LMS/LEH/S13284

First Five-Year Review for the Laboratory for Energy-Related Health Research Federal Facility University of California, Davis

September 2016

U.S. DEPARTMENT OF ENERGY | Legacy Management

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LMS/LEH/S13284

First Five-Year Review
for the
Laboratory for Energy-Related Health Research
Federal Facility
University of California, Davis

September 2016

Approved By:

Scott Surovchak, LEHR Site Manager
U.S. Department of Energy
Office of Legacy Management

9/15/16
Date

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Abbreviations

ARAR	applicable or relevant and appropriate requirement
CCR	*Code of California Regulations*
CDPH	California Department of Public Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CHE	Center for Health and the Environment
cm	centimeter
Co-60	cobalt-60
COC	constituent of concern
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
CRWQCB	California Regional Water Quality Control Board
DCM	Design and Construction Management
DL	designated level
DOE	U.S. Department of Energy
DSCSOC	Davis South Campus Superfund Oversight Committee
DSS	Domestic Septic System
DTSC	California Department of Toxic Substances Control
EDPs	Eastern Dog Pens
EH&S	Environmental Health and Safety
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FGVC	fruit, grain and vegetable consumption
FR	*Federal Register*
HSU	hydrostatic unit
kg DW/year	kilogram dry weight per year
LEHR	Laboratory for Energy-Related Health Research
LOAEL	lowest-observed adverse effect level
LVC	leafy vegetable consumption
MCL	maximum contaminant level
µg/L	micrograms per liter
mg/kg	milligrams per kilogram

MOA	Memorandum of Agreement
MOC	monitoring-only constituent
Navarro	Navarro Research and Engineering, Inc.
NCP	National Contingency Plan
NOAEL	no-observed adverse effect level
NWC	new well constituents
O&M	operations and maintenance
OSWER	Office of Solid Waste and Emergency Response
PCB	polychlorinated biphenyls
pCi/g	picocuries per gram
PRG	preliminary remediation goal
Ra-226	radium-226
Ra/Sr	radium/strontium
RAO	remedial action objective
RD/RAWP	Remedial Design/Remedial Action Work Plan
RI	Remedial Investigation
ROD	Record of Decision
SMP	Soil Management Plan
SN3	Stoller Newport News Nuclear, Inc.
Sr-90	strontium-90
SVOC	semivolatile organic compound
SWERA	Site-Wide Ecological Risk Assessment
SWRA	Sitewide Risk Assessment
SWT	Southwest Trenches
TBC	to be considered
UC Davis	University of California, Davis
VOC	volatile organic compound
WDPs	Western Dog Pens
Weiss	Weiss Associates

Executive Summary

This Five-Year Review report has been prepared pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act Section 121 and the National Contingency Plan for the Laboratory for Energy-Related Health Research (LEHR) Federal Facility, which is part of the LEHR/Old Campus Landfill Superfund site (the Site), U.S. Environmental Protection Agency No. CA2890190000, at the University of California, Davis (UC Davis) in Solano County, California. The purpose of the Five-Year Review is to assess whether the remedies at the LEHR Federal Facility, also referred to as the U.S. Department of Energy Areas (DOE Areas), are protective of human health and the environment. The methods, findings, and conclusions of the review are documented in this report. In addition, issues found during the review are identified and recommendations for corrective action are provided.

In accordance with the Record of Decision (ROD), signed December 10, 2009, the remedies for the DOE Areas are intended to monitor and control residual contamination at the site and include:

- Land-use restrictions, including a Soil Management Plan (SMP) and the prohibition of residential use in selected areas
- Long-term groundwater monitoring
- Contingency remediation

The selected remedies for each specific location within the DOE Areas are presented in Table ES-1. The trigger for this Five-Year Review was the start of the remedy.

Table ES-1. Selected Remedies for Each DOE Area

DOE Area	No Action/ No Further Action[a]	Long-Term Groundwater Monitoring/Contingency Remediation	Land-Use Restrictions	
			Soil Management Plan	No Residential Use
Radium/Strontium Treatment Systems (includes Domestic Septic System 2)		✓	✓	
Domestic Septic System 1	✓			
Domestic Septic System 3		✓	✓	
Domestic Septic System 4		✓	✓	✓
Domestic Septic System 5	✓			
Domestic Septic System 6	✓			
Domestic Septic System 7	✓			
DOE Disposal Box	✓			
Dry Wells A–E		✓	✓	
Eastern Dog Pens			✓	
Southwest Trenches		✓	✓	
Western Dog Pens	✓			

Notes:
[a] These checkmark-indicated locations within the DOE Areas are suitable for unlimited use and unrestricted exposure.

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Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name: Laboratory for Energy-Related Health Research (LEHR) Federal Facility		
EPA ID: CA2890190000		
Region: 9	**State:** CA	**City/County:** Solano
SITE STATUS		
NPL status: Final		
Multiple OUs? YES	**Construction completion date:** 7/11/2014	
REVIEW STATUS		
Have DOE Areas been put into reuse? YES		
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** U.S. Department of Energy		
Author name (Federal or State Project Manager): Scott Surovchak		
Author affiliation: U.S. DOE, Office of Legacy Management		
Review period: 4/1/2015 to 1/4/2016		
Date(s) of DOE Areas inspection: 6/16/2015		
Type of review: NPL		
Review number: 1 (first)		
Triggering action date: 1/4/2011		
Due date ***(five years after triggering action date)*****:** 1/4/2016		

ISSUES/RECOMMENDATIONS

Issues and Recommendations Identified in the Five-Year Review

Issue Category: Institutional Controls

Issue: Some survey monuments are not clearly visible, leading to potential accidental damage. This issue does not impact remedy protectiveness because the monuments are not relied on for determination of areas requiring controls. The monument locations are permanently recorded in the Land-Use Covenant. Although not necessary for protectiveness, monument condition is regularly inspected, and they are repaired or replaced as needed.

Recommendation: Install high visibility monument markers according to the specifications presented in the updated Soil Management Plan (SMP).

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	9/30/2016

Issue Category: Monitoring

Issue: Some monitoring well vaults are not clearly visible, leading to potential accidental damage. This issue does not impact remedy protectiveness; however, should vault damage lead to monitoring well damage, protectiveness could be impacted. This is prevented through regular vault inspections and as-needed repairs.

Recommendation: Install high-visibility well markers according to the specifications presented in the updated SMP.

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	9/30/2016

Issue Category: Institutional Controls

Issue: No specific procedures are in place for dealing with fallen trees and associated soil in restricted areas. This issue did not impact remedy protectiveness during the first five-year period because the only tree that fell was located outside of the area of potential contamination and is not subject to the requirements of the Soil Management Plan.

Recommendation: Incorporate procedures for handling/disposing of fallen trees and associated soil in restricted areas into annual SMP training.

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Potential Limited	Federal Facility	EPA/State	9/30/2016

Issue Category: Remedy Performance

Issue: The vapor intrusion pathway from soil has not been specifically evaluated for the DOE Areas.

Recommendation: Complete evaluation of vapor intrusion from soil, including evaluating existing data, conducting soil vapor investigation if needed, and assessing potential current risk associated with this pathway for areas with existing buildings and potential future risk associated with this pathway for each DOE Area.

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
Not Determined	Not Determined	Federal Facility	EPA/State	9/30/2017

PROTECTIVENESS STATEMENT
Immediate threats at the site have been addressed, and the remedy is protective of human health and the environment in terms of direct soil exposure, potential groundwater impact from soil contaminants, and ecological risk. On the basis of the preliminary vapor-intrusion evaluation conducted for this Five-Year Review, a protectiveness determination for this exposure pathway cannot be made without further data evaluation and possible collection and evaluation of soil-gas data from certain locations within the DOE Areas. It is expected that this vapor-intrusion evaluation will be completed by September 30, 2017, at which time a protectiveness determination will be made via an addendum to this Five-Year Review, anticipated to be completed by February 28, 2018.

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1.0 Introduction

The purpose of this Five-Year Review is to assess whether the remedies at the Laboratory for Energy-Related Health Research (LEHR) Federal Facility, which is part of the LEHR/Old Campus Landfill Superfund site (the Site) at the University of California, Davis (UC Davis), are protective of human health and the environment. The LEHR Federal Facility is also referred to as the U.S. Department of Energy Areas (DOE Areas). All of the land and buildings at the LEHR Federal Facility are owned by UC Davis. The methods, findings, and conclusions of the review are documented in this report. In addition, issues found during the review are identified and recommendations for corrective action are provided.

This Five-Year Review report has been prepared pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Contingency Plan (NCP). CERCLA Section 121(c) states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The NCP [40 *Code of Federal Regulations* (CFR) Section 300.430(f)(4)(ii)] further states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

DOE's Office of Legacy Management conducted the Five-Year Review of the remedies implemented at the DOE Areas. The U.S. Environmental Protection Agency's (EPA's) *Comprehensive Five-Year Review Guidance* (EPA 2001) was followed in preparing this Five-Year Review.

The contractors that conducted the analysis and provided technical input for the Five-Year Review included Stoller Newport News Nuclear, Inc. (SN3), a subsidiary of Huntington Ingalls Industries, Inc.; Navarro Research and Engineering Inc. (Navarro); and Weiss Associates (Weiss). The contractual arrangements under which this was done are as follows:

- SN3 was the prime contractor to the DOE Office of Legacy Management through September 30, 2015
- Navarro took over as prime contractor to the DOE Office of Legacy Management on October 1, 2015
- Weiss was subcontractor to SN3 and Navarro throughout the Five-Year Review period

This is the first Five-Year Review for the DOE Areas. The triggering action for this statutory review is the initiation of the remedial action. The Five-Year Review is required because hazardous substances, pollutants, or contaminants remain at the DOE Areas above levels that allow for unlimited use and unrestricted exposure.

2.0 DOE Areas Chronology

Table 1 presents the chronology of cleanup-related events at the LEHR Federal Facility.

Table 1. Timeline of LEHR Cleanup-Related Events

Events	Date
Removal of gravel and curbing from Western Dog Pens	1975
Initial Assessment Survey and initial discovery of contamination	1984
Memorandum of Agreement between DOE and the Regents	August 1988
"Phase II" investigation	1993
Final Listing on EPA National Priorities List	May 1994
Remedial Investigation/Feasibility Study Work Plan	1994
Voluntary Removal Action - Demolition of above-grade portions of the Imhoff Wastewater Treatment Facility	1995
Removal of concrete pedestals and wooden barrels from the Eastern and Western Dog Pens	1995 and 1996
Time-critical removal action at DOE Disposal Box Area	1996
Limited Field Investigation	1996
Decommissioned, decontaminated, and released for unrestricted use: Animal Hospital No. 1, Animal Hospital No. 2, Specimen Storage building, and Cobalt-60 building	Prior to 1997
Memorandum of Agreement between DOE and the Regents	June 1997
Non-time-critical removal action at the Southwest Trenches	1998
Groundwater Interim Remedial Action initiated by UC Davis	1998
Federal Facility Agreement between DOE and EPA	December 1999
Mixed Waste Storage Facility closure	1999
Non-time-critical removal actions at Ra/Sr Treatment Systems Area, DSS 2, portions of DSS 1, the leach field in DSS 5, and portions of Dry Wells A-E	1999–2000
Non-time-critical removal action in the Western Dog Pens	2001
Non-time-critical removal actions at DSS 3 and DSS 6	2002
DOE Areas Remedial Investigation Report	September 2003
Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment	March 2004
Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment Part B – Risk Characterization for DOE Areas	September 2005
Site-Wide Risk Assessment, Volume 2: Ecological Risk Assessment	August 2006
Removal and Disposal of concrete from Eastern Dog Pens	2007
Final DOE Areas Feasibility Study	March 2008
Proposed Plan	October 2008
Memorandum of Agreement between DOE and the Regents	July 2009
Record of Decision signed	December 2009
Quality Assurance Project Plan issued	October 2010
Remedial Design/Remedial Action Work Plan and Soil Management Plan issued	November 2010
Monitoring wells installed and developed	January 4–20, 2011
Land survey monuments installed	January 31, 2011–February 18, 2011
DOE Areas land survey	January 31, 2011–February 18, 2011

Table 1 (continued). Timeline of LEHR Cleanup-Related Events

Events	Date
Plaques installed on monitoring wells	February 23–24, 2011; December 7 and 13, 2012
2011 background and baseline sampling	March 7–14; May 3-9; August 15–17; November 14–16, 2011
LEHR Project Team decision to extend baseline and background sampling through 2012	January 24, 2012
2012 background and baseline sampling	March 5–7; May 30–31; August 13–14; October 2–4; December 19, 2012
Land-use covenant inspection	March 19–20; April 5 and 10, 2012
Soil disturbing activity interview	December 17, 2012
2013 groundwater monitoring	April 29–30; May 1; November 18 and 21; December 31, 2013
Land-use covenant inspection and soil-disturbing activity interview	June 13, 2013
2014 groundwater monitoring	March 3–5, 2014
Land-use covenant recorded by Solano County	July 11, 2014
Land-use covenant inspection and soil-disturbing activity interview	November 6, 2014; December 9, 2014
2015 groundwater monitoring	March 10–26, 2015
Five-Year Review	May 2015–September 2016

Abbreviations:
Ra/Sr = radium/strontium
Regents = Regents of the University of California
DSS = Domestic Septic System

3.0 Background

The LEHR Federal Facility is defined in a Federal Facility Agreement (FFA) signed in 1999 by DOE, EPA, the California Department of Public Health (CDPH) (formerly the California Department of Health Services), and the California Regional Water Quality Control Board (CRWQCB), Central Valley Region. The California Department of Toxic Substances Control (DTSC) joined as a signatory to the FFA in 2000.

This section presents Site physical characteristics, land and resource use, history of contamination, initial responses, and basis for taking action.

3.1 Physical Characteristics

The Site is located immediately east of Old Davis Road, about 2,500 feet south of U.S. Interstate 80 in Solano County, California. The Site is located in the southeast quarter of Section 21, Township 8 North, Range 2 East, Mount Diablo Base and Meridian (Figure 1). The former LEHR facility (Figure 2) is on the southern portion of Solano County Assessor's Parcel No. 110 05-04. It is approximately 1.5 miles south of the city of Davis, in the southeast portion (South Campus Area) of the UC Davis campus. The total area of the Site is approximately 15 acres, and the DOE Areas of it occupy approximately 4.5 acres.

Environmentally sensitive areas lie within or near the DOE Areas. Potential valley elderberry longhorn beetle habitat (elderberry shrubs) was identified at the Site as reported in the *Biological Assessment for the Laboratory for Energy-Related Health Research/Old Campus Landfill Remediation Project* (ICF 2014). One elderberry shrub was identified in the Western Dog Pens area, and five elderberry shrubs were identified in the Eastern Dog Pens area. The Putah Creek Riparian Reserve borders the Site to the south.

3.2 Land and Resource Use

LEHR is a former research facility that the U.S. Atomic Energy Commission (now DOE) operated at UC Davis. The LEHR Federal Facility comprises the land and improvements within the former LEHR facility boundary shown in Figure 2, including the following areas:

- All LEHR buildings
- The Cobalt-60 (Co-60) Irradiation Field
- The Radium/Strontium (Ra/Sr) Treatment Systems area
- Seven septic tanks (including leach fields and dry wells)
- The Southwest Trenches (SWT) area
- The Western Dog Pens (WDPs) area
- The Eastern Dog Pens (EDPs) area
- The DOE Disposal Box area
- Areas where contamination originating from the areas listed above is located, excluding areas assigned to UC Davis, by a Memorandum of Agreement (MOA) between the Regents of the University of California (Regents) and DOE (DOE 2009a)

