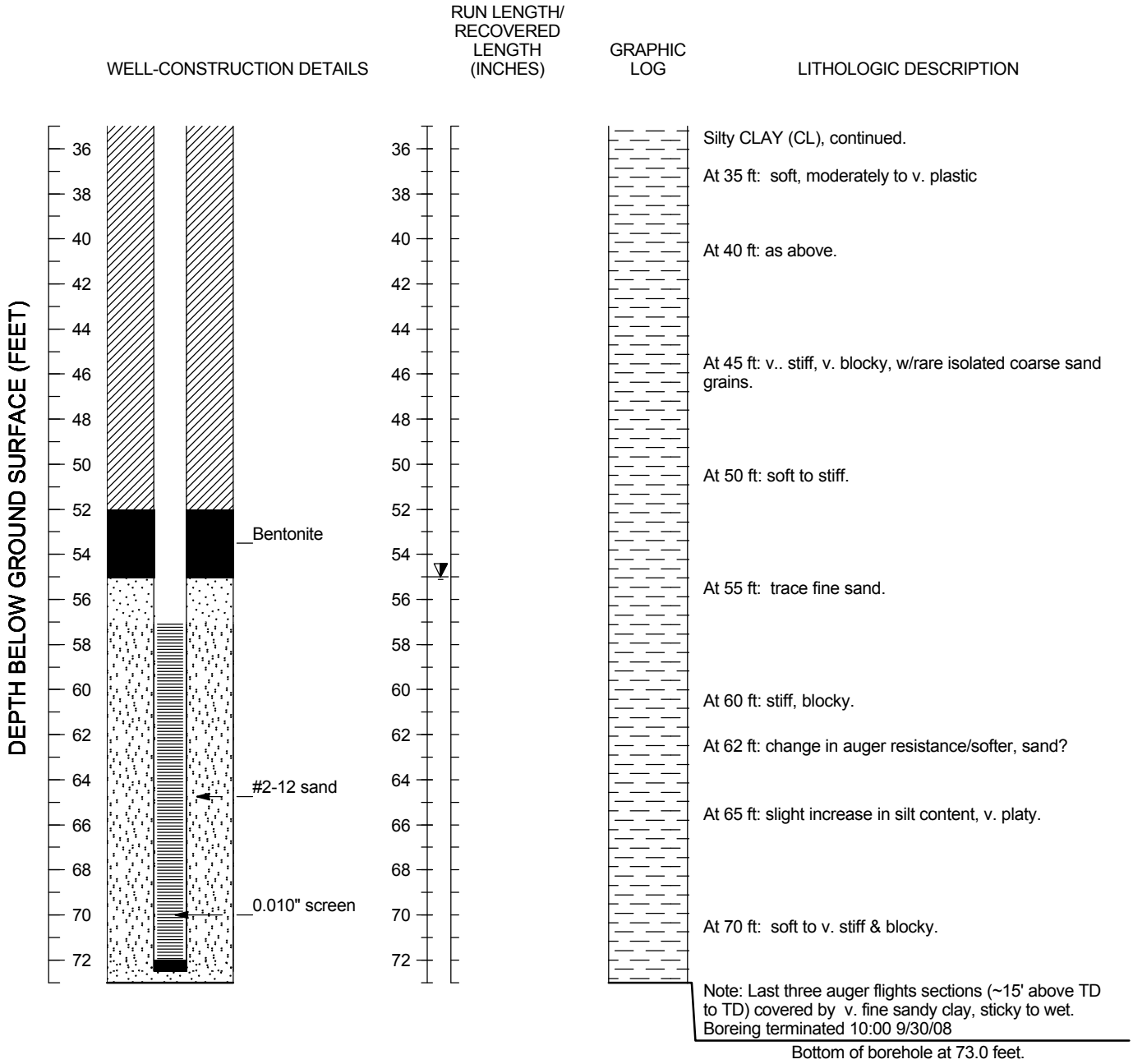
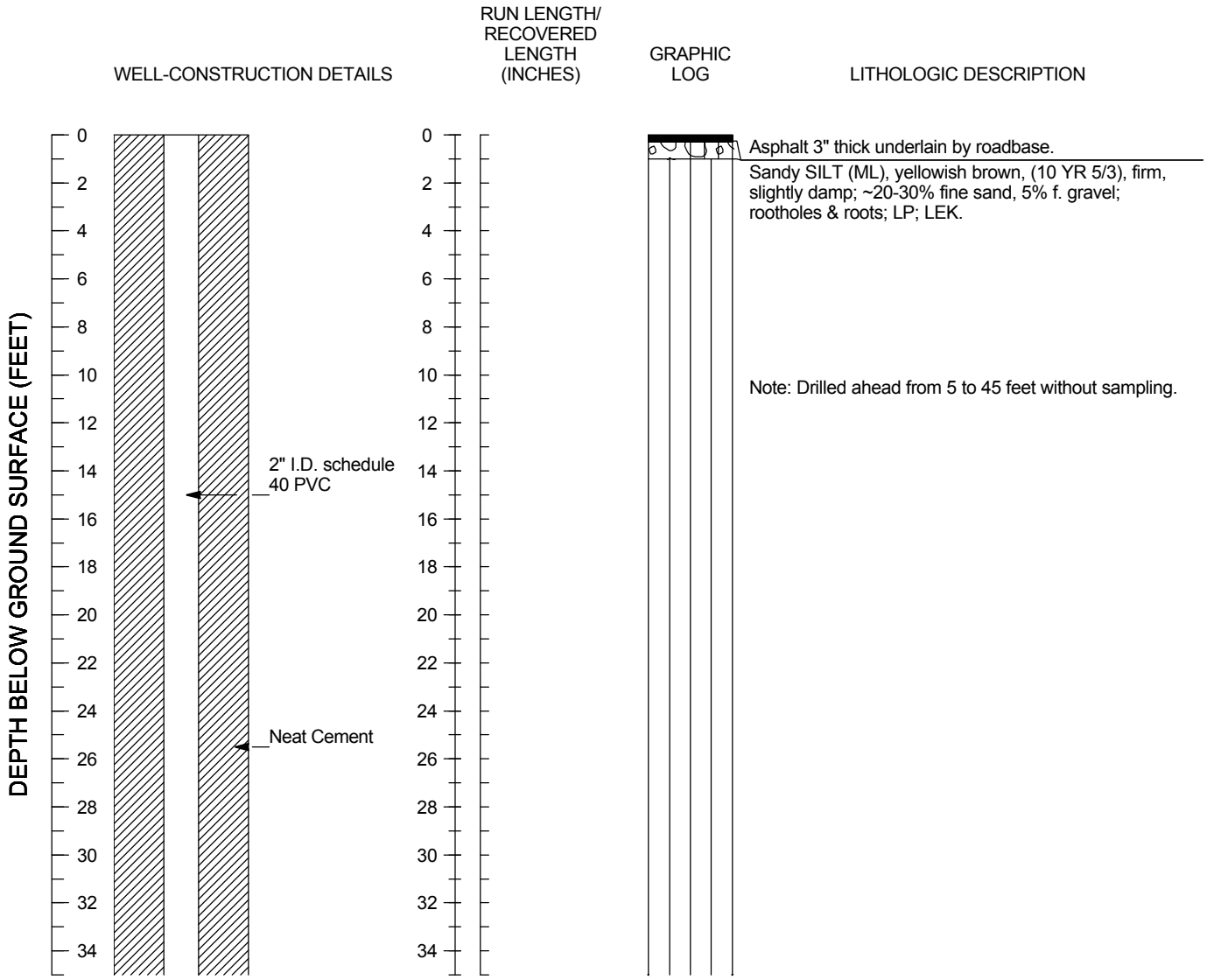


Figure C-10. Boring Log and Well-Construction Details for Well UCD1-65, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-66



EXPLANATION

Abbreviations:
Fe-ox = iron oxide
f-m-c = fine-medium-coarse
HEK = high estimated conductivity
LEK = low estimated conductivity
LP = low plasticity
MEK = medium estimated conductivity
Mn-ox = magnesium oxide
MP = medium plasticity

Notes:
1. 0-5' cleared via hand auger

Symbols:
Water level during drilling (first encountered)
Location of cored run

Logged by:	RKD
Checked by:	MLS
Drilling contractor:	Test America
Drilling contractor license:	819548
Driller:	icky Anderson
Date begun:	10/2/2008
Date completed:	10/2/2008
Drilling method:	Hollow Stem Auger
Type of sampler:	2" Cal Mod sampler
Ground-surface elevation:	48.3
Bore-hole diameter:	8"
Well-head completion:	
Well-casing diameter:	2"

Figure C-11. Boring Log and Well-Construction Details for Well UCD1-66, LEHR/SCDS, UC Davis, Davis, California

WELL UCD1-66

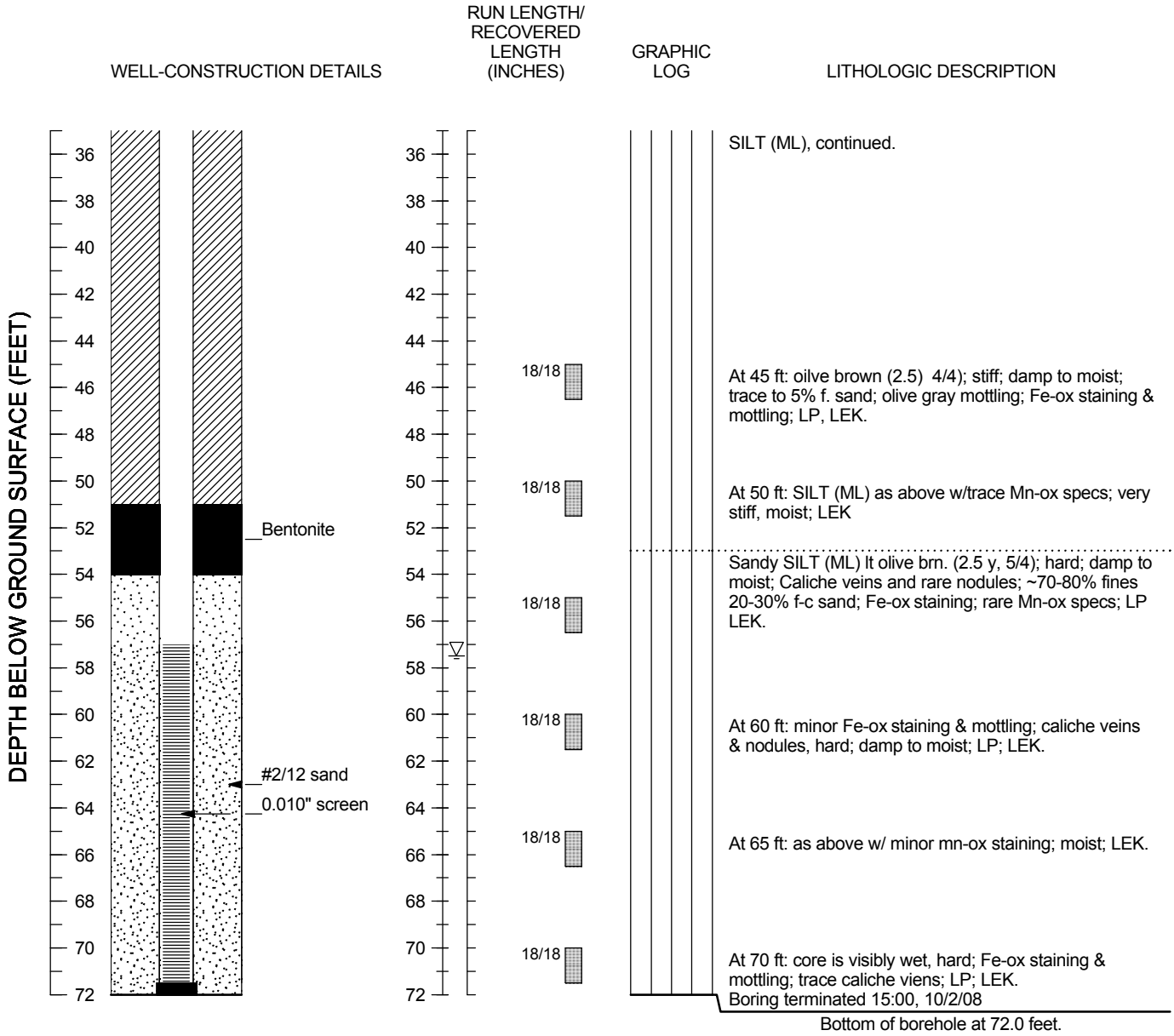


Figure C-11. Boring Log and Well-Construction Details for Well UCD1-66, LEHR/SCDS, UC Davis, Davis, California

APPENDIX D

GROUNDWATER IMPACT COPC EVALUATION

Table D-1. Representative Soil Profiles

Table D-2. Soil Parameters

Table D-3. Soil Constituents of Potential Concern for Groundwater Impact and Assumed Contaminated Depth Intervals

Table D-4. Chemical-Specific Parameters for Vadose Zone Modeling

Table D-5. Volatile Organic Compounds Included in NUFT Modeling

Table D-6. Summary of Designated Level Modeling Results for the Eastern Trenches Area

Table D-7. Summary of Designated Level Modeling Results for Landfill Unit 1

Table D-8. Summary of Designated Level Modeling Results for Landfill Unit 2

Table D-9. Summary of Designated Level Modeling Results for Landfill Unit 3

Table D-10. Summary of Designated Level Modeling Results for the Southern Trenches Area

Table D-11. Summary of Designated Level Modeling Results for the Waste Burial Holes Area

Table D-12. Summary of Designated Level Groundwater Constituents of Potential Concern at the Eastern Trenches Area Retained as Constituents of Potential Groundwater Concern

Table D-13. Summary of Designated Level Groundwater Constituents of Potential Concern at Landfill Unit 1 Retained as Constituents of Potential Groundwater Concern

Table D-14. Summary of Designated Level Groundwater Constituents of Potential Concern at Landfill Unit 2 Retained as Constituents of Potential Groundwater Concern

Table D-15. Summary of Designated Level Groundwater Constituents of Potential Concern at Landfill Unit 3 Retained as Constituents of Potential Groundwater Concern

Table D-16. Summary of Designated Level Groundwater Constituents of Potential Concern at the Southern Trenches Area Retained as Constituents of Potential Groundwater Concern

Table D-17. Summary of Designated Level Groundwater Constituents of Potential Concern at the Waste Burial Holes Area Retained as Constituents of Potential Groundwater Concern

Table D-18. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at the Eastern Trenches Area

Table D-19. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at Landfill Unit 1

Table D-20. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at Landfill Unit 2

Table D-21. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at Landfill Unit 3

Table D-22. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at the Southern Trenches Area

Table D-23. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at the Eastern Trenches Area

APPENDIX D. DESIGNATED LEVEL DETERMINATION AND GROUNDWATER RISK CHARACTERIZATION

D.1. DESIGNATED LEVEL DETERMINATION

One-dimensional vadose zone models were developed to calculate designated levels for the Laboratory for Energy-Related Health Research/South Campus Disposal Site (LEHR/SCDS), UC Davis, California. Designated levels are concentrations of constituents in waste (or soil) that are protective of water quality while accounting for environmental attenuation. Designated levels were determined for the Eastern Trenches, Landfill Unit 1, Landfill Unit 2, Landfill Unit 3, Southern Trenches and Waste Burial Holes areas following the Designated Level Methodology for Waste Classification and Cleanup Level Determination (CRWQCB, 1989). This appendix presents the approach, model assumptions, input parameters and results of designated level calculations.

The designated level methodology evaluates environmental attenuation between the location of contaminated waste and nearby receiving waters. At LEHR/SCDS, environmental attenuation is expected to occur in vadose zone soil located between buried waste (or contaminated soil) and groundwater. The designated level methodology suggests an initial simplified analysis of environmental attenuation using easily obtainable information on key site characteristics and conservative assumptions about other characteristics to approximate minimum expected attenuation. The methodology further states that "Whenever sufficient site- and waste-specific data can be obtained, a more thorough analysis of environmental fate should be substituted for this 'generic' attenuation factor approach". The Site and contaminant complexities encountered at LEHR/SCDS are not ideal for taking the simplified approach and may result in significant overestimation or underestimation of attenuation factors. Therefore, UC Davis proceeded with collection of site-specific and waste-specific data to perform a more thorough analysis of environmental fate for contaminants in the UC Davis areas.

In 2008, site-specific soil property data (D.B. Stephens, 2008) and waste-specific data were collected at each of the UC Davis areas. Soil property data were also collected at the Site by the United States Department of Energy (DOE) in 1996 (D.B. Stephens, 1996). UC Davis used the site-specific data in the multiphase fate and transport modeling code NUFT (Non-isothermal, Unsaturated Flow and Transport, Nitao 1996) to analyze contaminant migration and attenuation and determine designated levels. NUFT was developed and verified (Lee et al., 1993) at the Lawrence Livermore National Laboratory (LLNL) by Dr. John Nitao, in collaboration with Dr. Jacob Bear, to simulate multiphase flow and contaminant transport in one-, two-, or three-dimensions. DOE consistently used NUFT to determine designated levels for their areas of responsibility at LEHR. DOE removal actions in the Southwest Trenches, Radium/Strontium Treatment Systems, Domestic Septic System 3 and Domestic Septic System 6 areas at LEHR were guided using NUFT-derived designated

levels. Consistent with DOE, UC Davis used the previously established modeling approach to determine designated levels for their areas of responsibility.

Models developed for DOE areas of LEHR and the parameter sensitivity analysis using NUFT are described in detail in the One-Dimensional Vadose Zone Modeling Report for LEHR (Weiss, 1997). This modeling effort follows the established DOE areas modeling approach and uses UC Davis area-specific vadose zone soil profiles and modeling parameters. The modeling approach consisted of developing a soil profile for each area, selecting the most conservative site-specific parameters for each soil type, obtaining chemical property parameters for the constituents of concern, selecting hydrogeologic parameters, and iteratively running the model to determine designated levels.

D.1.1. Soil Profiles and Soil Parameters

Soil profiles were developed for the Eastern Trenches, Landfill Unit 1, Landfill Unit 2, Landfill Unit 3, Southern Trenches, and Waste Burial Holes areas (Table D-1). A Weiss Associates geologist reviewed soil boring logs recorded within each area and selected representative soil types for sediments located between ground surface and 27 feet bgs. Each soil profile represents the most permeable sediments typically encountered at comparable depths within an area. Thus, the boring logs over-represent high permeability sediments (sand and gravel) and under-represent the predominant silt and clay layers.

Shallow areas of buried waste are located within Landfill Units 1, 2, and 3 and the Eastern and Southern Trenches. All of the waste matrix was removed from the Waste Burial Holes in 1999. Buried waste is a variable matrix and was assumed to be represented by high permeability sandy-gravel. An exception was shallow soil in the Eastern Trenches that was assumed to consist of silty-sand. The Eastern Trenches contains small infrequent pockets of shallow buried waste (typically 2 feet in diameter) in silt and silty-sand sediments. Eastern Trenches shallow soil permeability is overestimated by sandy-gravel, so silty-sand was selected to best represent this interval.

Landfill Units 1, 2, and 3 and the Southern Trenches were assumed to contain lower permeability clay, silt and/or silty-sand layers below the sandy gravel waste matrix. The Eastern Trenches area was assumed to consist of silty sand between ground surface and 6 feet bgs, sandy/clayey silt between 6 feet and 18 feet bgs, and silty-sand between 18 feet and 27 feet bgs. The Waste Burial Holes had a unique layer of silty-gravel backfill above silty-sand and silty-clay. As shown in Table D-2, the geologist identified three unique silty-clays in the UC Davis areas.

Soil porosity, volumetric moisture content, hydraulic conductivity, dry bulk density, and the Van Genuchten parameters alpha and m are shown in Table D-2 for each of the soil types identified in the profiles. The parameters were determined from samples collected from DOE areas in 1996 and UC Davis areas in 2008 and submitted to a soil property testing laboratory (D.B. Stephens, 1996; D.B. Stephens, 2008). Sample soil types recorded by the field geologist were matched with the soil types in the profiles. Samples from UC Davis areas were given preference over samples collected from DOE areas. Two soil types were represented by DOE areas samples (sandy clay and sandy gravel) because none of the UC Davis areas samples matched these soil types. If more than one UC Davis area sample was

available to represent a soil type, the parameters most indicative of contaminant mobility were selected.

D.1.2. Chemical Parameters for Constituents of Potential Concern

Designated level constituents of potential concern (DL COPCs) and assumed contaminated depth intervals in each UC Davis area are shown in Table D-3. The DL COPCs were screened previously in the Feasibility Study Data Gaps Work Plan (Weiss, 2008), but changes were made to the list of DL COPCs since the screening was performed. Some volatile organic compound (VOC) DL COPCs were added to the list due to detection in soil gas samples collected during the data gaps investigation. Specifically, the additional VOC DL COPCs are:

- Eastern Trenches - acetone, tetrachloroethene, toluene, 1,1-dichloroethane, 1,2-dichloroethane and 1,2-dichloropropane
- Landfill 1 - toluene and 1,3-butadiene
- Landfill 2 - tetrachloroethene, toluene, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, 1,3-butadiene, methyl ethyl ketone and xylenes
- Landfill 3 - toluene
- Southern Trenches - methyl ethyl ketone and toluene
- Waste Burial Holes – toluene, 1,3-dichlorobenzene

Some DL COPCs were dropped from the list upon closer evaluation of historical sample data or based upon Data Gaps Investigation results. The eliminated constituents are:

Landfill Unit 1 – uranium-235 (All sample results were below the detection limits.)

Landfill Unit 2 – hexavalent chromium (Data Gaps Investigation results indicate hexavalent chromium is not present in soil.)

Waste Burial Holes – hexavalent chromium and uranium-235 (Data Gaps Investigation results indicate hexavalent chromium is not present in soil. All uranium-235 sample results were below the detection limits.)

Contaminated depth interval assumptions were made from soil and soil gas sample concentration data according to depth. If metal or radionuclide concentrations declined with depth below the background concentration, the contaminated interval was assumed to extend from ground surface to the depth of attenuation. In most cases, the metals and radionuclides did not attenuate to background levels with depth, and were therefore assumed to extend from ground surface to several feet below the water table. Concentration versus depth plots for those constituents that do show attenuation with depth and therefore have contaminated intervals that do not extend all the way to the water table are presented as Attachment D-1 to this appendix. The soil gas data indicated VOCs extended throughout the soil column. Thus,

VOCs were assumed to extend from ground surface to several feet below the water table. The depth interval assumptions are summarized in Table D-3.

Chemical-specific parameters for the DL COPCs are summarized in Table D-4. The soil adsorption/partitioning coefficient (K_d) values were compiled and reported previously in the Feasibility Study Data Gaps Work Plan (Weiss, 2008). The lowest reported K_d values from the literature were selected. Literature K_d values for tritium and carbon-14 were not used in the designated level calculations. Tritium and carbon-14 were assumed to partition completely into water in the form of tritiated water and methanol, respectively ($K_d = 0$). Henry's constants were obtained in units of atmospheres – cubic meters per mole and converted to unitless Henry's constants based on an average temperature of 65 degrees Fahrenheit (291.5 degrees Kelvin) in shallow groundwater in LEHR/SCDS monitoring wells. Molecular weight and organic carbon partition coefficients were obtained from the literature sources cited in Table D-4.

D.1.3. Hydrogeologic Parameters

UC Davis used the same conservative hydrogeologic parameter assumptions that were established in the designated level calculations performed by DOE for their areas at LEHR (Weiss, 2001; Weiss, 2002; Weiss, 2003). Prior to calculating designated levels, DOE performed a detailed sensitivity analysis on the hydrogeologic parameters in their One-Dimensional Vadose Zone Modeling report (Weiss, 1997). In brief, the established hydrogeologic parameters and their supporting assumptions are:

- Depth to groundwater: The smallest seasonal depth to the water table (20 ft) during years of above average precipitation at the Site was used in the model.

- Infiltration: 10.8 cm/year corresponding to 25% of the mean annual precipitation rate was used. The infiltration was assigned to the model at a constant rate resulting in continuous vertical flux towards the water table. The infiltration rate represents a reasonable maximum in an area with high evapotranspiration rates which reverse the direction of infiltration flux throughout most of the year.

- Dispersion: No dispersion was used for any of the COCs.

- Dilution: A thin aquifer thickness at the bottom of the model was used to represent the top of the water table as a receptor. Dilution is therefore minimal and this assumption likely overestimates the actual impact that COCs may have on groundwater.

D.1.4. Refinement of VOC DL COPCs

VOCs were detected in soil gas samples collected during the 2008 Feasibility Study Data Gaps investigation. Designated levels were determined for 17 of the 31 detected VOCs as shown in Table D-5. Modeling calculations were not performed for detected tracer compounds (hexane and isopropanol), ethanol (drinking alcohol) and co-located compounds with similar chemical structure/characteristics.

Designated levels were determined for proxy compounds selected to represent co-located chemical groups. Chloroform was the selected proxy for halogenated methanes,

which include carbon tetrachloride, chloromethane, dichlorodifluoromethane, methylene chloride and trichlorofluoromethane. Chloroform was selected due to its presence at significantly higher concentrations than the other halogenated methane compounds and because remedial technologies (to be identified in the Feasibility Study) for chloroform are expected to address the whole halogenated methane group. The same rationale was used to select toluene as a proxy for the fuel volatiles group. Although methyl-ethyl-ketone did not have the highest detected concentration in the ketones group it was selected due to a higher detection frequency. Although 1,1,2-trichloroethane was not detected in soil gas, it was selected as a group proxy due to significant concentrations detected in soil samples.

Designated levels were also determined individually for twelve compounds that were not part of the co-located groups (Table D-5).

D.1.5. Groundwater Goals

The groundwater goals and their sources are shown on Tables D-6 through D-11. The primary source of groundwater goals was the California Maximum Contaminant Levels (MCLs) for drinking water (DPH, 2009). If MCLs were unavailable, the United States Environmental Protection Agency, Region 9, Regional Screening Levels (RSLs) for tap water were used (EPA, 2008). The California Environmental Protection Agency risk-based target of 1.1 µg/L for water was used for chloroform. California notification levels (CNLs) were used as goal concentrations for carbon disulfide, 1,4-dioxane and formaldehyde (DPH, 2009). Water sample detection limits were also used to provide baseline goals for organic constituents.

Groundwater background values were determined for inorganic constituents (metals and radionuclides) using data from background well UCD1-18 located upgradient (west) of the Site. Groundwater sample data collected up through October 2008 were used. The established procedures for calculating LEHR site background values were followed (Weiss, 2000). Background values are the 80% lower confidence limit on the 95th quantile of sample data unless the data were censored (mostly non-detects). Half the detection limit was used for non-detect data to calculate background values when the percentage of detects was greater than 50%. Background values were calculated for barium, chromium, copper, antimony and selenium. Silver, cadmium, carbon-14, tritium, manganese, strontium-90, uranium-235 and uranium-238 data sets were censored. The lowest detection limit was selected as background for carbon-14, tritium, strontium-90, uranium-235 and uranium-238 because their data were either 100% non-detect, or the few detected concentrations were outliers and/or had data quality issues. Maximum detected concentrations were selected as background values for silver, cadmium and manganese after eliminating high outliers and detected concentrations with data quality issues.

D.1.6. Model Setup and Runs

The UC Davis areas models had two 1-meter thick atmospheric elements above ground surface. A continuous flux of water was applied at the bottom atmospheric element to provide infiltration. Soil elements were set at 0.15 meters (0.5 feet) thick throughout the soil column, except at contacts between soil types (Table D-1). Elements were divided into 0.08 meters (0.25 feet) thick above and below each soil contact to improve model continuity at

contact boundaries. The assumed water table was located 20 ft bgs and a seven-foot thick saturated zone was simulated beneath the water table to represent the uppermost portion of the groundwater system.

At the start of each run a constant COPC concentration was applied to all elements within the assumed contaminated interval. NUFT determined the movement of contaminant mass through each element at each time step. Water concentration data were output from the uppermost saturated element (0.15 m thick) to record the simulated peak concentration at the water table.

Modeled peak groundwater concentrations were compared to the groundwater goals to predict designated levels for the contaminated interval. The model was run again using the predicted designated level and the output compared to the groundwater goal. Iterative runs and parameter tolerance adjustments were performed to verify convergence of peak concentrations to within 1% of the groundwater goals.

D.1.6.1. VOC Soil Gas Equilibrium

Soil gas designated levels were determined for VOC DL COPCs to enable comparisons with soil gas sample data. Soil gas was assumed in equilibrium with soil. The equilibrium expression is:

$$\boxed{C_{v,eq} = \frac{H \cdot C_{soil} \cdot \rho_{bulk}}{\left(\theta_{water} + foc \cdot koc \cdot \rho_{bulk} + H \cdot \theta_{air}\right)}}$$

Where $C_{v,eq}$ is the equilibrium soil gas concentration, H is the unitless Henry's constant, C_{soil} is the concentration in soil, ρ_{bulk} is the soil bulk density, θ_{water} is the volumetric water content, foc is the fraction of organic carbon in soil, koc is the organic carbon partition coefficient, and θ_{air} is the volumetric air content. Values of C_{soil} were the NUFT input concentrations that resulted in the groundwater goal concentrations at the water table. Henry's constants and koc values are provided in Table D-4. Organic carbon data for LEHR/SCDS background soil samples were reviewed to select a koc value. The range of koc values spanned from 0.001 to 0.015. As indicated by the above equation, the highest koc value will result in the most conservative (lowest) designated level. Thus, 0.015 was selected for Koc. ρ_{bulk} and θ_{water} values are provided in Table D-2 for each of the modeled soil types. θ_{air} was determined from the difference between the porosity and θ_{water}. Porosity values are also provided in Table D-2.

$C_{v,eq}$ was determined for each VOC COPC and soil type in each UC Davis area.

D.1.7. Model Results

The designated level results for each UC Davis area are summarized in Table D-6 through Table D-11. Maximum concentrations in soil and soil gas are presented next to the designated levels. The maximum concentration is shown in bold if it exceeds the designated level. Contaminated interval assumptions and time to peak are provided for context and the groundwater goals are provided for reference.

Soil gas designated levels were determined for each soil type in each area. Only the lowest (most conservative) soil gas designated levels are presented in Table D-6 through Table D-11. The differences due to soil type were generally minimal with a few exceptions. Soil gas designated levels varied widely for acetone at Landfill Unit 1 (from 43,300 micrograms per cubic meter (µg/m^3) in type 2 silty-clay to 278,000 µg/m^3 in sandy gravel). However, maximum acetone soil gas concentrations at Landfill Unit 1 were below the lowest RSL-based soil gas designated level by more than a factor of 250. None of the maximum concentrations that exceed conservative (lowest) soil gas designated levels are below less conservative (highest) designated levels.

As shown in Table D-6, maximum soil gas concentrations are above the designated levels for acetone, chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, formaldehyde and toluene in the Eastern Trenches area. Maximum carbon-14 and tritium activity-concentrations in soil are also above the designated levels at the Eastern Trenches area.

Maximum acetone, formaldehyde and toluene soil gas concentrations and maximum copper, selenium and carbon-14 concentrations in soil are above designated levels at Landfill Unit 1 (Table D-7).

Soil gas concentrations are above the designated levels for acetone, chloroform, 1,1-dichloroethane, 1,2-dichloropropane, formaldehyde, methyl ethyl ketone, tetrachloroethene, toluene and xylenes in Landfill Unit 2 (Table D-8). 1,1,2-trichloroethane was not detected in soil gas samples from Landfill Unit 2, but the highest detection limit was more than 5 times the MCL-based designated level. In addition, the maximum concentration of 1,1,2-trichloroethane in Landfill Unit 2 soil was above the soil-based designated level. Cadmium, silver and carbon-14 had maximum soil concentration above designated levels.

The maximum concentrations of acetone, formaldehyde and toluene in Landfill Unit 3 soil gas were above designated levels (Table D-9). Maximum concentrations of antimony, barium, cadmium, copper, manganese, carbon-14 and tritium in soil were also above the designated levels at Landfill Unit 3. The maximum concentration of silver in Landfill Unit 3 soil was above the background-based designated level, but below the MCL-based designated level.

Acetone, methyl ethyl ketone and toluene concentrations in Southern Trenches area soil gas had maximum concentrations above designated levels (Table D-10).

Maximum concentrations of acetone, 1,3-dichlorobenzene, formaldehyde and toluene in soil gas were above designated levels at the Waste Burial Holes (Table D-11). Methyl ethyl ketone was not detected in soil gas at the Waste Burial Holes area, but the detection limit was above the designated level. Maximum carbon-14, tritium and uranium-238 activity concentrations in soil were above the designated levels. Only two samples were available to characterize uranium-238 in the Waste Burial Holes area. Uranium-238 was detected in both samples and the lower activity-concentration was below the background-based designated level, but above the MCL-based designated level.

D.2. RISK CHARACTERIZATION

Risk characterization is intended to provide risk managers with an understanding of the uncertainties and technical basis of estimated risks and help them formulate appropriate remedial strategies. To facilitate risk management decisions, the risk characterization evaluates and makes recommendations on whether constituents of potential groundwater concern (COPGWCs) should be evaluated as a constituent of concern (COC) in the Feasibility Study. COPGWCs were examined on an individual basis to evaluate the strengths and weaknesses of lines of evidence indicating whether a threat to groundwater resources exists. For each of the UC Davis areas, COPGWC spatial distribution, presence in groundwater, predicted impact timing/magnitude, analytical uncertainty, sample data representativeness and other factors were evaluated.

Prior to this risk characterization, designated level constituents of potential concern (DL COPCs) were identified in a screening evaluation presented in the Feasibility Study Data Gaps Work Plan (Weiss, 2008). As discussed in Section D.1.2 above, the list of DL COPCs was updated when additional characterization data were collected in 2008 during the Feasibility Study Data Gaps investigation. Designated levels were then determined for each DL COPC in each area, as presented in Section D.1.7 above.