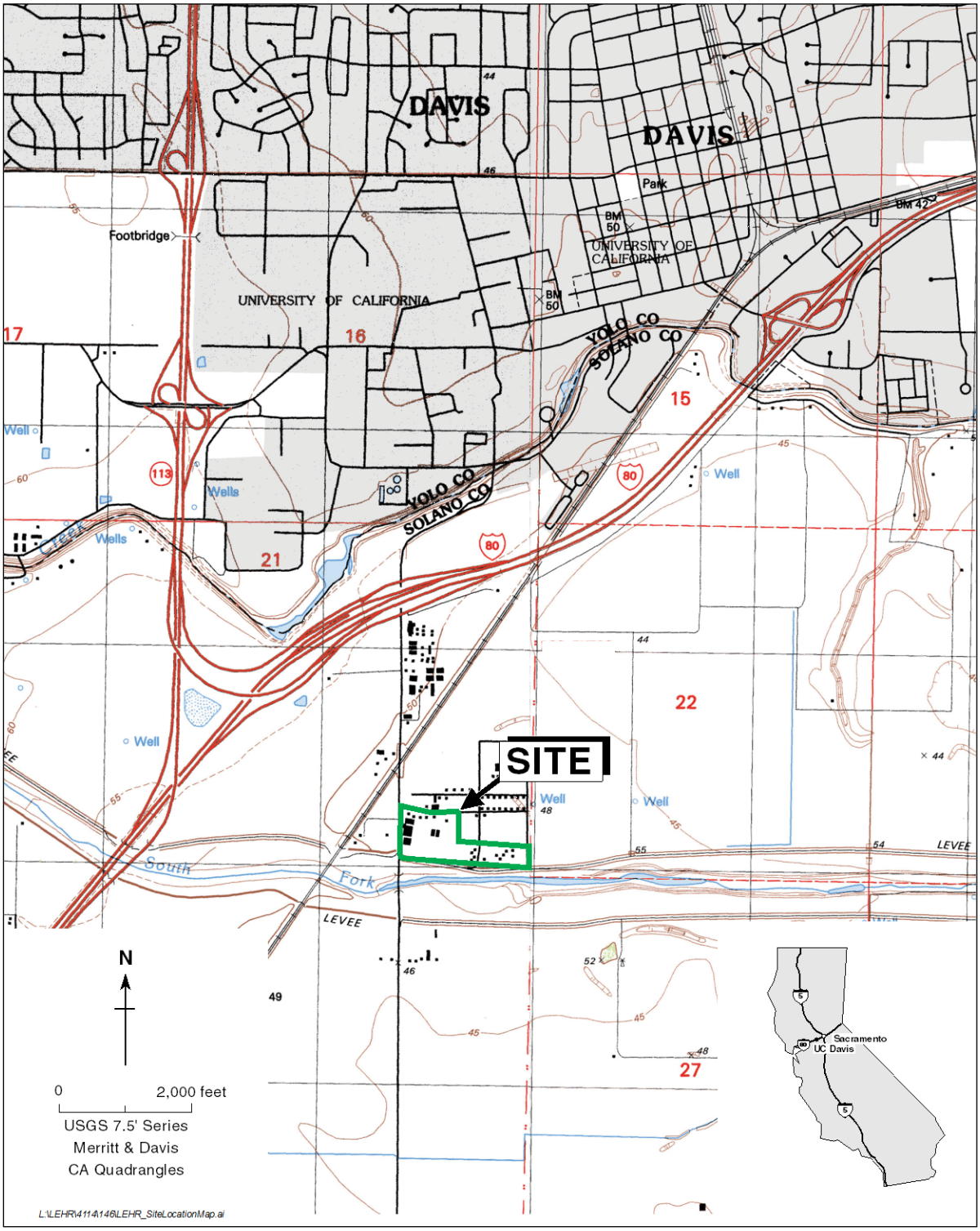

Figure 1. Location of the LEHR Site, UC Davis, Solano County, California

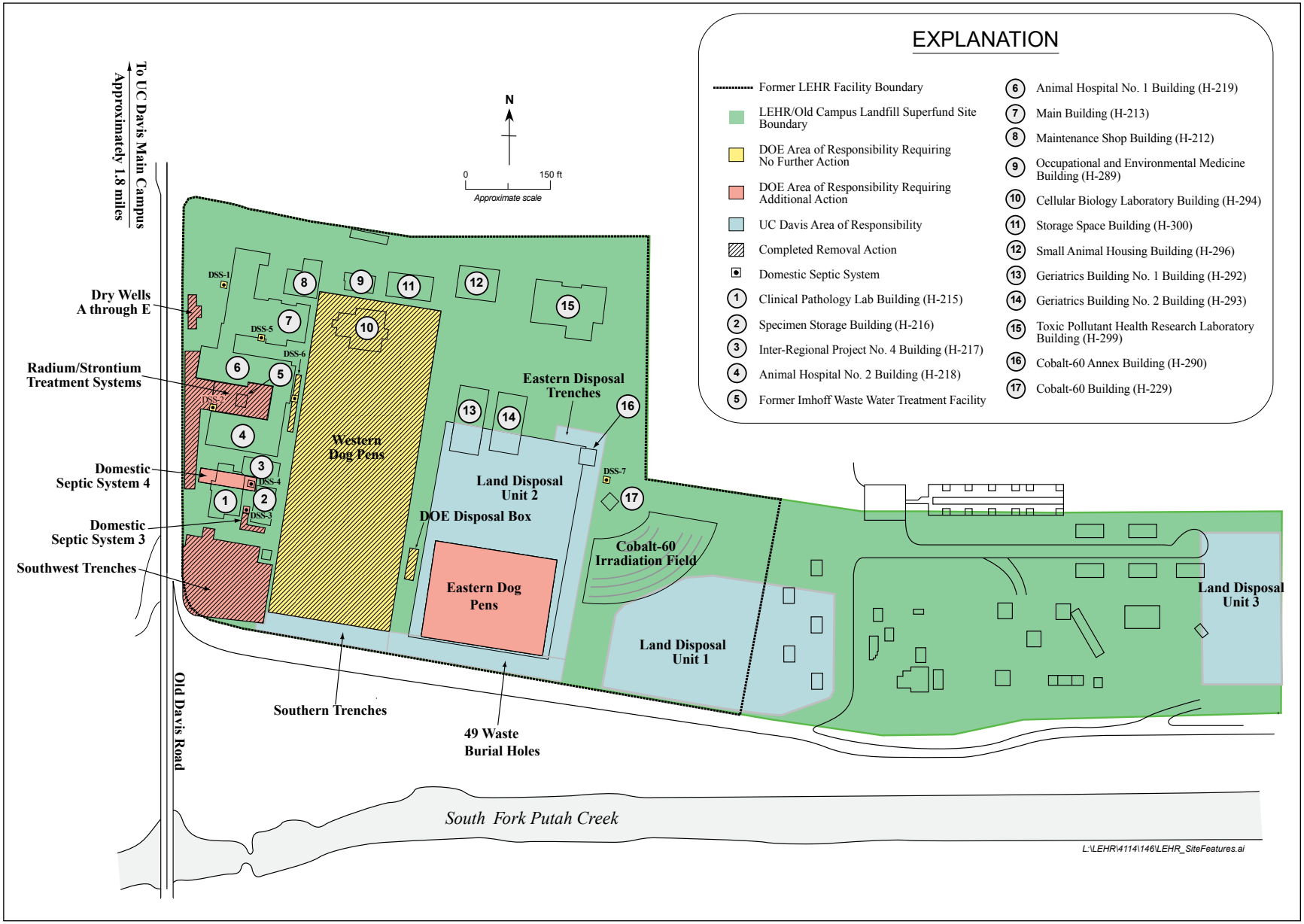

Figure 2. LEHR Site Features

The buildings are currently used for research and storage by the Center for Health and the Environment (CHE) at UC Davis. The SWTs, Domestic Septic System 6 (DSS 6), EDPs, Ra/Sr Treatment Systems, and portions of DSS 4 and DSS 7 are unused open land areas. Most of the WDPs area is also unused open land; however, a building and pavement overlie the northern portion. Dry Wells A–E, the DOE Box, and parts of DSS 1, DSS 3, and the Ra/Sr Treatment Systems areas are paved. Buildings overlie a portion of DSS 1 and DSS 4. Open land areas at the Site are generally not landscaped, and weeds are typically removed by UC Davis in the spring and summer months. Site groundwater monitoring wells are located within portions of open land areas in the SWTs, Ra/Sr Treatment Systems, DSS 3, and WDP areas. All of the land and buildings at the LEHR Federal Facility are owned by UC Davis. According to the UC Davis Long Range Development Plan (UC Davis 2003), the land and buildings within the DOE Areas are used to support University of California research activities and will continue to support research into the foreseeable future. Land uses in DOE Areas are not anticipated to change in the foreseeable future based on the 2017–2027 Long Range Development Plan Preliminary Planning Scenario (UC Davis 2016).

The groundwater underlying the Site is currently not used as a drinking water source. The dominant groundwater flow direction is to the east. Groundwater is not part of the DOE Areas (DOE 2009b).

3.3 History of Contamination

The U.S. Atomic Energy Commission first sponsored radiological studies on laboratory animals at UC Davis in the early 1950s. Initially on the main campus, LEHR was moved to its present location in 1958 (Figure 1). Research at LEHR through 1988 was focused on health effects from chronic exposure to radionuclides, primarily strontium-90 (Sr-90) and radium-226 (Ra-226), using beagles as research subjects. Other related research was conducted at the Site concurrently with these long-term studies. In the early 1970s, a Co-60 irradiator facility was constructed at the Site to study the effects of chronic exposure to gamma radiation.

A campus landfill with three waste burial units used from the 1940s until the mid-1960s is located at the Site (Figure 2). Several low-level radioactive-waste burial areas were also at the Site, and campus and LEHR research waste was buried in these areas until 1974 in accordance with regulations in effect at the time. Contamination was initially discovered through environmental investigations conducted in 1984. The principal environmental threats posed by contaminant releases associated with LEHR activities in the DOE Areas have been mitigated through several removal actions conducted since 1996. Limited amounts of residual contamination currently remain in the DOE Areas. DOE has concluded that the residual contamination presents a low to negligible threat to groundwater resources and human health. The infiltration of surface and rain water can potentially move some of the residual contaminants through the vadose zone to groundwater. The remedy implemented at the LEHR Federal Facility focuses on the monitoring of groundwater where residual contaminants are present in vadose-zone soil.

All DOE-funded research activities at LEHR ceased by 1988, and in the same year, pursuant to the MOA between the DOE and the Regents, DOE's Office of Energy Research initiated activities to close out the research program at LEHR.

3.4 Initial Response

In May 1994, EPA added the Site to the National Priorities List. In 1995, DOE demolished the above-grade portions of the Imhoff Wastewater Treatment Facility (Figure 2) as a voluntary removal action, and by 1997 DOE had completed building decontamination and decommissioning (62 *Federal Register* [FR] 51844–51845) (DOE 1997a). On the basis of DOE's compliance with DOE Order 5400.5 for release of property for unrestricted use (62 FR 51844–51845), DOE determined at the time that no action or no further action was required at all LEHR buildings and the Co-60 irradiation field (no identified contamination and no potential for radiological contamination based on historical use).

In 1997, an MOA divided the responsibility for environmental remediation between DOE and the Regents (DOE 1997b). On the basis of this agreement, the Regents are responsible for remediation of the "UC Disposal Areas," comprising Land Disposal Unit 1, Landfill Disposal Unit 2, Landfill Disposal Unit 3, the 49 Waste Burial Holes, the Eastern Disposal Trenches, and the Southern Trenches (see Figure 2), and "Affected Groundwater." By 2000, DOE had entered into an FFA with EPA, CRWQCB, CDPH, and DTSC whereby DOE is responsible for the remediation of the Ra/Sr Treatment Systems; a waste burial area known as the DOE Disposal Box; onsite domestic septic tanks, associated leach fields, and dry wells; DOE disposal trenches; and the former Dog Pens (EPA 1999).

Between 1999 and 2002, DOE conducted additional soil and groundwater characterization and the removal of contaminated underground tanks, trench structures, and contaminated soil at the DOE Areas in accordance with the requirements of Section 300.415(b)(4)(I) of the NCP.

3.5 Basis for Taking Action

As a result of pre-Record of Decision (ROD) removal actions conducted in compliance with the NCP, and building decontamination activities, risks at DOE Areas are either at or below state and federal human health cancer risk and non-cancer hazard thresholds for current and projected use as a research facility (DOE 2005). Risks at DOE Areas are also below the level of concern for ecological receptors (BBL 2006). However, under a hypothetical residential land-use scenario, risk estimates suggest that residual soil contamination in some areas could pose a cancer risk to an onsite resident. Table 2 summarizes risks for the three DOE areas where the cancer risk remains above 1 in 1 million. DOE determined that risk to a hypothetical onsite resident was only unacceptable in the Domestic Septic System 4 (DSS 4) area. No removal action was conducted in DSS 4 to remove the contamination that poses human health risk. The sink, floor drains, and associated piping in buildings that discharged to DSS 4 were not surveyed for radioactive contamination or remediated. A land-use covenant was recorded by Solano County in 2014 prohibiting future residential land use in the DSS 4 area (DTSC 2014).

Table 2. Human Health Risks by Exposure Route for Contaminants in Soil at the DOE Areas

Cancer Risk by Exposure Route									
DOE Area	**Constituent of Concern**	**Exposure Point Concentration (0–10 feet)[a]**	**Soil Ingestion**	**Soil Dermal Exposure**	**Aboveground Plant Ingestion[b]**	**Belowground Plant Ingestion[b]**	**External Radiation**	**Dust Inhalation**	**Total Cancer Risk**
Domestic Septic System 4	**Onsite Resident**								
	Benzo[*a*]anthracene	3.8	4×10^{-6}	1×10^{-6}	9×10^{-6}	1×10^{-6}	NA	3×10^{-10}	2×10^{-5}
	Benzo[*a*]pyrene	2.4	3×10^{-5}	7×10^{-6}	3×10^{-5}	5×10^{-6}	NA	2×10^{-9}	7×10^{-5}
	Benzo[*b*]fluoranthene	2.7	3×10^{-6}	8×10^{-7}	3×10^{-6}	5×10^{-7}	NA	2×10^{-10}	7×10^{-6}
	Benzo[*k*]fluoranthene	1.5	3×10^{-6}	7×10^{-7}	3×10^{-4}	5×10^{-5}	NA	7×10^{-11}	4×10^{-4}
	Dibenzo[*a,h*]anthracene	1.1	7×10^{-6}	2×10^{-6}	4×10^{-6}	6×10^{-7}	NA	5×10^{-10}	1×10^{-5}
	Indeno[1,2,3-*cd*]pyrene	0.86	2×10^{-6}	4×10^{-7}	1×10^{-6}	1×10^{-7}	NA	4×10^{-11}	4×10^{-6}
	Total								**5×10^{-4}**
	Onsite Construction Worker								
	Benzo[*a*]pyrene	2.4	8×10^{-7}	3×10^{-7}	NA	NA	NA	7×10^{-10}	**1×10^{-6}**
Eastern Dog Pens	**Onsite Resident**								
	Dieldrin	0.019	5×10^{-7}	9×10^{-8}	2×10^{-6}	2×10^{-7}	NA	4×10^{-11}	3×10^{-6}
	Strontium-90	0.33[c]	4×10^{-8}	NA	1×10^{-6}	NA	5×10^{-8}	5×10^{-13}	1×10^{-6}
	Total								**4×10^{-6}**
Southwest Trenches	**Onsite Resident**								
	Strontium-90	0.94	1×10^{-7}	NA	3×10^{-6}	NA	2×10^{-7}	2×10^{-12}	**3×10^{-6}**

Notes:
Source data from the *Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment*, Tables 7 and 8 (UC Davis 2004).
Constituents and risks are presented here if: (1) the constituent is present above Site background and if (2) the constituent contributes at least a factor of 1 in 1 million, or greater than 10 percent, to the excess cumulative cancer risk for a DOE Area and receptor.
Chemical concentrations are expressed in milligrams per kilogram (mg/kg); radionuclide concentrations are expressed in picocuries per gram (pCi/g).
[a] The 95 percent upper confidence level on the mean or maximum sample concentration.
[b] Homegrown produce; for radionuclides, plant ingestion is not subdivided into aboveground and belowground produce.
[c] Exposure point concentration after Eastern Dog Pens maintenance action.

Abbreviation:
NA = not applicable

In 2009, DOE and the Regents signed a revised MOA in part to clarify responsibilities related to groundwater (DOE 2009a). The Regents have implemented interim groundwater remediation and, based on the 2009 MOA, are responsible for implementation of the final remedy to address groundwater containing contaminants released from the "UC Disposal Areas" listed in Section 3.4. The MOA specifies that the Regents will include an analysis of groundwater affected by areas of DOE responsibility in their groundwater Feasibility Study and ROD but will have no responsibility for actions that federal and state agencies may require for groundwater impacts from these DOE Areas (DOE 2009a).

Groundwater fate and transport modeling suggests that residual soil contamination in some DOE Areas could impact groundwater. The areas where such risks remain are the SWT area, the Ra/Sr Treatment Systems area, DSS 3, DSS 4, Dry Wells A–E, and the EDPs (DOE 2005).

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4.0 Remedial Actions

This section discusses the remedy selection, remedy implementation, and systems operations and maintenance (O&M). Remedial action objectives (RAOs) for the DOE Areas are:

- Preventing human contact with contamination in soil that poses an excess cumulative cancer risk greater than the upper bound of the range of 1 in 1 million (1×10^{-6}) to 1 in 10,000 (1×10^{-4}). Any risk greater than 1 in 1 million requires investigation to determine if remedial action is necessary.
- Mitigating potential future impacts to groundwater.
- Minimizing threats to the environment, including but not limited to, sensitive habitats and critical habitats of species protected under the state and federal Endangered Species Acts.
- Complying with all applicable or relevant and appropriate requirements (ARARs).
- Minimizing impact to UC Davis research activities at the Site, as specified in the MOA (DOE 2009a) between DOE and the Regents.

4.1 Remedy Selection

In accordance with the ROD (DOE 2009b), signed December 10, 2009, the remedies selected for each of the DOE Areas are shown in Table 3.

Table 3. Selected Remedies for Each DOE Area

DOE Area	No Action/ No Further Action[a]	Long-Term Groundwater Monitoring/Contingency Remediation	Land-Use Restrictions	
			Soil Management Plan	No Residential Use
Radium/Strontium Treatment Systems (includes Domestic Septic System 2)		✓	✓	
Domestic Septic System 1	✓			
Domestic Septic System 3		✓	✓	
Domestic Septic System 4		✓	✓	✓
Domestic Septic System 5	✓			
Domestic Septic System 6	✓			
Domestic Septic System 7	✓			
DOE Disposal Box	✓			
Dry Wells A–E		✓	✓	
Eastern Dog Pens			✓	
Southwest Trenches		✓	✓	
Western Dog Pens	✓			

Note:
[a] These checkmark-indicated locations within the DOE Areas are suitable for unlimited use and unrestricted exposure.

Constituents of concern (COCs) for each area were selected based on their presence in soil at levels statistically above background and:

- Their presence at levels that were shown (by multiple lines of evidence) to present human health cancer risks above 1 in 1 million.

-or-

- Their potential to impact groundwater above background levels.

Table 4 lists soil remediation goals for the COCs at each DOE Area identified in the ROD (DOE 2009b) as presenting potential human health cancer risks that exceed 1 in 1 million. Table 5 presents ROD groundwater quality goals developed in conformance with the CRWQCB's guidance document *Designated Level Methodology for Waste Classification and Cleanup Level Determination* (CRWQCB 1989). These remediation goals represent contaminant concentrations in soil that, based on modeling, would not contaminate groundwater above groundwater background levels or water-quality goals.

Table 6 lists additional COCs identified that could possibly have a small impact on groundwater in the future, based on the analysis presented in the *Site-Wide Risk Assessment: Volume I: Human Health Risk Assessment (Part B Risk Characterization for DOE Areas*) (DOE 2005), referred to hereafter as the Risk Characterization Report.

Table 4. Soil Remediation Goals for the Protection of Human Health

DOE Area	Constituent of Concern	Exposure Point Concentration[a]	Remediation Goal[b]
Domestic Septic System 4	**Onsite Resident**		
	Benzo[*a*]anthracene	3.8	0.2
	Benzo[*a*]pyrene	2.4	0.03
	Benzo[*b*]fluoranthene	2.7	0.4
	Benzo[*k*]fluoranthene	1.5	0.004
	Dibenzo[*a,h*]anthracene	1.1	0.1
	Indeno[1,2,3-*cd*]pyrene	0.86	0.2
	Onsite Construction Worker		
	Benzo[*a*]pyrene	2.4	2
Southwest Trenches	**Onsite Resident**		
	Strontium-90+daughter	0.94	0.3
Eastern Dog Pens	**Onsite Resident**		
	Dieldrin	0.019	0.006
	Strontium-90+daughter	0.33[c]	0.3

Notes:
Chemical concentrations are expressed in milligrams per kilogram (mg/kg); radionuclide concentrations are expressed in picocuries per gram (pCi/g).

[a] Maximum concentration or 95 percent upper confidence level on the mean for soil located between 0 and 10 feet below ground surface.
[b] Remediation goals based on a risk of 1 in 1 million, determined using one significant figure total cancer risk. All concentrations are based on dry weight of soil sample.
[c] Exposure point concentration after Eastern Dog Pens maintenance action.

Table 5. Remedial Goals for the Protection of Groundwater

DOE Area	Constituents of Concern in Soil[a]	Maximum Soil Concentration[b]	Background Remediation Goal[c]	MCL Remediation Goal[d]
Domestic Septic System 3	Formaldehyde	2.2	0.00378	0.0151[f]
	Molybdenum	2.5	<0.26[e]	3.11[g]
	Nitrate as N	106	36[e]	36[e]
Domestic Septic System 4	Selenium	2.0[h]	4.0	35
Dry Wells A–E	Chromium	245	181[e]	181[e]
	Hexavalent chromium	1.62	1.3[e]	1.3[e]
	Mercury	5.3	0.63[e]	0.63[e]
	Molybdenum	1.3	0.30	3.6[g]
	Silver	53.8	0.55[e]	0.83
	Cesium-137	0.191	0.1	20[i]
	Strontium-90	0.176	0.0595	0.28
Radium/Strontium Treatment Systems[l]	Nitrate as N	304	36[e]	36[e]
	Carbon-14	2.41	0.13[e]	2.34[i,j]
	Radium-226	1.72[k]	0.752[e]	1.9
Southwest Trenches	Nitrate as N	909	36[e]	36[e]
	Carbon-14	5.84	0.13[e]	0.292[i,j]

Notes:
Chemical or nonradioactive elemental concentrations are expressed in milligrams per kilogram (mg/kg); radionuclide concentrations are expressed in picocuries per gram (pCi/g).

[a] Vadose-zone soil contaminant with potential to impact groundwater.
[b] Maximum level of the specified constituent detected in soil samples collected from the specified DOE area.
[c] Soil concentration predicted by transport modeling, above which groundwater impacts in excess of Site background are possible. The calculated remediation goals are expressed as dry weight.
[d] Soil concentration predicted by transport modeling, above which groundwater impacts above California drinking water maximum contaminant levels may occur, unless noted. The calculated remediation goals are expressed as dry weight.
[e] Soil background concentration was selected as the remediation goal because the calculated remediation goal is below the soil background concentration. Calculated remediation goals are presented in the Risk Characterization Report (DOE 2005).
[f] Based on the California Department of Public Health Notification Level of 100 micrograms per liter (*California Health and Safety Code* 116455).
[g] Based on EPA Region 9 preliminary remediation goal for tap water (EPA 2010).
[h] Residual selenium soil concentrations exceeded soil background in 23 percent of the samples collected, and modeling suggests that selenium concentrations in the soil are unlikely to impact groundwater at levels that exceed the remediation goals. However, selenium was retained as a COC due to its presence (one result) in a downgradient hydrostratigraphic unit 1 well at a concentration slightly above groundwater background.
[i] Based on the 4-millirem-per-year federal maximum contaminant level for beta particles and photon emitters (EPA 2000).
[j] The different maximum contaminant level remediation goals for the Radium/Strontium Treatment Systems and Southwest Trenches areas reflect the observed vertical distribution of contamination in these areas.
[k] The sample containing the maximum Ra-226 result in the Radium/Strontium Treatment Systems area was re-collected and reanalyzed. The reported maximum value is the average of the initial result (1.81 pCi/g) and re-collected sample result (1.63 pCi/g)).
[l] The Radium/Strontium Treatment Systems area is inclusive of Domestic Septic System 2.

Abbreviation:
MCL = maximum contaminant level

Table 6. Additional Constituents To Be Monitored Due to Potential Impact on Groundwater Quality

Area	Constituents of Potential Concern to be Monitored
Domestic Septic System 1	Aluminum
Domestic Septic System 3	Aluminum, silver
Domestic Septic System 4	Aluminum, chromium, nickel
Domestic Septic System 5	Aluminum
Domestic Septic System 6	Aluminum
Domestic Septic System 7	None
Dry Wells A–E	None
Radium/Strontium Treatment Systems[a]	Americium-241
Southwest Trenches	Mercury, zinc
Western Dog Pens	None
Eastern Dog Pens	alpha-Chlordane, gamma-Chlordane, Dieldrin
DOE Disposal Box	None

Note:
[a] The Radium/Strontium Treatment Systems area is inclusive of Domestic Septic System 2.

4.2 Remedy Implementation

The *Remedial Design/Remedial Action Work Plan for the Former Laboratory for Energy-related Health Research Federal Facility, University of California, Davis* (RD/RAWP) was finalized in November 2010 (DOE 2010a). This section describes the selected remedies: no action/no further action; long-term groundwater monitoring/contingent remediation; and land-use restrictions, including implementation of the Soil Management Plan (SMP) and a prohibition on residential use. Remedy implementation is documented in detail in the *Remedial Action Completion Report for the Former Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis*.[1] Remedy implementation and ongoing monitoring is performed in accordance with the *Quality Assurance Project Plan* (DOE 2010c).

4.2.1 Implementation of the No Action/No Further Action Remedy

DOE accelerated cleanup in the DOE Areas by completing several removal actions that successfully addressed principal environmental threats at the LEHR Federal Facility. Following the removal actions, risks to human health and the environment were estimated for the DOE Disposal Box, DSS 1, DSS 5, DSS 6, DSS 7, and WDP areas in the Risk Characterization Report (DOE 2005). As shown in Table 3, the no action/no further action remedy was selected for these DOE Areas.

Human health and ecological risk characterizations were performed to examine the strengths and weaknesses of lines of evidence indicating whether constituents of potential concern pose significant risks (DOE 2005; BBL 2006). A groundwater risk characterization was included in the human health Risk Characterization Report (DOE 2005). As documented in their approval

[1] This report is currently in progress.

of this report, the remedial project managers made a risk management decision that the risks were insignificant and no further action was required in these areas.

A follow-up risk assessment was conducted in 2007 to evaluate potential risk associated with post-removal action backfill in the WDP area (Weiss 2007). The results of this risk assessment did not change the remedial project managers' decision that no further action was required in the WDP (DOE 2009b).

A summary of constituent concentrations, risk calculations, and lines of evidence that form the basis of the risk management decisions is presented in the ROD (DOE 2009b).

On the basis of DOE's compliance with DOE Order 5400.5[2] for release of property for unrestricted use (62 FR 51844–51845) (DOE 1997a), no action or no further action was also selected for:

- LEHR buildings (including the Imhoff Wastewater Treatment Facility demolished in 1995)
- The Co-60 irradiation field (no identified contamination and no potential for contamination based on historical use)

All of these areas requiring No Action/No Further Action are suitable for unlimited use and unrestricted exposure.

4.2.2 Implementation of Long-Term Groundwater Monitoring/Contingent Remediation

This section discusses the implementation of the long-term groundwater monitoring and contingent remediation programs at the DOE Areas. As shown in Table 3, this remedy applies to the Ra/Sr Treatment Systems, DSS 3, DSS 4, Dry Wells A–E, and SWT areas.

4.2.2.1 Long-Term Groundwater Monitoring

Long-term groundwater monitoring was implemented in 2011. The monitoring wells included in the program are shown on Figure 3. Groundwater samples are collected for three categories of analytes:

- **COCs** are constituents that were identified in the Risk Characterization Report (DOE 2005) based on their presence in soil at levels statistically above background and at concentrations contributing to human health cancer risks above 1 in 1 million and/or their potential to impact groundwater at concentrations above background levels.
- **Monitoring-only constituents (MOCs)** were identified in the Risk Characterization Report (DOE 2005) as constituents that should be included in a monitoring plan for the DOE Areas; these compounds were identified as having a very low (but possible) potential to impact groundwater in the future.
- **New well constituents (NWCs)** are compounds that are potentially present above background levels in wells UCD1-068 through UCD1-072 based on full-suite analyses performed on samples collected from wells installed in 2011. (Note: NWCs were not identified in the ROD [DOE 2009b] but were added to the monitoring program after these new monitoring wells were installed in 2011 [DOE 2010b]).

[2] DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, was cancelled in its entirety by DOE Order 458.1.

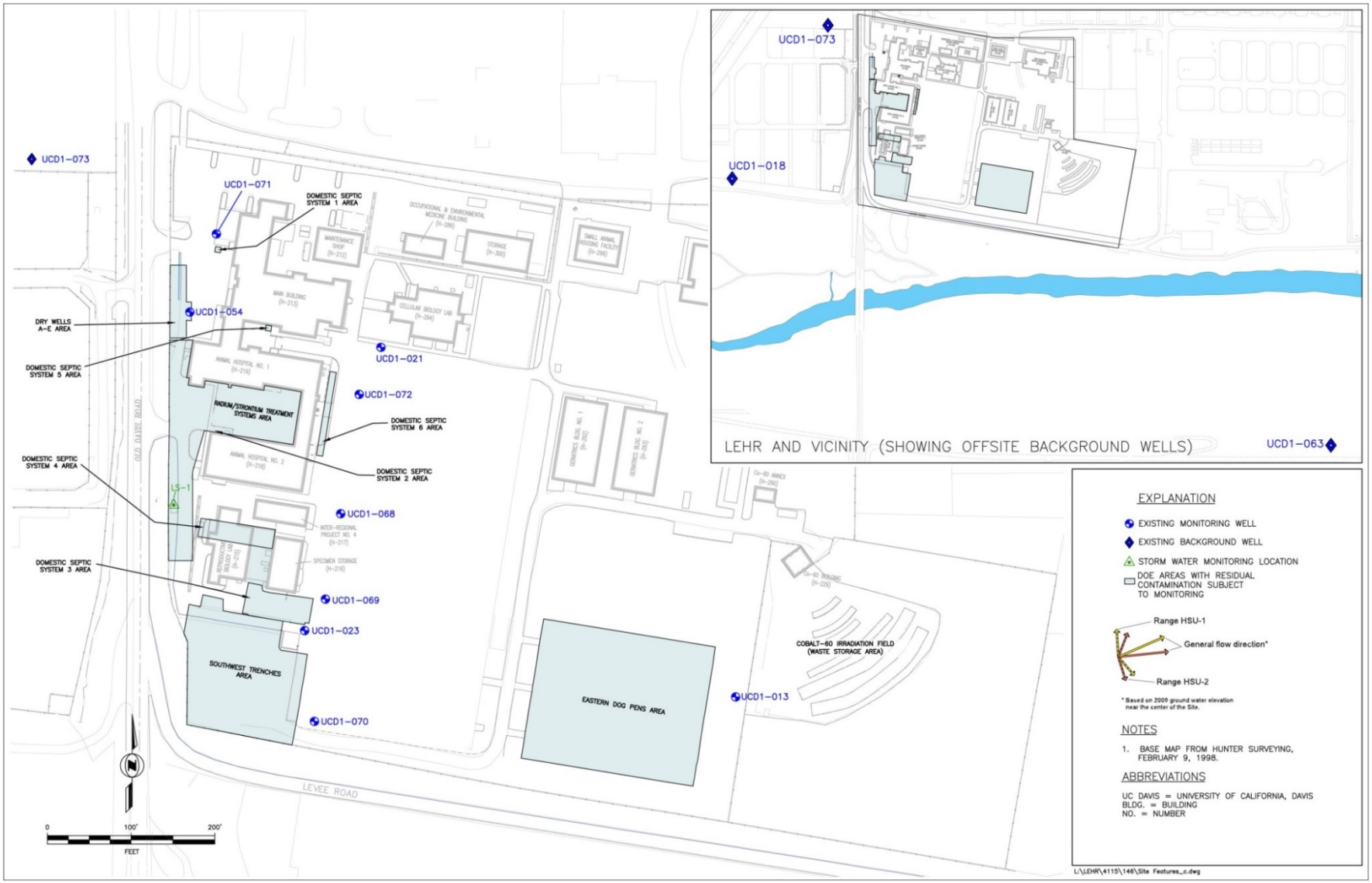


Figure 3. Groundwater Monitoring Locations

In 2011 and 2012, background and baseline values were established for each monitoring well-specific COC, MOC, and NWC based on the sampling program documented in the RD/RAWP (DOE 2010a) and LEHR regulatory stakeholder input (Weiss 2012). Annual samples have since been collected, compared to these values, and the sampling program updated, as appropriate, in coordination with the regulatory stakeholders. Annual monitoring reports recording these monitoring changes were prepared for 2011, 2012, and 2013 (Weiss 2013, 2014a, 2014b). A monitoring program decision process for COCs was presented in the RD/RAWP (DOE 2010a); however, during the first 5 years of monitoring it became evident that this process required revision to be workable. A revised program decision process for evaluating all well-specific constituents (COCs, MOCs, and NWCs) has been developed based on the annual data reviews conducted with input from the regulatory stakeholders; this process is summarized on Figure 4.

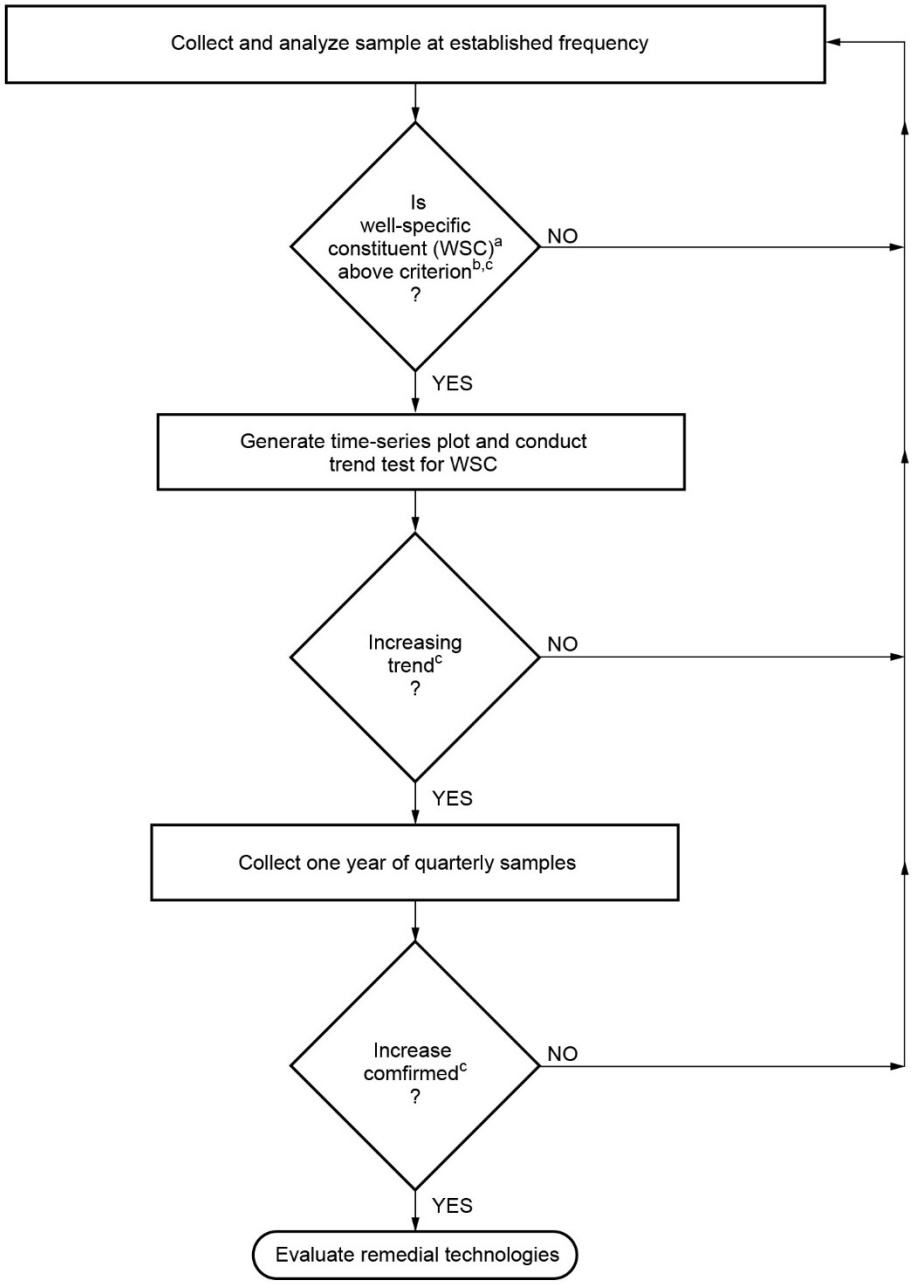
Results from the 2014 annual sampling were discussed at the remedial project managers meeting held on July 15, 2014, and a sampling plan for 2015 was proposed (Weiss 2014c). A comprehensive analysis of monitoring data collected during the Five-Year Review period (2011 through 2015) was conducted, and opportunities for further optimization were identified, as discussed further in Section 6.4.

As established in the RD/RAWP (DOE 2010a), if concentrations of COCs remain below background levels or are not detected for 5 consecutive years and show no increasing trend, the monitoring frequency is reduced from annual to biennial until the next Five-Year Review. If concentrations of COCs continue to be below background levels or not detected in the following five-year period, the sampling frequency may be further reduced to triennial or once every five years (approximately one year before the Five-Year Review report is due). Reduction in the monitoring frequency or termination of monitoring is considered for specific COCs and must be approved by the regulatory agencies before implementation. Based on the first five years of monitoring, DOE recommends that similar criteria for monitoring frequency reduction also apply to baseline levels for those constituents with baselines above background. For these constituents, sampling frequency may be reduced provided the baseline level is below the maximum contaminant level (MCL) or other relevant water-quality criterion and levels remain at or below baseline with no increasing trend, with any proposed frequency reductions being approved by the regulatory agencies before implementation.

The RD/RAWP (DOE 2010a) specifies that annual monitoring of MOCs and NWCs will be conducted until it can be determined, on the basis of monitoring data, that these constituents pose no threat to groundwater quality. Termination of monitoring of a constituent must be approved by the regulatory agencies. DOE recommends that monitoring frequency reduction for MOCs and NWCs be based on the same criteria as for COCs, with any proposed frequency reductions being approved by the regulatory agencies before implementation.

4.2.2.2 Contingent Remediation

During the first 5 years, contingent remediation has not been required. However, it is possible that continued long-term groundwater monitoring could eventually indicate that COCs are migrating from DOE Areas soil to groundwater and are impacting or may impact groundwater quality. In such a case, remedial cleanup technologies will be evaluated in accordance with CERCLA, ARARs, and the corrective action requirements of Title 27 of the *Code of California Regulations*.



Notes:

a. Inclusive of constituents of concern (COCs), monitoring-only constituents (MOCs), and new well constituents (NWCs).

b. Criterion is background if baseline is below background; otherwise criterion is baseline. Background and baseline were established in 2012 (Weiss2014a).

c. The following may be conducted to confirm the WSC is above the criterion and/or the trend is increasing:

- Data uncertainty evaluation
- Resampling
- Reevaluation of background (which may include sampling background wells)

Figure 4. Groundwater Monitoring Decision Process

Figure 4 includes the updated decision process for triggering remedial technology evaluations. As shown on this figure, each well-specific constituent result is first compared with the appropriate criterion (i.e., baseline for those constituents with baseline above background and background for those with baseline below background). If the criterion is exceeded, data quality and uncertainty is carefully evaluated. If the criterion is confirmed to be exceeded, the Mann-Kendall trend test is conducted at the alpha significance level of 1 percent, and time series plots are reviewed for trends. If monitoring data suggest an increasing concentration trend, data quality/uncertainty is considered and the background concentration is reevaluated to assess if background levels have increased. If needed, additional sampling and analysis for the constituent in the specific monitoring well in question and/or in background wells may be conducted. If the monitoring results indicate a significant increasing trend over the baseline or background, whichever is appropriate, the sampling frequency is increased to quarterly for 1 year and is then evaluated. If the evaluation indicates an ongoing increasing concentration trend, remedial cleanup technologies are evaluated. If not, monitoring reverts to its previous frequency.