Using groundwater monitoring data, site characterization data and the NUFT modeling results a three-step risk estimate procedure was followed for DL COPCs. The first step consisted of comparing groundwater concentrations to background. The maximum concentration in HSU-1 groundwater monitoring wells downgradient of each disposal area was compared to background. Groundwater monitoring data collected within the past ten years were used. Groundwater background was determined for inorganic and radionuclide GW COPCs using data from well UCD1-018 as described above. Background was assumed zero for organic compounds and the concentration was treated as zero if the compound was not detected. DL COPCs with maximum groundwater concentrations above background were automatically identified as a COPGWC for risk characterization. DL COPCs with maximum groundwater concentrations below background were evaluated in Step 2.

The second step of the risk estimate process was to compare soil or soil gas concentrations to the NUFT model designated levels for each area (see Section D.1.7 above). If the maximum soil (or soil gas) concentration was below all designated levels for the DL COPC, it was eliminated from further consideration. The DL COPC was also eliminated if the maximum soil concentration was below background. DL COPCs with maximum concentrations above background and above at least one designated level were carried forward to Step 3.

The third step consisted of evaluating DL COPCs based on their time to peak groundwater impact predicted by the model. If the peak arrival was predicted to occur after 500 years, the DL COPC was eliminated from further consideration. DL COPCs whose peak impact was predicted to occur in less than 500 years were identified as COPGWCs and carried forward into the risk characterization.

The risk characterization used multiple lines of evidence to evaluate COPGWC uncertainties and identify the final constituents of concern (COCs) that will be used in

making remedial action decisions in the Feasibility Study. The risk characterization lines of evidence are discussed in detail below for each COPGWC in each UC Davis disposal area. These lines of evidence include: percentage and spatial distribution of samples exceeding background, degradation and decay, uncertainties related to analytical issues and data representativeness, and relation of COPGWCs to Site operations. For those COPGWCs retained as COCs based on this evaluation, a conservative estimate of contaminant loading to groundwater was made, and any COC shown to impact less than one acre of groundwater at background levels was screened out as a COC. The only constituents for which this was a consideration in screening them out were 1,1-dichloroethene and 1,1,2-trichloroethane in Landfill Unit 2.

D.2.1. Eastern Trenches Area

D.2.1.1. Groundwater Risk Estimate

The Eastern Trenches DL COPCs are acetone, carbon disulfide, chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, 1,4-dioxane, formaldehyde, styrene, tetrachloroethene, toluene, carbon-14, tritium and Uranium-235. Maximum groundwater monitoring concentrations, maximum site characterization concentrations and the NUFT modeling results for DL COPCs are shown in Table D-6. The three-step risk estimate is shown in Table D-12 and discussed below.

Step 1 (Groundwater Background Comparison) - DL COPCs groundwater data collected from downgradient HSU-1 wells UCD1-008, UCD1-009, UCD1-012, UCD1-013, UCD1-049, UCD1-050, UCD1-051 and UCD1-066 and from Data Gaps grab groundwater samples ET-1 and ET-2 (see Table 2-4) were compared to groundwater background. It should be noted that all of these wells are also downgradient of Landfill Unit 2. Wells UCD1-008 and UCD1-013 are also downgradient of the Waste Burial Holes area. Background VOC concentrations were assumed zero. Results below detection limits were presumed to be below Site background. Acetone, carbon disulfide, chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane and tetrachloroethene were detected in downgradient HSU-1 groundwater. With the exception of carbon disulfide and tetrachloroethene, these constituents were also detected in grab groundwater sample ET-1. Formaldehyde, styrene, toluene and uranium-235 were not detected in samples collected from both the Data Gaps hydropunch samples and the downgradient HSU-1 wells. Carbon-14 and tritium concentrations in groundwater samples were significantly above background in the wells and grab samples. Therefore, acetone, carbon disulfide, chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, 1,4-dioxane, tetrachloroethene, carbon-14 and tritium were identified as COPGWCs in risk estimate Step 1 due to their presence in disposal unit and/or downgradient HSU-1 groundwater (Table D-12).

Step 2 (Comparison of maximum soil concentration to Background and NUFT Result) – Maximum concentrations in soil (or soil gas) were compared to NUFT modeling results and soil (or soil gas) background. Background was assumed zero (non-detect) for organic (soil gas) compounds. Based on the comparison, formaldehyde is predicted to impact groundwater above the RSL and CNL. Modeling results indicate it is unlikely that the low concentrations of styrene detected in the Eastern Trenches area soil gas samples will impact groundwater. Modeling results and soil gas data indicate toluene will be detected in local

groundwater, but remain below the MCL. Soil data and modeling results indicate uranium-235 will remain below groundwater background and the MCL. Based on this, styrene and uranium-235 were eliminated in Step 2 of the risk estimate (Table D-12).

Step 3 (Predicted Time to Peak Impact) – Peak concentrations of formaldehyde and toluene are predicted to occur in 16 to 27 years, respectively. No DL COPCs were eliminated in Step 3 of the risk estimate.

Based on the groundwater risk estimate process, all of the DL COPCs except styrene and uranium-235 were retained for further evaluation as COPGWCs.

D.2.1.2. Percentage and Spatial Distribution of Samples Exceeding Background

A localized area of VOC contamination exists at the north end of the Eastern Trenches area. Soil gas samples collected in 2008, during the Feasibility Study Data Gaps investigation, targeted this VOC contamination area. Chloroform was the primary VOC and was detected in all (100%) of the soil gas samples collected in the Eastern Trenches area in 2008. The highest concentration of chloroform in soil gas was 13,000 micrograms per cubic meter (µg/m^3) at 15 feet bgs. Lower concentrations of chloroform were detected in samples collected at 5 feet and 25 feet bgs (1,400 µg/m^3 and 710 µg/m^3, respectively). Acetone, carbon disulfide, 1,1-dichloroethane, 1,2-dichloropropane, formaldehyde, tetrachloroethene and toluene were detected in all (100%) of the Eastern Trenches soil gas samples. 1,2-dichloroethane was detected at 15 feet bgs (330 µg/m^3) and 25 feet bgs (43 µg/m^3), but not at 5 feet bgs (67% detected). The highest measured concentrations of VOCs in Eastern Trenches area soil gas were in samples collected at 15 feet bgs.

No spatial distribution data were available for 1,4-dioxane.

Four out of 44 (9%) of the carbon-14 soil sample results exceeded background in the Eastern Trenches area. Two of the above-background samples indicate a localized, vertical distribution of carbon-14 at the center of the Eastern Trenches area. Carbon-14 activity-concentrations were 6.7 +/- 1.9 picocuries per gram (pCi/g) and 8.3 +/- 1.4 pCi/g at 15 feet and 40 feet bgs, respectively, at the central location. Carbon-14 was above background and slightly above detection limits at two additional randomly distributed locations in the southern half of the Eastern Trenches.

Only one out of 17 (6 %) of the tritium soil sample results exceeded background in the Eastern Trenches area. The above-background sample (15.5 +/- 5.19 pCi/g) was collected in shallow soil (0.5 feet bgs) near the southwest boundary of the Eastern Trenches area.

D.2.1.3. Degradation and Decay of Contaminants of Potential Concern

Acetone, formaldehyde and toluene are expected to degrade quickly upon reaching groundwater. The published range of degradation half lives for acetone in groundwater is 2 to 14 days, for formaldehyde in groundwater is several hours to 14 days, and for toluene in groundwater is 7 days to 4 weeks (Howard, 1991; Glancer-Soljan et al., 2001). Formaldehyde has been shown to degrade under both aerobic and anaerobic conditions in aqueous and soil media (Leungprasert and Otten, 2009). Under aerobic conditions, as

generally present in the LEHR subsurface, formaldehyde degrades rapidly via formate or formic acid to carbon dioxide (Glancer-Soljan et al., 2001). Glancer-Soljan et al. (2001) demonstrated complete aerobic biodegradation of formaldehyde (1,000 mg/L) within 18 hours. During the aerobic degradation, formic acid developed as the intermediate product, which was also degraded within 18-24 hours. Under denitrifying and anaerobic conditions, formaldehyde has also been shown to be transformed into methanol and formic acid (Omil et al., 1999, Eiroa et al., 2004, and Eiroa et al., 2005). Eiroa et al. (2004) found that formaldehyde was completely biodegraded in less than 30 hours under denitrifying conditions. Carbon disulfide, chloroform 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, 1,4-dioxane and tetrachloroethene may also degrade to some extent in groundwater; however, for the purposes of this assessment no degradation was assumed.

Carbon-14 is not a naturally occurring isotope and has a half life of 5,730 years. Tritium occurs naturally through atmospheric processes, but does not accumulate, and its natural abundance is negligible. Tritium has a half life of 12.33 years.

D.2.1.4. Uncertainty

The objective of this section is to discuss the major sources of uncertainty that are specific to the assessment of the Eastern Trenches area.

D.2.1.4.1. Analytical Issues

Soil gas samples collected in 2008 were used to characterize VOC distribution in the Eastern Trenches Area. Acetone, carbon disulfide, chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, tetrachloroethene and toluene soil gas data had no validation qualifiers. All of the soil gas data collected in 2008 for formaldehyde were qualified as approximate (J) due to exceeded holding time. The formaldehyde samples were analyzed 1 day outside their specified 14 day holding time and the effect on analytical accuracy for these data is likely negligible.

No 1,4-dioxane soil sample data were available.

Soil sample data were used to characterize carbon-14 and tritium in the Eastern Trenches area. Nine of 44 carbon-14 results were qualified as approximate (J), including four above-background results. Two results had reported activity-concentrations above the background value, but well below their detection limits. These two non-detect results were not used to characterize above-background soil.

Two of 17 tritium results were qualified for trace activity-concentrations below the detection limit (UJ). Both of the qualified results are potentially within the detectable range based on adding the counting error to the activity-concentration. Twelve of the 17 tritium results were non-detect, but their detection limits were 3 to 5 times higher than background. Above-background concentrations may exist at the 12 sample locations, but these data show tritium concentrations are limited.

D.2.1.4.2. Data Representativeness

Soil gas samples collected during the 2008 Feasibility Study Data Gaps Investigation targeted VOCs contamination at the north end of the Eastern Trenches area. The 2008 soil gas data provided quantitative vertical characterization of the source area, but did not delineate the lateral extent. VOC migration is not expected to extend a significant distance laterally beyond the Eastern Trenches area due to low permeability native soil surrounding the disposal trenches. VOC data from soil samples collected in 1995 and 1996 were used qualitatively to verify the location of VOC concentrations in the Eastern Trenches Area, but these data were not used quantitatively due to accuracy issues associated with older sampling techniques that may not have prevented VOC losses during sample transport and storage. VOC data for a downhole soil gas flux sample collected in 1999 and for passive soil gas samples collected in 1998 were also used qualitatively to verify the location of VOC concentrations in the Eastern Trenches Area.

Eastern Trenches area soil sampling has consisted of discretionary grab samples and soil boring samples collected at depths ranging from 0.5 feet to 40 feet bgs. Carbon-14 and tritium soil sampling covers the lateral and vertical extent of the known potential source areas. The soil samples were collected and analyzed according to Superfund risk assessment data quality standards. These data are sufficient for characterizing the soil column in the Eastern Trenches area. No data gaps were identified.

Sample data from downgradient HSU-1 groundwater wells (see Section D2.1.1 above) represent combined impacts from the Eastern Trenches area, Waste Burial Holes area and Landfill Unit 2. These monitoring wells are downgradient of all three areas. The Waste Burial Holes area is known to contain significantly more carbon-14 and tritium contamination than the Eastern Trenches area. The fraction of Eastern Trenches area carbon-14 and tritium reaching downgradient HSU-1 wells may not be distinguishable from the larger Waste Burial Holes contribution. In addition, Landfill Unit 2 contains significant VOC concentrations. VOCs reaching the downgradient HSU-1 wells are likely a combination of contamination from Eastern Trenches area and Landfill Unit 2 sources. The Data Gaps grab groundwater samples collected in 2008 are also representative of these combined impacts.

D.2.1.5. Relation of Contaminants of Potential Groundwater Concern to Site Operations

From 1957 to 1965, waste materials including laboratory waste, pesticide containers, and gravel with bones and feces were disposed at the Eastern Trenches. The disposed wastes contained organic solvents, tritium and carbon-14, likely or known to be associated with LEHR Site operations.

Acetone is potentially associated with LEHR operations and is a common solvent for rinsing laboratory glassware due to its low cost, volatility, and ability to dissolve in water. Carbon disulfide may have been used as a non-polar solvent, but its use is commonly associated with the synthesis of organosulfur compounds. Chloroform was used at the Site and is a common anesthetizing agent and solvent. 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane and 1,4-dioxane can be used as solvents or fumigants and are potentially associated with LEHR operations. Formaldehyde was used at the Site and its common uses

include tissue fixative, disinfectant and embalming agent. The solvent tetrachloroethene is potentially associated with LEHR operations, but its use is commonly associated with dry cleaning operations. Toluene is a component of gasoline and is a common non-polar solvent. As a component of gasoline, toluene was used at the site. Tritium and carbon-14 are radioactive tracers/radiolabels that were used in experiments at LEHR.

D.2.1.6. Risk Characterization Summary and Recommendations Regarding Contaminants of Concern at the Eastern Trenches Area

The risk characterization summary is presented in Table D-18 and discussed below.

D.2.1.6.1. Acetone

Acetone was possibly used at the Site. The maximum concentration of acetone in groundwater was approximately two orders of magnitude below the RSL. These acetone data were frequently qualified due to laboratory contamination. Soil gas data indicate acetone is present in vadose zone soil (210 µg/m^3 maximum). Modeling suggests acetone will reach its peak concentration in groundwater in 20 years, but groundwater concentrations will remain far below the RSL. Acetone should not be retained as a COC because it has low toxicity, it degrades quickly in groundwater, its maximum concentration in groundwater was two orders of magnitude below the RSL and modeling suggests it will stay far below the RSL.

D.2.1.6.2. Carbon Disulfide

Carbon disulfide was possibly used at the Site, but it was detected only once in groundwater (less than 1% detection frequency) at a concentration more than three orders of magnitude below the RSL and two orders of magnitude below the CNL. Carbon disulfide concentrations in soil gas were low (81 µg/m^3 maximum). Modeling suggests carbon disulfide will remain well below the RSL and CNL. Carbon disulfide should not be retained as a COC due to its low concentration and infrequent detection in groundwater, low concentration in soil gas and insignificant predicted impact.

D.2.1.6.3. Chloroform

Chloroform was used at the Site and is currently impacting groundwater above the MCL and California EPA cleanup goal. Chloroform detected in downgradient HSU-1 groundwater likely originated from sources in the Eastern Trenches Area and Landfill Unit 2. Modeling suggests groundwater concentrations will peak above these goals in 24 years. High concentrations of chloroform were detected in soil gas (13,000 µg/m^3 maximum). Chloroform should be retained as a COC.

D.2.1.6.4. 1,1-Dichloroethane and 1,2-Dichloroethane

1,1-dichloroethane and 1,2-dichloroethane were possibly used at the Site and are currently impacting groundwater above MCLs. Modeling suggests groundwater concentrations will peak above these goals in 15 years. Maximum detected concentrations of

1,1-dichloroethane and 1,2-dichloroethane in soil gas were 550 µg/m^3 and 330 µg/m^3, respectively. 1,1-dichloroethane and 1,2-dichloroethane should be retained as COCs.

D.2.1.6.5. 1,2-Dichloropropane

1,2-dichloropropane was possibly used at the Site and is currently detected in groundwater at concentrations below the MCL. Modeling suggests groundwater concentrations will peak above the MCL in 16 years. The maximum detected concentration of 1,2-dichloropropane in soil gas was 1,900 µg/m^3. 1,2-dichloropropane should be retained as a COC.

D.2.1.6.6. Formaldehyde

Formaldehyde was used at the Site. The only formaldehyde samples collected from downgradient HSU-1 groundwater monitoring wells within the past ten years were from wells UCD1-013 and UCD1-066 in 2009. A Data Gaps grab groundwater sample was also collected within the Eastern Trenches. Formaldehyde was not detected in the Data Gaps sample or the downgradient groundwater samples. The maximum formaldehyde concentration in soil gas was 61.7 µg/m^3. Formaldehyde is expected to biodegrade quickly upon reaching groundwater, but without biodegradation, modeling predicts formaldehyde will impact groundwater above the RSL and CNL in 16 years. Formaldehyde should not be retained as a COC because it is expected to biodegrade quickly upon reaching groundwater and recent groundwater monitoring data indicates that formaldehyde is not impacting groundwater.

D.2.1.6.7. 1,4-Dioxane

1,4-dioxane was possibly used at the Site. Although 1,4-dioxane groundwater data are limited, the existing data indicate 1,4-dioxane is impacting downgradient HSU-1 groundwater above the CNL and RSL. Modeling suggests groundwater concentrations will peak above these goals in 17 years. 1,4-dioxane is a semivolatile organic compound and no soil sample data have been collected to characterize its presence or extent in the Eastern Trenches area. 1,4-dioxane should be retained as a COC.

D.2.1.6.8. Tetrachloroethene

Tetrachloroethene was possibly used at the Site and was detected in downgradient HSU-1 groundwater at concentrations below the MCL. Tetrachloroethene was not detected in the Data Gaps grab groundwater sample. Modeling suggests groundwater concentrations will remain below the MCL. Concentrations of tetrachloroethene in soil gas were low (7 µg/m^3 to 130 µg/m^3). Tetrachloroethene should not be retained as a COC due to its low concentration in groundwater and soil gas, and insignificant predicted impact.

D.2.1.6.9. Toluene

Toluene was used at the Site, but was not detected in groundwater and is expected to biodegrade quickly if it does reach groundwater. Concentrations of toluene in soil gas were low (44 µg/m^3 to 70 µg/m^3) and modeling suggests groundwater concentrations will remain below the MCL. Toluene should not be retained as a COC due to its absence in groundwater,

low concentration soil gas, insignificant predicted impact and fast groundwater biodegradation rate.

D.2.1.6.10. Carbon-14 and Tritium

Carbon-14 and tritium were used at the Site and are currently above background and near the MCLs in groundwater. Most of the groundwater contamination is likely due to carbon-14 and tritium originating from the Waste Burial Holes area. Site characterization data indicate the Waste Burial Holes area contains significantly more carbon-14 and tritium contamination in vadose zone soil than the Eastern Trenches area. However, modeling suggests that carbon-14 and tritium in the Eastern Trenches area will impact HSU-1 groundwater at concentrations above background and the MCL. Carbon-14 and tritium should be retained as COCs.

D.2.2. Landfill Unit 1

D.2.2.1. Groundwater Risk Estimate

The Landfill Unit 1 DL COPCs are acetone, 1,3-butadiene, formaldehyde, toluene, copper, selenium and carbon-14. Maximum groundwater monitoring concentrations, maximum site characterization concentrations and the NUFT modeling results for DL COPCs are shown in Table D-7. The three-step risk estimate is shown in Table D-13 and discussed below.

Step 1 (Groundwater Background Comparison) - DL COPCs groundwater data collected from downgradient HSU-1 wells UCD1-011 and UCD1-062 and Data Gaps grab groundwater sample LF1-2 (see Table 2-4) were compared to groundwater background. Acetone was detected in downgradient HSU-1 groundwater. 1,3-butadiene impacts in downgradient groundwater could not be evaluated in Step 1 of the risk estimate because no samples were collected for this constituent within the past ten years. Formaldehyde and toluene were not detected in samples collected from the downgradient HSU-1 wells. Copper, selenium and carbon-14 concentrations in downgradient groundwater samples were above background. Copper was above background in the Data Gaps hydropunch sample. Selenium and carbon-14 were not detected in the Data Gaps hydropunch sample. Acetone, copper, selenium and carbon-14 were identified as COPGWCs in risk estimate Step 1 due to their presence in disposal unit and/or downgradient HSU-1 groundwater (Table D-13).

Step 2 (Comparison of maximum soil (or soil gas) concentration to Background and NUFT Result) – The maximum concentration of 1,3-butadiene was below the soil gas designated level, indicating it is unlikely 1,3-butadiene will impact groundwater. Based on the comparison, formaldehyde is predicted to impact groundwater above the RSL and CNL. Modeling results and soil gas data indicate toluene will be detected in local groundwater, but remain below the MCL. 1,3-butadiene was eliminated in Step 2 of the risk estimate (Table D-13).

Step 3 (Predicted Time to Peak Impact) – Modeling suggests peak concentrations of formaldehyde and toluene in groundwater are predicted to occur in 21 and 40 years, respectively. No DL COPCs were eliminated in Step 3 of the risk estimate.

Based on the groundwater risk estimate process, all of the DL COPCs except 1,3-butadiene were retained for further evaluation as COPGWCs.

D.2.2.2. Percentage and Spatial Distribution of Samples Exceeding Background

VOCs contamination exists at the southwest corner of Landfill Unit 1. Soil gas samples collected in 2008, during the Feasibility Study Data Gaps investigation, targeted the VOCs contamination area. Low concentrations of acetone, 1,3-butadiene, formaldehyde and toluene were detected in the soil gas samples. Acetone was detected at 5 feet bgs (120 µg/m^3) and 15 feet bgs (150 µg/m^3), but not at 25 feet bgs (67% detected). 1,3-Butadiene was only detected in one sample (33% detected) at 15 feet bgs (74 µg/m^3). Formaldehyde was detected in all (100%) of the Landfill Unit 1 soil gas samples. Toluene was detected at 5 feet bgs (72 µg/m^3) and 15 feet bgs (120 µg/m^3), but not at 25 feet bgs (67% detected).

Six out of 33 (18%) of the copper soil sample results exceeded background in Landfill Unit 1. The two highest concentrations (2,690 mg/kg and 570 mg/kg) are located near the center of the western half of Landfill Unit 1. Above-background samples in the eastern half of the area are more randomly distributed. All of the above-background samples are located in shallow soil ranging from 0 ft bgs to 7 ft bgs.

Fourteen out of 33 (42%) of the selenium soil sample results exceeded background in Landfill Unit 1. The eight highest concentrations (3.3 mg/kg to 13 mg/kg) were located in shallow soil ranging from 2.5 ft bgs to 8.5 ft bgs. Most of the above-background concentrations are located in the Eastern half of Landfill Unit 1, but four were in the west half, including the highest concentration.

Carbon-14 was detected above background in five out of 21 sample results in the Landfill Unit 1 area (24%). Four of the above-background samples, including the highest (4.74 +/- 0.724 pCi/g), were located in a small cluster in the southwest corner of the area at depths ranging from 0.5 ft bgs to 20 ft bgs. The second highest detected concentration (2.6 +/- 1.6 pCi/g) was located at the center of Landfill Unit 1 at 25 feet bgs.

D.2.2.3. Degradation and Decay of Contaminants of Potential Concern

Acetone, formaldehyde and toluene are expected to degrade quickly upon reaching groundwater. The published range of degradation half lives for acetone in groundwater is 2 to 14 days, for formaldehyde in groundwater is several hours to 14 days (see Section D.2.1.3 for additional discussion), and for toluene in groundwater is 7 days to 4 weeks (Howard, 1991; Glancer-Soljan et al., 2001). Copper and selenium are assumed to undergo no significant degradation.

Carbon-14 is not a naturally occurring isotope and has a half life of 5,730 years.

D.2.2.4. Uncertainty

The objective of this section is to discuss the major sources of uncertainty that are specific to the assessment of Landfill Unit 1.

D.2.2.4.1. Analytical Issues

Soil gas samples collected in 2008 were used to characterize VOC distribution at Landfill Unit 1. Acetone, formaldehyde and toluene soil gas data had no validation qualifiers.

Soil sample data were used to characterize copper, selenium and carbon-14 at Landfill Unit 1. Copper was detected in all of the soil characterization samples with no data validation qualifiers. Selenium was detected in 22 out of 33 soil samples with no data validation qualifiers. All of the non-detect selenium data had detection limits below the background value.

One of 21 carbon-14 results was qualified as approximate (J), due to a low detected activity-concentration and radioanalytical counting uncertainty spanning the detection limit (trace level). One non-detect carbon-14 result was qualified due to a calibration verification problem. No other analytical uncertainty issues were found for carbon-14.

D.2.2.4.2. Data Representativeness

Soil gas samples collected in 2008, during the Feasibility Study Data Gaps Investigation, targeted VOCs contamination at the southwest corner of Landfill Unit 1. The 2008 soil gas data provided quantitative vertical characterization of the source area, but did not delineate the lateral extent. VOC migration is not expected to extend a significant lateral distance beyond the Landfill Unit 1 boundary due to low concentrations in soil gas and low permeability native soil surrounding the landfill. Previous soil gas analyses did not detect VOCs in Landfill Unit 1 (Weiss, 2008). Previous VOC data from soil samples collected in 1995 and 1996 were used qualitatively to verify the location of VOC concentrations in Landfill Unit 1, but these data were not used quantitatively due to accuracy issues associated with older sampling techniques that may not have prevented VOC losses during sample transport and storage.

Landfill Unit 1 soil sampling consisted of discretionary grab samples and soil boring samples collected at depths ranging from ground surface to 40 feet bgs. Copper, selenium and carbon-14 soil sampling covers the lateral and vertical extent of the known potential source areas. The soil samples were collected and analyzed according to Superfund risk assessment data quality standards. These data are sufficient for characterizing the soil column at Landfill Unit 1. No data gaps were identified.

Groundwater sample data used in this evaluation were from wells UCD1-011 and UCD1-062 and Data Gaps grab groundwater sample LF1-2. The groundwater flow direction in HSU-1 is generally toward the northeast. Landfill Unit 1 is located east-southeast of other LEHR/SCDS sources such as the Waste Burial Holes area, Landfill Unit 2 and Eastern Trenches Area. Well UCD1-011 is located downgradient/crossgradient of Landfill Unit 1 and approximately 150 feet north of the northeast landfill boundary. Well UCD1-011 is also located approximately 400 feet to 500 feet downgradient of the Waste Burial Holes, Landfill Unit 2 and Eastern Trenches Areas. Contaminants detected in samples from well UCD1-011 could originate from any of the four areas. All of the groundwater samples used in this evaluation, except one, were from well UCD1-011. Recently installed HSU-1 groundwater well UCD1-062 is located at the east boundary of Landfill Unit 1 and approximately 500 feet

east, crossgradient/downgradient, of the Waste Burial Holes, Landfill Unit 2 and Eastern Trenches Areas. Well UCD1-062 groundwater monitoring data are likely representative of Landfill Unit 1, but there is some potential for the well to pick up contamination from the other three sources. Data from only one sampling event were available from UCD1-062 at the time of this evaluation. Data Gaps grab groundwater sample LF1-2 was located in the southwest corner (upgradient end) of Landfill Unit 1 and crossgradient/downgradient of the Waste Burial Holes. Carbon-14 was not detected in sample LF1-2, suggesting the sample location was not affected by groundwater contamination migrating from the Waste Burial Holes.

D.2.2.5. Relation of Contaminants of Potential Groundwater Concern to Site Operations

Waste materials were disposed at Landfill Unit 1 in the 1940s and 1950s. Glass, metal and burned materials including ash, charcoal and melted glass were identified at Landfill Unit 1 during investigations of the area. Sludge from the adjacent sewage treatment plant was also reportedly disposed at Landfill Unit 1.

Acetone is a common solvent that was possibly disposed at Landfill Unit 1. Formaldehyde was used at LEHR/SCDS and its general uses include tissue fixative, disinfectant and embalming agent. Toluene is a component of gasoline and is a common non-polar solvent. As a component of gasoline, toluene was used at the Site. Copper is a common conductive metal and was probably disposed at Landfill Unit 1. Selenium was possibly disposed at Landfill Unit 1; its general historical (anthropogenic) uses include veterinary toxin, rubber compounding agent, steel alloying agent and in rectifiers. Carbon-14 is a radioactive tracer/radiolabel that was used in experiments at LEHR.

D.2.2.6. Risk Characterization Summary and Recommendations Regarding Contaminants of Concern at Landfill Unit 1

The risk characterization summary for Landfill Unit 1 is presented in Table D-19 and discussed below.

D.2.2.6.1. Acetone

Acetone was possibly used at the Site. The maximum concentration of acetone in downgradient HSU-1 groundwater was almost three orders of magnitude below the RSL. Soil gas data indicate acetone is present in vadose zone soil (150 $\mu g/m^3$ maximum). Modeling suggests acetone will reach its peak concentration in groundwater in 24 years, but groundwater concentrations will remain far below the RSL. Acetone should not be retained as a COC because it has low toxicity, it degrades quickly in groundwater, its maximum concentration in groundwater was almost three orders of magnitude below the RSL and modeling suggests it will remain far below the RSL.

D.2.2.6.2. Formaldehyde

Formaldehyde was used at LEHR/SCDS. The only formaldehyde samples collected from downgradient HSU-1 groundwater monitoring wells within the past ten years were from wells UCD1-011 and UCD1-062 in 2009. Formaldehyde was not detected in either of the two

samples. Without degradation, modeling predicts formaldehyde will impact groundwater above the RSL and CNL in 21 years; however, formaldehyde is expected to biodegrade quickly upon reaching groundwater. Formaldehyde should not be retained as a COC because it is expected to biodegrade quickly upon reaching groundwater and recent groundwater monitoring data indicates that formaldehyde is not impacting groundwater.

D.2.2.6.3. Toluene

Toluene was used at the Site, but was not detected in downgradient HSU-1 groundwater and is expected to biodegrade quickly if it does reach groundwater. Concentrations of toluene in soil gas were low (72 $\mu g/m^3$ to 120 $\mu g/m^3$) and modeling suggests groundwater concentrations will remain below the MCL. Toluene should not be retained as a COC due to its absence in groundwater, low concentration soil gas, insignificant predicted impact and fast groundwater biodegradation rate.

D.2.2.6.4. Copper

Copper was used at the Site. The maximum concentration of copper in groundwater was above background and more than two orders of magnitude below the MCL. High concentrations of copper were detected in shallow soil (2,690 mg/kg maximum). Modeling suggests that copper in Landfill Unit 1 will impact groundwater at concentrations exceeding background and the MCL, but the peak impact will not occur for more than 500 years. Copper should be retained as a COC due to its presence in groundwater and predicted impact.

D.2.2.6.5. Selenium

Selenium was possibly used at the Site and was above background, but below the MCL in downgradient HSU-1 groundwater. Selenium was not detected in Data Gaps grab groundwater sample LF1-2. The highest concentrations of selenium in Landfill Unit 1 soil were located at relatively shallow depths (2.5 ft bgs to 8.5 ft bgs). Modeling suggests that selenium should already be impacting groundwater at concentrations exceeding background and the MCL. Selenium should be retained as a COC.

D.2.2.6.6. Carbon-14

Carbon-14 was used at the Site and is currently above background, but below the MCL in downgradient HSU-1 groundwater. Carbon-14 was not detected in Data Gaps grab groundwater sample LF1-2. Contamination detected in the downgradient groundwater samples may also originate from the upgradient/crossgradient Waste Burial Holes area. Site characterization data indicate the Waste Burial Holes area contains significantly more carbon-14 contamination in vadose zone soil than Landfill Unit 1. However, modeling suggests that carbon-14 in Landfill Unit 1 may impact local groundwater at concentrations exceeding background and the MCL. Carbon-14 should be retained as a COC.

D.2.3. Landfill Unit 2

D.2.3.1. Groundwater Risk Estimate

The Landfill Unit 2 DL COPCs are acetone, 1,3-butadiene, carbon disulfide, chloroform, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, 1,4-dioxane, formaldehyde, methyl ethyl ketone, styrene, tetrachloroethene, toluene, 1,1,2-trichloroethane, xylenes, cadmium, silver, carbon-14, strontium-90 and uranium-235. Maximum groundwater concentrations, maximum Site concentrations and the NUFT modeling results for DL COPCs are shown in Table D-8. The three-step risk estimate is shown in Table D-14 and discussed below.

Step 1 (Groundwater Background Comparison) - DL COPCs groundwater data collected from downgradient HSU-1 wells UCD1-008, UCD1-009, UCD1-012, UCD1-013, UCD1-049, UCD1-050, UCD1-051 and UCD1-066 and Data Gaps grab groundwater samples LF2-1, LF2-2, LF2-3 and LF2-4 (see Table 2-4) were compared to groundwater background. It should be noted that the wells are also downgradient of the Eastern Trenches area. Wells UCD1-008 and UCD1-013 are also downgradient of the Waste Burial Holes area. Acetone, carbon disulfide, chloroform, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, 1,4-dioxane, methyl ethyl ketone, tetrachloroethene, toluene and 1,1,2-trichloroethane were detected in downgradient HSU-1 groundwater. Chloroform, 1,1-dichloroethene and formaldehyde were detected in Data Gaps grab groundwater samples. Impacts to downgradient groundwater by 1,3-butadiene could not be evaluated in Step 1 of the risk estimate because no 1,3-butadiene samples were collected at the Site within the past ten years. Formaldehyde, styrene, xylenes, strontium-90 and uranium-235 were not detected in samples collected from the downgradient HSU-1 wells. Acetone, carbon disulfide, 1,1-dichloroethane, 1,2-dichloropropane, methyl ethyl ketone, styrene, tetrachloroethene, toluene, 1,1,2-trichloroethane, xylenes, cadmium, silver, strontium-90 and uranium-235 were not detected in Data Gaps grab groundwater samples. Cadmium, silver and carbon-14 concentrations in downgradient groundwater samples were above background. Carbon-14 was above background in Data Gaps grab groundwater sample LF2-4. Acetone, carbon disulfide, chloroform, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, 1,4-dioxane, methyl ethyl ketone, tetrachloroethene, toluene, 1,1,2-trichloroethane, cadmium, silver and carbon-14 were identified as COPGWCs in risk estimate Step 1 due to their presence in disposal unit and/or downgradient HSU-1 groundwater (Table D-14).

Step 2 (Comparison of maximum soil (or soil gas) concentration to Background and NUFT Result) – Modeling results indicate it is unlikely that the low concentrations of 1,3-butadiene and styrene detected in Landfill Unit 2 soil gas samples will impact groundwater. Formaldehyde is predicted to impact groundwater above the RSL and CNL. The comparison indicates xylenes will impact groundwater below the MCL. Maximum soil concentration data and modeling results indicate strontium-90 and uranium-235 will remain below groundwater background and the MCLs. 1,3-Butadiene, styrene, strontium-90 and uranium-235 were eliminated in Step 2 of the risk estimate (Table D-14).