4.2.3 Implementation of Land-Use Restrictions

Per the requirements of the ROD (DOE 2009b), DTSC entered into an agreement with the Regents to restrict use of portions of the DOE Areas to protect present or future human health or safety or the environment from residual contaminants. The DTSC is the administrator of this Covenant. DOE Areas subject to land-use controls are shown on Figure 5. The Covenant was recorded with the County of Solano on July 11, 2014, as Document No. 201400051822 (DTSC 2014) and contains the following restrictions:

- Access must be granted for the purpose of collecting samples and maintaining groundwater monitoring wells
- Interference, tampering with, or destruction of the groundwater monitoring system is prohibited
- An SMP must be adhered to in all DOE Areas except where no action or no further action is the remedy
- Residential use, use for day care for children, and cultivation of crops for human consumption are prohibited in the DSS 4 area
- Reuse outside of the Site boundary of soil from locations within the DOE Areas subject to land-use controls for any purpose is prohibited without the DTSC and EPA's written approval
- EPA and DTSC shall have reasonable right of entry and access to the property for periodic inspections to ensure compliance with land-use restrictions

The Covenant (DTSC 2014), recorded in the chain of title for the property, serves to ensure enduring notice to parties of the restrictions on land use and land disturbance activities at the DOE Areas.

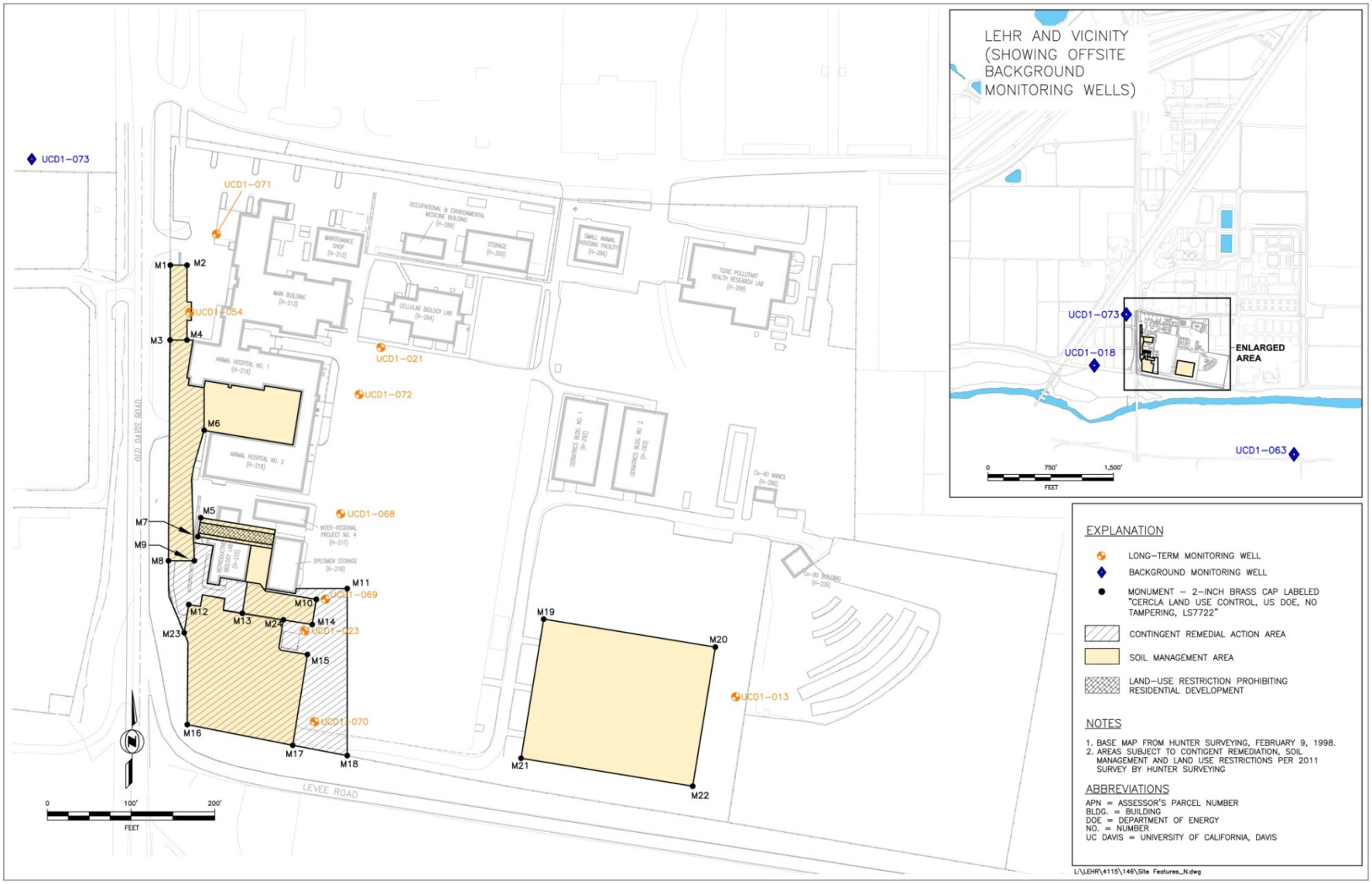


Figure 5. DOE Areas of the LEHR Federal Facility Subject to Land-Use Controls

Land-use restrictions shall be maintained until the concentrations of contaminants in soil are at levels that allow unrestricted use (see remediation goals in Table 4 and Table 5). As long as contamination requiring the implementation of an SMP or land-use restrictions remains in place, DOE shall continue to conduct Five-Year Reviews to ensure that the selected remedy remains protective. The SMP shall be maintained and updated during Five-Year Reviews.

In accordance with the MOA between DOE and the Regents, following each Five-Year Review, DOE shall consult with EPA, DTSC, CRWQCB, and CDPH, or the successors to these agencies, to determine whether it is necessary for the land-use covenants to remain in effect or if the land-use covenants can be terminated entirely or amended to delete specific DOE units from the land-use restrictions (DOE 2009a).

4.2.3.1 Soil Management Plan

Because residual contamination is left in place at LEHR, an SMP is required to address the residual chemical and radionuclide soil contamination, except for areas where no action or no further action was selected. All soil-disturbing activities—including excavation, grading, trenching, and utility installation or repair—are subject to the requirements of the SMP.

DOE has entered into an MOA with the Regents whereby UC Davis develops internal policies, procedures, and training to ensure implementation of the SMP in DOE Areas (DOE 2009a). The Environmental Health & Safety (EH&S) Unit at UC Davis provides ongoing training and guidance to university staff to communicate soil-management requirements to applicable units that may perform, manage, or contract for work at and near DOE Areas and to avoid unnecessary soil-disturbing activities in the areas subject to the SMP.

Information on the following topics is provided:

- Roles and responsibilities for soil management in the DOE Areas
- Areas and contaminants subject to soil-management requirements
- Soil management during excavation or construction
- Permits for soil-disturbing activities
- Plans and documentation
- Soil management during emergency work
- Waste management
- Waste characterization and disposal
- Inspections

The most recent SMP training occurred on July 23, 2015. SMP training is conducted annually. The soil management areas are inspected for soil disturbance annually and reported in annual land-use covenant inspection reports (DOE 2013, 2014, 2015a). No permit-required soil disturbing activities have occurred since the SMP was implemented in 2011, and no evidence of contaminated subsurface soil disturbance was found during the inspections.

Before any soil-disturbing activities may begin, a permit application detailing the nature of the project; the project's location; and the expected depth of any proposed trenching, excavation, drilling, or other soil disturbance must be submitted to the EH&S Unit. No work may begin until the EH&S Unit approves the permit for the proposed project.

4.2.3.2 No Residential Use

As specified in the ROD (DOE 2009b), specific land-use restrictions are required for the DSS 4 area (Figure 5) until the concentrations of contaminants in the soil are at levels that allow for unrestricted use (Table 4 and Table 5). In finalizing the Covenant (DTSC 2014), DTSC and EPA agreed to modify the land-use restrictions listed in the ROD to remove the restriction on use for any type of educational purpose for children under the age of 21, because this restriction was not necessary for protectiveness. The Covenant specifies that residential use, use for day care for children, and the cultivation of crops for human consumption are prohibited in the DSS 4 area.

4.2.3.3 Prohibition Against Interference with Monitoring System

The destruction or disturbance of monitoring wells is prohibited in the Covenant (DTSC 2014). Activities that may disturb the effectiveness of the groundwater monitoring well system (e.g., excavation, grading, removal, trenching, filling, earth movement, mining) are not permitted within the DOE Areas at LEHR without prior review and written approval by DTSC and EPA unless such activities are expressly allowed in the approved SMP.

4.3 Remedy Operations and Maintenance

O&M activities at DOE Areas are conducted according to the procedures specified in the RD/RAWP (DOE 2010a). These activities consist of groundwater monitoring and conducting ongoing training and implementation of the SMP, as described above. Maintenance activities include inspecting and maintaining groundwater monitoring wells and land-use restriction features. Inspections of groundwater monitoring wells, anti-tampering plaques, land survey monuments, and locations within the DOE Areas subject to land-use restrictions are conducted at least once per year and reported in Annual Land-Use Covenant Inspection Reports (DOE 2013; 2014; 2015a). Maintenance activities such as well repairs are also documented in the inspection reports.

Table 7 compares the long-term groundwater monitoring costs that were used as the basis for the ROD cost estimates to the actual costs for this first five-year period. The actual costs were lower than expected in the first year and higher in the second and third years because data collection to establish background and baseline levels was extended over 2 years (see Section 4.2.2.1) and evaluation of these data extended into the third year instead of being completed in 1 year as originally planned. Over all, five-year groundwater monitoring costs were higher than expected, mostly due to the more extensive effort required to establish background and baseline levels and the addition of NWC analyses.

Table 7. Five-Year Groundwater Monitoring Costs

Year	Cost Estimated for ROD[a] ($)	ROD Cost Estimate Basis	Actual Cost[a] ($)	Actual Work Performed
2011	225,000	Protocol development; quarterly sampling with full-suite analysis; data evaluation to establish analyte list, background and baseline levels; annual report	125,000	Protocol development; quarterly sampling with full-suite analysis; data evaluation; annual report
2012	33,000	Annual monitoring and reporting	146,000	Protocol development; quarterly sampling; data evaluation; annual report
2013	33,000	Annual monitoring and reporting	94,000	Completed data evaluation to establish background/baseline levels; Annual monitoring and reporting
2014	33,000	Annual monitoring and reporting	45,000	Annual monitoring and reporting
2015	33,000	Annual monitoring and reporting	39,000	Annual monitoring and reporting
Total	**358,000**		**449,000**	

Note:
[a] Rounded to the nearest $1000.

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5.0 Progress Since the Last Five-Year Review

This is the first Five-Year Review for the LEHR Federal Facility.

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6.0 Five-Year Review Process

This section discusses the Five-Year Review process for the LEHR Federal Facility.

6.1 Administrative Components

DOE's Office of Legacy Management, EPA, CDPH, CRWQCB, and DTSC established the Five-Year Review schedule with the following components:

- Community Involvement
- Document Review
- Data Review
- Inspection of the DOE Areas
- Local Interviews
- Five-Year Review Report Development and Review

The schedule extends into 2016.

6.2 Community Involvement

Notices of the Five-Year Review were published in *The Davis Enterprise* on May 29, 2015 (p. A-1, Appendix A); and *The Sacramento Bee* on June 1, 2015 (p. A-2, Appendix A). A notice is also currently accessible on the DOE's Office of Legacy Management website (p. A-3, Appendix A) (DOE 2015b). These notices describe the remedy implemented by DOE during this first Five-Year Review period but do not mention contingent remediation since none was required. In addition, UC Davis staff members with direct involvement in the Site were personally notified of the Five-Year Review. This includes staff members of the Center for Health and the Environment (CHE) (located at the Site), UC Davis Design and Construction Management (DCM), and UC Davis Grounds and Landscape Services. The Davis South Campus Superfund Oversight Committee (DSCSOC), a public participation group funded through the Technical Assistance Grant program, disbanded in March 2010. There has not been a formal community involvement group for the Site since that time.

6.3 Document Review

Documents reviewed for this Five-Year Review are listed in Section 12.0, "References." Additional documents reviewed are referenced in each of the appendixes, as appropriate. The tables of ARARs presented in the ROD (DOE 2009b) were reviewed for potential changes. Results of this evaluation are provided in Section 7.2.1 and Appendix B.

6.4 Data Review

In accordance with the procedures specified in the RD/RAWP (DOE 2010a), groundwater monitoring data from the monitoring well network are evaluated for evidence of groundwater impact annually by conducting trend analyses and comparing results to background and baseline levels for well-specific constituents identified in the RD/RAWP. The results of these

evaluations are presented in the annual water monitoring reports for the Site. For this Five-Year Review, a comprehensive trend analysis of data collected during the five-year reporting period was conducted for each well-specific constituent identified in the RD/RAWP to determine if any constituents have increasing concentrations or can be removed from the monitoring program or monitored less frequently (DOE 2010a). Results of this data analysis are presented in Appendix C.

On the basis of the analysis, no COC, MOC, or NWC concentrations are increasing such that increased monitoring frequency or other response actions are needed. Although trend analyses for chloroform in well UCD1-072 and nitrate in well UCD1-069 indicated an upward trend, the concentrations and potential trends for these well-specific constituents do not warrant increased monitoring frequency or other response, as described in Appendix C. No well-specific constituent is recommended for removal from the monitoring program based on the trend analysis; however, monitoring for most DOE Areas groundwater well-specific constituents can be optimized by reducing the frequency to biennial, which will still provide adequate data to evaluate potential groundwater impacts. Of the 72 well-specific constituents monitored, 46 are proposed for monitoring frequency reduction to biennial, with an additional 7 potentially proposed for biennial monitoring depending on 2016 results (Table C-4, Appendix C).

6.5 Inspection of the DOE Areas

The most recent inspection of the DOE Areas was conducted on June 16, 2015, by the project team as listed in Appendix D. The purpose of the inspections was to assess the protectiveness of the remedy. The inspection focused on:

- Prohibited uses at the DSS 4 area
- Compliance with the SMP
- Operation and maintenance of groundwater monitoring wells

No residential use, use for day care for children, or cultivation of crops for human consumption was observed in the DSS 4 Area.

Minor soil disturbance was found in the northwest corner of the EDPs due to removal activities associated with a fallen tree. The volume and depth of the soil disturbance were less than the quantities that would require a permit according to the specifications in the SMP (disturbed depths less than 1 foot and soil displaced less than 5 cubic yards [DOE 2010a]). However, the northwest survey monument for the EDP was removed and lost due to this activity.

Groundwater monitoring wells were in good condition, and none showed evidence of tampering. Some minor well maintenance issues were noted.

The full inspection of the DOE Areas, including the Inspection Checklist and photographs taken on June 16, 2015, is provided in Appendix D.

6.6 Interviews

Table 8 lists those approached for interviews for this Five-Year Review; each person's title, role on this project, and response to the interview request are also provided.

Interviews of the six people listed above who agreed to be interviewed were conducted by telephone between June 26 and July 1, 2015. The questionnaire used for the interview, as well as transcripts recording each interviewee's responses, is provided in Appendix E.

Table 8. Individuals Invited To Be Interviewed for the Five-Year Review

Person	Title	Role on DOE Areas Project	Response to Interview Request
Sue Fields	Environmental Manager, UC Davis EH&S Unit	UC Davis project manager	Yes
Cary Avery	Associate Director of Grounds and Landscape Services, UC Davis	Grounds maintenance	Yes
Ardie Dehghani	Campus Engineer, UC Davis DCM	Construction oversight	Yes
Sue Russell	Chief Administrative Officer, UC Davis CHE	Works at CHE, which is onsite	Yes
Shanie McCarty	EHS Specialist I, UC Davis CHE	Works at CHE, which is onsite	Yes
Kent Pinkerton	Director, UC Davis CHE	Works at CHE, which is onsite	Yes
Mary Rust	Neighboring Landowner	Member of former DSCSOC	Declined[a]
David Stensby	Remedial Project Manager	EPA Region 9	Declined[b]
Durin Linderholm	Engineering Geologist	CRWQCB	Declined[b]
John Bystra	Project Manager	DTSC	Declined[b]

Notes:
[a] Stated that she no longer lives in the area and is not up-to-date on DOE Areas activities.
[b] Indicated that they have no additional input beyond that provided through regular meetings and document review.

A summary of interviewee responses is provided below:

- All respondents felt that the DOE Areas remedy is adequately protective, and none were aware of any changes in DOE Areas conditions, laws, or regulations in the past 5 years that would affect the protectiveness and effectiveness of the remedy.
- All respondents felt that they were adequately informed about the remedy and land-use restrictions, trained on their responsibilities regarding the remedy implementation (as appropriate), and knew where to obtain information about the remedy. All respondents indicated that the UC Davis EH&S Unit is their primary source of information.
- In terms of impact that the DOE Areas remedy has had on the community, two UC Davis respondents mentioned concerns related to Pacific Gas and Electric's plan to install a new high-pressure gas line adjacent to the Site and the associated disruption to groundwater that could potentially impact the remedy. Two UC Davis respondents also mentioned community concern that the remedy was overly protective and costly. One respondent mentioned past community concern about the groundwater plume but stated that his understanding is that DOE has been very detailed in following that plume and its progress and has provided information on the plume to the public in regular meetings.

- When asked about complaints, violations, incidents, or activities involving the DOE Areas and remedy, one or more respondents mentioned:
  - Several years ago someone representing the State was planning to drill a soil boring to assess the Putah Creek levee adjacent to the Site. The UC Davis EH&S Unit was notified and helped the State representative select a location that would not interfere with the DOE Areas remedy.
  - A land survey monument for the DOE Areas remedy was recently lost and some surface soil was disturbed when a fallen tree at the Eastern Dog Pens was cleared out. The UC Davis EH&S Unit was notified and confirmed that no soil disturbance requiring notification had occurred. At the time of the interview, the EH&S Unit was in the planning stage for replacing the missing monument and including more highly visible markers for the monuments.
  - The UC Davis Department of Public Health Sciences recently asked the UC Davis EH&S Unit where they could site a shaded structure at the Site. A meeting was scheduled to select a location that would not impact any of the restricted areas.

7.0 Technical Assessment

This section provides the technical assessment of the selected remedies for the DOE Areas.

7.1 Question A: Is the Remedy Functioning As Intended by the Decision Documents?

The review of documents and data and the results of the DOE Areas inspection and interviews indicate that the remedy is functioning as intended by the ROD (DOE 2009b). Land-use controls and groundwater monitoring were implemented as specified in the ROD; both of these remedy elements are functioning well. As described in Section 4.3, O&M annual costs generally have been consistent with expectations. On the basis of the monitoring costs for the fifth year (see Table 7) and the opportunities for optimization described below, monitoring costs for the next Five-Year Review period are expected to be consistent with or lower than those estimated for the ROD.

7.1.1 Land-Use Restrictions

As stated in the ROD, the intended objectives of the land-use restrictions are to:

- Prevent exposure to contaminated soil.
- Prevent improper disposal of contaminated soils.
- Maintain the integrity of all present and future monitoring wells for alternatives requiring groundwater monitoring (DOE 2009b).

The land-use restrictions include a recorded deed restriction on residential use at DSS 4, access for contingency remediation, and SMP implementation at the Ra/Sr Treatment Systems, DSS 3, DSS 4, Dry Wells A-E, SWT area, and EDP areas. On the basis of the document review, inspection, and interviews, these land-use restrictions have been effectively implemented and are functioning as intended to meet the three objectives listed above. Land surveying and monument installation for the restricted areas was completed in 2011, and the Covenant prohibiting residential use was recorded by Solano County in 2014 (DTSC 2014). SMP training is conducted annually. Workers at the Site are well-informed on the SMP requirements and areas of applicability. O&M issues encountered during the five-year period have been routine and easily manageable. No soil-disturbing events that would require a permit have occurred. One incident of a minor soil disturbance was reported during the Five-Year Review period (see Appendixes D and E), but it was determined that the volume (less than 5 cubic yards) and depth (less than 1 foot) of the disturbed soil were less than those requiring a permit under the SMP. One monument (M19) was recently lost due to grounds maintenance work in the northwest corner of the EDPs. On September 29, 2015, Hunter Surveying, a California-licensed land surveyor, reinstalled monument M19 at its previous location.

Improving the visibility of the survey monuments by adding high-visibility markers is an opportunity for the optimization of land-use controls. The SMP specifies that the surveyor's maps shall be used by the EH&S Unit in reviewing every soil disturbance activity to determine if it is in a controlled area and prior to issuing a permit, and the monuments serve only as a secondary indicator of controlled areas. However, through improved visibility, the time required

to locate monuments during inspections and the likelihood of inadvertent damage of the monuments during grounds work should be reduced, thereby reducing ongoing O&M costs.

7.1.2 Long-Term Groundwater Monitoring

As stated in the ROD (DOE 2009b), the function of the long-term groundwater monitoring is to ensure that if contaminants begin to impact groundwater, remedial action will be taken to prevent the degradation of water quality. The monitoring well network described in the RD/RAWP (DOE 2010a) was implemented as designed in 2011 (identification plaques installed in 2011 and 2012) and provides adequate sampling points for assessing potential groundwater impact from DOE areas. O&M of the well network has, on the whole, been effective. Wells have required minor maintenance such as cover bolt replacement and thread cleaning, concrete apron repairs, vault replacement, and identification plaque replacement. Improving the visibility of wells prone to vault damage by grounds maintenance equipment was identified as an opportunity for optimization.

The groundwater monitoring optimization evaluation conducted for this Five-Year Review is described in Section 6.4 and Appendix C. On the basis of the analysis, no COC, MOC, or NWC concentrations are increasing such that increased monitoring frequency or other response actions are needed. Although trend analyses for chloroform in well UCD1-072 and nitrate in well UCD1-069 indicated an upward trend, the concentrations and potential trends for these well-specific constituents do not warrant increased monitoring frequency or other response, as described in Appendix C. No well-specific constituent is recommended for removal from the monitoring program; however, monitoring for most DOE Areas groundwater well-specific constituents can be optimized by reducing the frequency to biennial, which will still provide adequate data to evaluate potential groundwater impacts. Of the 72 well-specific constituents monitored, 46 are proposed for monitoring frequency reduction to biennial, with an additional 7 potentially proposed for biennial monitoring depending on 2016 results (Table C-4, Appendix C).

7.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Still Valid?

There have been no changes in the current and future land/groundwater uses and physical conditions in the DOE Areas that would affect the protectiveness of the remedy. The subsections below evaluate changes in standards, to-be-considered (TBC) criteria, toxicity, and ecological risk for the exposure pathways evaluated in the Risk Characterization Report (DOE 2005) and for vapor intrusion from soil. While groundwater is not part of the DOE Areas, mitigating potential future impacts to groundwater is an RAO for DOE Areas constituents, and groundwater-protective remediation goals for soil were established in the ROD (see Section 4). Therefore, the basis of each of these remediation goals was also evaluated for changes.

7.2.1 Evaluation of Changes in Standards and To-Be-Considered Criteria

For this Five-Year Review, the promulgated standards (i.e., MCLs), TBC criteria, and the soil remediation goals for the protection of human health and groundwater that were designated in the ROD (DOE 2009b) were reviewed for changes that may impact the protectiveness of the remedy.

Potential risks associated with direct exposure to soil were reevaluated based on new exposure and toxicity factors, as described in Section 7.2.2 below. After a reevaluation, the direct exposure soil remediation goals for the protection of human health (Table 4) remain protective for the identified COCs at 1 in 1 million cancer risk except for dibenzo(*a,h*)anthracene for hypothetical onsite residents and benzo(*a*)pyrene for construction workers. On the basis of the risk reevaluation (Section 7.2.2 and Appendix G), the remediation goals of 0.1 milligram per kilogram (mg/kg) for dibenzo(*a,h*)anthracene and 2 mg/kg for benzo(*a*)pyrene listed in the ROD represent a 2 in 1 million cancer risk for hypothetical onsite residents and construction workers, respectively. Dibenzo(*a,h*)anthracene was detected at the DSS 4 area in two of six samples. This change does not affect the protectiveness of the remedy for hypothetical onsite residents since there is a land-use restriction at the DSS 4 area that prohibits residential use. The results of risk assessment calculations in Appendix G indicate that the construction worker remediation goal for benzo(*a*)pyrene in the DSS 4 area should be lowered from 2 mg/kg to 1 mg/kg to be protective at 1 in 1 million cancer risk. However, these construction worker risk and remediation goals are likely overly conservative for construction work at DSS 4 because of the limited extent of benzo(*a*)pyrene contamination (immediate vicinity of the leach pipe) and the assumed 1-year exposure duration (substantially longer than would be anticipated).

The only new promulgated groundwater standards identified are a revised MCL for molybdenum and a new California MCL for hexavalent chromium (Appendix B). The remediation goals for the protection of groundwater were reviewed based on revisions to MCLs and the Site groundwater background values (Table 9). As described in Appendix F, the change in the molybdenum MCL results in revised calculated MCL-based molybdenum soil remediation goals for the protection of groundwater in the DSS 3 area and the Dry Wells A–E area. As specified in the RD/RAWP (DOE, 2010), sample collection and determination of background values was conducted to establish the background groundwater condition in support of the groundwater monitoring remedy in the DOE Areas. As described in Appendix F, calculated background-based remediation goals for formaldehyde in DSS 3, selenium in DSS 4, and molybdenum, cesium-137, and Sr-90 in the Dry Wells A–E area changed in response to the new groundwater background levels. As shown by the graphs in Appendix C (Attachment C-2), these changes do not affect the protectiveness of the remedy. Because both the background-based and MCL-based remediation goals for cesium-137 are above the maximum soil concentrations detected in the Dry Wells A–E area, this constituent is no longer considered a groundwater impact COC for this area.

Two guidance documents on vapor-intrusion evaluation were identified as new TBC criteria: *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)* (DTSC 2011) and *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (OSWER = Office of Solid Waste and Emergency Response) (EPA 2015a). These documents were considered in the reevaluation of vapor-intrusion potential described below.

7.2.2 Evaluation of Changes in Toxicity and Exposure Pathways for COCs

For the soil COCs, reference doses, cancer potency factors, and exposure assumptions were reviewed, and risks were recalculated based on updated toxicity values for chemical and radiological COCs and exposure assumptions (Appendix G). On the basis of the Five-Year Review recalculation of human health cancer risks and non-cancer hazards from the soil ingestion, dermal contact, plant ingestion, dust inhalation, and external radiation pathways for the identified COCs at DSS 4, the EDPs, and the SWTs, the cancer risks and non-cancer hazards are either lower, unchanged, or only slightly higher than those presented in the ROD. Recalculated non-cancer hazards remained below the threshold of 1. Recalculated risks that increased slightly were those for dibenzo(*a,h*)anthracene for hypothetical onsite residents (increased from 1×10^5 to 2×10^5) and benzo(*a*)pyrene for construction workers (increased from 1×10^6 to 2×10^6). As such, the current remedy is protective.

Table 9. Five-Year Review of Groundwater Basis for Designated Levels in the DOE Areas

Groundwater COC	Units	HSU-1 Background at Time of SWRA	Current HSU-1 Background[a]	Regulatory Level at Time of SWRA	Current Regulatory Level	Current Regulatory-Level References
Carbon-14	pCi/L	3.5	7	2000	2000	MCL (SWRCB 2015a)
Cesium-137	pCi/L	1	5	200	200	MCL (SWRCB 2015a)
Total chromium	µg/L	25	43.7	50	10	California EPA MCL[b] (SWRCB 2015a)
Chromium (hexavalent)	µg/L	39.4	40	50	10	California EPA MCL (SWRCB 2015a)
Formaldehyde	µg/L	1140	13	100	100	California Notification Level (SWRCB 2015b)
Mercury	µg/L	0.1	0.0479	2	2	MCL (SWRCB 2015a)
Molybdenum	µg/L	14.9	3.13	180	100	RSL (EPA 2015b)
Nitrate as N	mg/L	25.1	15	10	10	MCL (SWRCB 2015a)
Radium-226	pCi/L	1.14	1.17	5	5	Public Health Goals (SWRCB 2015a)
Selenium	µg/L	5.67	1.74	50	50	MCL (SWRCB 2015a)
Silver	µg/L	5	1	100	100	Secondary MCLs (EPA 2015c)
Strontium-90	pCi/L	1.7	1	8	8	MCL (SWRCB 2015a)

Notes:
[a] Groundwater background determined from wells UCD1-018 and UCD1-063 monitoring data collected in 2011 and 2012 (Weiss 2014a).
[b] Based on an assumption that total chromium is 100 percent hexavalent.

Abbreviations:
HSU-1 = hydrostatic unit 1
µg/L = micrograms per liter
mg/L = milligrams per liter
pCi/L = picocuries per liter
RSL = regional screening level
SWRA = Sitewide Risk Assessment
SWRCB = State Water Resources Control Board

Vapor intrusion was evaluated in the *Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment* (SWRA) (UC Davis 2004), but the evaluation did not distinguish between DOE and UC Davis areas of responsibility, and risks were evaluated using soil-gas data from the UC Davis areas. Appendix H provides an evaluation of the potential for vapor intrusion from soil contaminants in the DOE Areas. On the basis of EPA guidance (EPA 2015), 16 soil constituents with physical properties that may pose a residential risk from soil to indoor air were identified in the DOE Areas. Human health risks were not estimated from soil-sample data because EPA does not recommend using soil data to estimate the potential for vapor intrusion due to the potential for vapor loss during soil sampling, preservation, and chemical analysis and uncertainties associated with soil partitioning calculations (EPA 2015). Soil data are usable for qualitative identification of contaminant presence while soil-gas data are required for quantitative risk estimation (EPA 2015). After a preliminary evaluation, it is recommended that a detailed review of the soil-data quality and a spatial analysis of the location of all potentially vapor-forming constituents be conducted. If remedy protectiveness cannot be determined based on a review of the results of these analyses, soil-gas sampling may be recommended to estimate human health risk associated with vapor intrusion.

7.2.3 Evaluation of Toxicity of Non-COCs

Toxicity values for non-COCs detected above background in soil were reviewed for changes that may impact the protectiveness of the remedy (Appendix I). Both chemical and radiological constituents were evaluated. None of the chemical constituents that were not previously identified as COCs in the SWRA (UC Davis 2004) for the DOE Areas present a cancer risk or non-cancer hazard to human health based on the Five-Year Review evaluation.

For radiological constituents, the recalculated risks for this Five-Year Review are slightly higher than those calculated in the Risk Characterization Report (DOE 2005). However, as described in detail in Appendix I, these changes are small and do not affect the overall protectiveness of the remedy.

7.2.4 Evaluation of Ecological Risk

Soil screening levels for plant and soil invertebrate evaluation and species-specific toxicity reference values, lowest-observed adverse effect levels (LOAELs) and no-observed adverse effect levels (NOAELs) for the bird and mammal evaluation were reviewed and changes were compared to those used in the Site-Wide Ecological Risk Assessment (SWERA) (BBL 2006) (Appendix J). Although some of these comparison values have changed, the risk to ecological receptors in the DOE Areas remains similar to risks estimated in the SWERA (BBL 2006). For example, the largest change in calculated hazard quotient was for plants exposed to manganese at DSS 1, which changed from 1.8 to 4.0. The recalculated hazard quotients and those estimated in the SWERA (BBL 2006) are presented in Table J-4 in Appendix J.

7.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy?

No.

7.4 Summary

According to the data reviewed, inspection of the DOE Areas, and the interviews, the remedy is functioning as intended by the ROD (DOE 2009b). Land-use controls and groundwater monitoring are functioning well. Land-use control optimization includes improving the visibility of some survey monuments and monitoring wells to reduce inadvertent damage during grounds work. After a review of 5 years of groundwater data, 46 of 72 well-specific constituents are recommended for sampling frequency reduction.

There have been no changes in the current and future land/groundwater uses or physical conditions in the DOE Areas that would affect the protectiveness of the remedy. The only new promulgated standards identified include a revised MCL for molybdenum and a new California MCL for hexavalent chromium; these changes do not affect the protectiveness of the remedy (Section 7.2.1). Review of direct exposure soil remediation goals for the protection of human health (Table 4) indicates that the goals are protective for the identified COCs at 1 in 1 million cancer risk except for dibenzo(*a,h*)anthracene for hypothetical onsite residents and benzo(a)pyrene for hypothetical construction workers in the DSS 4 area, which are both calculated to represent a 2 in 1 million risk based on the updated evaluation. There is a land-use restriction at the DSS 4 area prohibiting residential use, and the construction worker scenario is overly conservative for this area (see Section 7.2.1); therefore, the direct exposure soil remediation goals remain protective.

Changes in toxicity factors for some soil COCs and exposure factors for some pathways (i.e., plant ingestion) result in risks that are either lower or unchanged from those presented in the ROD (DOE 2009b). The vapor-intrusion pathway was not specifically evaluated for the DOE Areas in the SWRA (UC Davis 2004). In the Five-Year Review evaluation, 16 soil constituents with physical properties that may pose a residential risk from soil to indoor air were identified. It is recommended that a detailed review of the soil data quality and a spatial analysis of the location of all potentially vapor-forming constituents be conducted; soil-gas sampling may be recommended.

Chemical constituents that were not previously identified as COCs in the SWRA (UC Davis 2004) for the DOE Areas do not present a risk to human health due to direct exposure (i.e., ingestion, dust inhalation, or dermal contact). For radiological constituents, the recalculated risks for this Five-Year Review are only slightly higher than those previously calculated. These changes do not affect the overall protectiveness of the remedy.

A few changes in ecological screening levels were identified; however, these do not affect the protectiveness of the remedy.

There is no other information that calls into question the protectiveness of the remedy.

8.0 Issues

Table 10 provides the issues that were identified in this Five-Year Review.

Table 10. Issues from the Five-Year Review

Issue	Currently Affects Protectiveness (Yes/No/Unknown)	Affects Future Protectiveness (Yes/No/Unknown)
Some monuments not clearly visible leading to accidental damage	No	No
Some monitoring well vaults not clearly visible leading to accidental damage	No	No
No specific procedures are in place for dealing with fallen trees and associated soil in restricted areas	No	Unknown
The vapor-intrusion pathway has not been evaluated completely	Unknown	Unknown

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9.0 Recommendations and Follow-Up Actions

To address the issues identified in Section 8.0, Table 11 provides recommended actions.

Table 11. Recommendations and Follow-Up Actions To Address Issues at the DOE Areas

Issue	Recommendations/ Follow Up Actions	Party Responsible	Oversight Agency	Milestone Date
Some monuments not clearly visible leading to accidental damage	Install new high-visibility markers for monuments[a]	Federal Facility	EPA/State	September 30, 2016
Some monitoring well vaults not clearly visible leading to accidental damage	Install new high-visibility markers for monitoring wells[a]	Federal Facility	EPA/State	September 30, 2016
No specific procedures are in place for dealing with fallen trees and associated soil in restricted areas	Include procedures for handling and disposing of fallen trees and associated soil in annual SMP training[a]	Federal Facility	EPA/State	September 30, 2016
The vapor-intrusion pathway has not been fully evaluated	Evaluate existing data, conduct soil vapor investigation if needed, and evaluate potential risk associated with this pathway for each DOE Area	Federal Facility	EPA/State	September 30, 2017

Note:
[a] As part of this Five-Year Review, the SMP will be updated to include specifications for high-visibility markers and procedures for handling and disposing of fallen trees.

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10.0 Protectiveness Statement

Immediate threats at the site have been addressed, and the remedy is protective of human health and the environment in terms of direct soil exposure, potential groundwater impact from soil contaminants, and ecological risk. On the basis of the preliminary vapor-intrusion evaluation conducted for this Five-Year Review, a protectiveness determination for this exposure pathway cannot be made without further data evaluation and possible collection and evaluation of soil-gas data from certain locations within the DOE Areas, as described above. It is expected that this vapor-intrusion evaluation will be completed by September 30, 2017, at which time a protectiveness determination will be made via an addendum to this Five-Year Review, anticipated to be completed by February 28, 2018.

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11.0 Next Review

The next five-year review for the LEHR Federal Facility is required 5 years from the completion date for this review.

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12.0 References

BBL (Blasland, Bouck, and Lee), 2006. *Final Site-Wide Ecological Risk Assessment*, *Laboratory for Energy-Related Health Research/South Campus Disposal Sites, University of California, Davis*, August.

CRWQCB (California Regional Water Quality Control Board), 1989. *Designated Level Methodology for Waste Classification and Cleanup Level Determination*, California Regional Water Quality Control Board, Central Valley Region, Sacramento, California.

DTSC (California Department of Toxic Substances Control), 2011. *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance),* October.