Step 3 (Predicted Time to Peak Impact) – The peak concentration of formaldehyde is predicted to occur in 9 years. Xylenes are predicted to have reached their maximum concentration. No DL COPCs were eliminated in Step 3 of the risk estimate.

Based on the groundwater risk estimate process, all of the DL COPCs except 1,3-butadiene, styrene, strontium-90 and uranium-235 were retained for further evaluation as COPGWCs.

D.2.3.2. Percentage and Spatial Distribution of Samples Exceeding Background

A localized area of VOCs contamination exists at the north end of Landfill Unit 2 and lesser concentrations were found in the southern half of the area. Soil gas samples were collected at locations in the north, southeast and southwest ends of Landfill Unit 2 during the 2008 Feasibility Study Data Gaps investigation. Chloroform was the primary VOC with a maximum soil gas concentration of 16,000 µg/m^3 in the sample collected at 15 feet bgs at the north end of Landfill Unit 2. The highest concentrations of acetone, carbon disulfide, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, tetrachloroethne, toluene and xylenes in soil gas were also found in samples collected at the north end of Landfill Unit 2. The concentration of methyl ethyl ketone was highest (61 µg/m^3) at the southeast soil gas sampling location. The highest concentration of formaldehyde (175 µg/m^3) was detected in the sample collected at 25 feet bgs near the southwest corner of the landfill.

The detection frequencies/percentages for VOCs in soil gas were:

- Acetone and toluene detected in seven out of nine (78%) soil gas samples;
- Carbon disulfide, chloroform, methyl ethyl ketone, tetrachloroethene and xylenes detected in six out of nine samples (67%);
- 1,1-dichloroethane and 1,2-dichloropropane detected in three samples each out of nine (33% detected);
- 1,1-dichloroethene detected in two samples out of nine (22% detected); and,
- 1,1,2-trichloroethane not detected in any soil gas samples.

No spatial distribution data were available for 1,4-dioxane.

Thirteen out of 40 (33%) of the cadmium soil sample results were detected above background in Landfill Unit 2. The highest concentration of cadmium (6.7 mg/kg) was detected in a sample collected at 2.5 feet bgs at the south border of Landfill Unit 2. The next five highest concentrations (1.6 mg/kg to 6.1 mg/kg) were located in the northwest quarter of Landfill Unit 2 at depths ranging from 2.5 feet bgs to 9.5 feet bgs. The remaining seven above-background samples were randomly distributed and span depth ranges of 0.5 feet bgs to 32.5 feet bgs.

Seven out of 40 (18%) of the silver soil sample results were detected above background in Landfill Unit 2. The five highest concentrations (4.5 mg/kg to 38.1 mg/kg) were located in the northwest quarter of the landfill at depths ranging from 2.5 ft bgs to 12.3 ft bgs. The remaining two above-background concentrations were located near the southern boundary of Landfill Unit 2 at depths of 0.5 feet bgs and 2.5 feet bgs.

Eight out of 40 (20%) of the carbon-14 soil sample results exceeded background in Landfill Unit 2. The highest detected concentration of carbon-14 (4.2 +/- 1.4 pCi/g) was located near the south landfill boundary at 0.3 feet bgs. The maximum had a field duplicate concentration of 2.0 +/- 1.2 pCi/g. Three more above-background samples were clustered near the maximum at depths ranging from 2.5 feet bgs to 12.5 feet bgs. Two more above-background samples were located in the northwest quarter of the landfill at depths of 7.5 feet bgs and 30 feet bgs in the same boring.

D.2.3.3. Degradation and Decay of Contaminants of Potential Concern

Acetone, formaldehyde, toluene and xylenes are expected to degrade quickly upon reaching groundwater. The published range of degradation half lives in groundwater for acetone is 2 to 14 days, for formaldehyde is several hours to 14 days, for toluene is 7 days to 4 weeks, and for xylenes is 2 weeks to 12 months (Howard, 1991; Glancer-Soljan et al., 2001). See Section D.2.1.3 for additional discussion on formaldehyde degradation.

Carbon disulfide, chloroform, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, 1,4-dioxane, methyl ethyl ketone, tetrachloroethene, 1,1,2-trichloroethane, cadmium and silver may also degrade in groundwater, but are assumed to not undergo any significant degradation for the purposes of this evaluation.

Although 1,1-dichloroethene and 1,1,2-trichloroethane were not assumed to undergo degradation, groundwater monitoring results for samples collected from downgradient HSU-1 monitoring wells over the past 10 years indicated declining concentration trends for these compounds. The concentration of 1,1-dichloroethene in downgradient wells steadily declined throughout the 10 year period and remained below the MCL (6 µg/L) in 2007, 2008 and the first half of 2009. 1,1,2-Trichloroethane has shown an overall declining trend in groundwater and been below the MCL (5 µg/L) in downgradient wells UCD1-012, UCD1-049 and UCD1-051 since 2005, but remained above the MCL in downgradient well UCD1-050 (24 µg/L on February 4, 2009).

Carbon-14 is not a naturally occurring isotope and has a half life of 5,730 years.

D.2.3.4. Uncertainty

The objective of this section is to discuss the major sources of uncertainty that are specific to the assessment of Landfill Unit 2.

D.2.3.4.1. Analytical Issues

Soil gas samples collected in 2008 were used to characterize VOC distribution in Landfill Unit 2. No data quality issues were identified for VOC soil gas data except two qualified formaldehyde results. The formaldehyde sample collected at 25 feet bgs from the southeast soil gas point was qualified approximate (J) due to exceeded holding time. This sample was analyzed 1 day outside of the 14 day holding time and the effect on analytical accuracy is likely negligible.

No 1,4-dioxane soil sample data were available for Landfill Unit 2.

Soil sample data were used to characterize cadmium, silver and carbon-14 at Landfill Unit 2. None of the 40 cadmium results were qualified. Twenty cadmium results were not detected, having detection limits above background (0.51 mg/kg). The range of above-background detection limits for cadmium non-detect results was 1 mg/kg to 1.2 mg/kg, except one sample with a detection limit of 11.2 mg/kg. Above-background cadmium concentrations could exist at these 20 sample locations, but the data show that 19 locations do not exceed background by more than a factor of 2.5.

One of 38 silver results was qualified as not detected (U) due to blank contamination. This qualified result was below background and has no effect on data quality.

Six out of 40 of the carbon-14 results were qualified as approximate (J) due to matrix spike recovery outside control limits. One result was qualified for trace activity-concentration above the detection limit (J) and another for trace activity-concentration below the detection limit (UJ). Adding or subtracting the counting error to these trace results would place the activity-concentration above or below the detection limit, respectively.

D.2.3.4.2. Data Representativeness

In 2008, soil gas samples were collected at the north, southeast and southwest regions of Landfill Unit 2 at depths of 5, 15 and 25 feet bgs. The 2008 soil gas data provided quantitative vertical and lateral characterization within the landfill, but did not delineate lateral extent beyond the landfill boundaries. VOC migration is not expected to extend a significant distance laterally beyond Landfill Unit 2 due to low permeability native soil surrounding the disposal cells. VOC data from soil samples collected in 1995 and 1996 were used qualitatively to verify the location of VOC concentrations in Landfill Unit 2, but these data were not used quantitatively due to accuracy issues associated with older sampling techniques that may not have prevented VOC losses during sample transport and storage. VOC data for four downhole soil gas flux samples collected in 1999 and for passive soil gas samples collected in 1998 were also used qualitatively to verify the location of VOC concentrations in Landfill Unit 2.

Landfill Unit 2 soil sampling consisted of discretionary grab samples and soil boring samples collected at depths ranging from ground surface to 32.5 feet bgs. Cadmium, silver and carbon-14 soil sampling covers the lateral and vertical extent of the known potential source areas. The soil samples were collected and analyzed according to Superfund risk assessment data quality standards. These data are sufficient for characterizing the soil column in Landfill Unit 2. No data gaps were identified.

VOCs data from downgradient HSU-1 groundwater wells are representative of Landfill Unit 2 and the Eastern Trenches area. Concentrations of VOCs in soil gas at Landfill Unit 2 and the Eastern Trenches area are comparable, indicating both areas contribute significantly to VOC impacts measured in the downgradient HSU-1 groundwater wells. Wells UCD1-008 and UCD1-013 are downgradient of Landfill Unit 2, Eastern Trenches and Waste Burial Holes areas. Data Gaps grab groundwater samples collected in 2008 were located within Landfill Unit 2 and upgradient of all other VOC sources. The grab sample VOC results are representative of Landfill Unit 2. The Waste Burial Holes area contains significantly more carbon-14 contamination than the other two areas, indicating the Waste

Burial Holes area is the most likely source of carbon-14 in downgradient HSU-1 groundwater. These complications with distinguishing sources of contamination should be considered when evaluating Landfill Unit 2 groundwater impacts. Data Gaps grab groundwater sample LF2-4 is located near the southern boundary of Landfill Unit 2 and downgradient of the Waste Burial Holes area. The detected concentration of carbon-14 in sample LF2-4 likely originated from the Waste Burial Holes area.

D.2.3.5. Relation of Contaminants of Potential Groundwater Concern to Site Operations

Landfill Unit 2 was operated from 1956 to 1967 and contains waste materials composed of glass, metal and burned material including ash, charcoal and melted glass. The disposed wastes contained organic solvents, metals and carbon-14 constituents likely or known to be associated with LEHR Site operations.

Acetone and methyl ethyl ketone are common solvents that were possibly used in LEHR operations. Carbon disulfide may have been used as a non-polar solvent, but is commonly associated with the synthesis of organosulfur compounds. Chloroform was used at the Site and is a common anesthetizing agent and solvent. 1,1-dichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethene, 1,2-dichloropropane and 1,4-dioxane can be used as solvents or fumigants and are possibly associated with LEHR operations. Formaldehyde was used at the Site and its common uses include tissue fixative, disinfectant and embalming agent. The solvent tetrachloroethene is possibly associated with LEHR operations, but its use is commonly associated with dry cleaning operations. Toluene and xylenes are components of gasoline and are common non-polar solvents. As components of gasoline, toluene and xylenes were used at the Site. Cadmium is most commonly used in nickel-cadmium batteries and this type of battery was likely used at the Site. Silver has numerous applications including electronic equipment and was likely used at the Site. Carbon-14 is a radioactive tracer/radiolabel that was used in experiments at LEHR.

D.2.3.6. Risk Characterization Summary and Recommendations Regarding Contaminants of Concern at the Landfill Unit 2 Area

The risk characterization summary for Landfill Unit 2 is presented in Table D-20 and discussed below.

D.2.3.6.1. Acetone

Acetone was possibly used at the Site. The maximum concentration of acetone in downgradient HSU-1 groundwater was approximately two orders of magnitude below the RSL. These acetone groundwater data were frequently qualified due to laboratory contamination. Acetone was not detected in the Data Gaps grab groundwater samples. However, soil gas data indicate significant concentrations of acetone are present in vadose zone soil (3,900 $\mu g/m^3$ maximum). Modeling suggests acetone will reach a peak concentration of 2,200 μg/L in groundwater in 12 years, and this groundwater concentration is below the RSL of 22,000 μg/L. The modeling does not account for the rapid degradation of acetone that occurs in groundwater (Howard, 1991), however, so peak impact will likely

be significantly less than predicted. However, because the predicted groundwater impact is well above background, acetone should be retained as a COC.

D.2.3.6.2. Carbon Disulfide

Carbon disulfide was possibly used at the Site, but was detected only once in downgradient HSU-1 groundwater (less than 1% detection frequency) at a concentration more than three orders of magnitude below the RSL and two orders of magnitude below the CNL. Carbon disulfide was not detected in the Data Gaps grab groundwater samples. Carbon disulfide concentrations in soil gas were low (140 µg/m^3 maximum). Modeling suggests carbon disulfide will remain well below the RSL and CNL. Carbon disulfide should not be retained as a COC due to its low concentration and infrequent detection in groundwater, low concentration in soil gas and insignificant predicted impact.

D.2.3.6.3. Chloroform

Chloroform was used at the Site and is currently impacting groundwater above the MCL and California EPA cleanup goal. Chloroform in downgradient groundwater is likely combination of disposal trench/cell sources in Landfill Unit 2 and the Eastern Trenches area. Modeling suggests groundwater concentrations will peak above the groundwater goals in 24 years. Significant concentrations of chloroform were detected in soil gas (9,600 µg/m^3 maximum). Chloroform should be retained as a COC.

D.2.3.6.4. 1,1-Dichloroethane

1,1-dichloroethane was possibly used at the Site and is currently impacting downgradient HSU-1 groundwater above the MCL. Concentrations of 1,1-dichloroethane in downgradient groundwater likely originate from sources in the Eastern Trenches area and Landfill Unit 2. 1,1-dichloroethane was not detected in the Data Gaps grab groundwater samples. Modeling suggests groundwater concentrations will peak above the MCL in 10 years. The maximum detected concentration of 1,1-dichloroethane in soil gas was 1,600 µg/m^3. 1,1-dichloroethane should be retained as a COC.

D.2.3.6.5. 1,1-Dichloroethene

1,1-dichloroethene was possibly used at the Site. The concentration of 1,1-dichloroethene in downgradient HSU-1 wells has steadily declined throughout the past 10 year period and remained below the MCL (6 µg/L) in 2007, 2008 and the first half of 2009. A low concentration (0.7 µg/L) of 1,1-dichloroethene was detected in Data Gaps grab groundwater sample LF2-1. The maximum detected concentration of 1,1-dichloroethene in soil gas was 390 µg/m^3. Modeling suggests groundwater concentrations will remain below the MCL. 1,1-dichloroethene should not be retained as a COC due to its low concentration in downgradient HSU-1 groundwater, declining concentration trend, low mass in vadose zone soil gas and predicted impact below the MCL.

D.2.3.6.6. 1,2-Dichloropropane

1,2-dichloropropane was possibly used at the Site and is currently detected in downgradient HSU-1 groundwater at concentrations below the MCL. Concentrations of 1,2-

dichloropropane in downgradient groundwater likely originate from sources in the Eastern Trenches area and Landfill Unit 2. However, 1,2-dichloropropane was not detected in the Data Gaps grab groundwater samples. Modeling suggests groundwater concentrations will peak above the MCL in 10 years. The maximum detected concentration of 1,2-dichloropropane in soil gas was 910 µg/m^3. 1,2-dichloropropane should be retained as a COC.

D.2.3.6.7. 1,4-Dioxane

1,4-dioxane was possibly used at the Site. Although groundwater data are limited for 1,4-dioxane, the data indicate 1,4-dioxane is impacting downgradient HSU-1 groundwater above the CNL and RSL. Modeling suggests groundwater concentrations will peak above these goals in 8 years. 1,4-dioxane is a semivolatile organic compound and no soil sample data have been collected to characterize its presence or extent at Landfill Unit 2. Without soil data to define the 1,4-dioxane source it is not possible to determine whether the groundwater contamination is originating from the Eastern Trenches area, Waste Burial Holes area or Landfill Unit 2. 1,4-dioxane should be retained as a COC.

D.2.3.6.8. Formaldehyde

Formaldehyde was used at the Site. The only formaldehyde samples collected from downgradient HSU-1 groundwater monitoring wells within the past ten years were from wells UCD1-013 and UCD1-066 in 2009. Formaldehyde was not detected in either of the two samples. Low concentrations of formaldehyde (4 µg/L) were detected in two of three Data Gaps grab groundwater samples. The maximum formaldehyde concentration in soil gas was 175 µg/m^3. Formaldehyde is expected to biodegrade quickly upon reaching groundwater. Without degradation, modeling predicts formaldehyde will impact groundwater above the RSL and CNL in 9 years. Formaldehyde should not be retained as a COC because it is expected to biodegrade quickly upon reaching groundwater and recent groundwater monitoring data indicates that formaldehyde is not significantly impacting groundwater.

D.2.3.6.9. Methyl Ethyl Ketone

Methyl ethyl ketone was possibly used at the Site, but was not detected in the Data Gaps grab groundwater samples and has not been detected in downgradient HSU-1 groundwater since 2000. Modeling suggests groundwater concentrations will peak in 11 years, but remain well below the RSL. Concentrations of methyl ethyl ketone in soil gas were low (1.4 µg/m^3 to 61 µg/m^3). Methyl ethyl ketone should not be retained as a COC due to its low concentration (or possible absence) in groundwater, low soil gas concentrations, and insignificant predicted impact.

D.2.3.6.10. Tetrachloroethene

Tetrachloroethene was possibly used at the Site and was detected in downgradient HSU-1 groundwater at concentrations below the MCL. Tetrachloroethene was not detected in the Data Gaps grab groundwater samples. Modeling suggests groundwater concentrations are currently at their peak and will remain below the MCL. The maximum concentration of tetrachloroethene in soil gas was 2,600 µg/m^3. Tetrachloroethene should not be retained as a COC due to its current low concentration in groundwater and insignificant predicted impact.

D.2.3.6.11. Toluene

Toluene was used at the Site, but has not been detected in downgradient HSU-1 groundwater since 2002. Toluene was not detected in the Data Gaps grab groundwater samples. The maximum concentration of toluene in soil gas was 8,000 µg/m^3. Modeling suggests groundwater concentrations will peak in 13 years, but remain below the MCL. Toluene is expected to biodegrade quickly if it does reach groundwater. Toluene should not be retained as a COC due to its absence in groundwater, insignificant predicted impact and fast groundwater biodegradation rate.

D.2.3.6.12. 1,1,2-Trichloroethane

1,1,2-trichloroethane was possibly used at the Site. Groundwater monitoring data from downgradient HSU-1 monitoring wells indicate an overall declining concentration trend. 1,1,2-trichloroethane has been below the MCL (5 µg/L) in downgradient wells UCD1-012, UCD1-049 and UCD1-051 since 2005, but remained above the MCL in downgradient well UCD1-050 (24 µg/L on February 4, 2009). 1,1,2-trichloroethane was not detected in the Data Gaps grab groundwater samples. 1,1,2-trichloroethane was not detected in soil gas samples collected in 2008, but low concentrations were detected in soil samples collected 14 years ago. Assuming soil vapor concentrations at the maximum detection limit, modeling suggests groundwater concentrations could peak above the MCL in 12 years. 1,1,2-trichloroethane should not be retained as a COC due to its absence in soil gas and declining concentration in groundwater.

D.2.3.6.13. Xylenes

Xylenes were used at the Site but were not detected in groundwater. The maximum concentration of xylenes in soil gas was 320 µg/m^3. Modeling suggests xylenes have reached their peak concentration in groundwater and will remain below the MCL. Xylenes are expected to biodegrade quickly if they reach groundwater. Xylenes should not be retained as a COC due to their absence in groundwater, insignificant predicted impact and fast groundwater biodegradation rate.

D.2.3.6.14. Cadmium

Cadmium was possibly used at the Site. Concentrations of cadmium in downgradient HSU-1 groundwater were above background, but below the MCL. Cadmium was not detected in Data Gaps grab groundwater sample LF2-4. The maximum concentration of cadmium in Landfill Unit 2 soil was 6.7 mg/kg. Analytical uncertainty was identified for half of the cadmium soil sample results due to high detection limits. Modeling suggests that cadmium should be impacting groundwater at concentrations exceeding background and the MCL. Cadmium should be retained as a COC.

D.2.3.6.15. Silver

Silver was possibly used at the Site. Concentrations of silver in downgradient HSU-1 groundwater were above background and more than three orders of magnitude below the MCL. Silver was not detected in Data Gaps grab groundwater sample LF2-4. The maximum concentration of silver in Landfill Unit 2 soil was 38.1 mg/kg. Modeling suggests that silver

in Landfill Unit 2 will impact groundwater at concentrations above background and below MCL. Peak impact is predicted to occur in 5,000 years. Silver should not be retained as a COC due to its low concentration in groundwater, predicted impact below the MCL and predicted long time until peak impact.

D.2.3.6.16. Carbon-14

Carbon-14 was used at the Site and is currently above background and near the MCLs in downgradient HSU-1 groundwater. Carbon-14 was above background, but more than two orders of magnitude below the MCL in Data Gaps grab groundwater sample LF2-4. Most of the groundwater contamination is likely due to carbon-14 originating from the Waste Burial Holes area. Site characterization data indicate the Waste Burial Holes area contains significantly more carbon-14 contamination than Landfill Unit 2. However, modeling suggests that carbon-14 in Landfill Unit 2 will impact HSU-1 groundwater at concentrations above background and the MCL. Carbon-14 should be retained as a COC.

D.2.4. Landfill Unit 3

D.2.4.1. Groundwater Risk Estimate

The Landfill Unit 3 DL COPCs are acetone, formaldehyde, toluene, antimony, barium, cadmium, copper, manganese, silver, carbon-14, strontium-90, tritium and uranium-235. Maximum groundwater monitoring concentrations, maximum Site characterization concentrations and the NUFT modeling results for DL COPCs are shown in Table D-9. The three-step risk estimate is shown in Table D-15 and discussed below.

Step 1 (Groundwater Background Comparison) - DL COPCs groundwater data collected from downgradient HSU-1 wells UCD1-010 and UCD1-064 and Data Gaps grab groundwater sample LF3-2 (see Table 2-4) were compared to groundwater background. Acetone was detected in downgradient HSU-1 groundwater. Formaldehyde impacts in downgradient groundwater could not be evaluated in Step 1 of the risk estimate because no groundwater data were available within the past ten years. Toluene was not detected in samples collected from the downgradient HSU-1 wells. Antimony, barium, manganese, silver, strontium-90, tritium and uranium-235 concentrations in downgradient groundwater were below background. Antimony, barium, cadmium, manganese, silver, carbon-14, strontium-90, tritium and uranium-235 concentrations were below background in the Data Gaps grab groundwater sample. Cadmium, copper and carbon-14 concentrations in downgradient groundwater samples were above background. Copper was above background in the Data Gaps grab groundwater sample. Acetone, cadmium, copper and carbon-14 were identified as COPGWCs in risk estimate Step 1 due to their presence in disposal unit and/or downgradient HSU-1 groundwater (Table D-15).

Step 2 (Comparison of maximum soil (or soil gas) concentration to Background and NUFT Result) – Maximum soil gas concentrations and designated levels indicate formaldehyde will impact groundwater above the RSL and CNL and toluene will impact groundwater below the MCL. Based on the comparison, antimony, barium and manganese are predicted to impact groundwater above background and MCLs. Silver is predicted to impact groundwater above background. Modeling results and soil data indicate strontium-90

and uranium-235 will remain below background and the MCLs in groundwater. Tritium is predicted to impact groundwater above background and the MCL, but tritium is below background in soil. Strontium-90, tritium and uranium-235 were eliminated in Step 2 of the risk estimate (Table D-15).

Step 3 (Predicted Time to Peak Impact) – Modeling suggests formaldehyde, toluene and barium are at their peak concentrations in groundwater. Antimony, manganese and silver are predicted to reach their peak groundwater concentrations in 31,000 years, 480,000 years and 87,000 years, respectively. Antimony, manganese and silver were eliminated in Step 3 of the risk estimate.

Based on the groundwater risk estimate process, acetone, formaldehyde, toluene, barium, cadmium, copper and carbon-14 were retained for further evaluation as COPGWCs (Table D-15).

D.2.4.2. Percentage and Spatial Distribution of Samples Exceeding Background

VOCs exist at the northeast corner of Landfill Unit 3. Soil gas samples collected in 2008, during the Feasibility Study Data Gaps investigation, targeted the VOCs. Low concentrations of acetone, formaldehyde and toluene were detected in the soil gas samples. Acetone was detected at 5 feet bgs (160 $\mu g/m^3$) and 25 feet bgs (110 $\mu g/m^3$), but not at 15 feet bgs (67% detected). Formaldehyde was detected in all (100%) of the Landfill Unit 3 soil gas samples. Toluene was detected at 5 feet bgs (61 $\mu g/m^3$) and 25 feet bgs (89 $\mu g/m^3$), but not at 15 feet bgs (67% detected).

Eight out of 38 (21%) of the barium soil sample results exceeded background in Landfill Unit 3. Four of the above-background samples, including the highest detected barium concentration (968 mg/kg), were localized in the northeast quarter of this disposal area at depths ranging from 1.3 feet bgs to 32.5 feet bgs. Five other above-background samples, including the second highest barium concentration (500 mg/kg) were localized along an east-west line spanning the southern third of the area at depths ranging from 0.3 feet to 25 feet bgs.

Fourteen out of 38 (37%) of the cadmium soil sample results exceeded background in Landfill Unit 3. Groups of above-background samples were located in the northern and southern thirds of the landfill. The northern group consisted of 11 samples with cadmium concentrations ranging from 0.89 mg/kg to 20 mg/kg and depths ranging from 1.3 feet bgs to 32.5 feet bgs. The southern group consisted of three samples (1.7 mg/kg to 12 mg/kg) located at depths ranging from 4 feet bgs to 8.5 feet bgs.

Eleven out of 38 (29%) of the copper soil sample results exceeded background in Landfill Unit 3. Again, groups of above-background samples were located in the northern and southern thirds of the landfill. The northern group consisted of 7 samples with copper concentrations ranging from 84.8 mg/kg to 684 mg/kg and depths ranging from ground surface to 10 feet bgs. The southern group of above-background samples consists of three samples (82.1 mg/kg to 1,700 mg/kg) located at depths ranging from 0.3 feet bgs to 8.5 feet bgs.

Carbon-14 was detected above background in seven out of 38 sample results in the Landfill Unit 3 area (18% above background). All but one of the above-background samples were located in the northern third of the landfill. The maximum concentration (3.77 +/- 0. 45 pCi/g) was located at ground surface in the center of the northern group of above-background samples. The second highest concentration (1.29 +/- 0.66 pCi/g) was located at 14 feet bgs, directly below the Site maximum. The third highest concentration (1.25 +/- 0.64 pCi/g) was located at ground surface near the center of the landfill and surrounded by non-detect samples.

D.2.4.3. Degradation and Decay of Contaminants of Potential Concern

Acetone, formaldehyde and toluene are expected to degrade quickly upon reaching groundwater. The published range of degradation half lives for acetone in groundwater is 2 to 14 days, for formaldehyde in groundwater is several hours to 14 days, and for toluene in groundwater is 7 days to 4 weeks (Howard, 1991; Glancer-Soljan et al., 2001). See Section D.2.1.3 for additional discussion on formaldehyde degradation. Barium, cadmium and copper are assumed to not undergo significant degradation.

Carbon-14 is not a naturally occurring isotope and has a half life of 5,730 years.

D.2.4.4. Uncertainty

The objective of this section is to discuss the major sources of uncertainty that are specific to the assessment of Landfill Unit 3.

D.2.4.4.1. Analytical Issues

Soil gas samples collected in 2008 were used to characterize VOC distribution in Landfill Unit 3. No analytical issues were identified for acetone, formaldehyde and toluene soil gas data.

Soil sample data were used to characterize barium, cadmium, copper and carbon-14 at Landfill Unit 3. Barium and copper were detected in all of the soil characterization samples with no data validation qualifiers.

None of the 38 cadmium results were qualified, but twenty-four results were not detected with detection limits above background (0.51 mg/kg). The range of above-background detection limits for non-detect results was 1 mg/kg to 1.3 mg/kg. Above-background cadmium concentrations could exist at 24 sample locations, but the non-detect results show that the concentrations did not exceed background by more than a factor of 2.5.

Six out of 38 of the carbon-14 results were qualified as approximate (J) due to matrix spike recovery outside control limits. One result was qualified for trace activity-concentration above the detection limit (J) and two for trace activity-concentration below the detection limit (UJ). Adding or subtracting the counting error to these trace results would place the activity-concentration above or below the detection limit, respectively.

D.2.4.4.2. Data Representativeness

Soil gas samples collected in 2008, during the Feasibility Study Data Gaps Investigation, targeted VOCs contamination in the northeast corner of Landfill Unit 3. The 2008 soil gas data provided quantitative vertical characterization of the source area, but did not delineate the lateral extent. VOC migration is not expected to extend a significant lateral distance beyond the Landfill Unit 3 boundary due to low concentrations in soil gas and low permeability native soil surrounding the landfill. Previous soil gas analyses did not detect significant VOCs in Landfill Unit 3 (Weiss, 2008). VOC data from soil samples collected in 1995 and 1996 were used qualitatively to verify the location of VOC concentrations in Landfill Unit 3, but these data were not used quantitatively due to accuracy issues associated with older sampling techniques that may not have prevented VOC losses during sample transport and storage.

Landfill Unit 3 soil sampling consisted of discretionary grab samples and soil boring samples collected at depths ranging from ground surface to 35 feet bgs. Barium, cadmium, copper and carbon-14 soil sampling covers the lateral and vertical extent of the known potential source areas. The soil samples were collected and analyzed according to Superfund risk assessment data quality standards. These data are sufficient for characterizing the soil column at Landfill Unit 3. No data gaps were identified.

Downgradient groundwater sample data used in this evaluation were from wells UCD1-010 and UCD1-064. The HSU-1 groundwater flow direction is generally toward the northeast. Well UCD1-010 is located at the northeast corner of Landfill Unit three and well UCD1-064 is located at the east boundary. Both wells are downgradient of Landfill Unit 3. Well UCD1-064 was recently installed and sampled once at the time this evaluation was conducted. A limited number of samples were collected from well UCD1-010 during the past ten years. One sample each was collected from wells UCD1-010 and UCD1-064 for barium, cadmium and copper analysis. Four carbon-14 samples were collected from UCD1-010 and one carbon-14 sample was collected from UCD1-064. Fourteen VOC (acetone and toluene) samples were collected from UCD1-010 and one VOC sample was collected from UCD1-064. Well UCD1-064 was sampled for formaldehyde in 2009, but the container broke during transit to the laboratory. No groundwater data were available for formaldehyde. On September 19, 2008, Data Gaps grab groundwater sample LF3-2 was collected at the downgradient northeast corner of Landfill Unit 3 and was analyzed for antimony, barium, cadmium, copper, manganese, silver, carbon-14, strontium-90, tritium and uranium-235.

The Data Gaps grab groundwater sample and groundwater monitoring data collected at wells UCD1-010 and UCD1-064 are considered representative of Landfill Unit 3. Landfill Unit 1 is located upgradient to crossgradient and approximately 700 feet from Landfill Unit 3. The Waste Burial Holes area, Landfill Unit 2 and Eastern Trenches area are located mostly crossgradient and approximately 1,200 feet from Landfill Unit 3.

D.2.4.5. Relation of Contaminants of Potential Groundwater Concern to Site Operations

Waste materials were disposed at Landfill Unit 3 from 1963 to 1967. Glass, rusted metal, concrete, gravel, bricks, ceramic material and other household and laboratory wastes were identified during investigations of the area.

Acetone is a common solvent that was possibly disposed at Landfill Unit 3. Formaldehyde was used at LEHR/SCDS and its general uses include tissue fixative, disinfectant and embalming agent. Toluene is a component of gasoline and is a common non-polar solvent. As a component of gasoline, toluene was used at the Site. Barium was possibly used at the Site and its common uses include drilling mud, radiocontrast agent for X-ray imaging and rat poison. Cadmium is most commonly used in nickel-cadmium batteries and this type of battery was likely used at the Site. Copper is a common conductive metal and was undoubtedly disposed at Landfill Unit 3. Carbon-14 is a radioactive tracer/radiolabel that was used in experiments at LEHR.

D.2.4.6. Risk Characterization Summary and Recommendations Regarding Contaminants of Concern at Landfill Unit 3

The risk characterization summary is presented in Table D-21 and discussed below.

D.2.4.6.1. Acetone

Acetone was possibly used at the Site. The maximum concentration of acetone in downgradient HSU-1 groundwater was more than three orders of magnitude below the RSL. Soil gas data indicate low concentrations of acetone are present in vadose zone soil (160 $\mu g/m^3$ maximum). Modeling suggests acetone has reached its peak concentration in groundwater and will remain far below the RSL. Acetone should not be retained as a COC because it has low toxicity, it degrades rapidly in groundwater, its maximum concentration in groundwater was more than three orders of magnitude below the RSL and modeling suggests it will remain far below the RSL.

D.2.4.6.2. Formaldehyde

Formaldehyde was used at LEHR/SCDS. A formaldehyde sample was collected from downgradient well UCD1-064 in May 2009, but the container broke during transport to the laboratory. Therefore, no data are available to evaluate formaldehyde presence in groundwater. The maximum concentration of formaldehyde in soil gas was 121 $\mu g/m^3$, which is lower than maximum concentrations in Landfill Unit 2. Modeling predicts formaldehyde should be impacting groundwater above the RSL and CNL; however, formaldehyde is expected to biodegrade quickly upon reaching groundwater. Formaldehyde is not retained as a COC at this time based on low soil gas concentrations, biodegradability in groundwater, and lack of groundwater impact downgradient of Landfill Unit 2, which had higher formaldehyde concentrations in soil gas. The decision to include formaldehyde will be revisited when groundwater data for well UCD1-064 are available later in 2010.

D.2.4.6.3. Toluene

Toluene was used at the Site, but was not detected in downgradient HSU-1 groundwater and is expected to biodegrade quickly if it does reach groundwater. Concentrations of toluene in soil gas were low (61 µg/m^3 to 89 µg/m^3) and modeling suggests groundwater concentrations will remain below the MCL. Toluene should not be retained as a COC due to its absence in groundwater, low concentration soil gas, insignificant predicted impact and fast groundwater biodegradation rate.

D.2.4.6.4. Barium

Barium was possibly used at the Site. Concentrations of barium in HSU-1 groundwater were below background and the MCL. The maximum concentration of barium in soil was 968 mg/kg. Modeling suggests that barium in Landfill Unit 3 should be impacting groundwater at concentrations exceeding background and the MCL. Although there is no current evidence of groundwater impact from barium, it was retained as a COC to be conservative. This decision will be revisited when additional groundwater barium data are available later in 2010.

D.2.4.6.5. Cadmium

Cadmium was possibly used at the Site. Concentrations of cadmium in downgradient HSU-1 groundwater were above background, but below the MCL. Cadmium was not detected in Data Gaps grab groundwater sample LF3-2. The maximum concentration of cadmium in Landfill Unit 2 soil was 20 mg/kg. Analytical uncertainty was identified for half of the cadmium soil sample results due to high detection limits. Modeling suggests that cadmium should be impacting groundwater at concentrations exceeding background and the MCL. Cadmium should be retained as a COC.