DTSC (California Department of Toxic Substances Control), 2014. *Covenant to Restrict Use of Property, Environmental Restriction (Re: Portions of County of Solano Assessor's Parcel No. 110-05-04 UC Davis, Laboratory for Energy-related Health Research/Old Campus Landfill (LEHR/OCL) Superfund Site*, Site Code 100424), Solano County Recorder's Office Document Number 201400051822, July 11.

DOE (U.S. Department of Energy), 1993. DOE Order 5400.5, Change 2, *Radiation Protection of the Public and the Environment*, January 7. DOE Order 5400.5 was cancelled in its entirety by DOE Order 458.1, same title (currently Change 3, dated January 15, 2013).

DOE (U.S. Department of Energy), 1997a. 62 FR 51844–51845. U.S. Department of Energy, "Certification of the Radiological Condition of Four Buildings at the Laboratory for Energy-Related Health Research, Davis, California," *Federal Register*, October 3.

DOE (U.S. Department of Energy), 1997b. Memorandum of Agreement between the United States Department of Energy and the Regents of the University of California Regarding the Investigation and Remediation of the Laboratory for Energy-Related Health Research at the University of California, Davis.

DOE (U.S. Department of Energy), 2005. *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment (Part B-Risk Characterization for DOE Areas) at the Laboratory for Energy-Related Health Research, University of California, Davis*, prepared for the U.S. DOE by Weiss Associates, September 30.

DOE (U.S. Department of Energy), 2009a. *Memorandum of Agreement Between the United States Department of Energy and the Regents of the University of California Regarding the Investigation, Remediation, Long-Term Surveillance, Maintenance, and Contingent Remediation of the Laboratory for Energy-Related Health Research at the University of California, Davis*.

DOE (U.S. Department of Energy), 2009b. *Record of Decision for DOE Areas at the Laboratory for Energy-Related Health Research, University of California, Davis,* LMS/LEH/S05069, Office of Legacy Management, September.

DOE (U.S. Department of Energy), 2010a. *Remedial Design/Remedial Action Work Plan for the Former Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis*, LMS/LEH/S05822, Office of Legacy Management, November.

DOE (U.S. Department of Energy), 2010b. *Responses to Selected Comments Pertaining to the Draft Remedial Design/Remedial Action Work Plan Contained in the Review of the Responses to Additional Comments on the Draft Remedial Design/Remedial Action Work Plan*, responses received from Mr. David Stensby of EPA, November.

DOE (U.S. Department of Energy), 2010c. *Quality Assurance Project Plan for the U.S. Department of Energy Laboratory for Energy-Related Health Research Federal Facility*, Davis, California, LMS/LEH/S06784, Office of Legacy Management, October.

DOE (U.S. Department of Energy), 2013. *2012 Annual Land-Use Covenant Inspection Report for DOE Areas at the Laboratory for Energy-Related Health Research/Old Campus Landfill Superfund Site, University of California, Davis*, LMS/LEH/S09606, Office of Legacy Management, January.

DOE (U.S. Department of Energy), 2014. *2013 Annual Land-Use Covenant Inspection Report for DOE Areas at the Laboratory for Energy-Related Health Research/Old Campus Landfill Superfund Site, University of California, Davis*, LMS/LEH/S11325, Office of Legacy Management, January.

DOE (U.S. Department of Energy), 2015a. *2014 Annual Land-Use Covenant Inspection Report for DOE Areas at the Laboratory for Energy-Related Health Research/Old Campus Landfill Superfund Site, University of California, Davis*, LMS/LEH/S12552, Office of Legacy Management, January.

DOE (U.S. Department of Energy), 2015b. *Notice of LEHR CERCLA Five-Year Review,* DOE Office of Legacy Management website, http://energy.gov/lm/articles/notice-lehr-cercla-five-year-review, accessed October 12.

EPA (U.S. Environmental Protection Agency), 1999. *California Department of Toxic Substances Control (DTSC), Central Valley Regional Water Quality Control Board, (RWQCB), California Department of Health Services (DHS), and DOE, Federal Facility Agreement* under CERCLA Section 120, Administrative Docket No. 99-17, in the matter of the U.S. Department of Energy Laboratory for Energy-Related Health Research.

EPA (U.S. Environmental Protection Agency), 2000. *Soil Screening Guidance for Radionuclides: User's Guide*, EPA/540-R-00-007, October.

EPA (U.S. Environmental Protection Agency), 2001. *Comprehensive Five-Year Review Guidance*, EPA 540-R-01-007, June.

EPA (U.S. Environmental Protection Agency), 2010. *Regional Screening Levels (Formerly PRGs)*, May, http://www.epa.gov/region9/superfund/prg/, accessed on September 10, 2012.

EPA (U.S. Environmental Protection Agency), 2015a. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, 9200.2-154, June.

EPA (U.S. Environmental Protection Agency), 2015b. *Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants*, Pacific Southwest, Region 9. http://www3.epa.gov/region09/superfund/prg/. Accessed June 30, 2015.

EPA (U.S. Environmental Protection Agency), 2015c. *Drinking Water Contaminants, Secondary Drinking Water Regulations: Guidance for Nuisance Chemicals*. http://water.epa.gov/drink/contaminants/secondarystandards.cfm#tabletop, accessed July 10, 2015.

ICF (Inner City Fund International), 2014. *Biological Assessment for the Laboratory for Energy-Related Health Research/Old Campus Landfill Remediation Project.*

SWRCB (State Water Resource Control Board), 2015a. *Comparison of MCLs and PHGs for Regulated Contaminants in Drinking Water*, Download page for California and Federal Drinking Water Standards (MCLs), Detection Limits for Purposes of Report (DLRs) and Public Health Goals (PHGs), http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.shtml, last updated February 27, 2015, accessed July 10, 2015.

SWRCB (State Water Resource Control Board), 2015b. *Division of Drinking Water (DDW), Drinking Water Notification Levels and Response Levels: An Overview*, http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf, accessed July 10, 2015.

UC Davis (University of California, Davis), 2003. *UC Davis Long Range Development Plan, 2003-2015,* University of California, Davis, October,http://sustainability.ucdavis.edu/progress/commitment/planning/lrdp.html.

UC Davis (University of California, Davis), 2004. *Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment*, University of California, Davis, March.

UC Davis (University of California, Davis), 2016. *2017–2027 Long Range Development Plan Preliminary Planning Scenario,* University of California, Davis, May, http://campustomorrow.ucdavis.edu/.

Weiss (Weiss Associates), 2007. *Former Western Dog Pens Backfill Risk Assessment for the Laboratory for Energy-Related Health Research, University of California, Davis*, April 26.

Weiss (Weiss Associates), 2012. *LEHR Team Meeting Summary, Laboratory for Energy-Related Health Research/Old Campus Landfill Site*, *University of California, Davis*, Environmental Restoration Program, Final, recorded by Lynne Srinivasan and Mary Stallard, January 24.

Weiss (Weiss Associates), 2013. *Final 2011 Comprehensive Annual Water Monitoring Report for the Laboratory for Energy-Related Health Research/ Old Campus Landfill Superfund Site*, *University of California, Davis*, March 18.

Weiss (Weiss Associates), 2014a. *Final 2012 Comprehensive Annual Water Monitoring Report for the Laboratory for Energy-Related Health Research/ Old Campus Landfill Superfund Site*, *University of California, Davis*, February 6.

Weiss (Weiss Associates), 2014b. *Draft 2013 Comprehensive Annual Water Monitoring Report for the Laboratory for Energy-Related Health Research/ Old Campus Landfill Superfund Site*, *University of California, Davis*, September 2.

Weiss (Weiss Associates), 2014c. *Draft 2014–2016 Multi-Year Water Sampling Plan for the Laboratory for Energy-Related Health Research/ Old Campus Landfill Superfund Site*, *University of California, Davis*, October 2.

Appendix A

Five-Year Review Public Notices

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"I love showing off what I and the Madrigals can do, because we are pretty dedicated," Barbieri said. "I love performing in concerts because I get to express my music through the audience and share it with my community," Barbieri said.

Being in the Madrigals has long been a dream of Barbieri's. Although many years have passed since she first thought of joining the singing group, Barbieri still finds it hard to believe that her time in high school with the Madrigals will soon be over. This concert serves as her final reminder of the end of her high school experience.

"Senioritis is strong and they go to college," Chu said.

Chu has forged these lifelong relationships through the many field trips the choirs took throughout the school year. From Seattle to Washington D.C., the music program has allowed students to see each other outside of the Davis High campus, and therefore has created and strengthened these relationships.

"Definitely the trips were some of my best experiences in ATC because we all bonded over being super tired and just being with each other 24/7. We all really got to know one another during those times, plus the trips wrong arrangement, but we all did the wrong thing together, so somehow it worked out and still sounded fine. Even when things go wrong we're having a great time."

Hopefully things will go well for this year's concert, but regardless, it will be a show to remember.

Sprague, James Angello, Matthew Debbaudt, Wesley Miller, Matt Gilbert, Nuno Correia and Lauren Rayburn engage in experimental processes, improvisational outcomes and anti-hierarchical forms that address historical and contemporary violence, environmental ruin, and writings and companion essays by UC Davis art history graduate students is being published in conjunction with the exhibit.

A reception is from 5:30 to 7:30 p.m. Friday, June 5. of the Mondavi Center for the Performing Arts.

The master of fine arts thesis exhibition will continue in coming years in another location to be determined.

U.S. DEPARTMENT OF ENERGY | Legacy Management

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- Long-term groundwater monitoring
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The purpose of the review is to ensure the remedies remain protective of human health and the environment. The review team will study site reports, past and present monitoring and inspection data, monitoring and surveillance practices, and conduct a physical inspection of the site. In addition, interviews will be conducted with select land owners, students, researchers, and environmental professionals at the University of California, Davis, and State of California regulatory agencies to obtain comments and concerns regarding the effectiveness of the remedies and administration of the site. The review will begin in June 2015 and conclude in January 2016.

A *Five-Year Review Report* will be prepared at the conclusion of the review to document and present the findings. The report will be available on the LM LEHR website at **http://www.lm.doe.gov/lehr/Sites.aspx**.

For more information visit the website or contact:

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Campaign finance watchdog groups are pushing the Justice Department to step up enforcement of campaign laws by investigating whether Bush is improperly coordinating political activities with a super PAC he launched.

The groups are concerned that Bush and his super PAC, Right to Rise, "are engaged in knowing and willful violations of federal campaign finance laws." The groups are calling on Attorney General Loretta Lynch to appoint an independent special counsel to investigate potential violations.

On Sunday, Bush dismissed the allegations.

"I would never do that," he told CBS' "Face the Nation." "And I'm nearing the end of this journey of traveling and listening to people, garnering, trying to get a sense of whether my candidacy would be viable or not. We're going to completely adhere to the law, for sure. Look, politics is politics. There's always people that are going to be carping on the sidelines. And should I be a candidate – and that will be in the relatively near future where that decision will be made – there'll be no coordination at all with any super PAC."

"Face the Nation" moderator Bob Schieffer asked Bush whether he thinks the legacy of his brother, former president George W. Bush, could become a dominating subject that derails his chances.

"No, I don't," he said. "This is hard for me, to be honest with you, to – I have to do the Heisman onto my brother, that I love. You know, this is – this is not something I'm cy.

"Unfortunately, you won't be around for me to announce a possible candidacy," Bush told Schieffer, making note of the moderator's final broadcast.

federal investigation.

The millions of dollars paid out, a total far higher than officials had previously believed, indicate the ease with which thousands of former Nazis managed to settle into new lives in the United

report. The officials spoke on the condition of anonymity because the report had not yet been made public.

In the 1960s and 1970s, more than three dozen former Nazis received a total of $5.7 million in Social Security benefits before they were deported, the officials said.

who requested the investigation after new evidence emerged last year of Nazis receiving benefits.

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Last Updated: 5/29/2015

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Appendix B

Applicable or Relevant and Appropriate Requirements Review

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The tables of Applicable or Relevant and Appropriate Requirements (ARARs) in the Record of Decision (ROD) for the United States Department of Energy Areas (DOE Areas) of the Laboratory for Energy-Related Health Research (LEHR) were reviewed to determine if any standards identified as ARARs have changed or if there are any newly promulgated standards that might be ARARs or if any of the to-be-considered criteria have changed. The ROD tables are included here for reference.

- Table B-1 contains the chemical-specific ARARs
- Table B-2 contains the location-specific ARARs
- Table B-3 contains the action-specific ARARs

Based on this review, the only changes that have occurred are the promulgation of new maximum contaminant levels (MCLs) and the development of new site-specific background levels for evaluating degradation of groundwater.[1] ARARs that involve MCLs and/or background groundwater levels are as follows:

- Safe Drinking Water Act (42 United States Code [USC] 300 and 40 CFR 141.11–16, 141.23–24, 141.50–51, and 141.61–62)
- Porter-Cologne Water Quality Control Act (California Water Code, Div. 7 13000 *et seq.* and 23 *Code of California Regulations* (CCR) Chap. 15, 2510–2559, 2580–2601)
- Central Valley Regional Water Quality Control Board Basin Plan, Chapters II and III
- Statement of Policy with Respect to Maintaining High Quality Waters in California, State Water Resources Control Board Resolution No. 68-16 (Anti-Degradation Policy)
- Sources of Drinking Water Policy, State Water Resources Control Board Resolution No. 88-63
- Policies and Procedures for Investigation, Cleanup and Abatement of Discharges under Water Code Section 13304, State Water Resources Control Board Resolution No. 92-49 (as amended April 21, 1994)
- The Safe Drinking Water and Toxic Enforcement Act (California Health & Safety Code 25249.5–25249.13) Title 22 CCR, Sections 64431–64445

No new ARARs were identified.

[1] Specific changes are discussed in Appendix F, Potential Groundwater Impact Evaluation.

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Table B-1. Chemical-Specific Requirements for the Selected Remedy for the DOE Areas for the LEHR Federal Facility

Requirement/Authority	Description	Applicability	Area	ARAR Category
Federal				
Safe Drinking Water Act (42 USC 300 and 40 CFR 141.11–16, 141.23-24, 141.50-51, and 141.61-62)	Establishes MCLs for drinking water in public water supply systems based on acceptable health-based criteria.	Groundwater beneath the Site is identified by the State of California as a potential source of drinking water. Although there is no public water-supply system at the Site, contaminants released to the soil at the DOE Areas may migrate and impact the beneficial use of underlying groundwater; therefore, this requirement is relevant and appropriate. Unless otherwise noted, federal MCLs and background concentration values were used by DOE as the reference standard for defining acceptable residual concentrations of contaminants in soil where migration of these contaminants from soil to groundwater has occurred or may occur. Those contaminants for which a state MCL or standard was used as the reference standard are specifically identified in the text of this Record of Decision and in this ARARs table.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Relevant and Appropriate
Uranium Mill Tailings Radiation Control Act (UMTRCA) 42 USC Chapter 88 (40 CFR 192.12(a) and 192.32(b))	Establishes cleanup criteria for uranium and thorium mill tailings, and properties contaminated with uranium and thorium mill tailings. Ra-226 cleanup standards are established as 5 pCi/g above natural background to a depth of 15 cm and 15 pCi/g above natural background for deeper soil.	While the Site is not subject to UMTRCA, long-term soil management may need to address Ra-226 in soil; therefore, the UMTRCA cleanup criteria are relevant and appropriate. All locations within the DOE Areas were evaluated using a site-specific risk-based cleanup goal, which was well below the UMTRCA cleanup criteria, and thus, the DOE Areas would comply with this regulation.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Relevant and Appropriate
Use of Soil Cleanup Criteria for 40 CFR 192 as Remediation Goals for CERCLA Sites (OSWER Directive 9200.4–25, February 12, 1998)	OSWER Directive 9200.4-25 addresses the use of the soil cleanup criteria in 40 CFR 192 when setting remediation goals at CERCLA sites with radioactive contamination. In particular, it clarifies the intent of 40 CFR 192 in setting remediation levels for subsurface soil. Subpart B of 40 CFR 192 contains two different soil standards: concentration criterion for surface soil of 5 pCi/g of radium-226, and the concentration criterion for subsurface of 15 pCi/g of radium-226. The 15 pCi/g standard would be expected to achieve an actual subsurface cleanup level of below 5 pCi/g in practice.	Same as above.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	To Be Considered
State and Local				
Criteria for Identifying Hazardous Wastes (CCR, Title 22, 66261. 21–33)	Tests for identifying hazardous waste characteristics are set forth in these regulations. If a chemical is either listed or tested and found hazardous, then remedial actions must comply with the applicable CCR Title 22 requirements.	Applies to waste generated during well installation, groundwater monitoring, future development, or maintenance activities involving contaminated soil, groundwater, or other material.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable
Porter-Cologne Water Quality Control Act (California Water Code, Div. 7 13000, *et seq.* and 23 CCR Chap. 15, 2510–2559, 2580–2601)	Establishes authority for state and regional water boards to determine site-specific waste discharge requirements and to regulate disposal of waste to land. Authorizes regional boards to protect existing and probable future beneficial uses of waters of the state.	Applies to all residual soil contamination.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Central Valley Regional Water Quality Control Board Basin Plan, Chapter II	Describes water basins in the Central Valley Region, establishes beneficial uses of groundwater and surface waters, establishes water-quality objectives and numerical standards, establishes implementation plans to meet water-quality objectives and protect beneficial uses, and incorporates statewide water-quality control plans and policies. The substantive provisions of this plan dealing with the beneficial uses of water bodies and water-quality objectives identified in the Basin Plan are applicable to the cleanup. Under CERCLA, the implementation requirements of this plan are not applicable.	Identifies groundwater beneath the Site as a potential source of drinking, agricultural, and industrial supply. Water-quality objectives and numerical standards apply to residual soil contamination in specific areas that may impact the beneficial use of groundwater in the future.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Central Valley Regional Water Quality Control Board Basin Plan, Chapter III	Requires that groundwater not contain chemical constituents in concentrations that exceed beneficial uses. At a minimum, groundwater designated for use as "MUN" shall not contain chemical constituents in excess of the MCLs specified in Title 22. To protect all beneficial uses, the Regional Water Board may apply limits more stringent than the MCLs. Groundwater shall be maintained free of toxic substances in concentrations that produce detrimental physiological response in human, plant, animal, or aquatic life associated with designated beneficial uses. Groundwater shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.[a]	Applies to areas where residual soil contamination may impact the beneficial use of groundwater in the future.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable

Table B-1 (continued). Chemical-Specific Requirements for the Selected Remedy for the DOE Areas for the LEHR Federal Facility

Requirement/Authority	Description	Applicability	Area	ARAR Category
Policies and Procedures for Investigation, Cleanup and Abatement of Discharges under Water Code Section 13304, State Water Resources Control Board Resolution No. 92-49 Paragraph III G	The "Policy for Investigation and Cleanup of Contaminated Sites" establishes and describes policy for investigation and remediation of contaminated sites. Also includes implementation actions for setting groundwater and soil cleanup levels. Cleanup levels for soils should be equal to levels that would achieve background concentrations in groundwater unless such levels are technically and economically infeasible to achieve. In such cases, soil cleanup levels are such that groundwater will not exceed applicable groundwater quality objectives.	Applies to areas where residual soil contamination may impact the beneficial use of groundwater in the future.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Relevant and Appropriate[b]
Statement of Policy with Respect to Maintaining High Quality Waters in California, State Water Resources Control Board Resolution No. 68-16 (Anti-Degradation Policy)	Requires that high-quality surface and groundwater be maintained to the maximum extent possible. Degradation of waters will be allowed (or allowed to remain) only if it is consistent with the maximum benefit to the people of the state, does not unreasonably affect present and anticipated beneficial uses, and does not result in water quality less than that prescribed in CRWQCB and SWRCB policies, as defined by the substantive requirements. If degradation is allowed, the discharge must meet best practicable treatment or control, which must prevent pollution or nuisance and result in the highest water quality consistent with maximum benefit to the people of the state.	Applies to areas where residual soil contamination may impact the beneficial use of groundwater in the future.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Sources of Drinking Water Policy, State Water Resources Control Board Resolution No. 88-63	Applies in determining beneficial uses for water that may be affected by discharges of waste. SWRCB Resolution 88-63 applies to all sites that may be affected by discharges of waste to groundwater or surface water. The resolution specifies that, with certain exceptions, all groundwater and surface water have the beneficial use of municipal use or domestic supply. Consequently, California primary MCLs are relevant and appropriate; however, the most stringent federal or state standard will be the ARAR.	Applies to areas where residual soil contamination may impact the beneficial use of groundwater in the future.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
The Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) Division 20 of the California Health and Safety Code	Proposition 65 prohibits the discharge of a significant amount of a known human carcinogen or reproductive toxin into any source of drinking water. Title 22 CCR Section 12000 *et seq.* lists chemicals subject to the discharge prohibition and regulatory levels, defining a significant amount for many of these chemicals.	Applies where residual formaldehyde (DSS 3), mercury, and hexavalent chromium (Dry Wells A–E) and selenium (DSS 4) will remain in the soil and have potential to impact groundwater. Also applies to all areas where radionuclides remain in the soil (Dry Wells A–E, Ra/Sr Treatment Systems, and SWT).	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable
The Safe Drinking Water and Toxic Enforcement Act (California Health & Safety Code 25249.5–25249.13) Title 22 CCR, Sections 64431–64445	Title 22 CCR Sections 64431–64445 provides primary MCLs that must be met by all public drinking water systems to which they apply. MCLs are to be used as a reference for defining acceptable residual levels of site contaminants with potential to impact groundwater in areas of the site where migration of contaminants from soil to groundwater has occurred or may occur.	Groundwater beneath the Site is identified by the State of California as a potential source of drinking water. Although there is no public water supply system at the Site, contaminants released at the Site may impact the beneficial use of underlying groundwater; therefore, this requirement is relevant and appropriate for total chromium for which the California MCL is more stringent that the federal MCL in areas where total chromium soil contamination may impact groundwater quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Relevant and Appropriate
California Civil Code section 1471, and Health and Safety Code section 25222.1	Requires that land-use covenants, restrictions, and conditions subject to which a property and relevant portions shall be improved, held, used, occupied, leased, sold, hypothecated, encumbered, and/or conveyed be followed. Runs with the land and Civil Code section 1471.	Applies to any areas where residual contamination requires the restriction of land use.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable
Title 27 CCR, Division 2, Subdivision 1, Section 20080 *et seq.* and Title 23 CCR, Division 3, Chapter 15, Section 2510 *et seq.*	Establishes waste and siting classification systems and minimum waste-management standards for discharges of waste to land for treatment, storage, or disposal. Engineered alternatives that are consistent with Title 27 and Title 23 CCR performance goals may be considered. Establishes corrective action requirements for responding to leaks and other unauthorized discharges. Applies to all discharges of waste to land for treatment, storage, or disposal that may affect water quality.	Applies to waste generated during well installation, groundwater monitoring, future development, or maintenance activities involving contaminated soil, groundwater, or other material.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 23 CCR, Sections 2520 and 2521	Requires that hazardous waste be discharged to Class I waste-management units that meet certain design and monitoring standards. Applies to discharges of hazardous waste to land for treatment, storage, and disposal.	Applies to waste generated during well installation, groundwater monitoring, future development, or maintenance activities involving contaminated soil, groundwater, or other material.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable
Title 27 CCR, Sections 20200 (c) and 20210	Requires that designated waste be discharged to Class I or Class II waste-management units. Applies to discharges of designated waste (nonhazardous waste that could cause degradation of surface or groundwater) to land for treatment, storage, or disposal.	Applies to waste generated during well installation, groundwater monitoring, future development, or maintenance activities involving contaminated soil, groundwater, or other material.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable

Table B-1 (continued). Chemical-Specific Requirements for the Selected Remedy for the DOE Areas for the LEHR Federal Facility

Requirement/Authority	Description	Applicability	Area	ARAR Category
Title 27 CCR, Section 20230	Requires that inert waste does not need to be discharged at classified units. Applies to discharges of inert waste to land for treatment, storage, or disposal.	Applies to waste generated during well installation, groundwater monitoring, future development, or maintenance activities involving contaminated soil, groundwater, or other material.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Sections 20200 (c) and 20220	Requires that nonhazardous solid waste be discharged to a classified waste-management unit. Applies to discharges of nonhazardous solid waste to land for treatment, storage, or disposal.	Applies to waste generated during well installation, groundwater monitoring, future development, or maintenance activities involving contaminated soil, groundwater, or other material.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable
Title 27 CCR, Section 20080 (g) and Title 23 CCR, Section 2510 (g)	Requires monitoring of land where discharges had ceased as of November 27, 1984. If water quality is threatened, corrective action consistent with Title 27 and Title 23 is required.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Section 20385 and Title 23 CCR, Section 2550.1	Requires detection monitoring for all areas where waste has been discharged to land in order to determine the threat to water quality. Once a significant release has occurred, evaluation or corrective action monitoring is required.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Section 20390 and Title 23 CCR Section 2550.2	Requires the establishment of a water-quality protection standard consisting of a list of constituents of concern, concentration limits, compliance monitoring, and all monitoring points. Applies to all areas where waste has been discharged to land where groundwater is threatened.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Section 20395 and Title 23 CCR, Section 2550.3	Requires the development of a list of constituents of concern, which includes all waste constituents that are reasonably expected to be present in the soil from discharges to land and could adversely affect water quality. Applies to all areas where waste has been discharged to land where groundwater is threatened.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Section 20400 and Title 23 CCR, Section 2550.4	Concentration limits must be established for groundwater, surface water, and the unsaturated zone and must be based on background, must be equal to background, or, for corrective actions, may be greater than background, not to exceed the lower of the applicable water-quality objective or the concentration technologically or economically achievable. Specific factors must be considered in setting cleanup standards above background levels. If water quality is threatened, this section applies to setting soil cleanup levels for the total cleanup of discharges of waste to land.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Section 20405 and Title 23 CCR, Section 2550.5	Requires identification of the point of compliance, hydraulically downgradient from the area where waste was discharged to land. Applies to all areas where waste has been discharged to land where groundwater is threatened.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Section 20410 and Title 23 CCR, Section 2550.6	Requires monitoring of all soil-cleaning activities for compliance with remedial action objectives for three years from the date of achieving cleanup levels.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Section 20415 and Title 23 CCR, Section 2550.7	Requires general soil, surface water, and groundwater monitoring for all areas where waste has been discharged to land.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Section 20420 and Title 23 CCR, Section 2550.8	Requires detection monitoring to determine if a release has occurred in all areas where waste has been discharged to land where groundwater is threatened.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable

Table B-1 (continued). Chemical-Specific Requirements for the Selected Remedy for the DOE Areas for the LEHR Federal Facility

Requirement/Authority	Description	Applicability	Area	ARAR Category
Title 27 CCR, Section 20425 and Title 23 CCR, Section 2550.9	Requires an assessment of the nature and extent of the release, including a determination of the spatial distribution and concentration of each constituent. Applies to sites at which monitoring results show statistically significant evidence of a release.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27 CCR, Section 20430 and Title 23 CCR, Section 2550.10	Requires the implementation of corrective action measures that ensure that cleanup levels are achieved throughout the zone affected by the release by removing the waste constituent or treating it in place. Source control may be required. Also requires monitoring to determine the effectiveness of the corrective actions. This section applies to all soil cleanup activities if water quality is threatened.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Relevant and Appropriate
Title 22 CCR Division 4.5, Section 66261.21–33	Provides criteria for identifying and handling hazardous waste. Regulations include soluble threshold limit concentration and total threshold limit concentration analytical procedures.	Applies to waste generated during well installation, groundwater monitoring, future development, or maintenance activities involving contaminated soil, groundwater, or other material.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable
California Health and Safety Code, Division 20, Chapter 6.5, Section 25100 *et seq.*	Governs hazardous waste control.	Applies to waste generated during well installation, groundwater monitoring, future development, or maintenance activities involving contaminated soil, groundwater, or other material.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable
Title 22 CCR, Section 66268 *et seq.*	Defines land disposal restrictions establishing specific treatment standards of hazardous wastes prior to disposal to land.	Applies to hazardous waste generated during well installation, groundwater monitoring, future development, or maintenance activities involving contaminated soil, groundwater, or other material.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable

Notes:

[a] Two policies in Chapter IV of the Basin Plan explain how appropriate cleanup levels are determined: "Policy for Application of Water Quality Objectives" explains how the Regional Water Board applies numerical and narrative water-quality objectives to ensure the reasonable protection of beneficial uses of water and how the Regional Water Board applies Resolution No. 68-16 to promote the maintenance of existing high-quality waters; "Policy for Investigation and Cleanup of Contaminated Sites" explains how cleanup levels are established for soils and groundwater.

[b] CRWQCB disagrees with EPA regarding the characterization of this requirement as relevant and appropriate, but it accepts the ROD notwithstanding. CRWQCB considers the requirements to be applicable.

Abbreviations:

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
DSS	Domestic Septic System
DW A–E	Dry Wells A–E
EDP	Eastern Dog Pens
OSWER	Office of Solid Waste and Emergency Response
pCi/g	picocuries per gram
Ra/Sr	Radium/Strontium Treatment System
CRWQCB	California Regional Water Quality Control Board
SWRCB	State Water Resources Control Board
SWT	Southwest Trenches
UMTRCA	Uranium Mill Tailings Radiation Control Act

Table B-2. Location-Specific Requirements for the Selected Remedy for the DOE Areas for the LEHR Federal Facility

Requirement/Authority	Comments	Applicability	Area	ARAR Category
Federal				
Endangered Species Act of 1973 (16 USC § 1536; §1538, 50 CFR 402)	Facilities or practices shall not cause or contribute to the taking of any endangered or threatened species of plants, fish, or wildlife [16 USC §1538 (a) (1)]. Activities must be evaluated to determine their impact on listed species and species proposed for listing and their habitat [16 USC §1536(a)]. If jeopardy or adverse modification will result from any site activities, a determination will be made based on a consultation with the USFWS regarding the need for mitigation measures or an incidental take statement (50 CFR § 402.14). Specific mitigation measures will be identified and implemented per USFWS guidelines.	Applies to all field remediation activities, such as well installation and monitoring or maintenance activities that may impact listed species. No impacts of any endangered or threatened species of plants, fish, or wildlife are associated with residual contamination.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Fish and Wildlife Coordination Act (16 USC 661–666)	Requires action to preserve endangered species or threatened species. Before any ground-disturbing activities are conducted in areas with potential for presence of such species, surveys will be conducted for species of concern.	Applies to all field remediation activities, such as well installation and monitoring or maintenance activities that may impact listed species.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
State and Local				
California Endangered Species Act (California Fish and Game Code § 2050–2068 and 2080)	Requires action to preserve endangered species or threatened species. Before any ground-disturbing activities are conducted in areas with potential for presence of such species, surveys will be conducted for species of concern.	Applies to all field remediation activities, such as well installation and monitoring or maintenance activities that may impact listed species. No impacts of any endangered or threatened species of plants, fish, or wildlife are associated with residual contamination.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable

Abbreviations:

CFR	*Code of Federal Regulations*
DSS	Domestic Septic System
DW A–E	Dry Wells A–E
Ra/Sr	Radium/Strontium Treatment System
SWT	Southwest Trenches
USFWS	U.S. Fish and Wildlife Service

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Table B-3. Action-Specific Requirements for the Selected Remedy for the DOE Areas for the LEHR Federal Facility

Requirement/Authority	Description	Applicability	Area	ARAR Category
Federal				
Clean Water Act § 404 (33 USC 1344, 33 CFR 328 and 40 CFR 230)	Establishes a national program to control the discharge of dredge or fill materials into "waters of the United States." "Waters of the United States" is defined to include all tributaries of navigable waters and nearly all wetlands.	These requirements apply if site remediation activities (well installation and monitoring) cause turbid water to enter drainages or if site activities impact wetlands adjacent to Putah Creek.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Pretreatment Standards under the Clean Water Act (40 CFR Part 403)	Discharges of treated waste to sanitary sewers may be proposed and would be regulated under the pretreatment program of the UC Davis POTW. CRWQCB is involved in oversight of the pretreatment program.	Applies to all areas where discharges to sanitary sewer may occur as part of the monitoring activities.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Transportation of Hazardous Material, 49 USC 5101-5127; and 49 CFR 172.3 and 172.200–700 *et seq.*	49 USC 5101-5127, and 49 CFR 172.3 and 172.200-700 *et seq.* regulate transportation, including security, of hazardous material in intrastate, interstate, and foreign commerce to ensure the safe transportation of such material.	Applies to any hazardous materials and wastes generated during well installation, well monitoring, or the future development and maintenance activities transported off site.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
10 CFR 835 Occupational Radiation Protection	Provides for the protection of radiation workers at DOE facilities. Includes dose limits and requirements to reduce the dose to levels that are ALARA.	Applies to areas where residual radioactive contamination may be excavated.	Ra/Sr DW A–E SWT	Applicable
Noise Control Act of 1972, as amended by the Quiet Communities Act of 1978 (40 CFR 204, 205, 211)	Construction and transportation equipment noise levels (e.g., portable air compressors, medium and heavy trucks), process equipment noise levels, and noise levels at the property boundaries of the project are regulated under this act. State or local agencies typically enforce these levels.	Applies to all areas where noise may occur during the installation of monitoring wells and groundwater sampling.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Licensing Requirements for Land Disposal of Radioactive Waste (10 CFR 61)	Establishes requirements for radiation protection, access restrictions, future impacts, siting, drainage, final cover, buffer zones, groundwater monitoring, and waste disposal requirements.	Applies to all areas where radionuclides may remain at levels above natural background.	Ra/Sr DW A–E SWT EDP	Relevant and Appropriate
State and Local				
State Water Resources Control Board Resolution No. 92-49 (as amended April 21, 1994)	Establishes requirements for the investigation, cleanup, and abatement of discharges. Among other requirements, dischargers must clean up and abate the effects of discharges in a manner that promotes the attainment of either background water quality or the best water quality that is reasonable if background water quality cannot be restored. Requires the application of Title 23, CCR, Section 2550.4 requirements for cleanups.	Applies to all locations within the DOE Areas at the Site where residual soil contamination may impact water quality.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Relevant and Appropriate[a]
Yolo-Solano Air Quality Management District Rules and Regulations, Rule 2.3, Ringlemann Chart	Establishes a permissible limit on visible dust emissions (Ringlemann Chart).	Applies to all areas where dust emissions may be generated during well installation, monitoring, future development, or maintenance activities.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Prohibited Acts, California Health and Safety Code § 41700	Prevents discharge of pollutants into the air that will cause injury, detriment, nuisance, or annoyance to any considerable number of persons or the public.	Applies to all areas where dust emissions may be generated during well installation, monitoring, future development, or maintenance activities.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Control of Radioactive Contamination in the Environment (California Health and Safety Code, § 114705, *et seq.*)	Establishes state surveillance and control programs for activities that could lead to the introduction of radioactive materials into the environment. This statute specifically exempts DOE from state surveillance of the storage, packaging, transportation, and loading of radioactive materials.	Applies to well installation, monitoring, future development, or maintenance activities if radioactive materials are present at levels that could result in a significant release to the environment. If these conditions are encountered, state surveillance, monitoring, or other controls may be required to ensure that there are no significant releases of radioactive materials to the environment.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Radiation Control Law (California Health and Safety Code, § 114960, *et seq.*)	Institutes and maintains a regulatory program for sources of ionizing radiation to provide for compatibility with standards and regulatory programs of the federal government and an integrated system within the state. Applicable unless activity is governed by DOE statutory authority.	Applies to all actions that would leave radionuclides in place at levels above natural background and to actions such as well installation, monitoring, future development, or maintenance activities, where low-level radioactive waste may be removed and disposed off-site. Under Section 114985 of the California Health and Safety Code, the Radiation Control Law applies to persons, defined to exclude DOE or any successor thereto, and federal government agencies licensed by the U.S. Nuclear Regulatory Commission, under prime contract to DOE, or any successor thereto. Hence, the portions of the Radiation Control Law (California Health and Safety Code, § 114960, *et seq.*) addressing the management of low-level radioactive waste within California would be considered as relevant and appropriate for offsite disposal of low-level radioactive waste.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Relevant and Appropriate

Table B-3 (continued). Action-Specific Requirements for the Selected Remedy for the DOE Areas for the LEHR Federal Facility

Requirement/Authority	Description	Applicability	Area	ARAR Category
State Department of Health Service Radiation Regulations (17 CCR, Chapter 5, Subchapter 4 § 30100, *et seq.*)	Presents regulations of the Department of Health Services pertaining to radiation, such as standards for protection against radiation, low-level radioactive waste disposal, and transportation regulations. Applicable unless activity is governed by DOE statutory authority or regulation.	Applies to all areas where radionuclides may remain at levels above natural background. Also applies to all areas where waste containing radionuclides above natural background may be generated during well installation, monitoring, future development, or maintenance activities.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Relevant and Appropriate
Executive Order D-62-02 by the Governor of the State of California	Restricts the disposal of decommissioned waste in Class III landfills and unclassified waste management units, as described in 27 CCR, Sections 20260 and 20230.	Applies to all areas where waste containing radionuclides above background may be generated during well installation, monitoring, future development, or maintenance activities.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	To Be Considered
The Toxic Injection Well Control Act of 1985, California Health and Safety Code 25159.10	The Toxic Injection Well Control Act of 1985 prohibits underground injection of hazardous waste. Hazardous waste is defined as any waste specified as hazardous waste or extremely hazardous waste, as defined in Chapter 6.5, "Hazardous Waste Control," of the California Health and Safety Code, and any waste mixture formed by mixing any waste or substance with a hazardous waste.	Applies where hazardous waste may be generated during well installation, monitoring, future development, or maintenance activities.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable
Title 22 CCR, 66262 *et seq.*	Presents standards applicable to generators of hazardous waste, including waste characterization, manifest, and transportation requirements.	Applies where hazardous waste may be generated during well installation, monitoring, future development, or maintenance activities.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EPD	Applicable
Title 22 CCR, Division 4.5, Chapter 39, Section 67391.1(a)(1) and (2), (d), (e)(1) and (2)	Provides requirements for land-use covenants.	Applies to all areas where residual contamination requires additional controls based on land use.	Ra/Sr DSS 3 DSS 4 DW A–E SWT EDP	Applicable
Title 27, CCR, Section 20090(d) and Title 23 CCR, Section 2511(d)	Requires that remedial actions intended to contain wastes at the place of release shall implement applicable provisions of Title 27 Division 2 and Title 23 Chapter 15, to the extent feasible.	Applies to all areas where residual contamination requires remediation or monitoring.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable
Title 27, CCR, Sections 20950(a)(1) and (a)(2)(A)2	Groundwater monitoring shall continue until such time as the wastes in the soil no longer constitute a potential threat to water quality.	Groundwater beneath and downgradient of each closed unit shall be monitored until DOE demonstrates and the regulatory agencies concur that the waste in that unit no longer poses a threat to groundwater quality. DOE can evaluate if the wastes no longer threaten water quality in its first five-year review.	Ra/Sr DSS 3 DSS 4 DW A–E SWT	Applicable

Notes:

[a] CRWQCB disagrees with EPA regarding the characterization of this requirement as relevant and appropriate, but it accepts the ROD notwithstanding. CRWQCB considers the requirements to be applicable.