D.2.4.6.6. Copper

Copper was used at the Site. Concentrations of Copper in groundwater were above background, but more than two orders of magnitude below the MCL. High concentrations of copper were detected in soil (1,700 mg/kg maximum). Modeling suggests that copper in Landfill Unit 3 will impact groundwater at concentrations exceeding background and the MCL, but the peak impact will not occur until 4,000 years. Copper should be retained as a COC due to its presence in groundwater and predicted impact.

D.2.4.6.7. Carbon-14

Carbon-14 was used at the Site and is currently above background, but more than two orders of magnitude below the MCL in downgradient HSU-1 groundwater. Carbon-14 was not detected in Data Gaps grab groundwater sample LF3-2. The maximum detected concentration in soil was 3.77 +/- 0.45 pCi/g. Modeling suggests that carbon-14 in Landfill Unit 3 will impact local groundwater at concentrations exceeding background and the MCL. Carbon-14 should be retained as a COC.

D.2.5. Southern Trenches Area

D.2.5.1. Groundwater Risk Estimate

The Southern Trenches DL COPCs are acetone, carbon disulfide, methyl ethyl ketone, styrene and toluene. Maximum groundwater monitoring concentrations, maximum Site characterization concentrations and the NUFT modeling results for DL COPCs are shown in Table D-10. The three-step risk estimate is shown in Table D-16 and discussed below.

Step 1 (Groundwater Background Comparison) - DL COPCs groundwater data collected from downgradient HSU-1 wells UCD1-008, UCD1-013 and UCD1-024 and Data Gaps grab groundwater sample ST-1 (see Table 2-4) were compared to groundwater background. Acetone was detected in the Data Gaps grab groundwater sample and downgradient HSU-1 groundwater and identified as a COPGWC in risk estimate Step 1 (Table D-16). Carbon disulfide, methyl ethyl ketone, styrene and toluene were not detected in samples collected from the downgradient HSU-1 wells or the Data Gaps grab groundwater sample.

Step 2 (Comparison of maximum soil gas concentrations to Background and NUFT Results) – Modeling results indicate it is unlikely that the low concentrations of carbon disulfide and styrene detected in the Southern Trenches area soil gas samples will impact groundwater. Modeling results and soil gas data indicate methyl ethyl ketone and toluene will be detected in local groundwater but remain below the RSL and MCL, respectively. Carbon disulfide and styrene were eliminated in Step 2 of the risk estimate (Table D-16).

Step 3 (Predicted Time to Peak Impact) – Modeling predictions indicate methyl ethyl ketone and toluene have reached their peak concentrations in groundwater. No DL COPCs were eliminated in Step 3 of the risk estimate.

Based on the groundwater risk estimate process, acetone, methyl ethyl ketone and toluene were retained for further evaluation as COPGWCs.

D.2.5.2. Percentage and Spatial Distribution of Samples Exceeding Background

Soil gas samples collected in 2008, during the Feasibility Study Data Gaps investigation targeted VOCs at the west end of the Southern Trenches area. Acetone, methyl ethyl ketone and toluene were detected in all of the soil gas samples (100% detected). The highest soil gas VOC concentration was 300 $\mu g/m^3$ of acetone at 25 feet bgs. Concentrations of acetone at 5 feet bgs and 15 feet bgs were 74 $\mu g/m^3$ and 63 $\mu g/m^3$, respectively. Methyl ethyl ketone concentrations in soil gas ranged from 7.2 $\mu g/m^3$ to 19 $\mu g/m^3$ and toluene concentrations ranged from 17 $\mu g/m^3$ to 34 $\mu g/m^3$.

D.2.5.3. Degradation and Decay of Contaminants of Potential Concern

Acetone and toluene is expected to degrade quickly upon reaching groundwater. The published range of degradation half lives for acetone in groundwater is 2 to 14 days and for toluene in groundwater is 7 days to 4 weeks (Howard, 1991). Although methyl ethyl ketone

may also rapidly degrade in groundwater, no degradation is assumed for the purposes of this evaluation.

D.2.5.4. Uncertainty

The objective of this section is to discuss the major sources of uncertainty that are specific to the assessment of the Southern Trenches area.

D.2.5.4.1. Analytical Issues

Soil gas samples collected in 2008 were used to characterize VOC distribution in the Southern Trenches Area. Acetone, methyl ethyl ketone and toluene soil gas data had no validation qualifiers and all of the concentrations were detected within the calibrated range. The soil gas samples have no data quality issues.

D.2.5.4.2. Data Representativeness

Soil gas samples collected in 2008, during the Feasibility Study Data Gaps Investigation, targeted VOCs contamination at the west end of the Southern Trenches area. The 2008 soil gas data provided quantitative vertical characterization of the source area, but did not delineate the lateral extent. VOC migration is not expected to extend a significant distance laterally beyond the Southern Trenches area due to low permeability native soil surrounding the disposal trenches. Previous soil gas analyses showed no significant VOCs in the area (Weiss, 2008a). VOC data from soil samples collected in 1996 were used qualitatively to verify the location of VOC concentrations in the Southern Trenches area, but these data were not used quantitatively due to accuracy issues associated with older sampling techniques that may not have prevented VOC losses during sample transport and storage.

VOCs data from downgradient HSU-1 groundwater wells UCD1-008 and UCD1-013 represent combined impacts from the Southern Trenches area, Landfill Unit 2 and Eastern Trenches area. Landfill Unit 2 and the Eastern Trenches area contain significantly more VOCs contamination than the Southern Trenches area and are closer to downgradient wells UCD1-008 and UCD1-013. Because the VOCs detected in the Southern Trenches are not unique to this are, the small fraction of Southern Trenches area VOCs reaching wells UCD1-008 and UCD1-013 may not be distinguishable from the larger Landfill Unit 2 and the Eastern Trenches area contributions. Well UCD1-024 is upgradient of Landfill Unit 2 and the Eastern Trenches area. There are other upgradient sources in DOE areas, but DOE areas do not contain VOC contamination. Therefore, VOC data from well UCD1-024 are considered representative of the Southern Trenches area. Data Gaps grab groundwater sample ST-1 was collected near the west end of the Southern Trenches area. This grab sample location is upgradient of other potential sources and is likely representative of the Southern Trenches area.

D.2.5.5. Relation of Contaminants of Potential Groundwater Concern to Site Operations

The Southern Trenches are two east-west oriented trenches that were operated between 1957 and 1965 (UC Davis, 2004). Waste materials identified in the trenches during

investigation activities include gravel, bones, animal feces and small amounts of laboratory waste.

Acetone is potentially associated with LEHR operations and is a common solvent for rinsing laboratory glassware due to its low cost, volatility, and ability to dissolve in water. Methyl ethyl ketone is another common solvent with properties similar to acetone and was possibly used in LEHR operations. Toluene is a component of gasoline and is a common non-polar solvent. As a component of gasoline, toluene was used at the Site.

D.2.5.6. Risk Characterization Summary and Recommendations Regarding Contaminants of Concern at the Southern Trenches Area

The risk characterization summary is presented in Table D-22 and discussed below.

D.2.5.6.1. Acetone

Acetone was possibly used at the Site. Maximum concentrations of acetone in downgradient HSU-1 groundwater and the Data Gaps grab groundwater sample were more than three orders of magnitude below the RSL. Soil gas data indicate acetone is present in vadose zone soil (300 µg/m^3 maximum). Modeling suggests acetone has reached its peak concentration in groundwater and will remain far below the RSL. Acetone should not be retained as a COC because it has low toxicity, it degrades quickly in groundwater, its maximum concentration in groundwater was more than three orders of magnitude below the RSL and modeling suggests acetone will remain far below the RSL.

D.2.5.6.2. Methyl Ethyl Ketone

Methyl ethyl ketone was possibly used at the Site, but was not detected in groundwater. Modeling suggests groundwater concentrations have reached their peak and will remain well below the RSL. Concentrations of methyl ethyl ketone in soil gas were low (7.2 µg/m^3 to 19 µg/m^3). Methyl ethyl ketone should not be retained as a COC due to its absence in groundwater, low soil gas concentrations and insignificant predicted impact.

D.2.5.6.3. Toluene

Toluene was used at the Site, but was not detected in groundwater and is expected to biodegrade quickly if it does reach groundwater. Concentrations of toluene in soil gas were low (17 µg/m^3 to 34 µg/m^3) and modeling suggests groundwater concentrations have reached their peak and will remain far below the MCL. Toluene should not be retained as a COC due to its absence in groundwater, low concentration soil gas, insignificant predicted impact and fast groundwater biodegradation rate.

D.2.6. Waste Burial Holes Area

D.2.6.1. Groundwater Risk Estimate

The Waste Burial Holes DL COPCs are acetone, benzene, chloroform, 1,3-dichlorobenzene, 1,4-dioxane, formaldehyde, methyl ethyl ketone, toluene, carbon-14, strontium-90, tritium and uranium-238. Maximum groundwater monitoring concentrations,

maximum Site characterization concentrations and the NUFT modeling results for DL COPCs are shown in Table D-11. The three-step risk estimate is shown in Table D-17 and discussed below.

Step 1 (Groundwater Background Comparison) - DL COPCs groundwater data collected from downgradient HSU-1 wells UCD1-008, UCD1-013 and UCD1-065 were compared to groundwater background. It should be noted that wells UCD1-008 and UCD1-013 are also downgradient of higher concentration VOC sources in Landfill Unit 2 and the Eastern Trenches area. Benzene, chloroform and 1,4-dioxane were detected in downgradient HSU-1 groundwater. Acetone, 1,3-dichlorobenzene, formaldehyde, methyl ethyl ketone and toluene were not detected. Carbon-14 and tritium concentrations in groundwater samples were significantly above background. Strontium-90 and uranium-238 were below background. Benzene, chloroform, 1,4-dioxane, carbon-14 and tritium were identified as COPGWCs in risk estimate Step 1 due to their presence above background in downgradient HSU-1 groundwater (Table D-17).

Step 2 (Comparison of maximum soil (or soil gas) concentration to Background and NUFT Result) –Modeling results and soil gas data indicate 1,3-dichlorobenzene will impact groundwater above the MCL and formaldehyde will impact groundwater above the RSL and CNL. Based on the comparison, acetone and methyl ethyl ketone will be detected in local groundwater, but remain below the RSLs. Toluene is predicted to impact groundwater below the MCL. Soil data and modeling results indicate strontium-90 will remain below groundwater background and the MCL. Uranium-238 is predicted to impact groundwater above the MCL, but below groundwater background (uranium-238 MCL is below background). Strontium-90 was eliminated in Step 2 of the risk estimate (Table D-17). Methyl ethyl ketone was also eliminated in Step 2 because it was not detected in soil gas and the detection limit was reasonably low (34 $\mu g/m^3$).

Step 3 (Predicted Time to Peak Impact) – Modeling predictions indicate acetone, 1,3-dichlorobenzene, formaldehyde and toluene have reached their peak concentrations in groundwater. Uranium-238 is predicted to reach its peak concentration in 11,000 years and was eliminated in Step 3 of the risk estimate.

Based on the groundwater risk estimate process, all of the DL COPCs except methyl ethyl ketone, strontium-90 and uranium-238 were retained for further evaluation as COPGWCs.

D.2.6.2. Percentage and Spatial Distribution of Samples Exceeding Background

Soil gas samples collected in 2008, during the Feasibility Study Data Gaps investigation targeted VOCs at the east end of the Waste Burial Holes area. The VOC concentrations were generally low or not detected. Acetone was detected at 5 feet bgs (140 $\mu g/m^3$) and 25 feet bgs (140 $\mu g/m^3$), but not at 15 feet bgs (67% detected). Benzene and chloroform were not detected in any of the soil gas samples (0% detected). 1,3-Dichlorobenzene was detected in the sample collected at 25 feet bgs (79 $\mu g/m^3$) but not detected at 5 feet bgs or 15 feet bgs (33% detected). Formaldehyde was detected in all (100%) of the Waste Burial Holes soil gas samples. Toluene was detected in all (100%) of the Waste Burial Holes soil gas samples and had a maximum concentration of 110 $\mu g/m^3$.

No spatial distribution data were available for 1,4-dioxane.

Fifty-nine out of 108 (55%) of the carbon-14 soil sample results exceeded background in the Waste Burial Holes area. The highest concentration of carbon-14 was in an isolated sample (1,442 +/- 84 pCi/g) and its field duplicate (100 +/- 13 pCi/g) located in the northwest corner of the Waste Burial Holes area at 7 feet bgs. Carbon-14 was below background (or not detected) in all of the samples surrounding the maximum. A cluster of above-background carbon-14 activity-concentrations (0.415 +/- 0.238 pCi/g to 15.7 +/- 7.3 pCi/g) were located in/below sorted soil backfill in the eastern half of the area at depths ranging from 3.5 feet bgs to 19 feet bgs. Another cluster of above-background carbon-14 activity-concentrations were located in/below sorted soil backfill in the northwestern quarter of the area, but separate from the maximum.

Fifty-seven out of 108 (53 %) of the tritium soil sample results exceeded background in the Waste Burial Holes area. The highest tritium concentration (902 +/- 8.09 pCi/g) was located at the west end of the northwest volume of sorted soil backfill at 9 feet bgs. Above-background tritium concentrations are distributed throughout the northwest volume of sorted soil backfill. Significant tritium concentrations (up to 133 +/- 6.06 pCi/g) are also located below excavated holes in the eastern half of the area, near the north border.

D.2.6.3. Degradation and Decay of Contaminants of Potential Concern

Acetone, formaldehyde and toluene are expected to biodegrade quickly upon reaching groundwater. The published range of biodegradation half lives for acetone and formaldehyde in groundwater is 2 to 14 days, and the published range for toluene is 7 days to 4 weeks (Howard, 1991). See Section D.2.1.3 for additional discussion on formaldehyde degradation. Although benzene, chloroform, 1,3-dichlorobenzene and 1,4-dioxane may also degrade in groundwater, no degradation was assumed for the purposes of this evaluation.

Carbon-14 is not a naturally occurring isotope and has a half life of 5,730 years. Tritium occurs naturally through atmospheric processes, but does not accumulate, and its natural abundance is negligible. Tritium has a half life of 12.33 years.

D.2.6.4. Uncertainty

The objective of this section is to discuss the major sources of uncertainty that are specific to the assessment of the Waste Burial Holes area.

D.2.6.4.1. Analytical Issues

Soil gas samples collected in 2008 were used to characterize VOC distribution in the Waste Burial Holes Area. Acetone, benzene, chloroform, 1,3-dichlorobenzene, 1,4-dioxane, formaldehyde and toluene soil gas data had no validation qualifiers.

No 1,4-dioxane soil sample data were available.

Soil sample data were used to characterize carbon-14 and tritium in the Waste Burial Holes area. Twenty-one of 93 carbon-14 results were qualified as approximate (J), including sixteen above-background results. Thirty-nine of the carbon-14 results were not detected, but

the detection limits ranging from 0.131 pCi/g to 11 pCi/g were above background (<0.13 pCi/g). These non-detect data were treated as background in this evaluation, but it is uncertain whether the soil represented by these samples is below background due to the above-background detection limits. None of the radioanalytical laboratories considered for analysis of the data gaps investigation samples collected in 2008 were capable of achieving detection limits below the carbon-14 background level. Carbon-14 detection limits achieved by the selected laboratory for the 2008 data gaps samples ranged from 0.87 pCi/g to 0.94 pCi/g. Thus, the existing carbon-14 background value is not a practical basis for background comparisons.

Sixteen of 93 tritium results were qualified as approximate (J), including twelve above-background results. Again, thirty-nine results were not detected, but the detection limits ranging from 1.54 pCi/g to 6.43 pCi/g were above background (<1.2 pCi/g). These non-detect data were treated as below background in this evaluation, but it is uncertain whether the soil represented by these samples is below background due to the above-background detection limits. The Data Gaps samples collected in 2008 had detection limits below tritium background.

D.2.6.4.2. Data Representativeness

Soil gas samples collected in 2008, during the Feasibility Study Data Gaps Investigation, targeted VOCs contamination at the east end of the Waste Burial Holes area. The 2008 soil gas data provided quantitative vertical characterization of the source area, but did not delineate the lateral extent. VOC migration is not expected to extend a significant distance laterally beyond the Waste Burial Holes area due to low permeability native soil surrounding the area. VOC data from soil samples collected in 1995, 1996 and 1999 and from previous passive soil gas samples were used qualitatively to verify the location of VOC concentrations in the Waste Burial Holes Area, but these data were not used quantitatively.

Waste Burial Holes area soil sampling consisted of discretionary grab samples and soil boring samples collected at depths ranging from ground surface to 35 feet bgs. Carbon-14 and tritium soil sampling covers the lateral and vertical extent of the known potential source areas. The soil samples were collected and analyzed according to Superfund risk assessment data quality standards. These data are sufficient for characterizing the soil column in the Waste Burial Holes area. No data gaps were identified.

Sample data from downgradient HSU-1 groundwater wells UCD1-008 and UCD1-013 may represent combined impacts from the Waste Burial Holes area, Eastern Trenches area and Landfill Unit 2. Wells UCD1-008 and UCD1-013 are likely representative of carbon-14 and tritium released from the Waste Burial Holes area because this area is known to contain significantly more carbon-14 and tritium contamination than the other areas. The Eastern Trenches area and Landfill Unit 2 contain more VOCs contamination than the Waste Burial Holes area. VOCs detected in samples collected from wells UCD1-008 and UCD1-013 most likely originate from the Eastern Trenches area and/or Landfill Unit 2. Well UCD 1-65 is located near the east border of the Waste Burial Holes area, away from other areas' sources. Therefore, well UCD 1-65 is considered representative of the Waste Burial Holes area.

D.2.6.5. Relation of Contaminants of Potential Groundwater Concern to Site Operations

From 1956 to 1974, waste materials including low-level radioactive materials, laboratory chemicals, vials, syringes, laboratory glassware and animal carcasses were disposed in waste burial holes. In 1999, the area was excavated to 12 feet bgs, waste materials were sorted from soil and the sorted soil was backfilled. Sorted waste was disposed off-site.

Acetone was possibly associated with LEHR operations and is a common solvent for rinsing laboratory glassware due to its low cost, volatility, and ability to dissolve in water. Benzene and toluene are components of gasoline and were common non-polar solvents at the time the Waste Burial Holes area was operational. As components of gasoline, benzene and toluene were used at the Site. Chloroform was used at the Site and is a common anesthetizing agent and solvent. 1,3-dichlorobenzene can be used as a solvent and was possibly associated with LEHR operations. Formaldehyde was used at the Site and its common uses include tissue fixative, disinfectant and embalming agent. 1,4-dioxane can be used as a solvent or fumigant and was possibly associated with LEHR operations. Tritium and carbon-14 are radioactive tracers/radiolabels that were used in experiments at LEHR.

D.2.6.6. Risk Characterization Summary and Recommendations Regarding Contaminants of Concern at the Waste Burial Holes Area

The risk characterization summary is presented in Table D-23 and discussed below.

D.2.6.6.1. Acetone

Acetone was possibly used at the Site, but was not detected in downgradient HSU-1 groundwater. Soil gas data indicate low concentrations of acetone are present in vadose zone soil (140 $\mu g/m^3$ maximum). Modeling suggests acetone has reached its peak concentration in groundwater and will remain far below the RSL. Acetone should not be retained as a COC because it has low toxicity, it degrades quickly in groundwater, was not detected in groundwater and modeling suggests it will remain far below the RSL.

D.2.6.6.2. Benzene

Benzene was used at the Site, and was detected in one of 15 downgradient HSU-1 groundwater samples. The single detected groundwater concentration was below the MCL. Benzene was not detected in soil gas. Modeling suggests the concentration of benzene in groundwater has reached its peak and will remain below the MCL. Benzene should not be retained as a COC due to its low concentration (or absence) in groundwater, absence in soil gas and insignificant predicted groundwater impact.

D.2.6.6.3. Chloroform

Chloroform was used at the Site and detected in downgradient HSU-1 groundwater at concentrations below the MCL and California EPA cleanup goal. The concentrations in groundwater were likely from chloroform sources in Landfill Unit 2 and/or the Eastern Trenches area. Chloroform was not detected in Waste Burial Holes soil gas samples.

Modeling suggests groundwater concentrations have reached their peak and will remain below the MCL and California EPA cleanup goal. Chloroform should not be retained as a COC due to its low concentration in downgradient HSU1 groundwater, absence in soil gas and insignificant predicted groundwater impact.

D.2.6.6.4. 1,3-Dichlorobenzene

1,3-dichlorobenzene was possibly used at the Site, but was not detected in downgradient HSU-1 groundwater. Modeling suggests 1,3-dichlorobenzene will impact groundwater at concentrations slightly above the MCL. Modeling also indicates groundwater concentrations have reached their peak. 1,3-dichlorobenzene was detected in one soil gas sample at a concentration of 79 µg/m^3. 1,3-dichlorobenzene should not be retained as a COC due to its absence in groundwater, low concentration in soil gas and low predicted groundwater impact.

D.2.6.6.5. Formaldehyde

Formaldehyde was used at the Site, but was not detected in the sample collected in 2009 from downgradient HSU-1 monitoring well UCD1-065 (only downgradient formaldehyde sample within past ten years). A low concentration of formaldehyde (5 µg/L) was detected in the one Data Gaps grab groundwater sample in the Waste Burial Holes. Modeling predicts formaldehyde will impact groundwater above the RSL and CNL, but modeling predictions also indicate groundwater concentrations have reached their peak. Formaldehyde is expected to biodegrade quickly upon reaching groundwater. Formaldehyde should not be retained as a COC because it is expected to biodegrade quickly upon reaching groundwater and recent groundwater monitoring data indicates that formaldehyde is not impacting groundwater.

D.2.6.6.6. 1,4-Dioxane

1,4-dioxane was possibly used at the Site. Although 1,4-dioxane groundwater data are limited, the existing data indicate 1,4-dioxane is impacting downgradient HSU-1 groundwater above the CNL and RSL. Modeling suggests 1,4-dioxane has reached its peak concentration in groundwater. 1,4-dioxane is a semivolatile organic compound and no soil sample data have been collected to characterize its presence or extent in the Waste Burial Holes area. 1,4-dioxane should be retained as a COC.

D.2.6.6.7. Toluene

Toluene was used at the Site, but was not detected in downgradient HSU-1 groundwater and is expected to biodegrade quickly if it does reach groundwater. Concentrations of toluene in soil gas were low (110 µg/m^3 maximum) and modeling suggests groundwater concentrations will remain below the MCL. Toluene should not be retained as a COC due to its absence in groundwater, low concentration soil gas, insignificant predicted impact and fast groundwater biodegradation rate.

D.2.6.6.8. Carbon-14 and Tritium

Carbon-14 and tritium were used at the Site and are currently above background and near the MCLs in downgradient HSU-1 groundwater. Most of the carbon-14 and tritium contamination in downgradient HSU-1 groundwater is likely due to sources in the Waste Burial Holes area. Maximum concentrations of carbon-14 and tritium in Waste Burial Holes area soil samples were 1,442 +/- 84 pCi/g and 902 +/- 8.09 pCi/g, respectively. Modeling suggests that carbon-14 and tritium in the Waste Burial Holes area will impact HSU-1 groundwater at concentrations above background and the MCL. Carbon-14 and tritium should be retained as COCs.

D.3. REFERENCES CITED

California Department of Public Health (CDPH), 2009, Chemicals and Contaminants in Drinking Water, http://ww2.cdph.ca.gov/certlic/drinkingwater/Pages/Chemicalcontaminants.aspx, Update February, 24, 2009.

Central Valley Regional Water Quality Control Board (CRWQCB), CVR (1989), The Designated Level Methodology for Waste Classification and Cleanup Level Determination, June.

Daniel B. Stephens & Associates, Inc. (DB Stephens), 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.

DB Stephens, 2008, Laboratory Report for Weiss Associates (Project 388-1856-1-32), December 12, 2008.

Eiroa, M., Kennes, C., and M. C. Veiga. 2004. *Formaldehyde and urea removal in a denitrifying granular sludge blanket reactor*. Water Research, Vol. 38 (16) 3495-3502.

Eiroa, M., Vilar, A., Kennes, C., and M. C. Veiga. 2005. *Formaldehyde biodegradation in the presence of methanol under denitrifying conditions*. Journal of Chemical Technology & Biotechnology, Vol. 8, November 21.

Glancer-Soljan, M., Soljan, V., Dragicevic T.L. and L. Cacic. 2001. *Aerobic Degradation of Formaldehyde in Wastewater from the Production of Melamine Resins*. Food technol. biotechnol. 39(3) 197–202.

Howard, P.H., Boethling, R.S., Jarvis, W.F., Meylan, W.M., Michalenko, E.M., 1991, Handbook of Environmental Degradation Rates, Lewis Publishers.

Lee, K.H., A. Kulshrestha, and J.J. Nitao (1993), Interim Report on Verification and Benchmark Testing of the NUFT Computer Code, Lawrence Livermore National Laboratory, Livermore, CA (UCRL-ID-113521).

Leungprasert, S. and L. Otten. *Fate of Formaldehyde in MDF Sawdust during MSW Composting*, School of Engineering, University of Guelph, Guelph, Ontario. North Carolina Division of Pollution Prevention and Environmental Assistance, December 29, 2009, http://www.p2pays.org/COMPOST/presentpubs.asp.

Nitao, J.J. (1996), Reference Manual for the NUFT Flow and Transport Code, Lawrence Livermore National Laboratory, Livermore, CA (UCRL-ID-113520).

Omil, F., Méndez, D., Vidal, G., Méndez R. and J. M. Lema. 1999. *Biodegradation of formaldehyde under anaerobic conditions*. Enzyme and Microbial Technology, Vol. 24, April 1.

United States Environmental Protection Agency (EPA), 2008, Region 9, Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, http://www.epa.gov/region09/superfund/RSL/index.html, September 2008.

Weiss Associates (Weiss), 1997, Draft Final One-Dimensional Vadose Zone Modeling for the U.S. Department of Energy Areas at the Laboratory for Energy-Related Health Research, University of California at Davis, California, April.

Weiss, 2000, Work Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas, at the Laboratory for Energy-Related Health Research, University of California at Davis, July 24, 2000, Rev. 0.

Weiss, 2001, Final Southwest Trenches Area 1998 Removal Action Confirmation Report for the Laboratory for Energy-Related Health Research, University of California, Davis, June 13, 2001, Rev. 0.

Weiss, 2002, Final Radium/Strontium Treatment Systems Area Removal Action Confirmation Report for the Laboratory for Energy-Related Health Research, University of California, Davis, July 5, 2002, Rev. 1.

Weiss, 2003, DOE Areas Remedial Investigation Report for the Laboratory for Energy-Related Health Research, University of California, Davis, September 18, 2003, Rev. 0.

Weiss, 2008, Feasibility Study Data Gaps Work Plan at the Laboratory For Energy-Related Health Research/ South Campus Disposal Site, University of California, Davis, August 26, 2008, Rev. 0.

TABLES

Table D-1. Representative Soil Profiles, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Eastern Trenches

Element	Depth (feet)	Soil Type
60	0.00	Atmosphere
59	0.00	
58	0.50	silty sand
57	1.00	
56	1.50	
55	2.00	
54	2.50	
53	3.00	
52	3.50	
51	4.00	
50	4.50	
49	5.00	
48	5.50	
47	5.75	
46	6.00	
45	6.25	sandy/clayey silt
44	6.50	
43	7.00	
42	7.50	
41	8.00	
40	8.50	
39	9.00	
38	9.50	
37	10.00	
36	10.50	
35	11.00	
34	11.50	
33	12.00	
32	12.50	
31	13.00	
30	13.50	
29	14.00	
28	14.50	
27	15.00	
26	15.50	
25	16.00	
24	16.50	
23	17.00	
22	17.50	
21	17.75	
20	18.00	
19	18.25	silty sand
18	18.50	
17	19.00	
16	19.50	
15	20.00	water table
14	20.50	
13	21.00	
12	21.50	
11	22.00	
10	22.50	
9	23.00	
8	23.50	
7	24.00	
6	24.50	
5	25.00	
4	25.50	
3	26.00	
2	26.50	
1	27.00	

Landfill Unit 1

Element	Depth (feet)	Soil Type
62	0.00	Atmosphere
61	0.00	
60	0.50	sandy gravel
59	1.00	
58	1.50	
57	2.00	
56	2.50	
55	3.00	
54	3.50	
53	4.00	
52	4.50	
51	5.00	
50	5.50	
49	5.75	
48	6.00	
47	6.25	silty sand
46	6.50	
45	7.00	
44	7.50	
43	8.00	
42	8.50	
41	9.00	
40	9.50	
39	10.00	
38	10.50	
37	11.00	
36	11.50	
35	12.00	
34	12.50	
33	13.00	
32	13.50	
31	14.00	
30	14.50	
29	14.75	
28	15.00	
27	15.25	sandy clay
26	15.50	
25	16.00	
24	16.50	
23	17.00	
22	17.50	
21	18.00	
20	18.50	
19	19.00	
18	19.50	
17	20.00	water table
16	20.50	
15	21.00	
14	21.50	
13	22.00	
12	22.50	
11	23.00	
10	23.50	
9	23.75	
8	24.00	
7	24.25	silty clay - type 2
6	24.50	
5	25.00	
4	25.50	
3	26.00	
2	26.50	
1	27.00	

Landfill Unit 2

Element	Depth (feet)	Soil Type
60	0.00	Atmosphere
59	0.00	
58	0.50	sandy gravel
57	1.00	
56	1.50	
55	2.00	
54	2.50	
53	3.00	
52	3.50	
51	4.00	
50	4.50	
49	5.00	
48	5.50	
47	6.00	
46	6.50	
45	7.00	
44	7.50	
43	8.00	
42	8.50	
41	9.00	
40	9.50	
39	10.00	
38	10.50	
37	11.00	
36	11.50	
35	12.00	
34	12.50	
33	13.00	
32	13.50	
31	13.75	
30	14.00	
29	14.25	silt/sandy silt
28	14.50	
27	15.00	
26	15.50	
25	16.00	
24	16.50	
23	16.75	
22	17.00	
21	17.25	silty sand
20	17.50	
19	18.00	
18	18.50	
17	19.00	
16	19.50	
15	20.00	water table
14	20.50	
13	21.00	
12	21.50	
11	22.00	
10	22.50	
9	23.00	
8	23.50	
7	24.00	
6	24.50	
5	25.00	
4	25.50	
3	26.00	
2	26.50	
1	27.00	

Table D-1. Representative Soil Profiles, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Landfill Unit 3

Element	Depth (feet)	Soil Type
60	0.00	Atmosphere
59	0.00	
58	0.50	sandy gravel
57	1.00	
56	1.50	
55	2.00	
54	2.50	
53	3.00	
52	3.50	
51	4.00	
50	4.50	
49	5.00	
48	5.50	
47	6.00	
46	6.50	
45	7.00	
44	7.50	
43	8.00	
42	8.50	
41	9.00	
40	9.50	
39	9.75	
38	10.00	
37	10.25	silty sand
36	10.50	
35	11.00	
34	11.50	
33	12.00	
32	12.50	
31	13.00	
30	13.50	
29	14.00	
28	14.50	
27	14.75	
26	15.00	
25	15.25	silty clay - type 3
24	15.50	
23	16.00	
22	16.50	
21	17.00	
20	17.50	
19	18.00	
18	18.50	
17	19.00	
16	19.50	
15	20.00	water table
14	20.50	
13	21.00	
12	21.50	
11	22.00	
10	22.50	
9	23.00	
8	23.50	
7	24.00	
6	24.50	
5	25.00	
4	25.50	
3	26.00	
2	26.50	
1	27.00	

Southern Trenches

Element	Depth (feet)	Soil Type
62	0.00	Atmosphere
61	0.00	
60	0.50	sandy gravel
59	1.00	
58	1.50	
57	2.00	
56	2.50	
55	3.00	
54	3.50	
53	4.00	
52	4.50	
51	4.75	
50	5.00	
49	5.25	silty clay - type 1
48	5.50	
47	6.00	
46	6.50	
45	7.00	
44	7.50	
43	7.75	
42	8.00	
41	8.25	silty sand
40	8.50	
39	9.00	
38	9.50	
37	10.00	
36	10.50	
35	11.00	
34	11.50	
33	12.00	
32	12.50	
31	13.00	
30	13.50	
29	14.00	
28	14.50	
27	14.75	
26	15.00	
25	15.25	silty clay - type 1
24	15.50	
23	16.00	
22	16.50	
21	17.00	
20	17.50	
19	18.00	
18	18.50	
17	19.00	
16	19.50	
15	20.00	water table
14	20.50	
13	21.00	
12	21.50	
11	22.00	
10	22.50	
9	23.00	
8	23.50	
7	24.00	
6	24.50	
5	25.00	
4	25.50	
3	26.00	
2	26.50	
1	27.00	

Waste Burial Holes

Element	Depth (feet)	Material Type
60	0.00	Atmosphere
59	0.00	
58	0.50	silty gravel (compacted backfill)
57	1.00	
56	1.50	unique to WBH
55	2.00	
54	2.50	
53	3.00	
52	3.50	
51	4.00	
50	4.50	
49	5.00	
48	5.50	
47	5.75	
46	6.00	
45	6.25	silty sand
44	6.50	
43	7.00	
42	7.50	
41	8.00	
40	8.50	
39	9.00	
38	9.50	
37	10.00	
36	10.50	
35	11.00	
34	11.50	
33	12.00	
32	12.50	
31	13.00	
30	13.50	
29	14.00	
28	14.50	
27	15.00	
26	15.50	
25	16.00	
24	16.50	
23	16.75	
22	17.00	
21	17.25	silty clay - type 2
20	17.50	
19	18.00	
18	18.50	
17	19.00	
16	19.50	
15	20.00	water table
14	20.50	
13	21.00	
12	21.50	
11	22.00	
10	22.50	
9	23.00	
8	23.50	
7	24.00	
6	24.50	
5	25.00	
4	25.50	
3	26.00	
2	26.50	
1	27.00	

Table D-2. Soil Parameters, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Soil Type	Porosity (cm^3/cm^3)	Moisture (cm^3/cm^3)	Hydraulic Conductivity (cm/s)	Dry Bulk Density (g/cm^3)	Van Genuchten Parameters α (1/cm)	Van Genuchten Parameters M (unitless)	Notes
sandy clay	0.37	0.299	6.70E-05	1.7	0.033	0.245	Sandy clay sample GEO2
sandy gravel	0.29	0.042	4.70E-03	1.9	0.085	0.476	Sandy gravel sample GEO1
silt/sandy silt	0.42	0.29	9.70E-05	1.52	0.0224	0.16	silt/sandy silt sample SSLF2-4-15
silty clay - type 1	0.39	0.36	2.80E-07	1.7	0.0008	0.183	Most conservative parameters between silty clay samples SSST-2-15.5 and SSST-2-25
silty clay - type 2	0.34	0.337	1.20E-08	1.79	0.0007	0.186	Most conservative parameters between silty clay samples SSWBH-3-25 and SSLF1-2-25
silty clay - type 3	0.32	0.322	1.70E-09	1.81	0.0003	0.245	Silty clay at Landfill Unit 3, sample SSLF3-2-25
silty gravel (WBH)	0.35	0.271	6.80E-08	1.72	0.0013	0.177	Silty gravel (compacted backfill) unique to WBH, sample SSWBH-3-5
silty sand	0.45	0.17	1.30E-04	1.45	0.007	0.482	Most conservative parameters between silty sand samples SSET-2-20 and SSLF3-2-15

Abbreviations:

WBH	Waste Burial Holes area
cm^3/cm^3	volumetric ratio
cm/s	centimeters per second
g/cm^3	grams per cubic centimeter
1/cm	per centimeter

Table D-3. Soil Constituents of Potential Concern for Groundwater Impact and Assumed Contaminated Depth Intervals, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

	Assumed Contaminated Depth Interval (feet below ground surface)					
COPC	Eastern Trenches	Landfill Unit 1	Landfill Unit 2	Landfill Unit 3	Southern Trenches	Waste Burial Holes
1,1,2-Trichloroethane	---	---	0 - 25	---	---	---
1,1-Dichloroethane	0 - 25	---	0 - 25	---	---	---
1,1-Dichloroethene	---	---	0 - 25	---	---	---
1,2-Dichloroethane	0 - 25	---	---	---	---	---
1,2-Dichloropropane	0 - 25	---	0 - 25	---	---	---
1,3-Butadiene	---	0 - 25	0 - 25	---	---	---
1,3-Dichlorobenzene	---	---	---	---	---	0 - 25
1,4-Dioxane	0 - 25	---	0 - 25	---	---	0 - 25
Acetone	0 - 25	0 - 25	0 - 25	0 - 25	0 - 25	0 - 25
Antimony	---	---	---	0 - 12	---	---
Barium	---	---	---	0 - 25	---	---
Benzene	---	---	---	---	---	0 - 25
Cadmium	---	---	0 - 25	0 - 25	---	---
Carbon-14 (in methanol)	0 - 25	0 - 25	0 - 25	0 - 25	---	0 - 25
Carbon disulfide	0 - 25	---	0 - 25	---	0 - 25	---
Chloroform	0 - 25	---	0 - 25	---	---	0 - 25
Copper	---	0 - 7	---	0 - 10	---	---
Formaldehyde	0 - 25	0 - 25	0 - 25	0 - 25	---	0 - 25
Manganese	---	---	---	0 - 12	---	---
Methyl Ethyl Ketone	---	---	0 - 25	---	0 - 25	0 - 25
Selenium	---	0 - 25	---	---	---	---
Silver	---	---	0 - 12.5	0 - 10	---	---
Strontium-90	---	---	0 - 12.5	0 - 15	---	0 - 15
Styrene	0 - 25	---	0 - 25	---	0 - 25	---
Tetrachloroethene	0 - 25	---	0 - 25	---	---	---
Toluene	0 - 25	0 - 25	0 - 25	0 - 25	0 - 25	0 - 25
Tritium (in water)	0 - 25	---	---	0 - 12	---	0 - 25
Uranium-235	0 - 25	---	0 - 12.5	0 - 25	---	---

Table D-3. Soil Constituents of Potential Concern for Groundwater Impact and Assumed Contaminated Depth Intervals, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

	Assumed Contaminated Depth Interval (feet below ground surface)					
COPC	Eastern Trenches	Landfill Unit 1	Landfill Unit 2	Landfill Unit 3	Southern Trenches	Waste Burial Holes
Uranium-238	---	---	---	---	---	0 - 5
Xylenes	---	---	0 - 25	---	---	---

Abbreviations:
COPC constituent of potential concern
--- not a constituent of potential concern in area

Table D-4. Chemical-Specific Parameters for Vadose Zone Modeling, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

COPC	K_d[a] (ml/g)	Mol Wt[b]	Henry's constant[c, d] (unitless)	k_{oc}[e] (m^3/kg)
1,1,2-Trichloroethane	0.10	133.40	0.0380	0.0501
1,1-Dichloroethane	0.063	98.96	0.234	0.0316
1,1-Dichloroethene	0.35	96.94	1.09	0.0589
1,2-Dichloroethane	0.035	98.96	0.0410	0.0174
1,2-Dichloropropane	0.087	112.99	0.117	0.0437
1,3-Butadiene	0.72	54.09	7.44	0.12
1,3-Dichlorobenzene	1.2	147.00	0.100	0.617
1,4-Dioxane	0.0081	88.1	2.04 E-04	NA
Acetone	0.087	58.08	0.00163	0.000575
Antimony	45	121.76	NA	NA
Barium	41	137.33	NA	NA
Benzene	0.62	78.11	0.234	0.0589
Cadmium	75	112.41	NA	NA
Carbon-14 (in methanol)	0.0	34.03	0.000190	NA
Carbon disulfide	0.091	76.14	3.80	0.0457
Chloroform	0.53	119.38	0.155	0.0398
Copper	4.0	63.55	NA	NA
Formaldehyde	0.0023	30.03	1.37E-05	0.0369
Manganese	750	54.94	NA	NA
Methyl Ethyl Ketone	0.072	72.11	0.00234	0.0045
Selenium	5.0	78.96	NA	NA
Silver	120	107.87	NA	NA
Strontium-90	35	89.91	NA	NA
Styrene	120	104.15	0.113	0.776
Tetrachloroethene	2.7	165.83	0.753	0.155
Toluene	0.36	92.14	0.276	0.182
Tritium (in water)	0.0	20.02	NA	NA
Uranium-235	15	235.04	NA	NA
Uranium-238	15	238.05	NA	NA
Xylenes	2.4	106.17	0.276	0.407

Notes:

[a] From Feasibility Study Data Gaps Work Plan (Weiss, 2008) Appendix C, Table C2.

[b] Values from NIST, 2008, Search for Species Data by Chemical Name, http://webbook.nist.gov/chemistry/name-ser.html

[c] Values from US EPA, 2009,Superfund Chemical Data Matrix, http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm, website as last updated on Tuesday, January 13th, 2009.

[d] Unitless Henry's constant based on pore water temperature of 65 degrees Fahrenheit (291.5 degrees Kelvin) from shallow groundwater temperature measurements in LEHR/SCDS monitoring wells.

[e] Values from US EPA Region 9, 2008, Regional Screening Levels, http://www.epa.gov/region09/superfund/prg/index.html, website as Last updated on Tuesday, December 16th, 2008.

Table D-4. Chemical-Specific Parameters for Vadose Zone Modeling, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Abbreviations:

COPC	constituent of potential concern
K_d	soil - water partition coefficient
K_{oc}	organic carbon partition coefficient
m^3/kg	cubic meters per kilogram
ml/g	milliliters per gram
Mol Wt	molecular weight
NA	not applicable
NIST	National Institute of Standards and Technology

Table D-5. Volatile Organic Compounds Included in NUFT Modeling Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Modeled		Not Modeled		
Individual	Group Proxy for Not Modeled Compounds	Co-Located Group Members [1]	Soil Gas Detection Ratio[2]	Soil Gas Maximum (µg/m^3)
Acetone			21 / 26	3,900
Benzene			12 / 26	14
1,3-Butadiene			5 / 14	74
Carbon disulfide			12 / 26	140
	Chloroform	*Halogenated Methanes*	13 / 26	16,000
		Carbon tetrachloride	1 / 26	0.42
		Chloromethane	3 / 26	10
		Dichlorodifluoromethane	6 / 26	5
		Methylene chloride	1 / 26	1.6
		Trichlorofluoromethane	6 / 26	2.6
1,1-Dichloroethane			7 / 26	1,600
1,1-Dichloroethene			5 / 26	390
1,2-Dichloroethane			2 / 26	330
1,2-Dichloropropane			6 / 26	1,900
	1,3-Dichlorobenzene	*Dichlorobenzenes*	2 / 26	79
		1,4-Dichlorobenzene	3 / 26	16
Formaldehyde			21 / 21	175
	Methyl Ethyl Ketone	*Ketones*	14 / 26	61
		Methyl isobutyl ketone	8 / 26	80
Styrene			6 / 26	2.2
	1,1,2-Trichloroethane	*Trichloroethanes*	0[3] / 26	ND
		1,1,1-Trichloroethane	3 / 26	58
Tetrachloroethene			15 / 26	2,600
	Toluene	*Fuel Volatiles*	22 / 26	8,000
		1,2,4-Trimethylbenzene	12 / 26	88
		1,3,5-Trimethylbenzene	7 / 26	27
		4-Ethyltoluene	7 / 26	62
		Ethylbenzene	10 / 26	88
Xylenes			11 / 26	220

Abbreviations:

µg/m^3 micrograms per cubic meter
VOC volatile organic compound

Notes:

Hexane, isopropanol and ethanol were detected in soil gas but not modeled. Hexane and isopropanol were sample collection tracer compounds.

[1] Proxy compounds were modeled in proxy for VOCs with similar chemical structure and/or chemical properties and co-located with the surrogate.

[2] Ratio of detected concentrations to total number of samples analyzed.

[3] 1,1,2-Trichloroethane was detected in soil samples.

Table D-6. Summary of Designated Level Modeling Results for the Eastern Trenches Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

COC	Groundwater Goal (µg/L or pCi/L)	Goal Source	Contaminated Depth Interval (feet)	Max Soil Concentration (pCi/g)	Soil Background (pCi/g)	Soil Designated Level (µg/kg or pCi/g)	Max Soil Vapor Concentration (µg/m^3)	Soil Vapor Designated Level[1] (µg/m^3)	Time to Peak[3] (years)	Predicted Peak Groundwater Concentration[11] (µg/L or pCi/L)	Max Groundwater Concentration[2] (µg/L or pCi/L)
Acetone	22,000	RSL	0 - 25	NA	NA	5,000	210	43,700	19	106	257
Acetone	5.0	CRDL	0 - 25	NA	NA	1.13	**210**	9.84	20	106	257
Carbon disulfide	1,000	RSL	0 - 25	NA	NA	255	81	631,000	16	0.128	0.6
Carbon disulfide	160	CNL	0 - 25	NA	NA	40.4	81	100,000	16	0.128	0.6
Carbon disulfide	1.0	CRDL	0 - 25	NA	NA	0.253[4]	81	625[4]	16	0.128	0.6
Chloroform	80	MCL[5]	0 - 25	NA	NA	48.7	**13,000**	9,640	27	108	8,170
Chloroform	1.1	Cal	0 - 25	NA	NA	0.670[4]	**13,000**	133[4]	27	108	8,170
Chloroform	0.5	CRDL	0 - 25	NA	NA	0.304[4]	**13,000**	60.3[4]	27	108	8,170
1,1-Dichloroethane	5.0	MCL	0 - 25	NA	NA	1.12	**550**	395	15	6.96	31.7
1,2-Dichloroethane	0.50	MCL	0 - 25	NA	NA	0.104	**330**	9.68	15	17.0	20.5
1,2-Dichloropropane	5.0	MCL	0 - 25	NA	NA	1.20	**1,900**	168	16	56.5	2.9
1,4-Dioxane[6]	6.1	RSL	0 - 25	NA	NA	0.966	NA	NA	17	NA	14
1,4-Dioxane[6]	3.0	CNL	0 - 25	NA	NA	0.479	NA	NA	17	NA	14
Formaldehyde	7,300	RSL	0 - 25	NA	NA	1,130	**61.7** J1	20.4	16	132,000	< 20
Formaldehyde	100	CNL	0 - 25	NA	NA	15.3	**61.7** J1	0.278	16	132,000	< 20
Formaldehyde	50	CRDL	0 - 25	NA	NA	7.65[4]	**61.7** J1	0.139[4]	16	132,000	< 20
Styrene	100	MCL	0 - 25	NA	NA	9,160	1.8	87,400	0	0.00206	< 1
Styrene	0.5	CRDL	0 - 25	NA	NA	45.8	1.8	437	0	0.00206	< 1
Tetrachloroethene	5.0	MCL	0 - 25	NA	NA	11.3	130	3,280	0	0.198	2.9
Tetrachloroethene	0.5	CRDL	0 - 25	NA	NA	1.13[4]	130	328[4]	0	0.198	2.9
Toluene	150	MCL	0 - 25	NA	NA	70.7	70	6,680	24	1.57	< 50
Toluene	0.5	CRDL	0 - 25	NA	NA	0.230	**70**	21.7	27	1.57	< 50
Carbon-14	2,000	MCL[7]	0 - 25	**8.3**	< 0.13	< 0.1	NA	NA	28	> 2,000	1,380
Carbon-14	< 7.25	BGD[8]	0 - 25	**8.3**	< 0.13	< 0.1	NA	NA	28	> 2,000	1,380
Tritium	20,000	MCL	0 - 25	**280** [10]	< 1.2	< 1.0	NA	NA	23	> 20,000	14,700
Tritium	< 170	BGD[8]	0 - 25	**280** [10]	< 1.2	< 1.0	NA	NA	23	> 20,000	14,700
Uranium-235	20	MCL	0 - 25	0.142 [9]	0.038	0.233	NA	NA	0	12.2	< 13.9
Uranium-235	< 15	BGD[8]	0 - 25	0.142 [9]	0.038	0.175	NA	NA	0	12.2	< 13.9

Abbreviations:

< n	not detected; detection limit equal to n.
BGD	groundwater background value
Cal	California EPA cleanup goal for chloroform.
COC	constituent of concern
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
CRDL	contract-required detection limit
g/cm^3	grams per cubic centimeter
J1	Formaldehyde was analyzed one day outside of the specified 14 day holding time. The effect on analytical accuracy is likely negligible.
LEHR/SCDS	Laboratory for Energy-Related Health Research/ South Campus Disposal Site
MCL	State of California Maximum Contaminant Level, drinking water
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
NA	not available or not applicable
pCi/g	picocuries per gram

Table D-6. Summary of Designated Level Modeling Results for the Eastern Trenches Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Abbreviations (continued):

pCi/L	picocuries per liter
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, residential tap water
v/v	volume ratio

Notes:

Concentrations shown in bold if greater than the designated levels.

[1] Lowest soil vapor designated level among soil types in soil column. Soil vapor designated level may be significantly higher in other soil types.

[2] Maximum concentration during past ten years (1999 - 2008) in downgradient wells UCD1-008, UCD1-009, UCD1-012, UCD1-013, UCD1-049, UCD1-050, UCD1-051 and UCD1-066 and Data Gaps grab groundwater samples collected in 2008.

[3] A time-to-peak of zero means the modeled maximum concentration in groundwater was present immediately (zero years) and the modeled concentration at subsequent time steps was equal to or less than the concentration at zero years.

[4] Designated level proportioned from previous (preceding row in table) NUFT result for COC. Designated level concentrations are mathematically proportional to groundwater goal concentrations.

[5] MCL for total trihalomethanes.

[6] 1,4-dioxane was recently detected in groundwater immediately downgradient of Landfill Unit 2, Eastern Trenches, and Waste Burial Holes; however no soil analyses for 1,4-dioxane have been conducted to date. A soil designated level for 1,4 dioxane was calculated using Landfill Unit 2 lithology for potential use during the Feasibility Study.

[7] Derived limit for drinking water from the 4 roentgen equivalent man per year Federal MCL for beta particles and photon emitters (EPA, 2000)

[8] Background values determined from well UCD1-018 groundwater samples data (hydrostratigraphic unit 1 background) up to October 2008.

[9] Uranium-235 activity-concentration is only slightly above the detection limit. The Uranium-235 data set for the Eastern Trenches has high detection limits and only one detect. Comparison to soil background (0.038 pCi/g) is inconclusive for these data. Uranium-235 may be below background.

[10] Calculated from pCi/L activity-concentration based on volumetric water content (0.17 v/v) and bulk density (1.45 g/cm^3) for silty sand soil type. Data reported in pCi/L were not included in original screening process (see Table 2-2).

[11] Proportioned from designated level, groundwater goal and maximum soil or soil vapor concentration. Predicted peak groundwater concentrations are mathematically proportional to the initial soil or soil vapor concentration.

Table D-7. Summary of Designated Level Modeling Results for Landfill Unit 1, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

COC	Groundwater Goal (µg/L or pCi/L)	Goal Source	Contaminated Depth Interval (feet)	Max Soil Concentration (µg/kg or pCi/g)	Soil Designated Level (µg/kg or pCi/g)	Soil Background (µg/kg or pCi/g)	Max Soil Vapor Concentration (µg/m^3)	Soil Vapor Designated Level[1] (µg/m^3)	Time to Peak[2] (years)	Predicted Peak Groundwater Concentration [7] (ug/L or pCi/L)	Max Groundwater Concentration[3](µg/L or pCi/L)
Acetone	22,000	RSL	0 - 25	NA	5,240	NA	150	43,300	24	76.2	34.1
Acetone	5.0	CRDL	0 - 25	NA	1.19[4]	NA	**150**	9.84[4]	24	76.2	34.1
1,3-Butadiene	0.16	RSL	0 - 25	NA	0.124	NA	74	275	10	0.0431	NA
Formaldehyde	7,300	RSL	0 - 25	NA	1,220	NA	**69.7**	22.5	21	136,000	< 20
Formaldehyde	100	CNL	0 - 25	NA	16.7[4]	NA	**69.7**	0.308[4]	21	136,000	< 20
Formaldehyde	50	CRDL	0 - 25	NA	8.36[4]	NA	**69.7**	0.154[4]	21	136,000	< 20
Toluene	150	MCL	0 - 25	NA	70.4	NA	120	6,650	40	2.71	< 1.0
Toluene	0.5	CRDL	0 - 25	NA	0.235[4]	NA	**120**	22.2[4]	40	2.71	< 1.0
Copper	1000	MCL	0 - 7	**2,690,000**	43,500[4]	60,000	NA	NA	930	62,000	5.3
Copper	1.43	BGD[5]	0 - 7	**2,690,000**	62.2	60,000	NA	NA	770	62,000	5.3
Selenium	50	MCL	0 - 25	**13,000**	216	1,200	NA	NA	0	3,010	12
Selenium	4.2	BGD[5]	0 - 25	**13,000**	18.1	1,200	NA	NA	0	3,010	12
Carbon-14	2000	MCL[6]	0 - 25	**4.74**	< 0.1	< 0.13	NA	NA	43	> 2,000	36.1
Carbon-14	< 7.25	BGD[5]	0 - 25	**4.74**	< 0.1	< 0.13	NA	NA	43	> 2,000	36.1

Abbreviations:

< n	not detected; detection limit equal to n.
BGD	background groundwater concentration
COC	constituent of concern
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
CRDL	contract-required detection limit
LEHR/SCDS	Laboratory for Energy-Related Health Research/ South Campus Disposal Site
MCL	State of California Maximum Contaminant Level, drinking water
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
µg/m^3	micrograms per cubic meter
NA	not available or not applicable
pCi/L	picocuries per liter
pCi/g	picocuries per gram
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, residential tap water

Notes:

Concentrations shown in **bold** if greater than the designated levels.

[1] Lowest soil vapor designated level among soil types in soil column. Soil vapor designated level may be significantly higher in other soil types.

[2] A time-to-peak of zero means the modeled maximum concentration in groundwater was present immediately (zero years) and the modeled concentration at subsequent time steps was equal to or less than the concentration at zero years.

[3] Maximum concentration during past ten years (1999 - 2008) in downgradient wells UCD1-11 and UCD1-62 and the Data Gaps grab groundwater sample collected in 2008.

[4] Designated level proportioned from NUFT result for COC at other groundwater goal (see preceding or following line of table). Designated level concentrations are mathematically proportional to groundwater goal concentrations.

[5] Background values determined from well UCD1-018 groundwater samples data (hydrostratigraphic unit 1 background) up to October 2008.

[6] Derived limit for drinking water from the 4 roentgen equivalent man per year Federal MCL for beta particles and photon emitters (EPA, 2000)

[7] Proportioned from designated level, groundwater goal and maximum soil or soil vapor concentration. Predicted peak groundwater concentrations are mathematically proportional to the initial soil or soil vapor concentration.

Table D-8. Summary of Designated Level Modeling Results for Landfill Unit 2, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

COC	Groundwater Goal (µg/L or pCi/L)	Goal Source	Contaminated Depth Interval (feet)	Max Soil Concentration (µg/kg or pCi/g)	Soil Designated Level (µg/kg or pCi/g)	Soil Background (µg/kg or pCi/g)	Max Soil Vapor Concentration (µg/m^3)	Soil Vapor Designated Level[1] (µg/m^3)	Time to Peak[2] (years)	Predicted Peak Groundwater Concentration[11] (µg/L or pCi/L)	Max Groundwater Concentration[3] (µg/L or pCi/L)
Acetone	22,000	RSL	0 - 25	NA	4,780	NA	3,900	39,000	12	2,200	257
Acetone	5	CRDL	0 - 25	NA	1.09 [4]	NA	**3,900**	8.86 [4]	12	2,200	257
1,3-Butadiene	0.16	RSL	0 - 25	NA	0.125	NA	4.4	278	5	0.00253	NA
Carbon disulfide	1,000	RSL	0 - 25	NA	296	NA	140	732,000	6	0.191	0.6
Carbon disulfide	160	CNL	0 - 25	NA	47.4 [4]	NA	140	117,000 [4]	6	0.191	0.6
Carbon disulfide	1.0	CRDL	0 - 25	NA	0.296 [4]	NA	140	732 [4]	6	0.191	0.6
Chloroform	80	MCL [5]	0 - 25	NA	50.7	NA	9,600	9,780	15	78.5	8,170
Chloroform	1.1	Cal	0 - 25	NA	0.697 [4]	NA	**9,600**	134 [4]	15	78.5	8,170
Chloroform	0.5	CRDL	0 - 25	NA	0.317 [4]	NA	**9,600**	61.1 [4]	15	78.5	8,170
1,1-Dichloroethane	5.0	MCL	0 - 25	NA	1.24	NA	**1,600**	422	10	19.0	31.7
1,1-Dichloroethene	6.0	MCL	0 - 25	NA	2.97	NA	390	2,670	10	0.876	29.2
1,2-Dichloropropane	5.0	MCL	0 - 25	NA	1.34	NA	**910**	183	10	24.9	0.83
1,4-Dioxane[6]	6.1	RSL	0 - 25	NA	1.18	NA	NA	NA	8	NA	14
1,4-Dioxane[6]	3.0	CNL	0 - 25	NA	0.580 [4]	NA	NA	NA	8	NA	14
Formaldehyde	7,300	RSL	0 - 25	NA	1,210	NA	**175**	22.2	9	345,000	4
Formaldehyde	100	CNL	0 - 25	NA	16.6 [4]	NA	**175**	0.304 [4]	9	345,000	4
Formaldehyde	50	CRDL	0 - 25	NA	8.29 [4]	NA	**175**	0.152 [4]	9	345,000	4
Methyl Ethyl Ketone	7,100	RSL	0 - 25	NA	1,530	NA	61	13,900	11	31.2	46.1
Methyl Ethyl Ketone	1.0	CRDL	0 - 25	NA	0.215 [4]	NA	**61**	1.96 [4]	11	31.2	46.1
Styrene	100	MCL	0 - 25	NA	9,160	NA	2.2	87,300	0	0.00252	< 1
Styrene	0.5	CRDL	0 - 25	NA	45.8 [4]	NA	2.2	437 [4]	0	0.00252	< 1
Tetrachloroethene	5.0	MCL	0 - 25	NA	11.3	NA	2,600	3,280	0	3.96	2.9
Tetrachloroethene	0.5	CRDL	0 - 25	NA	1.13	NA	**2,600**	328	0	3.96	2.9
Toluene	150	MCL	0 - 25	NA	73.8	NA	**8,000**	6,910	13	174	0.73
Toluene	0.5	CRDL	0 - 25	NA	0.246 [4]	NA	**8,000**	23.0 [4]	13	174	0.73
1,1,2-Trichloroethane	5.0	MCL	0 - 25	**15**	1.20	NA	< 2.7 to **< 320**	48.2	12	33.2	58.4
Xylenes	1,750	MCL	0 - 25	NA	3,610	NA	320	158,000	0	3.54	< 100
Xylenes	1.0	CRDL	0 - 25	NA	2.06 [4]	NA	**320**	90.3 [4]	0	3.54	< 100
Cadmium	5.0	MCL	0 - 25	**6,700**	287	510	NA	NA	0	117	0.52
Cadmium	0.202	BGD[7]	0 - 25	**6,700**	11.6	510	NA	NA	0	117	0.52
Silver	100	MCL	0 - 12.5	38,100	53,300	550	NA	NA	5,000	71.5	0.05
Silver	0.017	BGD[7]	0 - 12.5	**38,100**	9.07	550	NA	NA	5,000	71.5	0.05
Carbon-14	2,000	MCL[8]	0 - 25	**4.2**	< 0.1	< 0.13	NA	NA	10	> 2,000	1,380
Carbon-14	< 7.25	BGD[7]	0 - 25	**4.2**	< 0.1	< 0.13	NA	NA	10	> 2,000	1,380
Strontium-90	8.0	MCL	0 - 12.5	0.42 [9]	>>	0.056	NA	NA	500	< 0.1	< 0.574
Strontium-90	< 0.481	BGD[7]	0 - 12.5	0.42 [9]	>>	0.056	NA	NA	500	< 0.1	< 0.574
Uranium-235	20	MCL	0 - 12.5	0.14 [10]	1.54	0.038	NA	NA	1,000	1.82	< 13.9
Uranium-235	< 15	BGD[7]	0 - 12.5	0.14 [10]	1.16	0.038	NA	NA	1,000	1.82	< 13.9

Abbreviations:

>>	Designated level is significantly larger than highest activity-concentrations encountered at Site
< n	not detected; detection limit equal to n
BGD	background groundwater concentration
Cal	California EPA cleanup goal for chloroform.

Table D-8. Summary of Designated Level Modeling Results for Landfill Unit 2, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Abbreviations (continued):

CNL	California Notification Level, California Department of Public Health - Drinking Water Program
COC	constituent of concern
CRDL	contract-required detection limit
LEHR/SCDS	Laboratory for Energy-Related Health Research/ South Campus Disposal Site
MCL	State of California Maximum Contaminant Level, drinking water
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
$\mu g/m^3$	micrograms per cubic meter
NA	not applicable
pCi/g	picocuries per gram
pCi/L	picocuries per liter
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, residential tap water

Notes:

Concentrations shown in bold if greater than the designated levels. Detection limits shown in bold if more than twice the designated levels.

[1] Lowest soil vapor designated level among soil types in soil column. Soil vapor designated level may be significantly higher in other soil types.

[2] A time-to-peak of zero means the modeled maximum concentration in groundwater was present immediately (zero years) and the modeled concentration at subsequent time steps was equal to or less than the concentration at zero years.

[3] Maximum concentration during past ten years (1999 - 2008) in downgradient wells UCD1-8, UCD1-009, UCD1-012, UCD1-13, UCD1-049, UCD1-050, UCD1-051 and UCD1-66 and Data Gaps grab groundwater samples collected in 2008.

[4] Designated level proportioned from previous (preceding row in table) NUFT result for COC. Designated level concentrations are mathematically proportional to groundwater goal concentrations.

[5] MCL for total trihalomethanes.

[6] 1,4-dioxane was recently detected in groundwater immediately downgradient of Landfill Unit 2, Eastern Trenches, and Waste Burial Holes; however no soil analyses for 1,4-dioxane have been conducted to date. A soil designated level for 1,4 dioxane was calculated using Landfill Unit 2 lithology for potential use during the Feasibility Study.

[7] Background values determined from well UCD1-018 groundwater samples data (hydrostratigraphic unit 1 background) up to October 2008.

[8] Derived limit for drinking water from the 4 roentgen equivalent man per year Federal MCL for beta particles and photon emitters (EPA, 2000).

[9] Strontium-90 maximum detected concentration was only slightly above the detection limit (generally high detection limits throughout data set, from 0.3 pCi/g to 1.1 pCi/g). Comparison to soil background (0.056 pCi/g) is inconclusive for these data. Strontium-90 may be below background.

[10] Uranium-235 result shown is below the detection limit. The Uranium-235 data set for Landfill Unit 2 has high detection limits: 0.1 pCi/g to 0.49 pCi/g. Comparison to soil background (0.038 pCi/g) is inconclusive for these data. Uranium-235 may be below background.

[11] Proportioned from designated level, groundwater goal and maximum soil or soil vapor concentration. Predicted peak groundwater concentrations are mathematically proportional to the initial soil or soil vapor concentration.

Table D-9. Summary of Designated Level Modeling Results for Landfill Unit 3, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

COC	Groundwater Goal (µg/L or pCi/L)	Goal Source	Contaminated Depth Interval (feet)	Max Soil Concentration (µg/kg or pCi/g)	Soil Designated Level (µg/kg or pCi/g)	Soil Background (µg/kg or pCi/g)	Max Soil Vapor Concentration (µg/m^3)	Soil Vapor Designated Level[1] (µg/m^3)	Time to Peak[2] (years)	Predicted Peak Groundwater Concentration [9] (µg/L or pCi/L)	Max Groundwater Concentration[3] (µg/L or pCi/L)
Acetone	22,000	RSL	0 - 25	NA	4,930	NA	160	43,300	0	81.3	4.46
Acetone	5.0	CRDL	0 - 25	NA	1.12 [4]	NA	**160**	9.84 [4]	0	81.3	4.46
Formaldehyde	7,300	RSL	0 - 25	NA	1,110	NA	**121**	20.8	0	255,000	NA
Formaldehyde	100	CNL	0 - 25	NA	15.2 [4]	NA	**121**	0.285 [4]	0	255,000	NA
Formaldehyde	50	CRDL	0 - 25	NA	7.60 [4]	NA	**121**	0.142 [4]	0	255,000	NA
Toluene	150	MCL	0 - 25	NA	68.4	NA	89	6,490	0	2.06	<0.5
Toluene	0.5	CRDL	0 - 25	NA	0.228 [4]	NA	**89**	21.6 [4]	0	2.06	<0.5
Antimony	6.0	MCL	0 - 12	**13,800**	2,910	1,400	NA	NA	31,000	28.5	< 5
Antimony	4.77	BGD[5]	0 - 12	**13,800**	2,320	1,400	NA	NA	31,000	28.5	< 5
Barium	1,000	MCL	0 - 25	**968,000**	35,000	260,000	NA	NA	0	27,700	150
Barium	198	BGD[5]	0 - 25	**968,000**	6,920	260,000	NA	NA	0	27,700	150
Cadmium	5.0	MCL	0 - 25	**20,000**	319	510	NA	NA	0	313	0.41
Cadmium	0.202	BGD[5]	0 - 25	**20,000**	12.9	510	NA	NA	0	313	0.41
Copper	1,000	MCL	0 - 10	**1,700,000**	138,000	60,000	NA	NA	4,000	12,300	6.8
Copper	1.43	BGD[5]	0 - 10	**1,700,000**	197	60,000	NA	NA	4,000	12,300	6.8
Manganese	50	MCL	0 - 12	**4,300,000**	549,000	750,000	NA	NA	560,000	392	0.62
Manganese	9.9	BGD[5]	0 - 12	**4,300,000**	107,000	750,000	NA	NA	480,000	392	0.62
Silver	100	MCL	0 - 10	158,000	368,000	550	NA	NA	94,000	42.9	< 10
Silver	0.92	BGD[5]	0 - 10	**158,000**	12,600	550	NA	NA	87,000	42.9	< 10
Carbon-14	2,000	MCL[6]	0 - 25	**3.77**	< 0.1	< 0.13	NA	NA	140	> 2,000	11.2
Carbon-14	< 7.25	BGD[5]	0 - 25	**3.77**	< 0.1	< 0.13	NA	NA	140	> 2,000	11.2
Strontium-90	8.0	MCL	0 - 15	5.07	>>	0.056	NA	NA	360	< 0.1	< 0.49
Strontium-90	< 0.481	BGD[5]	0 - 15	5.07	>>	0.056	NA	NA	350	< 0.1	< 0.49
Tritium	20,000	MCL	0 - 12	**0.0113** [8]	< 1.0	< 1.2	NA	NA	36	> 20,000	< 293
Tritium	< 170	BGD[5]	0 - 12	**0.0113** [8]	< 1.0	< 1.2	NA	NA	36	> 20,000	< 293
Uranium-235	20	MCL	0 - 25	0.09 [7]	0.258	0.038	NA	NA	0	6.98	< 23
Uranium-235	< 15	BGD[5]	0 - 25	0.09 [7]	0.193	0.038	NA	NA	0	6.98	< 23

Abbreviations:

>>	designated level is significantly larger than highest activity-concentrations encountered at Site
< n	not detected; detection limit equal to n
BGD	background groundwater concentration
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
COC	constituent of concern
CRDL	contract-required detection limit
g/cm^3	grams per cubic centimeter
LEHR/SCDS	Laboratory for Energy-Related Health Research/ South Campus Disposal Site
MCL	State of California Maximum Contaminant Level, drinking water
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
NA	not applicable
pCi/g	picocuries per gram
pCi/L	picocuries per liter
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, residential tap water
v/v	volume ratio

Table D-9. Summary of Designated Level Modeling Results for Landfill Unit 3, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Notes:

Concentrations shown in bold if greater than the designated levels.

[1] Lowest soil vapor designated level among soil types in soil column. Soil vapor designated level may be significantly higher in other soil types.

[2] A time-to-peak of zero means the modeled maximum concentration in groundwater was present immediately (zero years) and the modeled concentration at subsequent time steps was equal to or less than the concentration at zero years.

[3] Maximum concentration during past ten years (1999 - 2008) in downgradient wells UCD1-010 and UCD1-064 and the Data Gaps grab groundwater sample collected in 2008.

[4] Designated level proportioned from previous (preceding row in table) NUFT result for COC. Designated level concentrations are mathematically proportional to groundwater goal concentrations.

[5] Background values determined from well UCD1-018 groundwater samples data (hydrostratigraphic unit 1 background) up to October 2008.

[6] Derived limit for drinking water from the 4 roentgen equivalent man per year Federal MCL for beta particles and photon emitters (EPA, 2000)

[7] Data are not accurate due to high detection limits. All results were non-detect. Maximum detection limit shown.

[8] Calculated from pCi/L activity-concentration based on soil water content (0.042 v/v) and bulk density (1.9 g/cm^3) for sandy gravel soil type. Results reported in pCi/L were not included in original screening process (see Table 2-2). In addition, some data reported in pCi/kg that were used in original screening have been screened out based on reported activities below reporting limit.

[9] Proportioned from designated level, groundwater goal and maximum soil or soil vapor concentration. Predicted peak groundwater concentrations are mathematically proportional to the initial soil or soil vapor concentration.

Table D-10. Summary of Designated Level Modeling Results for the Southern Trenches Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

COC	Groundwater Goal (µg/L)	Goal Source	Contaminated Depth Interval (feet)	Soil Designated Level (µg/kg)	Max Soil Vapor Concentration (µg/m^3)	Soil Vapor Designated Level[1] (µg/m^3)	Time to Peak[2] (years)	Predicted Peak Groundwater Concentration [5] (µg/L)	Max Groundwater Concentration [3] (µg/L)
Acetone	22,000	RSL	0 - 25	5,650	300	41,800	0	158	18
Acetone	5.0	CRDL	0 - 25	1.28 [4]	**300**	9.50 [4]	0	158	18
Carbon disulfide	1,000	RSL	0 - 25	260	2.7	643,000	0	0.00420	< 1
Carbon disulfide	160	CNL	0 - 25	41.6 [4]	2.7	103,000 [4]	0	0.00420	< 1
Carbon disulfide	1.0	CRDL	0 - 25	0.260 [4]	2.7	643 [4]	0	0.00420	< 1
Methyl Ethyl Ketone	7,100	RSL	0 - 25	1,740	19	14,600	0	9.24	< 1
Methyl Ethyl Ketone	1.0	CRDL	0 - 25	0.245 [4]	**19**	2.06 [4]	0	9.24	< 1
Styrene	100	MCL	0 - 25	9,580	1.3	91,100	3,700	0.00143	< 0.5
Styrene	0.5	CRDL	0 - 25	47.9 [4]	1.3	456 [4]	3,700	0.00143	< 0.5
Toluene	150	MCL	0 - 25	71.8	34	6,720	0	0.759	< 0.5
Toluene	0.5	CRDL	0 - 25	0.239 [4]	**34**	22.4 [4]	0	0.759	< 0.5

Abbreviations:

< n	not detected; detection limit equal to n
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
COC	constituent of concern
CRDL	contract-required detection limit
LEHR/SCDS	Laboratory for Energy-Related Health Research/ South Campus Disposal Site
MCL	State of California Maximum Contaminant Level, drinking water
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, residential tap water

Notes:

Concentrations shown in **bold** if greater than the designated levels.

[1] Lowest soil vapor concentration among soil types in soil column. Soil vapor designated level may be significantly higher in other soil types.

[2] A time-to-peak of zero means the modeled maximum concentration in groundwater was present immediately (zero years) and the modeled concentration at subsequent time steps was equal to or less than the concentration at zero years.

[3] Maximum concentration during past ten years (1999 - 2008) in downgradient wells UCD1-008, UCD1-013 and UCD1-024 and the Data Gaps grab groundwater sample.

[4] Designated level proportioned from previous (preceding row in table) NUFT result for COC. Designated level concentrations are mathematically proportional to groundwater goal concentrations.

[5] Proportioned from designated level, groundwater goal and maximum soil or soil vapor concentration. Predicted peak groundwater concentrations are mathematically proportional to the initial soil or soil vapor concentration.

Table D-11. Summary of Designated Level Modeling Results for the Waste Burial Holes Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

COC	Groundwater Goal (µg/L or pCi/L)	Goal Source	Contaminated Depth Interval (feet)	Max Soil Concentration (pCi/g)	Soil Designated Level (µg/kg or pCi/g)	Soil Background (pCi/g)	Max Soil Vapor Concentration (µg/m^3)	Soil Vapor Designated Level[1] (µg/m^3)	Time to Peak[2] (years)	Predicted Peak Groundwater Concentration [11] (µg/L or pCi/L)	Max Groundwater Concentration[3] (µg/L or pCi/L)
Acetone	22,000	RSL	0 - 25	NA	5,120	NA	140	42,300	0	72.8	<5.5
Acetone	5.0	CRDL	0 - 25	NA	1.16 [4]	NA	**140**	9.61 [4]	0	72.8	<5.5
Benzene	1.0	MCL	0 - 25	NA	0.680	NA	< 36	148	0	0.243	0.47
Chloroform	80	MCL [5]	0 - 25	NA	48.4	NA	< 56	9,520	0	0.471	1
Chloroform	1.1	Cal	0 - 25	NA	0.666 [4]	NA	< 56	131 [4]	0	0.471	1
Chloroform	0.5	CRDL	0 - 25	NA	0.303 [4]	NA	< 56	59.5 [4]	0	0.471	1
1,3-Dichlorobenzene	5.0	MCL [6]	0 - 25	NA	5.84	NA	**79**	62.0	0	6.37	< 0.5
1,3-Dichlorobenzene	0.5	CRDL	0 - 25	NA	0.584 [4]	NA	**79**	6.20 [4]	0	6.37	< 0.5
1,4-Dioxane[7]	6.1	RSL	0 - 25	NA	1.01	NA	NA	NA	0	NA	14
1,4-Dioxane[7]	3.0	CNL	0 - 25	NA	0.499	NA	NA	NA	0	NA	14
Formaldehyde	7,300	RSL	0 - 25	NA	1,180	NA	**71.2**	21.7	0	144,000	< 20
Formaldehyde	100	CNL	0 - 25	NA	16.2 [4]	NA	**71.2**	0.297 [4]	0	144,000	< 20
Formaldehyde	50	CRDL	0 - 25	NA	8.08 [4]	NA	**71.2**	0.149 [4]	0	144,000	< 20
Methyl Ethyl Ketone	7,100	RSL	0 - 25	NA	1,560	NA	< 34	14,300	0	16.9	< 2.0
Methyl Ethyl Ketone	1.0	CRDL	0 - 25	NA	0.220 [4]	NA	**< 34**	2.01 [4]	0	16.9	< 2.0
Toluene	150	MCL	0 - 25	NA	69.3	NA	110	6,550	0	2.52	< 0.5
Toluene	0.5	CRDL	0 - 25	NA	0.231 [4]	NA	**110**	21.8 [4]	0	2.52	< 0.5
Carbon-14	2,000	MCL[8]	0 - 25	**1,440**	0.319	< 0.13	NA	NA	0	> 2,000	1,380
Carbon-14	< 7.25	BGD [9]	0 - 25	**1,440**	< 0.1	< 0.13	NA	NA	0	> 2,000	1,380
Strontium-90	8.0	MCL	0 - 15	25.5	>>	0.056	NA	NA	360	< 0.1	< 0.704
Strontium-90	< 0.481	BGD [9]	0 - 15	25.5	>>	0.056	NA	NA	360	< 0.1	< 0.704
Tritium	20,000	MCL	0 - 25	**3,080** [10]	3.19	< 1.2	NA	NA	0	> 20,000	14,700
Tritium	< 170	BGD [9]	0 - 25	**3,080** [10]	< 1.0	< 1.2	NA	NA	0	> 20,000	14,700
Uranium-238	20	MCL	0 - 5	**2.17**	1.18	0.65	NA	NA	11,000	36.8	1.32
Uranium-238	< 136	BGD [9]	0 - 5	2.17	8.12	0.65	NA	NA	11,000	36.8	1.32

Abbreviations:

>>	Designated level is significantly larger than highest activity-concentrations encountered at Site
< n	not detected; detection limit equal to n.
BGD	background in groundwater
Cal	California EPA cleanup goal for chloroform.
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
COC	constituent of concern
CRDL	contract-required detection limit
g/cm^3	grams per cubic centimeter
LEHR/SCDS	Laboratory for Energy-related Health Research/ South Campus Disposal Site
MCL	State of California Maximum Contaminant Level, drinking water
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
NA	not applicable
pCi/g	picocuries per gram
pCi/L	picocuries per liter
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, residential tap water
v/v	volume ratio

Table D-11. Summary of Designated Level Modeling Results for the Waste Burial Holes Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Notes:

Concentrations shown in bold if greater than the designated levels. Detection limits shown in bold if more than twice the designated levels.

[1] Lowest soil vapor designated level among soil types in soil column. Soil vapor designated level may be significantly higher in other soil types.

[2] A time-to-peak of zero means the modeled maximum concentration in groundwater was present immediately (zero years) and the modeled concentration at subsequent time steps was equal to or less than the concentration at zero years.

[3] Maximum concentration during past ten years (1999 - 2008) in downgradient wells UCD1-008, UCD1-013, UCD1-065.

[4] Designated level proportioned from previous (preceding row in table) NUFT result for COC. Designated level concentrations are mathematically proportional to groundwater goal concentrations.

[5] MCL for total trihalomethanes.

[6] 1,4-dichlorobenzene MCL used for 1,3-dichlorobenzene. No MCL or RSL available for 1,3-dichlorobenzene

[7] 1,4-dioxane was recently detected in groundwater immediately downgradient of Landfill Unit 2, Eastern Trenches, and Waste Burial Holes; however no soil analyses for 1,4-dioxane have been conducted to date. A soil designated level for 1,4 dioxane was calculated using Landfill Unit 2 lithology for potential use during the Feasibility Study.

[8] Derived limit for drinking water from the 4 roentgen equivalent man per year Federal MCL for beta particles and photon emitters (EPA, 2000)

[9] Background values determined from well UCD1-018 groundwater samples data (hydrostratigraphic unit 1 background) up to October 2008.

[10] Calculated from pCi/L activity-concentration based on water content (0.17 v/v) and bulk density (1.45 g/cm^3) for silty sand soil type. Data reported in pCi/L were not included in original screening process (see Table 2-2).

[11] Proportioned from designated level, groundwater goal and maximum soil or soil vapor concentration. Predicted peak groundwater concentrations are mathematically proportional to the initial soil or soil vapor concentration.

Table D-12. Summary of Designated-Level Groundwater Constituents of Potential Concern at the Eastern Trenches Area Retained as Constituents of Potential Groundwater Concern, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Designated-Level Constituent of Potential Concern	❶ Are the DL COPCs groundwater concentrations above site background?[1] If yes, enter ✓ in ❹ If no, go to ❷	❷ Are the DL COPC soil concentrations above soil background and the NUFT soil results?[2] If yes, go to ❸ If no, stop and enter ✕ below	❸ Will the DL COPC impact groundwater above background levels in the next 500 years? If yes, enter ✓ in ❹ If no, stop and enter ✕ below	❹ Retained as COPGWC in risk characterization? ✓ = Yes
Acetone	Yes	-	-	✓
Carbon disulfide	Yes	-	-	✓
Chloroform	Yes	-	-	✓
1,1-Dichloroethane	Yes	-	-	✓
1,2-Dichloroethane	Yes	-	-	✓
1,2-Dichloropropane	Yes	-	-	✓
1,4-Dioxane	Yes	-	-	✓
Formaldehyde	No	Yes	Yes	✓
Styrene	No	✕	-	-
Tetrachloroethene	Yes	-	-	✓
Toluene	No	Yes	Yes	✓
Carbon-14	Yes	-	-	✓
Tritium	Yes	-	-	✓
Uranium-235	No	✕	-	-

Notes:

[1]Maximum COPC groundwater concentrations are shown in Table D-6. Organic chemical background is assumed zero. For inorganic constituents, compare downgradient groundwater concentration to groundwater background concentration. Results below detection limits are presumed to be below site background.

[2] For volatile organic compounds: Are the DL COPC soil vapor concentrations detected and above the NUFT soil vapor results?

Abbreviations:

✕	not retained as a COPGWC
✓	retained as a COPGWC
-	skip
COPC	constituent of potential concern
COPGWC	constituent of potential groundwater concern
DL	designated-level
MCL	California Maximum Contaminant Level for groundwater
N/A	not available
NUFT	Non-Isothermal, Unsaturated Flow and Transport

Table D-13. Summary of Designated-Level Groundwater Constituents of Potential Concern at Landfill Unit 1 Retained as Constituents of Potential Groundwater Concern, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Designated-Level Constituent of Potential Concern	❶	❷	❸	❹
	Are the DL COPCs groundwater concentrations above site background?[1]	Are the DL COPC soil concentrations above soil background and the NUFT soil results?[2]	Will the DL COPC impact groundwater above background levels in the next 500 years?	Retained as COPGWC in risk characterization? ✓ = Yes
	If yes, enter ✓ in ❹ If no, go to ❷	If yes, go to ❸ If no, stop and enter ✕ below	If yes, enter ✓ in ❹ If no, stop and enter ✕ below	
Acetone	Yes	-	-	✓
1,3-Butadiene	N/A	✕	-	-
Formaldehyde	No	Yes	Yes	✓
Toluene	No	Yes	Yes	✓
Copper	Yes	-	-	✓
Selenium	Yes	-	-	✓
Carbon-14	Yes	-	-	✓

Notes:

[1]Maximum COPC groundwater concentrations are shown in Table D-7. Organic chemical background is assumed to be zero. For inorganic constituents, compare downgradient groundwater concentration to groundwater background concentration. Results below detection limits are presumed to be below site background.

[2]For volatile organic compounds: Are the DL COPC soil vapor concentrations detected and above the NUFT soil vapor results?

Abbreviations:

✕	not retained as a COPGWC
✓	retained as a COPGWC
-	skip
COPC	constituent of potential concern
COPGWC	constituent of potential groundwater concern
DL	designated-level
MCL	California Maximum Contaminant Level for groundwater
N/A	not available
NUFT	Non-Isothermal, Unsaturated Flow and Transport

Table D-14. Summary of Designated-Level Groundwater Constituents of Potential Concern at Landfill Unit 2 Retained as Constituents of Potential Groundwater Concern, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Designated-Level Constituent of Potential Concern	❶ Are the DL COPCs groundwater concentrations above site background?[1] If yes, enter ✓ in ❹ If no, go to ❷	❷ Are the DL COPC soil concentrations above soil background and the NUFT soil results?[2] If yes, go to ❸ If no, stop and enter ✕ below	❸ Will the DL COPC impact groundwater above background levels in the next 500 years? If yes, enter ✓ in ❹ If no, stop and enter ✕ below	❹ Retained as COPGWC in risk characterization? ✓ = Yes
Acetone	Yes	-	-	✓
1,3-Butadiene	N/A	✕	-	-
Carbon disulfide	Yes	-	-	✓
Chloroform	Yes	-	-	✓
1,1-Dichloroethane	Yes	-	-	✓
1,1-Dichloroethene	Yes	-	-	✓
1,2-Dichloropropane	Yes	-	-	✓
1,4-Dioxane	Yes	-	-	✓
Formaldehyde	Yes	-	-	✓
Methyl Ethyl Ketone	Yes	-	-	✓
Styrene	No	✕	-	-
Tetrachloroethene	Yes	-	-	✓
Toluene	Yes	-	-	✓
1,1,2-Trichloroethane	Yes	-	-	✓
Xylenes	No	Yes	Yes	✓
Cadmium	Yes	-	-	✓
Silver	Yes	-	-	✓
Carbon-14	Yes	-	-	✓
Strontium-90	No	✕	-	-
Uranium-235	No	✕	-	-

Notes:

[1]Maximum COPC groundwater concentrations are shown in Table D-8. Organic chemical background is assumed to be zero. For inorganic constituents, compare downgradient groundwater concentration to groundwater background concentration. Results below detection limits are presumed to be below site background.

[2]For volatile organic compounds: Are the DL COPC soil vapor concentrations detected and above the NUFT soil vapor results?

Abbreviations:

✕ not retained as a COPGWC
✓ retained as a COPGWC
\- skip

Table D-14. Summary of Designated-Level Groundwater Constituents of Potential Concern at Landfill Unit 2 Retained as Constituents of Potential Groundwater Concern LEHR/SCDS, University of California, Davis (continued)

Abbreviations (continued):

COPC	constituent of potential concern
COPGWC	constituent of potential groundwater concern
DL	designated-level
MCL	California Maximum Contaminant Level for groundwater
N/A	not available
NUFT	Non-Isothermal, Unsaturated Flow and Transport

Table D-15. Summary of Designated-Level Groundwater Constituents of Potential Concern at Landfill Unit 3 Retained as Constituents of Potential Groundwater Concern, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Designated-Level Constituent of Potential Concern	❶ Are the DL COPCs groundwater concentrations above site background?[1] If yes, enter ✓ in ❹ If no, go to ❷	❷ Are the DL COPC soil concentrations above soil background and the NUFT soil results?[2] If yes, go to ❸ If no, stop and enter ✕ below	❸ Will the DL COPC impact groundwater above background levels in the next 500 years? If yes, enter ✓ in ❹ If no, stop and enter ✕ below	❹ Retained as COPGWC in risk characterization? ✓ = Yes
Acetone	Yes	-	-	✓
Formaldehyde	N/A	Yes	Yes	✓
Toluene	No	Yes	Yes	✓
Antimony	No	Yes	✕	-
Barium	No	Yes	Yes	✓
Cadmium	Yes	-	-	✓
Copper	Yes	-	-	✓
Manganese	No	Yes	✕	-
Silver	No	Yes	✕	-
Carbon-14	Yes	-	-	✓
Strontium-90	No	✕	-	-
Tritium	No	✕	-	-
Uranium-235	No	✕	-	-

Notes:

[1]Maximum COPC groundwater concentrations are shown in Table D-9. Organic chemical background is assumed to be zero. For inorganic constituents, compare downgradient groundwater concentration to groundwater background concentration. Results below detection limits are presumed to be below site background.

[2]For volatile organic compounds: Are the DL COPC soil vapor concentrations detected and above the NUFT soil vapor results?

Abbreviations:

✕	not retained as a COPGWC
✓	retained as a COPGWC
-	skip
COPC	constituent of potential concern
COPGWC	constituent of potential ground water concern
DL	designated-level
MCL	California Maximum Contaminant Level for ground water
N/A	not available
NUFT	Non-Isothermal, Unsaturated Flow and Transport

Table D-16. Summary of Designated-Level Groundwater Constituents of Potential Concern at the Southern Trenches Area Retained as Constituents of Potential Groundwater Concern, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Designated-Level Constituent of Potential Concern	❶ Are the DL COPCs groundwater concentrations above site background?[1] If yes, enter ✓ in ❹ If no, go to ❷	❷ Are the DL COPC soil vapor concentrations detected and above the NUFT soil vapor results? If yes, go to ❸ If no, stop and enter ✕ below	❸ Will the DL COPC impact groundwater above background levels in the next 500 years? If yes, enter ✓ in ❹ If no, stop and enter ✕ below	❹ Retained as COPGWC in risk characterization? ✓ = Yes
Acetone	Yes	-	-	✓
Carbon disulfide	No	✕	-	-
Methyl Ethyl Ketone	No	Yes	Yes	✓
Styrene	No	✕	-	-
Toluene	No	Yes	Yes	✓

Note:
[1]Maximum COPC groundwater concentrations are shown in Table D-10. Organic chemical background is assumed zero. Results below detection limits are presumed to be below site background.

Abbreviations:

✕	not retained as a COPGWC
✓	retained as a COPGWC
-	skip
COPC	constituent of potential concern
COPGWC	constituent of potential groundwater concern
DL	designated-level
MCL	California Maximum Contaminant Level for groundwater
N/A	not available
NUFT	Non-Isothermal, Unsaturated Flow and Transport

Table D-17. Summary of Designated-Level Groundwater Constituents of Potential Concern at the Waste Burial Holes Area Retained as Constituents of Potential Groundwater Concern, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Designated-Level Constituent of Potential Concern	❶ Are the DL COPCs groundwater concentrations above site background?[1] If yes, enter ✓ in ❹ If no, go to ❷	❷ Are the DL COPC soil concentrations above soil background and the NUFT soil results?[2] If yes, go to ❸ If no, stop and enter ✕ below	❸ Will the DL COPC impact groundwater above background levels in the next 500 years? If yes, enter ✓ in ❹ If no, stop and enter ✕ below	❹ Retained as COPGWC in risk characterization? ✓ = Yes
Acetone	No	Yes	Yes	✓
Benzene	Yes	-	-	✓
Chloroform	Yes	-	-	✓
1,3-Dichlorobenzene	No	Yes	Yes	✓
1,4-Dioxane	Yes	-	-	✓
Formaldehyde	No	Yes	Yes	✓
Methyl Ethyl Ketone	No	✕ [3]	-	-
Toluene	No	Yes	Yes	✓
Carbon-14	Yes	-	-	✓
Strontium-90	No	✕	-	-
Tritium	Yes	-	-	✓
Uranium-238	No	Yes	✕	-

Notes:

[1]Maximum COPC groundwater concentrations are shown in Table D-11. Organic chemical background is assumed zero. For inorganic constituents, compare downgradient groundwater concentration to groundwater background concentration. Results below detection limits are presumed to be below site background.

[2]For volatile organic compounds: Are the DL COPC soil vapor concentrations detected and above the NUFT soil vapor results?

[3] Methyl ethyl ketone was not detected in soil vapor and the detection limit was reasonably low.

Abbreviations:

✕	not retained as a COPGWC
✓	retained as a COPGWC
-	skip
COPC	constituent of potential concern
COPGWC	constituent of potential groundwater concern
DL	designated-level
MCL	California Maximum Contaminant Level for groundwater
N/A	not available
NUFT	Non-Isothermal, Unsaturated Flow and Transport

Table D-18. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at the Eastern Trenches Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Driver COPGWC	Spatial Distribution	Historically Used at the Site	Level of Ground Water Impact [1]	Data Reliability	Recommended Action	Basis for Recommendation
Acetone	Localized	Possible	detected	• Groundwater data qualified frequently due to laboratory contamination. • Common laboratory contaminant.	No Further Action	• Maximum groundwater concentration is approximately two orders of magnitude below the RSL. • Modeling suggests peak impact above the CRDL in 20 years, but groundwater impact will remain far below the RSL.
Carbon disulfide	Localized	Possible	detected	• Representative soil vapor sampling and groundwater sampling. • Detected only once in groundwater; detection frequency less than 1%.	No Further Action	• Maximum groundwater concentration is more than three orders of magnitude below the RSL, two orders of magnitude below the CNL, and the CRDL. • Modeling suggests groundwater impact will remain well below the RSL and CNL, and below the CRDL. • Presence of carbon disulfide in groundwater is questionable due to low concentration/low frequency of detection.
Chloroform	Localized	Yes	> MCL, Cal	• Good data quality. • Representative soil vapor sampling and groundwater sampling.	Evaluate in FS	• Currently impacting groundwater above the MCL and California EPA cleanup goal. • Modeling suggests peak impact in 24 years.
1,1-Dichloroethane	Localized	Possible	>MCL	• Good data quality. • Representative soil vapor sampling and groundwater sampling.	Evaluate in FS	• Currently impacting groundwater above the MCL. • Modeling suggests peak impact 15 years.
1,2-Dichloroethane	Localized	Possible	>MCL	• Good data quality. • Representative soil vapor sampling and groundwater sampling.	Evaluate in FS	• Currently impacting groundwater above the MCL. • Modeling suggests peak impact 15 years.
1,2-Dichloropropane	Localized	Possible	detected	• Good data quality. • Representative soil vapor sampling and groundwater sampling.	Evaluate in FS	• Detected in groundwater. • Modeling suggests groundwater impact above the MCL in 16 years.
Formaldehyde	Localized	Yes	not detected	• Limited groundwater data. • Representative soil vapor sampling.	No Further Action	• Formaldehyde was not detected in one Data Gaps grab groundwater sample collected in 2008 and two downgradient groundwater samples collected in 2009. No other groundwater samples were available for formaldehyde. • Modeling suggests groundwater impact above the CNL and RSL in 16 years. • Formaldehyde expected to biodegrade quickly upon reaching groundwater.[2]
1,4-Dioxane	No data	Possible	>CNL, RSL	• Limited groundwater sampling. • No soil sample data.	Evaluate in FS	• Downgradient groundwater above groundwater goals (CNL and RSL). • Modeling suggests peak impact in 17 years.
Tetrachloroethene	Localized	Possible	detected	• Good data quality. • Representative soil vapor sampling and ground water sampling.	No Further Action	• Maximum groundwater concentration is below the MCL. • Modeling suggests groundwater impact will remain below the MCL.

Table D-18. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at the Eastern Trenches Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Driver COPGWC	Spatial Distribution	Historically Used at the Site	Level of Ground Water Impact [1]	Data Reliability	Recommended Action	Basis for Recommendation
Toluene	Localized	Yes	not detected	• Good data quality. • Representative soil vapor sampling and groundwater sampling.	No Further Action	• Not detected in groundwater. • Modeling suggests groundwater impact will remain below the MCL. • Toluene expected to biodegrade quickly upon reaching groundwater.[3]
Carbon-14	Localized	Yes	> bkgd	• Some qualified soil data. • Representative soil and groundwater sampling.	Evaluate in FS	• Currently impacting groundwater above background but below MCL. • Modeling suggests peak impact above background and the MCL in 28 years.
Tritium	Localized	Yes	> bkgd	• Good data quality. • Representative soil and groundwater sampling.	Evaluate in FS	• Currently impacting groundwater above background but below MCL. • Modeling suggests peak impact above background and the MCL in 23 years.

Notes:
[1]Level of groundwater impact assessed using the most recent ten years (1999 - 2008) of monitoring data from downgradient wells UCD1-008, UCD1-009, UCD1-012, UCD1-013, UCD1-049, UCD1-050, UCD1-051 and UCD1-066. Note: these wells are also directly downgradient of Landfill Unit 2.
[2] The published range of biodegradation half lives for formaldehyde in ground water is a few hours to 14 days (Howard, 1991).
[3] The published range of biodegradation half lives for toluene in ground water is 7 days to 4 weeks (Howard, 1991).

Abbreviations:

>	greater than
<	less than
bkgd	background
Cal	California EPA cleanup goal for chloroform
COPGWC	constituent of potential ground water concern
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
CRDL	contract-required detection limit
FS	Feasibility Study
MCL	California Maximum Contaminant Level for ground water
NA	not available
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, 2008

Table D-19. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at Landfill Unit 1, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Driver COPGWC	Spatial Distribution	Historically Used at the Site	Level of Ground Water Impact [1]	Data Reliability	Recommended Action	Basis for Recommendation
Acetone	Random	Possible	detected	• Representative soil vapor sampling. • Low frequency of detection in soil and groundwater. • Common laboratory contaminant.	No Further Action	• Maximum groundwater concentration was significantly below the RSL. • Modeling suggests peak impact above the CRDL in 24 years, but groundwater impact will remain far below the RSL. • Low frequency of detection in groundwater.
Formaldehyde	Not in soil vapor	Yes	not detected	• Limited groundwater data. • Representative soil vapor sampling.	No Further Action	• Formaldehyde was not detected in two groundwater samples collected in 2009. No other groundwater samples were available for formaldehyde. • Modeling suggests groundwater impact above the CNL and RSL in 21 years. • Formaldehyde expected to biodegrade quickly upon reaching groundwater.[2]
Toluene	Random	Yes	not detected	• Good data quality. • Representative soil vapor sampling and groundwater sampling.	No Further Action	• Not detected in downgradient groundwater. • Modeling suggests groundwater impact will remain below the MCL. • Toluene expected to biodegrade quickly upon reaching groundwater.[3]
Copper	Localized	Yes	> bkgd	• Representative soil sampling. • Good soil sample data quality.	Evaluate in FS	• Maximum groundwater concentration is above background. • Modeling suggests peak groundwater concentration will arrive in 770 years.
Selenium	Localized	Possible	> bkgd	• Representative soil sampling. • Good data quality.	Evaluate in FS	• Above background in downgradient groundwater. • Not detected in Data Gaps grab groundwater sample LF1-2. • Modeling suggests impact currently above background and the MCL.
Carbon-14	Localized	Yes	> bkgd	• Representative soil sampling. • Detected in only one of 31 groundwater samples. • Single groundwater detection had high counting error.	Evaluate in FS	• Downgradient groundwater potentially above background; high uncertainty in single detection above groundwater background. • Not detected in Data Gaps grab groundwater sample LF1-2. • Modeling suggests impact above background and MCL in 43 years.

Notes:

[1]Level of groundwater impact assessed using the most recent ten years (1999 - 2008) of monitoring data from downgradient wells UCD1-11 and UCD1-62.

[2] The published range of biodegradation half lives for formaldehyde in ground water is a few hours to 14 days (Howard, 1991).

[3] The published range of biodegradation half lives for toluene in ground water is 7 days to 4 weeks (Howard, 1991).

Abbreviations:

>	greater than
<	less than
bkgd	background
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
COPGWC	constituent of potential ground water concern
CRDL	contract-required detection limit
FS	Feasibility Study
MCL	California Maximum Contaminant Level for ground water
NA	not available
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, 2008

Table D-20. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at Landfill Unit 2, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Driver COPGWC	Spatial Distribution	Historically Used at the Site	Level of Ground Water Impact [1]	Data Reliability	Recommended Action	Basis for Recommendation
Acetone	Localized	Possible	detected	• Representative soil vapor sampling. • Many groundwater sample results are qualified due to laboratory contamination. • Common laboratory contaminant.	Evaluate in FS	• Significant concentration in soil gas (3,900 ug/m^3 maximum). • Modeling suggests peak impact above the CRDL in 12 years, but groundwater impact predicted to remain below the RSL. • Maximum groundwater concentration was significantly below the RSL.
Carbon disulfide	Localized	Possible	detected	• Representative soil vapor sampling and ground water sampling. • Detected only once in groundwater; detection frequency less than 1%.	No Further Action	• Maximum groundwater concentration is more than three orders of magnitude below the RSL, two orders of magnitude below the CNL, and below the CRDL. • Modeling suggests groundwater impact will remain well below the RSL and CNL, and below the CRDL. • Presence of carbon disulfide in groundwater is questionable due to low concentration/low frequency of detection.
Chloroform	Localized	Yes	detected, >RSL, MCL	• Representative groundwater[2] and soil vapor sampling.	Evaluate in FS	• Concentration in groundwater is above groundwater goals (RSL and MCL). • Modeling suggests peak groundwater concentration in 10 years.
1,1-Dichloroethane	Localized	Possible	detected, >MCL	• Representative groundwater[2] and soil vapor sampling.	Evaluate in FS	• Downgradient groundwater above groundwater goal (MCL). • Not detected in Data Gaps grab groundwater samples. • Modeling suggests peak groundwater concentration in 10 years.
1,1-Dichloroethene	Localized	Possible	detected, >MCL, declining trend	• Representative groundwater[2] and soil vapor sampling.	No Further Action	• Concentrations of 1,1-dichloroethene have steadily declined in downgradient wells over past 10 years and were below the MCL in 2007, 2008, and first half of 2009. • Low concentration /non-detect in Data Gaps grab groundwater samples. • Modeling predicts impact below the MCL.
1,2-Dichloropropane	Localized	Possible	detected	• Representative groundwater[2] and soil vapor sampling. • Not detected in most groundwater samples.	Evaluate in FS	• Detected in downgradient groundwater. • Not detected in Data Gaps grab groundwater samples. • Modeling suggests impact above the MCL in 10 years.
1,4-Dioxane	No data	Possible	>CNL, RSL	• Limited groundwater[2] sampling. • No soil sample data.	Evaluate in FS	• Downgradient groundwater above groundwater goals (CNL and RSL). • Modeling suggests peak impact in 8 years.
Formaldehyde	Localized	Yes	detected	• Limited groundwater data. • Representative soil vapor sampling.	No Further Action	• Low concentrations of formaldehyde were detected in two of three Data Gaps grab groundwater samples and formaldehyde was not detected in two downgradient groundwater samples collected in 2009. No other groundwater samples were available for formaldehyde. • Modeling suggests groundwater impact above the CNL and RSL in 9 years. • Formaldehyde expected to biodegrade quickly upon reaching groundwater.[3]

Table D-20. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at Landfill Unit 2, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Driver COPGWC	Spatial Distribution	Historically Used at the Site	Level of Ground Water Impact [1]	Data Reliability	Recommended Action	Basis for Recommendation
Methyl Ethyl Ketone	Random	Possible	detected	• Representative groundwater[2] and soil vapor sampling. • Not detected in groundwater since December 2000. • Low concentrations in soil vapor.	No Further Action	• Maximum groundwater concentration was more than two orders of magnitude below the RSL. • Modeling suggests peak impact above the CRDL in 11 years, but groundwater impact will remain far below the RSL.
Tetrachloroethene	Localized	Possible	detected	• Representative groundwater[2] and soil vapor sampling.	No Further Action	• Maximum groundwater concentration is below the MCL. • Modeling suggests tetrachloroethene is currently at its peak concentration in groundwater and that the concentration will remain below the MCL.
Toluene	Localized	Yes	not detected	• Representative groundwater[2] and soil vapor sampling. • Not detected in groundwater since 2002.	No Further Action	• Toluene is currently not detected in groundwater. • Toluene expected to biodegrade quickly upon reaching groundwater.[3] • Without accounting for biodegradation, modeling suggests impact slightly above the MCL in 13 years.
1,1,2-Trichloroethane	Random	Possible	detected, >MCL, declining trend	• Representative groundwater[2] and soil vapor sampling. • Present in groundwater and soil but not detected in soil vapor. • Some soil vapor samples had high detection limits.	No Further Action	• Concentrations of 1,1,2-trichloroethane in downgradient groundwater indicate a declining trend. • Not detected in Data Gaps grab groundwater samples. • 1,1,2-trichloroethane not detected in soil vapor.
Xylenes	Localized	Yes	not detected	• Representative groundwater[2] and soil vapor sampling.	No Further Action	• Xylenes are currently not detected in groundwater. • Xylenes are expected to biodegrade quickly upon reaching groundwater.[3] • Without accounting for biodegradation, modeling suggests that groundwater concentrations will remain significantly below the MCL. • Modeling suggests groundwater concentrations are currently at their peak.
Cadmium	Localized	Possible	>bkgd	• Representative soil sampling. • Limited groundwater sampling. • Soil detection limits above background.	Evaluate in FS	• Downgradient groundwater concentration is above background. However, downgradient groundwater data are limited/uncertain. • Not detected in Data Gaps grab groundwater sample. • Modeling suggests impact above background and the MCL.
Silver	Localized	Possible	>bkgd	• Representative soil sampling. • Limited groundwater sampling.	No Further Action	• Downgradient groundwater concentration is above background but more than three orders of magnitude below the MCL. • Not detected in Data Gaps grab groundwater sample. • Modeling suggests impact will remain below the MCL. • Peak impact predicted to occur in 5,000 years.
Carbon-14	Localized	Yes	>bkgd	• Representative soil and groundwater sampling. • Soil samples have high detection limits.	Evaluate in FS	• Groundwater concentration is above background. • Modeling suggests impact above background and the MCL in 10 years.

Notes:
[1]Level of groundwater impact assessed using the most recent ten years (1999 - 2008) of monitoring data from downgradient wells UCD1-8, UCD1-009, UCD1-012, UCD1-13, UCD1-049, UCD1-050, UCD1-051 and UCD1-66. Mass of contamination in disposal unit used to conservatively predict area of groundwater impact.
[2] The groundwater data are from wells downgradient of both Eastern Trenches and Landfill Unit 2 areas. Groundwater contamination could be from either area.

Table D-20. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at Landfill Unit 2, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Notes (continued)

[3] The published range of biodegradation half lives for formaldehyde in ground water is a few hours to 14 days; the published range for toluene is 7 days to 4 weeks; the published range for xylenes is 2 weeks to 12 months (Howard, 1991).

Abbreviations:

>	greater than
<	less than
bkgd	background
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
COPGWC	constituent of potential ground water concern
CRDL	contract-required detection limit
FS	Feasibility Study
MCL	California Maximum Contaminant Level for groundwater
NA	not available
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, 2008

Table D-21. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at Landfill Unit 3, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Driver COPGWC	Spatial Distribution	Historically Used at the Site	Level of Ground Water Impact [1]	Data Reliability	Recommended Action	Basis for Recommendation
Acetone	Random	Possible	detected	• Representative soil vapor sampling. • Some groundwater sample results are qualified due to laboratory contamination. • Common laboratory contaminant.	No Further Action	• Maximum groundwater concentration more than three orders of magnitude below the RSL. • Modeling suggests peak impact above the CRDL, but groundwater impact will remain far below the RSL.
Formaldehyde	Localized	Yes	NA	• No recent groundwater data. • Representative soil vapor sampling.	Evaluate in FS[4]	• No monitoring data were collected within the past ten years. • Modeling suggests groundwater impact above the CNL and RSL. • Formaldehyde expected to biodegrade quickly upon reaching groundwater.[2]
Toluene	Random	Yes	not detected	• Representative soil vapor sampling and groundwater sampling. • Good data quality.	No Further Action	• Not detected in downgradient groundwater. • Modeling suggests groundwater impact will remain below the MCL. • Toluene expected to biodegrade quickly upon reaching groundwater.[3]
Barium	Random	Possible	detected	• Representative soil sampling. • Limited groundwater sampling (2 samples).	Evaluate in FS [5]	• Maximum groundwater concentration is below background and the MCL, but data are very limited. • Modeling suggests barium impact above background and the MCL.
Cadmium	Localized	Possible	>bkgd	• Representative soil sampling but most sample results have detection limits above background. • Limited groundwater sampling (2 samples).	Evaluate in FS	• Maximum groundwater concentration is above background. • Modeling suggests cadmium is at its peak concentration in groundwater and is predicted to currently exceed background and the MCL.
Copper	Localized	Yes	>bkgd	• Representative soil sampling. • Limited groundwater sampling (2 samples).	Evaluate in FS	• Maximum groundwater concentration is above background. • Modeling suggests peak groundwater concentration above background and the MCL will arrive in 4,000 years.
Carbon-14	Localized	Yes	>bkgd	• Representative soil sampling but most sample results have detection limits above background. • Limited groundwater sampling (5 samples).	Evaluate in FS	• Maximum groundwater concentration is above background. • Not detected in Data Gaps grab groundwater sample. • Modeling suggests peak impact above background and MCL in 140 years.

Notes:

[1] Level of groundwater impact assessed using the most recent ten years (1999 - 2008) of monitoring data from downgradient wells UCD1-10 and UCD1-64.
[2] The published range of biodegradation half lives for formaldehyde in ground water is a few hours to 14 days (Howard, 1991).
[3] The published range of biodegradation half lives for toluene in ground water is 7 days to 4 weeks (Howard, 1991).
[4] This decision will be revisited when groundwater formaldehyde data are available for well UCD1-64 in first quarter 2010.
[5] This decision will be revisited when additional groundwater barium data are available in first quarter 2010.

Abbreviations:

>	greater than
<	less than
bkgd	background
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
COPGWC	constituent of potential ground water concern
CRDL	contract-required detection limit
FS	Feasibility Study

Table D-21. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at Landfill Unit 3, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

Abbreviations (continued):

MCL	California Maximum Contaminant Level for ground water
NA	not available
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, 2008

Table D-22. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at the Southern Trenches Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Driver COPGWC	Spatial Distribution	Historically Used at the Site	Level of Ground Water Impact [1]	Uncertainty	Recommended Action	Basis for Recommendation
Acetone	Localized	Possible	detected	• Representative soil vapor sampling. • All but two of the detected concentrations in groundwater are qualified due to laboratory contamination. • Common laboratory contaminant.	No Further Action	• Maximum groundwater concentration more than three orders of magnitude below the RSL. • Modeling suggests groundwater concentrations will remain more than two orders of magnitude below the RSL.
Methyl Ethyl Ketone	Random	Possible	not detected	• Representative groundwater and soil vapor sampling. • Low concentrations in soil vapor.	No Further Action	• Methyl ethyl ketone is currently not detected in groundwater. • Modeling suggests groundwater concentrations are currently at their peak and will remain far below the RSL.
Toluene	Localized	Yes	not detected	• Representative groundwater and soil vapor sampling. • Low concentrations in soil vapor.	No Further Action	• Toluene is currently not detected in groundwater. • Toluene expected to biodegrade quickly upon reaching groundwater.[2] • Without accounting for biodegradation, modeling suggests impact slightly above the CRDL and well below the MCL.

Notes:
[1] Level of groundwater impact assessed using the most recent ten years (1999 - 2008) of monitoring data from downgradient wells UCD1-008, UCD1-013 and UCD1-024.
[2] The published range of biodegradation half lives for toluene in groundwater is 7 days to 4 weeks (Howard, 1991).

Abbreviations:

>	greater than
<	less than
bkgd	background
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
COPGWC	constituent of potential ground water concern
CRDL	contract-required detection limit
FS	Feasibility Study
MCL	California Maximum Contaminant Level for ground water
NA	not available
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, 2008

Table D-23. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at the Waste Burial Holes Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis

Driver COPGWC	Spatial Distribution	Historically Used at the Site	Level of Ground Water Impact [1]	Data Reliability	Recommended Action	Basis for Recommendation
Acetone	Random	Possible	not detected	• Representative groundwater[2] and soil vapor sampling. • Three of 15 groundwater samples qualified due to laboratory contamination. • Common laboratory contaminant.	No Further Action	• Acetone was not detected in groundwater. • Modeling suggests groundwater concentrations are currently at their peak and will remain more than two orders of magnitude below the RSL.
Benzene	Not in soil vapor	Yes	detected	• Representative groundwater[2] and soil vapor sampling. • All soil vapor results are below the detection limit.	No Further Action	• One trace concentration detected out of 15 downgradient groundwater samples. • Benzene was not detected in the soil vapor samples. • Downgradient groundwater concentrations are currently below the MCL and modeling suggests that concentrations will remain below the MCL.
Chloroform	Not in soil vapor	Yes	detected	• Representative groundwater[2] and soil vapor sampling. • All soil vapor results are below the detection limit.	No Further Action	• Chloroform was not detected in the soil vapor samples. • Chloroform in downgradient groundwater is due to contamination in Landfill Unit 2 and Eastern Trenches areas.[2]
1,3-Dichlorobenzene	Random	Possible	not detected	• Representative groundwater[2] and soil vapor sampling.	No Further Action	• 1,3-Dichlorobenzene was not detected in groundwater. • Modeling suggests 1,3-dichlorobenzene is currently at its peak concentration in groundwater and that a localized area will only slightly exceed the MCL.
Formaldehyde	Not in soil vapor	Yes	not detected	• Limited groundwater data (two samples). • Representative soil vapor sampling.	No Further Action	• A low concentration of Formaldehyde was detected in the Data Gaps grab groundwater sample and formaldehyde was not detected in one downgradient well groundwater sample collected in 2009. No other groundwater samples were available for formaldehyde. • Modeling suggests groundwater impact above the CNL and RSL. • Formaldehyde expected to biodegrade quickly upon reaching groundwater.[3]
1,4-Dioxane	No data	Possible	>CNL, RSL	• Limited groundwater[2] sampling. • No soil sample data.	Evaluate in FS	• Downgradient groundwater above groundwater goals (CNL and RSL). • Modeling suggests groundwater concentrations are currently at their peak.
Toluene	Localized	Yes	not detected	• Representative groundwater and soil vapor sampling. • Low concentrations in soil vapor.	No Further Action	• Toluene was not detected in groundwater. • Low concentrations in soil vapor. • Toluene expected to biodegrade quickly upon reaching groundwater.[4] • Without accounting for biodegradation, modeling suggests impact slightly above the CRDL and well below the MCL.
Carbon-14	Localized	Yes	>bkgd	• Representative soil and groundwater sampling. • Some soil samples have high detection limits.	Evaluate in FS	• Downgradient groundwater concentration is above background. • Modeling suggests impact above background and the MCL.
Tritium	Localized	Yes	>bkgd	• Representative soil and groundwater sampling. • Soil samples have high detection limits.	Evaluate in FS	• Downgradient groundwater concentration is above background. • Modeling suggests impact above background and the MCL.

Notes:
[1]Level of groundwater impact assessed using the most recent ten years (1999 - 2008) of monitoring data from downgradient wells UCD1-008, UCD1-013, UCD1-065.
[2] The groundwater data from wells UCD1-008, UCD1-013 are downgradient of the Waste Burial Holes, Eastern Trenches and Landfill Unit 2 areas. Groundwater contamination in these wells could be from any of the three areas.
[3] The published range of biodegradation half lives for formaldehyde in ground water is a few hours to 14 days (Howard, 1991).
[4] The published range of biodegradation half lives for toluene in ground water is 7 days to 4 weeks (Howard, 1991).

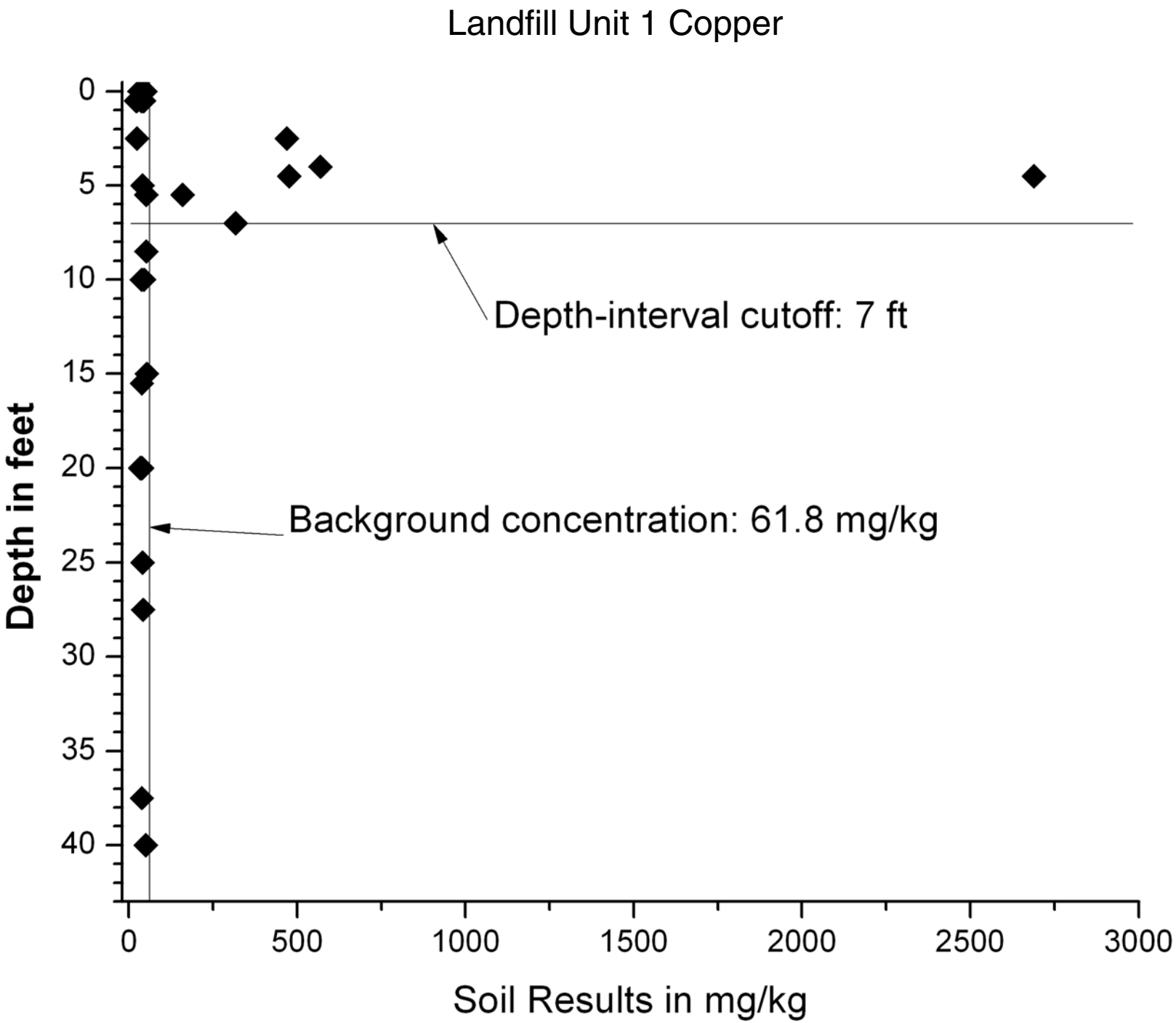
Table D-23. Summary of Major Factors Driving Ground Water Risk and Recommendations for Future Action at the Waste Burial Holes Area, Laboratory for Energy-related Health Research/South Campus Disposal Site, University of California, Davis (continued)

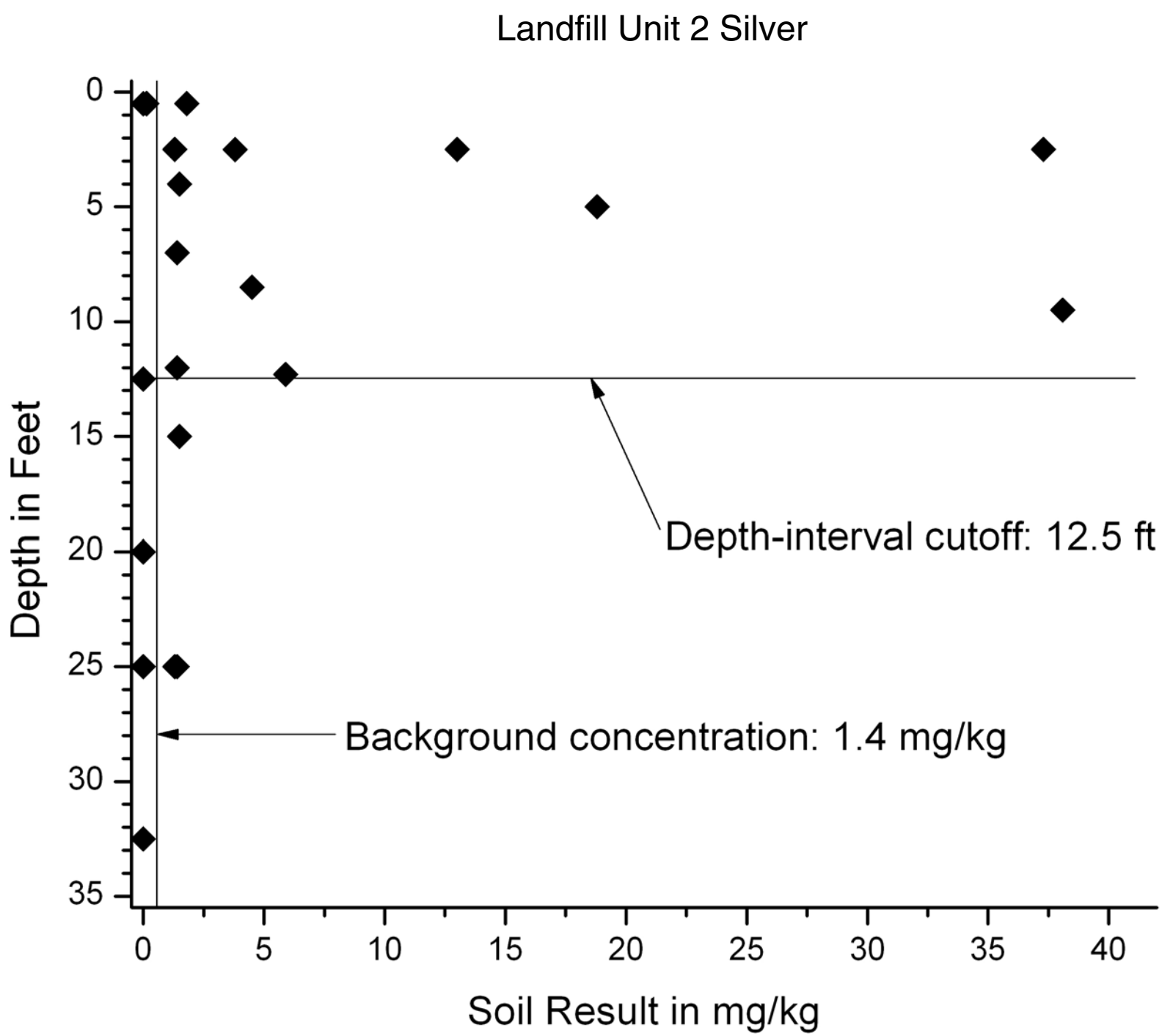
Abbreviations:

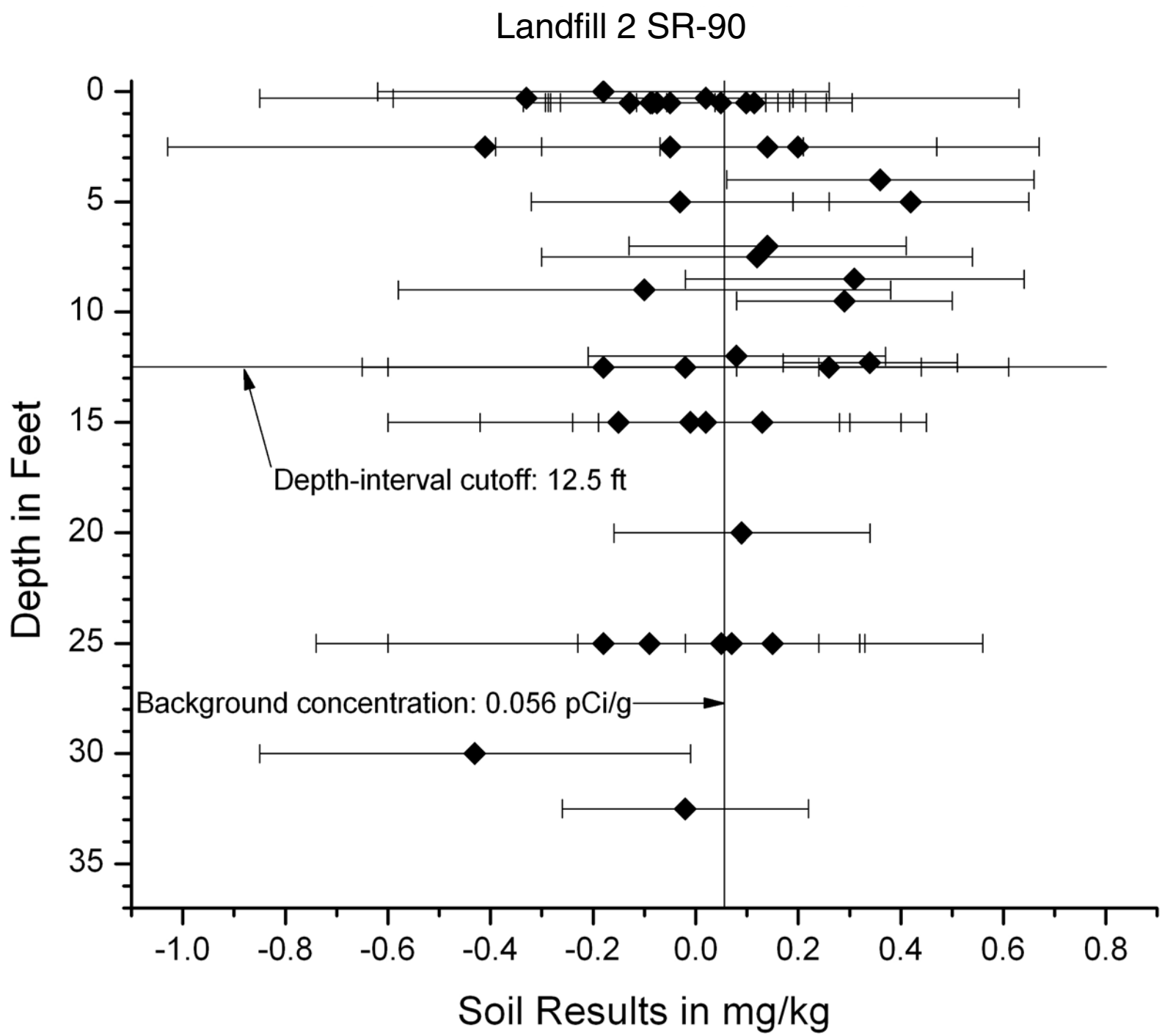
>	greater than
<	less than
bkgd	background
CNL	California Notification Level, California Department of Public Health - Drinking Water Program
COPGWC	constituent of potential ground water concern
CRDL	contract-required detection limit
FS	Feasibility Study
MCL	California Maximum Contaminant Level for ground water
NA	not available
RSL	United States Environmental Protection Agency Region 9 Regional Screening Level, 2008

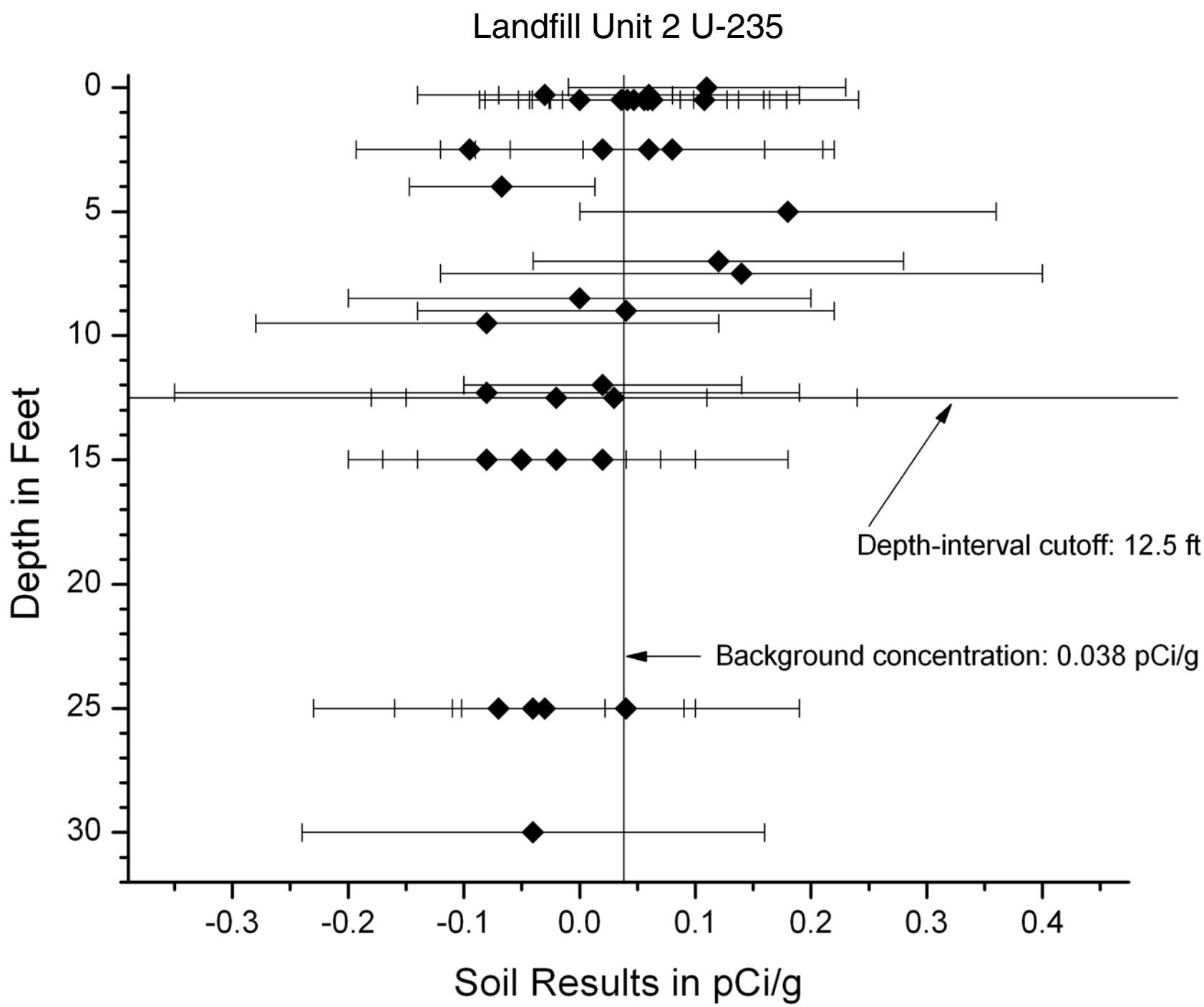
ATTACHMENT D1

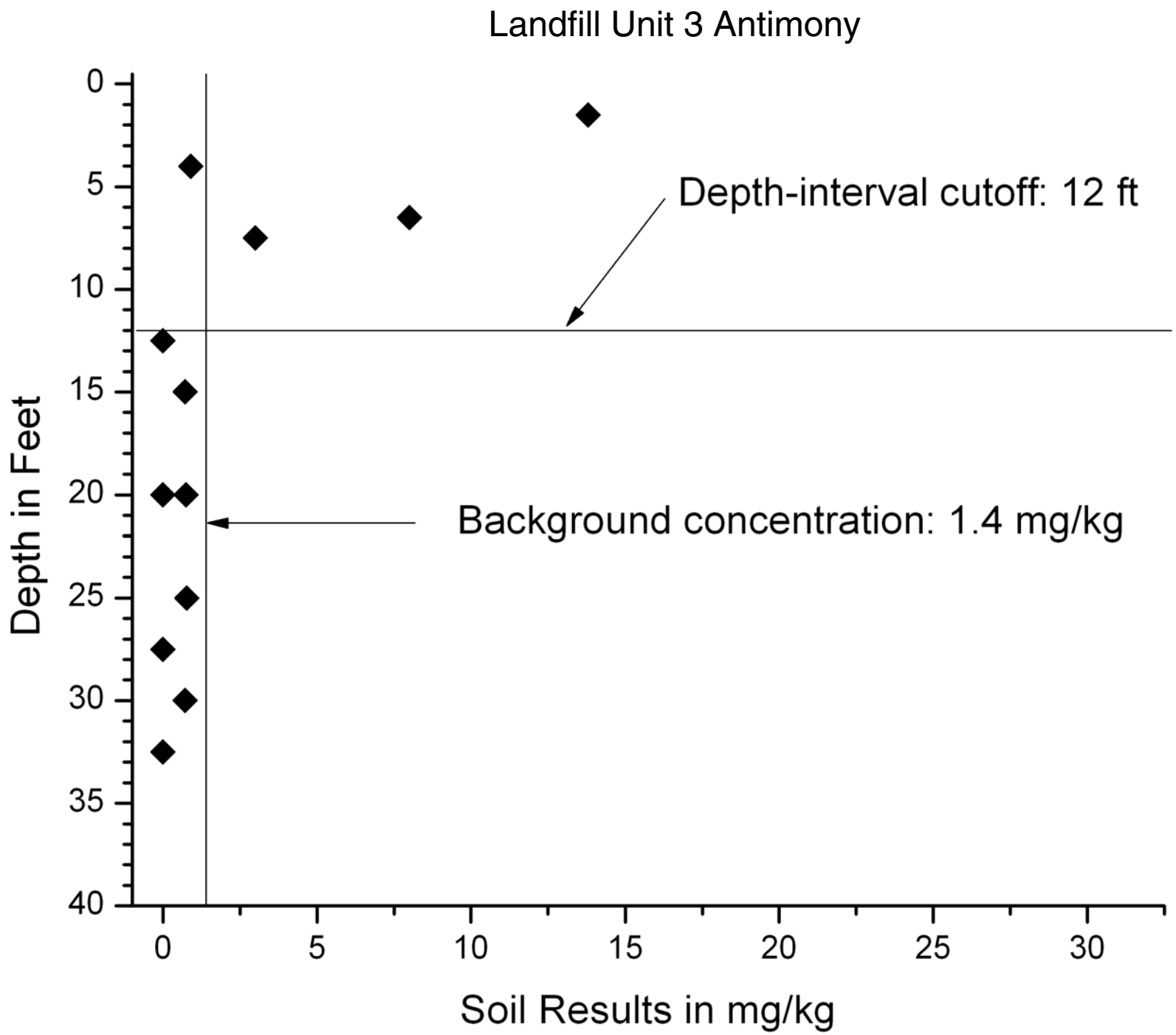
CONCENTRATION VS. DEPTH PLOTS FOR DL COPCS THAT ATTENUATE WITH DEPTH

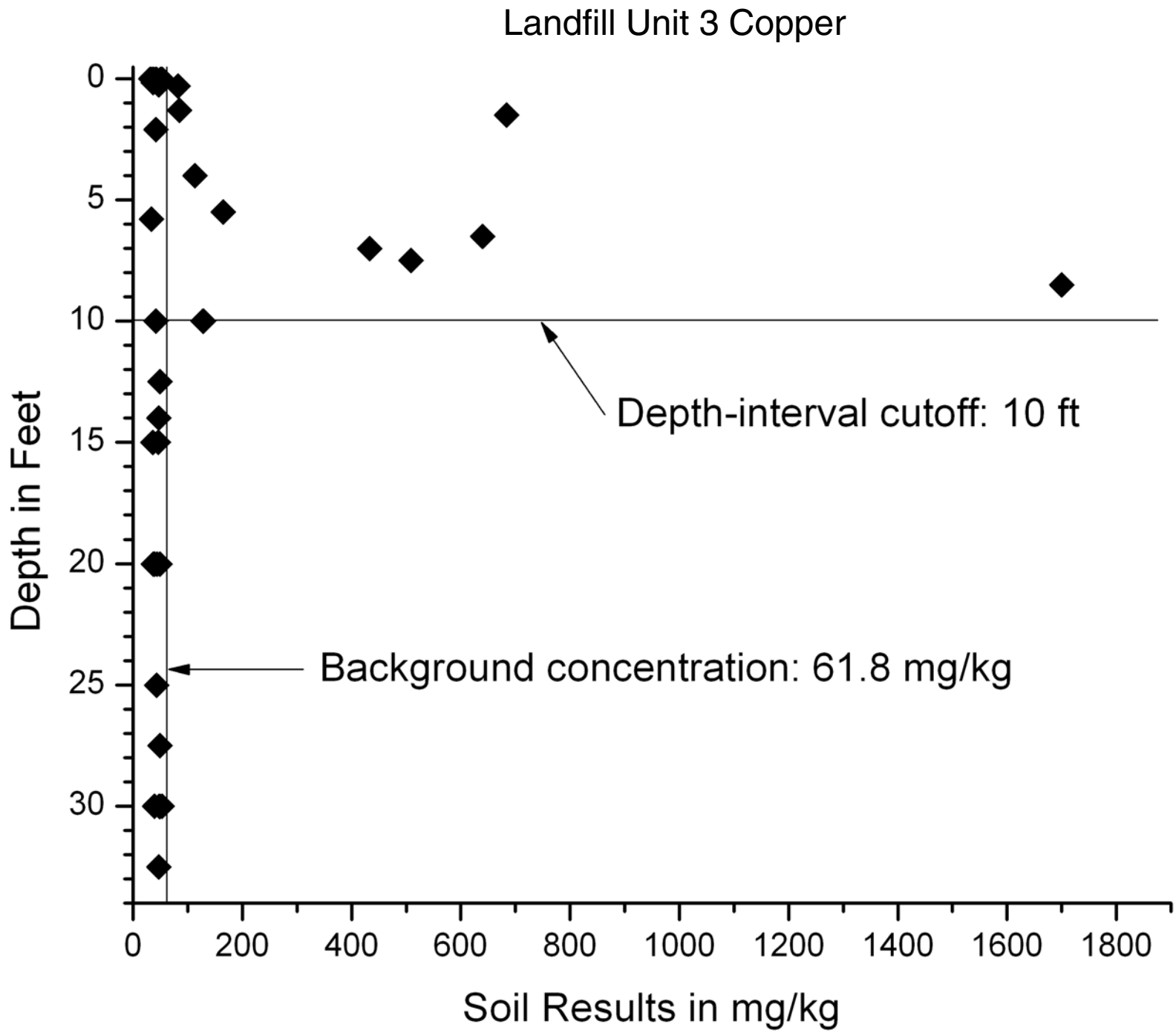

Landfill Unit 1 Copper
Depth in feet
0
5
10
15
20
25
30
35
40
Depth-interval cutoff: 7 ft
Background concentration: 61.8 mg/kg
0
500
1000
1500
2000
2500
3000
Soil Results in mg/kg

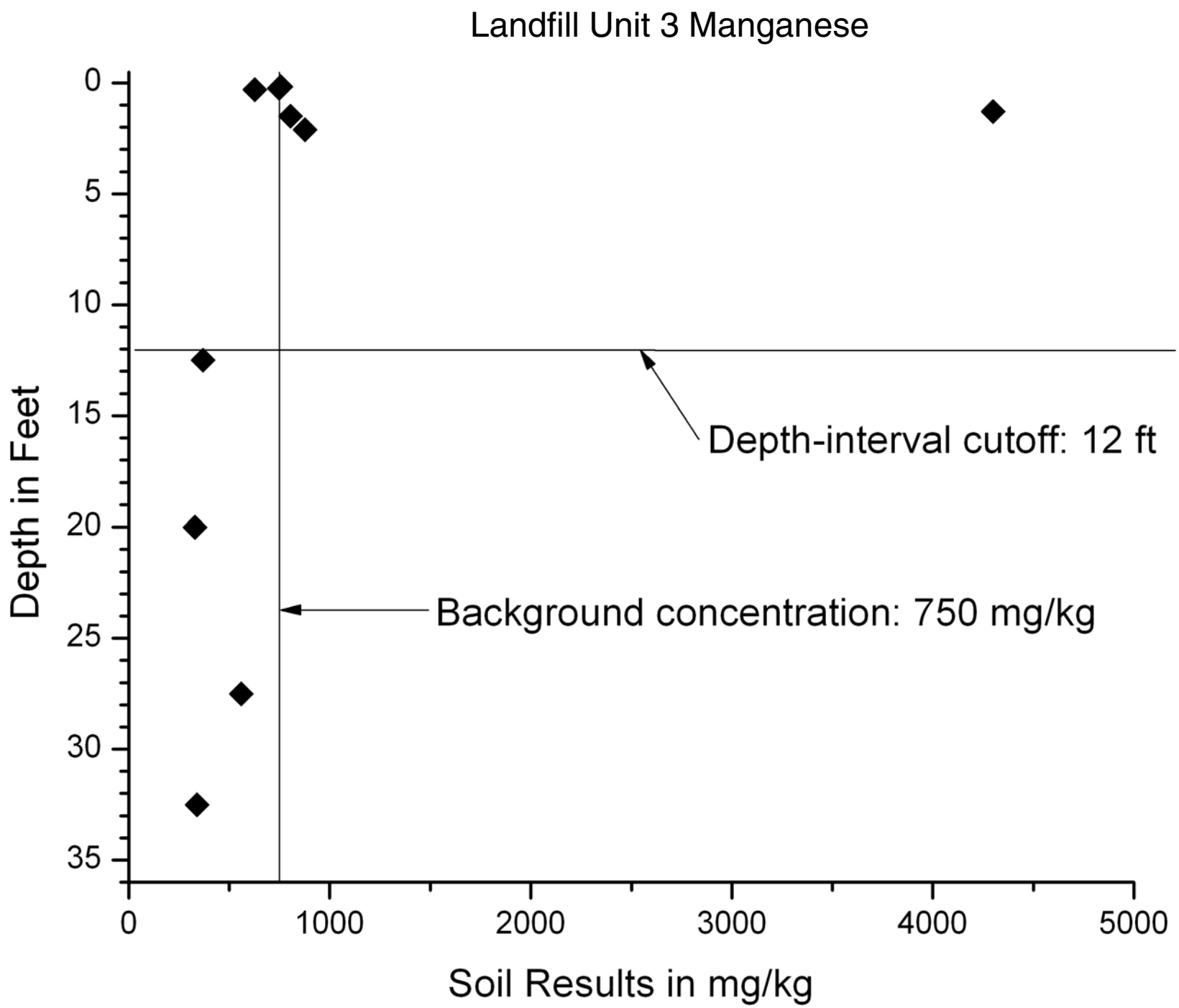

Landfill Unit 2 Silver
Depth in Feet
0
5
10
15
20
25
30
35
Soil Result in mg/kg
0
5
10
15
20
25
30
35
40
Depth-interval cutoff: 12.5 ft
Background concentration: 1.4 mg/kg

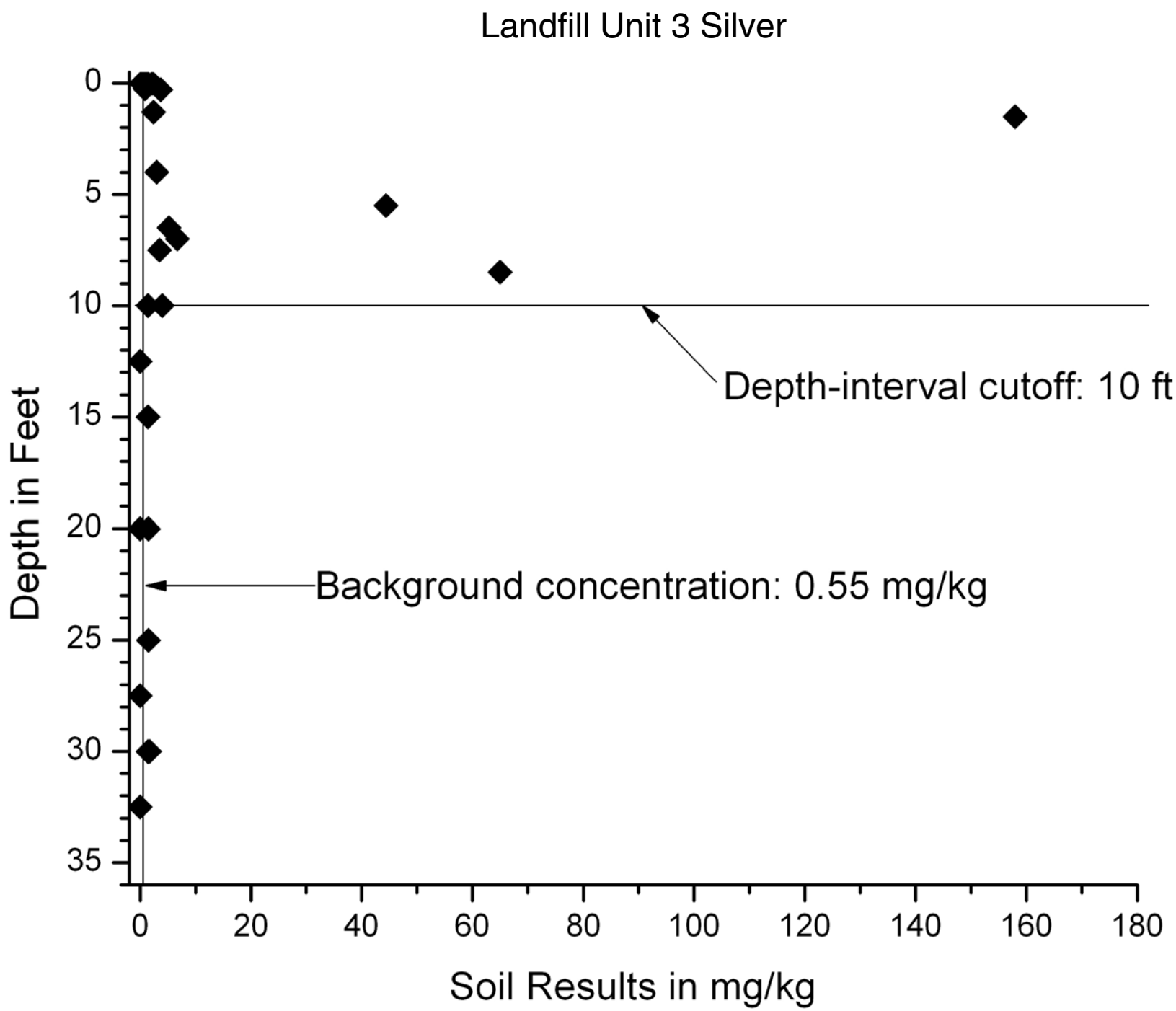

Landfill 2 SR-90
Depth in Feet
0
5
10
15
20
25
30
35
Depth-interval cutoff: 12.5 ft
Background concentration: 0.056 pCi/g
-1.0
-0.8
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
0.8
Soil Results in mg/kg

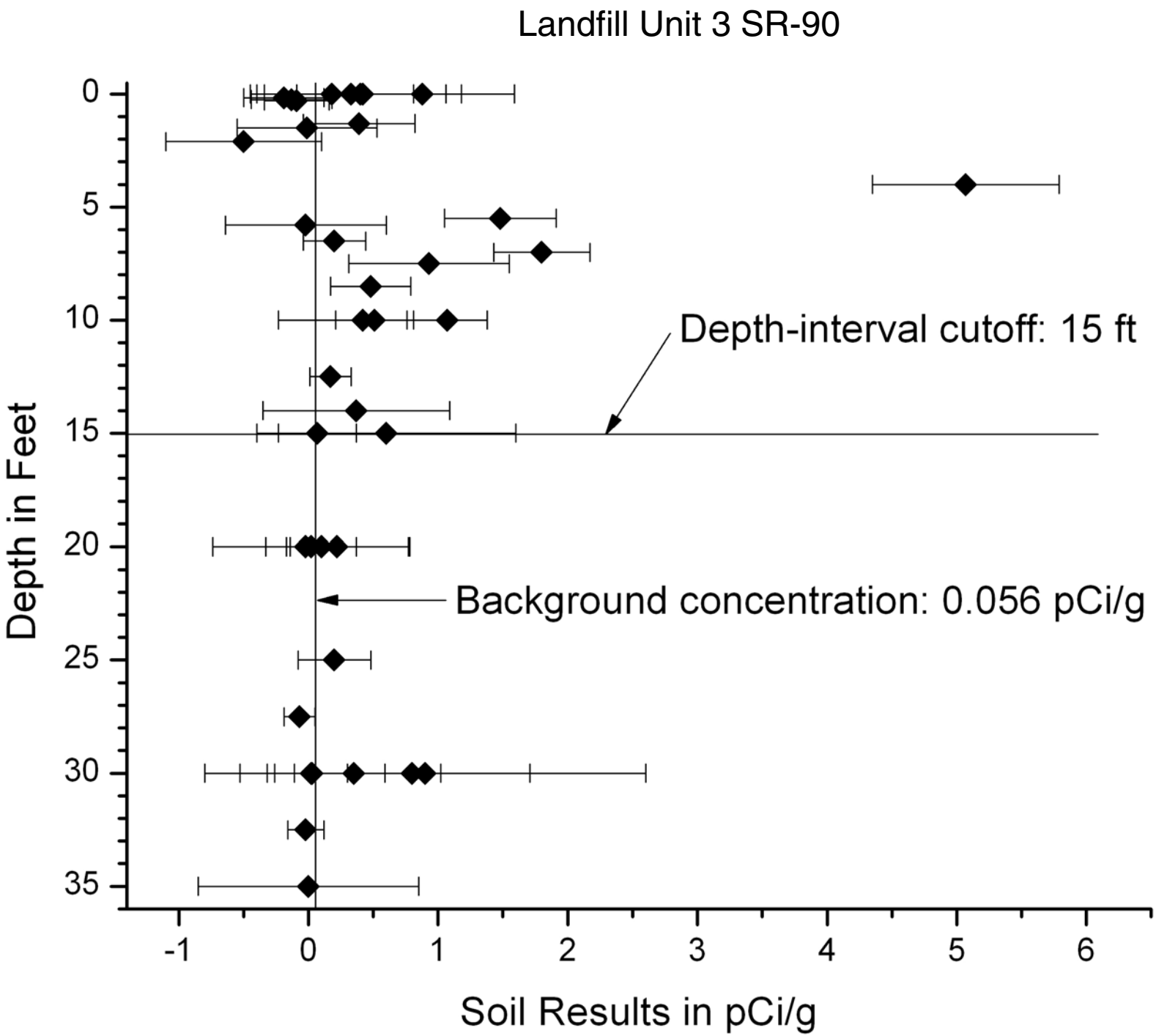

Landfill Unit 2 U-235
Depth in Feet
0
5
10
15
20
25
30
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
Soil Results in pCi/g
Depth-interval cutoff: 12.5 ft
Background concentration: 0.038 pCi/g

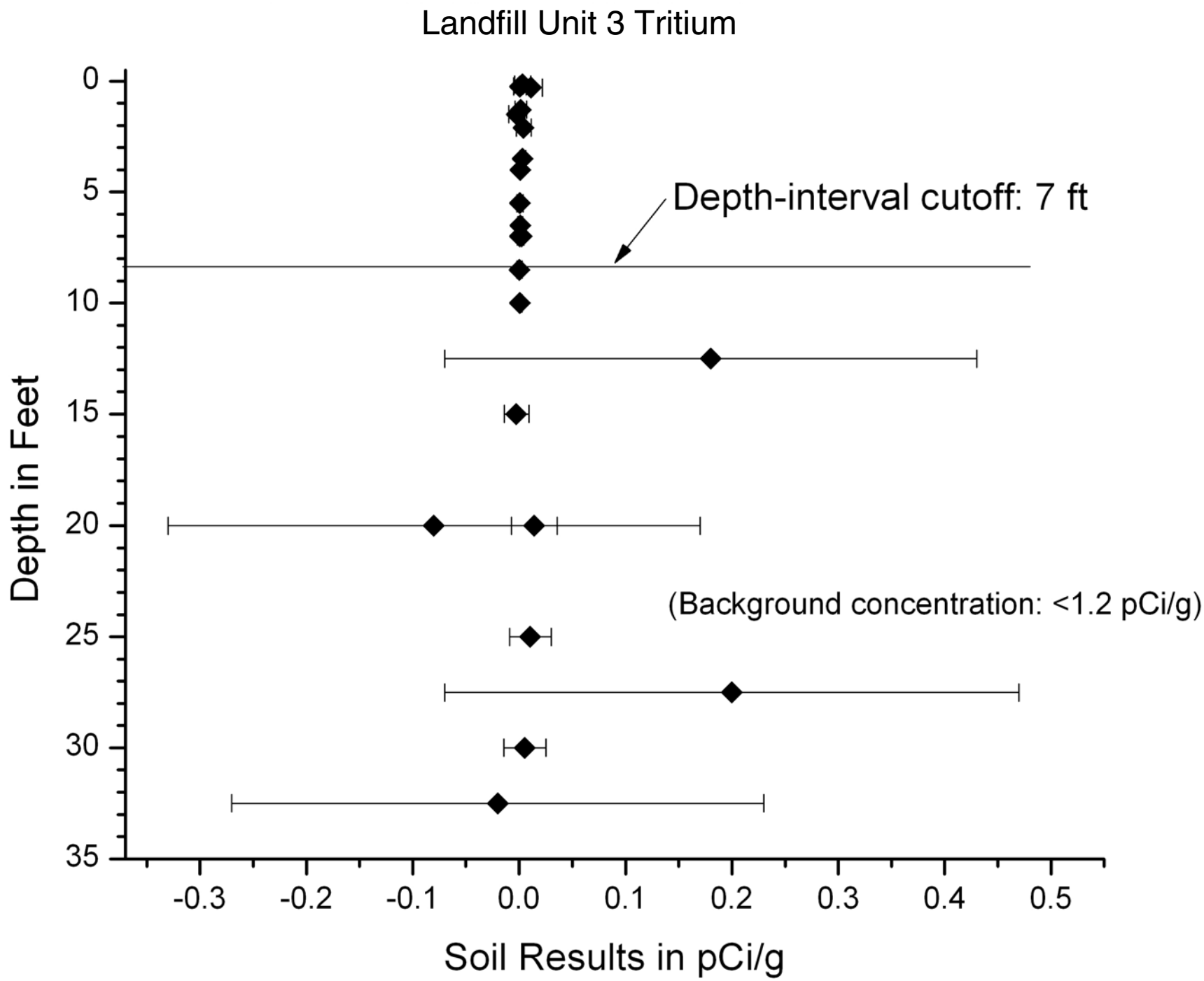

Landfill Unit 3 Antimony
Depth-interval cutoff: 12 ft
Background concentration: 1.4 mg/kg
Depth in Feet
Soil Results in mg/kg
0
5
10
15
20
25
30
35
40
0
5
10
15
20
25
30

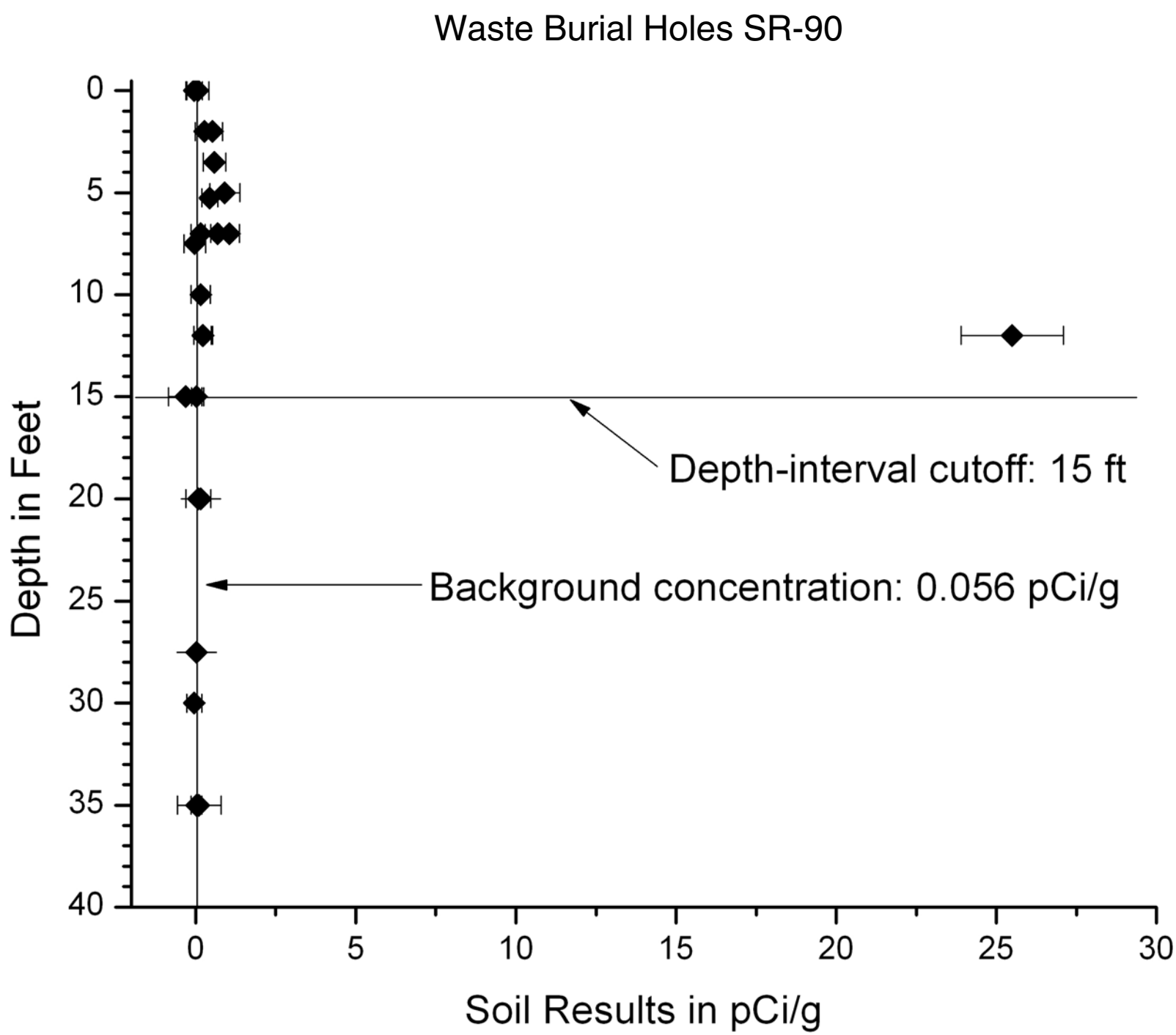

Landfill Unit 3 Copper
Depth in Feet
0
5
10
15
20
25
30
Depth-interval cutoff: 10 ft
Background concentration: 61.8 mg/kg
0
200
400
600
800
1000
1200
1400
1600
1800
Soil Results in mg/kg

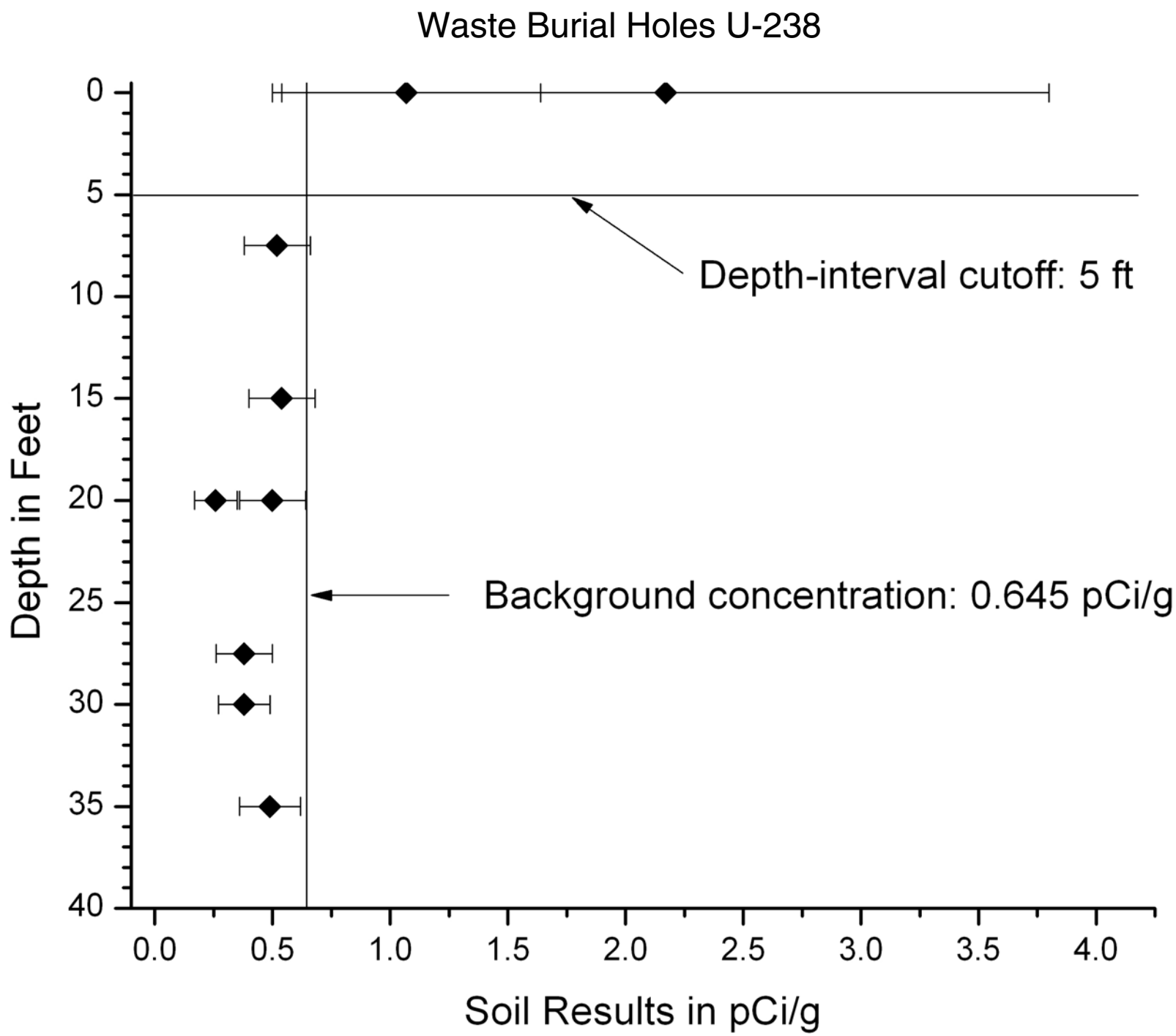

Landfill Unit 3 Manganese
Depth in Feet
0
5
10
15
20
25
30
35
Depth-interval cutoff: 12 ft
Background concentration: 750 mg/kg
0
1000
2000
3000
4000
5000
Soil Results in mg/kg


Landfill Unit 3 Silver
Depth in Feet
0
5
10
15
20
25
30
35
Depth-interval cutoff: 10 ft
Background concentration: 0.55 mg/kg
0
20
40
60
80
100
120
140
160
180
Soil Results in mg/kg


Landfill Unit 3 SR-90
Depth-interval cutoff: 15 ft
Background concentration: 0.056 pCi/g
Depth in Feet
Soil Results in pCi/g
0
5
10
15
20
25
30
35
-1
0
1
2
3
4
5
6


Landfill Unit 3 Tritium
Depth-interval cutoff: 7 ft
(Background concentration: <1.2 pCi/g)
Depth in Feet
0
5
10
15
20
25
30
35
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
0.5
Soil Results in pCi/g


Waste Burial Holes SR-90
Depth in Feet
0
5
10
15
20
25
30
35
40
Depth-interval cutoff: 15 ft
Background concentration: 0.056 pCi/g
0
5
10
15
20
25
30
Soil Results in pCi/g


Waste Burial Holes U-238
Depth-interval cutoff: 5 ft
Background concentration: 0.645 pCi/g
Depth in Feet
0
5
10
15
20
25
30
35
40
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Soil Results in pCi/g

APPENDIX E

VAPOR INTRUSION SCREENING LEVEL DEVELOPMENT

Appendix E. Vapor Intrusion Screening Level Development

Risk-based screening values were determined for VOCs in soil vapor in each of the six UC Davis disposal areas (i.e., Landfill Unit 1 [LFU1], Landfill Unit 2 [LFU2], Landfill Unit 3 [LFU3], Eastern Trenches, Waste Burial Holes [WBHs], and Southern Trenches). The screening values were determined using the United States Environmental Protection Agency (USEPA) version of the Johnson and Ettinger model (J&E, 1991) as modified by the California Department of Toxic Substances Control (DTSC) to include California-specific toxicity factors. The model software (spreadsheet) was downloaded from DTSC's Johnson and Ettinger Model Website (DTSC, 2007). This model simulates the transport of soil vapors through subsurface soil into indoor air by both diffusion and advection. The model contains a health risk component added by USEPA to calculate the risk from inhaling a specific chemical at the concentration estimated in indoor air. Soil vapor screening values were determined based on a target risk level of 10^{-6} for carcinogens and a hazard quotient of 1.0 for non-carcinogens.

Site-specific soil parameters were used in the screening value determinations. The parameters were determined from soil samples collected at the LEHR/SCDS site and analyzed by a soil property laboratory (DB Stephens, 1996; DB Stephens, 2008). A Weiss Associates geologist compared soil boring logs to soil sample geologic descriptions and the soil laboratory results to select representative site-specific parameters for each area. Samples matching the most permeable soil type recorded in area boring logs within specific depths were used to represent site-specific conditions. The parameters were selected for depths of five ft, 15 ft and 25 ft bgs). The representative soil samples, their rationale for selection, the soil type and soil parameters are presented in Table E-1.

A site-specific soil temperature of 65 degrees Fahrenheit (18.3 degrees Celsius) was used to correct Henry's law constant to the appropriate subsurface temperature as recommended by DTSC (DTSC, 2005). The temperature is based on *in-situ* measurements of shallow groundwater at the site.

Human receptors that could receive exposure to the VOCs in indoor air have been identified as onsite indoor researchers and hypothetical future onsite residents. Researchers currently use buildings overlying some of the VOC-impacted areas. Residents do not occupy the site, but may occupy it in the future. Human health exposure parameters established in the *Site-Wide Risk Assessment Work Plan* (UC Davis, 2002) were used for these receptors. The averaging times for carcinogens and non-carcinogens were 70 years and 30 years, respectively. The residential receptor exposure duration and exposure frequency values were 30 years and 350 days per year, respectively. Onsite indoor researcher exposure duration and exposure frequency values were 25 years and 250 days per year, respectively.

As recommended by DTSC for future building scenarios, the soil gas advection rate of five liters per minute and default building parameters were used to determine screening values for hypothetical future onsite residents. Onsite indoor researcher screening values were determined using the calculation option for soil gas advection rates using site–specific soil parameters. No modifications were made to any other building parameter assumptions provided in the model.

Vapor intrusion contaminants of potential concern (VI COPCs) were determined using soil gas data collected at depths of five, 15 and 25 ft bgs. All detected VOCs except those with very low toxicity and/or low concentrations were identified as VI COPCs. Specifically, ethanol, isopropyl alcohol, and hexane were eliminated as VI COPCs. The only detected concentration of hexane in soil vapor was 12 $\mu g/m^3$ in a sample collected at 15 ft bgs in Landfill Unit 1. Isopropyl alcohol was used for leak detection during soil gas sampling, therefore concentrations detected are not representative of site conditions. Some VOCs that were not detected in soil vapor but were historically detected in soil samples (e.g. benzene in the Waste Burial Holes area) were included as VI COPCs. Risk-based screening values were determined for all of the VI COPCs. These screening values are presented in Tables 3-1 and 3-2 of this document.

REFERENCES CITED:

California Department of Toxic Substances Control (DTSC), 2005, Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air, December 15, 2004, (Revised February 7, 2005).

DTSC, 2007, Johnson and Ettinger Models Website http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm

Daniel B. Stephens and Associates Inc. (DB Stephens), 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.

DB Stephens, 2008, Laboratory Report for Weiss Associates (Project 388-1856-1-32), December 12, 2008.

Johnson, P. C., and R. A. Ettinger (J&E). 1991. Heuristic Model for Predicting the Intrusion of Contaminant Vapors into Buildings. Environmental Science and Technology, v. 25, n. 8, p. 1445 – 1452.

University of California, Davis, 2002, Site-Wide Risk Assessment Work Plan, LEHR/SCDS Environmental Restoration, March 6, 2002.

Table E-1. Summary of Site-specific Parameters Used in Soil Vapor Screening Value Calculations, LEHR/SCDS, University of California, Davis

Location	Depth/s (ft)	Vadose zone soil dry bulk density (g/cm^3)	Vadose zone soil total porosity (unitless)	Vadose zone soil water-filled porosity (cm^3/cm^3)	Soil Type	Representative Site Sample	Rationale for Representative Site Sample Selection
Eastern Trenches	5, 15 and 25	1.45	0.45	0.17	Silty Sand	SSET-2-20	Silty sand was recorded in the zero to 6 ft depth interval and 18 ft to 27 ft depth interval at the Eastern Trenches. Sample SSET-2-20 data were selected to represent soil throughout the Eastern Trenches because the sample was from the Eastern Trenches and is representative of the majority of soil encountered (sitly sand). Sandy/clayey silt was recorded in the 6 ft to 18 ft depth interval but parameters for this soil type were not used because they are less conservative.
Landfill Unit 1	5	1.9	0.29	0.042	Sandy Gravel	GEO1	Sandy gravel was recorded in the zero to 6 ft depth interval. Sample GEO1 is representative of this soil type.
Landfill Unit 1	15 and 25	1.45	0.45	0.17	Silty Sand	SSET-2-20	Silty sand was recorded in the 6 ft to 15 ft depth interval. Sample SSET-2-20 data were selected to represent conditions at the 15 foot depth because SSET-2-20 is representative of sitly sand near Landfill Unit 1. Sandy clay and silty clay were recorded between 15 ft and 25 ft, but silty sand sample SSET-2-20 was conservatively selected to represent conditions at the depth of 25 ft.
Landfill Unit 2	5 and 15	1.9	0.29	0.042	Sandy Gravel	GEO1	Sandy gravel was recorded in the zero to 14 ft depth interval. Sample GEO1 is representative of this soil type.
Landfill Unit 2	25	1.45	0.45	0.17	Silty Sand	SSET-2-20	Silt and silty sand were recorded in the 14 ft to 27 ft depth interval at Landfill Unit 2. Sample SSET-2-20 is representative of sitly sand.
Landfill Unit 3	5	1.9	0.29	0.042	Sandy Gravel	GEO1	Sandy gravel was recorded in the zero to 10 ft depth interval. Sample GEO1 is representative of this soil type.
Landfill Unit 3	15 and 25	1.45	0.45	0.17	Silty Sand	SSET-2-20	Silty sand was recorded in the 10 ft to 15 ft depth interval. Data from silty sand sample SSET-2-20 were selected to represent conditions at 15 ft. Silty clay was recorded between 15 ft and 25 ft, but silty sand sample SSET-2-20 was conservatively selected to represent conditions at 25 ft.
Southern Trenches	5	1.9	0.29	0.042	Sandy Gravel	GEO1	Sandy gravel was recorded in the zero to 5 ft depth interval. Sample GEO1 is representative of this soil type.
Southern Trenches	15 and 25	1.45	0.45	0.17	Silty Sand	SSET-2-20	Silty clay was recorded in the 5 ft to 8 ft depth interval and silty sand was recorded in the 8 ft to 15 ft depth interval. Data from silty sand sample SSET-2-20 were selected to represent conditions at 15 ft. Silty clay was recorded between 15 ft and 25 ft, but silty sand sample SSET-2-20 was conservatively selected to represent conditions at 25 ft.
Waste Burial Holes	5	1.72	0.35	0.271	Silty Gravel Fill	SSWBH-3-5	Silty gravel was recorded in the zero to 6 ft depth interval. Sample SSWBH-3-5 data were selected because the sample is representative of silty gravel unique to the Waste Burial Holes.
Waste Burial Holes	15 and 25	1.45	0.45	0.17	Silty Sand	SSET-2-20	Silty sand was recorded in the 6 ft to 17 ft depth interval. Data from silty sand sample SSET-2-20 were selected to represent conditions at 15 ft. Silty clay was recorded between 17 ft and 25 ft, but silty sand sample SSET-2-20 was conservatively selected to represent conditions at 25 ft.

Abbreviations:
g/cm^3 grams per cubic centimeter
cm^3/cm^3 volume ratio in cubic centimeters
ft feet

APPENDIX F

DATA GAPS SUPPORTING DATA (CD)