The California Environmental Quality Act was listed as an ARAR in the Feasibility Study, but it has been determined as functionally addressed by the CERCLA process, and therefore, it is not required to be listed as a separate ARAR.

Abbreviations:

ALARA	As low as reasonably achievable
CFR	*Code of Federal Regulations*
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CEQA	California Environmental Quality Act
DOE	U.S. Department of Energy
DSS	Domestic Septic System
DW A–E	Dry Wells A–E
EDPs	Eastern Dog Pens
POTW	publicly owned treatment works
Ra/Sr	Radium/Strontium Treatment System
SWT	Southwest Trenches
UC Davis	University of California, Davis

Appendix C

Monitoring Data Trend Analysis

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C1.0 Monitoring Data Trend Analysis

As specified in the Remedial Design/Remedial Action Work Plan (RD/RAWP) (DOE 2010), groundwater monitoring data for the U.S. Department of Energy (DOE) Areas of the Laboratory for Energy-Related Health Research (LEHR) are evaluated annually by conducting trend analyses and comparing results to background and baseline levels for well-specific constituents identified in the RD/RAWP. The results of these evaluations are presented in the LEHR Annual Water Monitoring Reports.

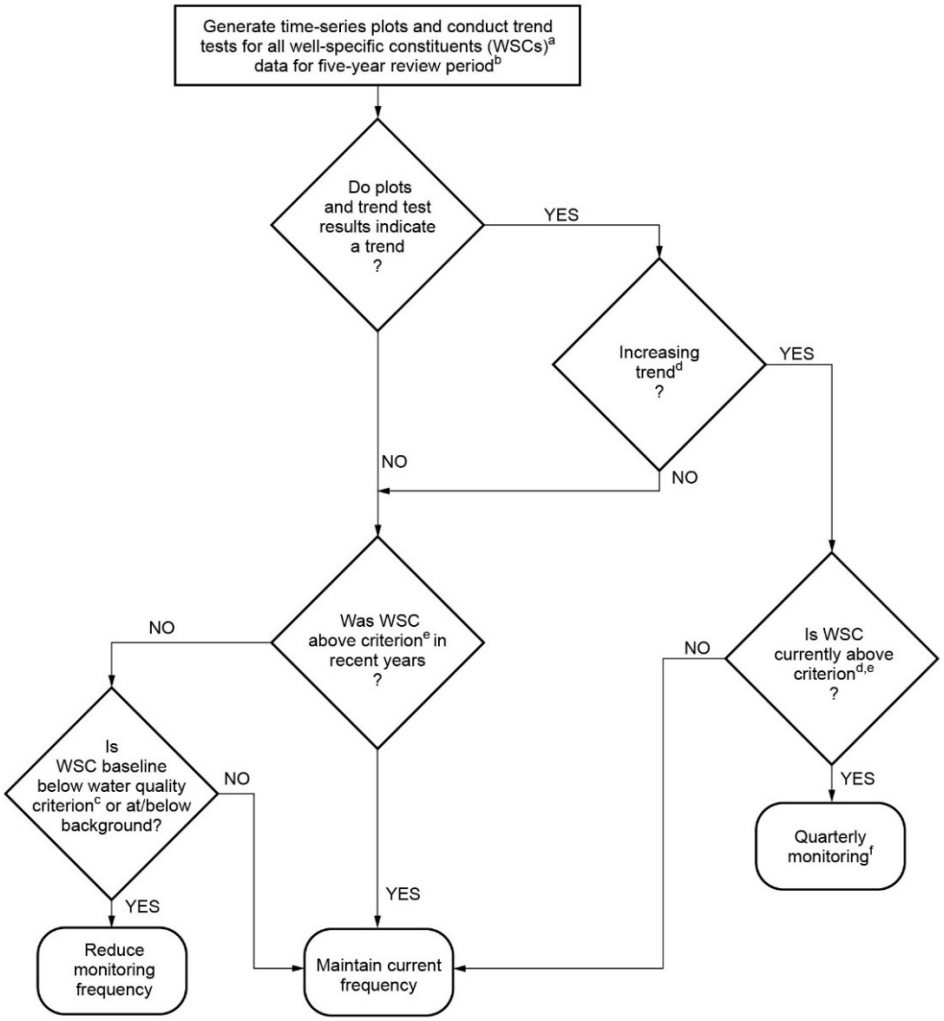
The first annual water-monitoring program was conducted in 2011 and followed the sampling protocol outlined in the RD/RAWP (DOE 2010). On the basis of these results, the sampling program was refined and the 2012–2013 annual sampling program was developed and approved by the regulatory agencies (Weiss 2013). Based on results from the 2012–2013 sampling results, the Draft 2014–2016 Multi-Year Sampling Plan was developed (Weiss 2014) and has been reviewed by the regulatory agencies. Attachment C-1 provides summaries of the sampling programs for 2011–2016.

For this Five-Year review, a comprehensive trend analysis of data collected between 2011 and 2015 was conducted for each well-specific constituent identified in the RD/RAWP to determine if any constituents have increasing concentrations or can be removed from the monitoring program or monitored less frequently (DOE 2010). This comprehensive trend analysis is in addition to the data analysis conducted annually. For the annual process, trend tests are only conducted when a well-specific constituent is above its relevant criteria (background or baseline). For the Five-Year Review evaluation, trend analysis was conducted for all well-specific constituents regardless of whether they were above or below their relevant criteria. Figure C-1 shows the evaluation process used for the Five-Year Review.

To evaluate concentration trends, the Mann-Kendall trend test was conducted in accordance with the U.S. Environmental Protection Agency (EPA) guidance *Data Quality Assessment: Statistical Methods for Practitioners* (EPA 2006). The decision error (alpha significance level) used in the test was 1 percent, indicating a 1 percent chance the statistical test will conclude that the data represents a trend when they do not. Data trends were also evaluated visually using best professional judgment. As described further below, well-specific constituents that show no trend or a decreasing trend using these evaluation methods are proposed for biennial monitoring for the next five-year period. The visual trend assessment was only used to determine monitoring frequency in cases where the Mann-Kendall trend test indicated no trend but an upward trend was noted visually, as was the case with nitrate in well UCD1-069. In this case, the visual assessment was taken into consideration and the proposed monitoring frequency is maintained at annual.

Results of this data analysis are summarized below and presented in Tables C-1, C-2, and C-3. Graphs are provided in Attachment C-2, Mann-Kendall trend test results are provided in Attachment C-3, and comparisons of baseline concentrations with background and water-quality criteria are presented in Attachment C-4. After this evaluation, a proposed monitoring plan for 2017 through 2020 (the end of the next Five-Year Review period) was developed and is presented in Table C-4. As specified in the RD/RAWP (DOE 2010), the monitoring frequency for constituents of concern (COCs) that are below background levels or not detected for 5 years is reduced from annual to biennial. Most other COCs, monitoring-only constituents (MOCs), and

new well constituents (NWCs) are also proposed for biennial monitoring based on (1) all or most concentrations being at or below background and/or baseline levels, (2) detections above background/baseline being not significantly above these criteria given analytical uncertainty, (3) no concentration trend over time, and (4) a baseline value below the maximum contaminant level (MCL; or other water-quality criterion [WQC] for constituents without an MCL) or at/below the background level.



Notes:

a. Inclusive of constituents of concern (COCs), monitoring-only constituents (MOCs), and new well constituents (NWCs).

b. Longer periods may be used if needed to provide sufficient data for trend testing.

c. Maximum Contaminant Level (MCL) or other criterion for constituents without an MCL.

d. The following may be conducted to confirm the WSC is above the criterion and/or the trend is increasing:

Data uncertainty evaluation

Resampling

Reevaluation of background (which may include sampling background wells)

e. Criterion is background if baseline is below background; otherwise criterion is baseline. Background and baseline were established in 2012 (Weiss 2014).

f. If quarterly monitoring confirms increasing trend above criterion, evaluate remedial technologies; if not resume monitoring at previous frequency.

Figure C-1. Five-Year Review Monitoring Decision Process

Table C-1. DOE Constituents of Concern Five-Year Summary and Comparison to Background and Baseline, Laboratory for Energy-Related Health Research/Old Campus Landfill, University of California, Davis

Monitoring Well	Constituent	Five-Year Comparison of Results with Baseline/Background[a]	Five-Year Trend Analysis		Baseline Below WQC or Background?[b]	Proposed Monitoring Frequency
			Mann-Kendall Test Result	Visual Test Result		
Baseline Historically Above Background						
UCD1-021	Nitrate as N	2 most recent of 9 above Baseline	No trend[c]	No trend[d]	No	Annual
UCD1-023	Carbon-14	All at or below Baseline	No trend[c]	Decreasing trend[d]	Yes	Biennial[g]
UCD1-054	Mercury	All at or below Baseline	NA[e]	NA[e]	Yes	Biennial
UCD1-068	Selenium	12 of 14 below Baseline (4 of 14 below Background)	No trend[c]	No trend[d]	Yes	Biennial[h]
UCD1-070	Carbon-14	10 of 11 below Baseline (4 of 11 below Background)	No trend[c]	No trend[d]	Yes	Biennial[h]
UCD1-071	Chromium	All at or below Baseline (7 of 9 below Background)	No trend[c]	No trend[d]	No	Annual
UCD1-071	Chromium (hexavalent)	All at or below Baseline (6 of 11 below Background)	No trend[c]	No trend[d]	No	Annual
UCD1-071	Mercury	All at or below Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-071	Molybdenum	All at or below Baseline (8 of 9 below Background)	No trend[c]	No trend[d]	Yes	Biennial
UCD1-072	Nitrate as N	All at or below Baseline	No trend[c]	No trend[d]	No	Annual
Baseline Historically at or Below Background or not Detected						
UCD1-021	Carbon-14	All at or below Background/Baseline	NA[f]	No trend[d]	Yes	Biennial
UCD1-021	Radium-226	All at or below Background (3 most recent of 9 above Baseline)	No trend[c]	No trend[d]	Yes	Annual
UCD1-023	Nitrate as N	All at or below Background/Baseline	No trend[c]	No trend[d]	Yes	Biennial
UCD1-054	Cesium-137	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-054	Chromium	All at or below Background/Baseline	No trend[c]	No trend[d]	Yes	Biennial
UCD1-054	Chromium (hexavalent)	All at or below Background/Baseline	No trend[c]	No trend[d]	Yes	Biennial
UCD1-054	Molybdenum	All at or below Background/Baseline	No trend[c]	No trend[d]	Yes	Biennial
UCD1-054	Silver	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-054	Strontium-90	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-068	Carbon-14	All at or below Background/Baseline	NA[e]	No trend[d]	Yes	Biennial

Table C-1 (continued). DOE Constituents of Concern Five-Year Summary and Comparison to Background and Baseline, Laboratory for Energy-Related Health Research/Old Campus Landfill, University of California, Davis

Monitoring Well	Constituent	Five-Year Comparison of Results with Baseline/Background[a]	Five-Year Trend Analysis		Baseline Below WQC or Background?[b]	Proposed Monitoring Frequency
			Mann-Kendall Test Result	Visual Test Result		
UCD1-068	Nitrate as N	All at or below Background/Baseline	No trend[c]	No trend[d]	Yes	Biennial
UCD1-068	Radium-226	All at or below Background (3 of 12 above Baseline)	No trend[c]	No trend[d]	Yes	Biennial
UCD1-069	Formaldehyde	All at or below Background/Baseline	NA[e]	No trend[d]	Yes	Biennial
UCD1-069	Molybdenum	All at or below Background/Baseline	No trend[c]	No trend[d]	Yes	Biennial
UCD1-069	Nitrate as N	All at or below Background, most recent 3 of 9 above Baseline	No trend[c]	Increasing trend[d]	Yes	Annual
UCD1-070	Nitrate as N	All at or below Background/Baseline	No trend[c]	No trend[d]	Yes	Biennial
UCD1-071	Cesium-137	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-071	Silver	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-071	Strontium-90	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-072	Carbon-14	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-072	Radium-226	All at or below Background, 2 of 11 at or above Baseline	No trend[c]	No trend[d]	Yes	Biennial[h]

Notes:
[a] Data from 2011 through 2015; monitoring results compared to baseline when baseline is above background.
[b] "No" indicates that baseline level is either below the WQC or, if above the WQC, is at or below the background level. WQC is primary Maximum Contaminant Level (MCL) or, if none established, either the secondary MCL, California Notification Level, or EPA Regional Screening Level. See Attachment C-4.
[c] Insufficient evidence to identify a significant trend at 1% significance level (DOE 2010).
[d] Time series plots were prepared and inspected for visual evidence of trends.
[e] Analyte not detected with sufficient frequently to provide reliable trend test result; trace concentration detected in two or fewer samples.
[f] Analyte not detected in samples collected from well; trend test is not applicable.
[g] Once every 2 years.
[h] Will be maintained at annual frequency if 2016 result exceeds baseline.

Abbreviations:
NA = not applicable to the comparison

Table C-2. DOE Monitoring-Only Constituents Five-Year Summary and Comparison to Background and Baseline
Laboratory for Energy-Related Health Research/Old Campus Landfill, University of California, Davis

Monitoring Well	Constituent	Five-Year Comparison of Results with Baseline/Background[a]	Five-Year Trend Analysis		Baseline Below WQC or Background?[b]	Proposed Monitoring Frequency
			Mann-Kendall Test Result	Visual Test Result		
Baseline Historically Above Background						
UCD1-069	Aluminum	All at or below Baseline	No trend[c]	No trend[d]	No	Annual
UCD1-070	Zinc	All at or below Baseline	No trend[c]	No trend[d]	Yes	Biennial[g]
UCD1-071	Aluminum	All at or below Baseline	NA[e]	No trend[d]	Yes	Biennial
UCD1-072	Aluminum	All at or below Baseline	No trend[c]	No trend[d]	Yes	Biennial
Baseline Historically at or Below Background or not Detected						
UCD1-013	Chlordane	All at or below Background/Baseline	NA[f]	NA[f]	No	Annual
UCD1-013	Dieldrin	All at or below Background/Baseline	NA[f]	NA[f]	No	Annual
UCD1-021	Aluminum	All at or below Background/Baseline	NA[e]	NA[e]	Yes	Biennial
UCD1-021	Americium-241	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-023	Mercury	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-023	Zinc	All at or below Background/Baseline	No trend[c]	No trend[d]	Yes	Biennial
UCD1-068	Aluminum	All at or below Background/Baseline	NA[e]	NA[e]	Yes	Biennial
UCD1-068	Americium-241	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-068	Chromium	6 of 7 below Background, 5 of 7 below Baseline	No trend[c]	No trend[d]	Yes	Biennial[h]
UCD1-068	Nickel	All at or below Background/Baseline	No trend[c]	No trend[d]	Yes	Biennial
UCD1-069	Silver	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-070	Mercury	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial
UCD1-072	Americium-241	All at or below Background/Baseline	NA[f]	NA[f]	Yes	Biennial

Notes:
[a] Data from 2011 through 2015; monitoring results compared to baseline when baseline is above background.
[b] "No" indicates that baseline level is either below the WQC or, if above the WQC, is at or below the background level. WQC is primary Maximum Contaminant Level (MCL) or, if none established, either the secondary MCL, California Notification Level, or EPA Regional Screening Level. See Attachment C-4.
[c] Insufficient evidence to identify a significant trend at 1% significance level (DOE 2010).
[d] Time series plots were prepared and inspected for visual evidence of trends.
[e] Analyte not detected with sufficient frequently to provide reliable trend test result; trace concentration detected in two or fewer samples.
[f] Analyte not detected in samples collected from well; trend test is not applicable.
[g] Once every 2 years.
[h] Will be maintained at annual frequency if 2016 result exceeds baseline.

Abbreviations:
NA = not applicable to the comparison

Table C-3. DOE New Well Constituents Five-Year Summary and Comparison to Background and Baseline, Laboratory for Energy-Related Health Research/Old Campus Landfill, University of California, Davis

Monitoring Well	Constituent	Five-Year Comparison of Results with Baseline/Background[a]	Five-Year Trend Analysis		Baseline Below WQC or Background?[b]	Proposed Monitoring Frequency
			Mann-Kendall Test Result	Visual Test Result		
Baseline Historically Above Background						
UCD1-068	Gross beta	All at or below Baseline (5 of 10 below Background)	Decreasing trend	Deceasing trend[d]	No	Annual
UCD1-068	Chloroform	All at or below Baseline	No trend[c]	No trend[d]	Yes	Biennial[g]
UCD1-068	Chromium (hexavalent)	8 of 9 below Baseline (6 of 9 below Background)	No trend[c]	No trend[d]	No	Annual
UCD1-068	Formaldehyde	All at or below Baseline	NA[d]	NA[e]	Yes	Biennial
UCD1-068	Uranium-238	All at or below Baseline (3 of 9 below Background)	No trend[c]	No trend[d]	Yes	Biennial
UCD1-069	1,1-Dichloroethane	All at or below Baseline	NA[d]	NA[e]	Yes	Biennial
UCD1-069	Gross Beta	All at or below Baseline (4 of 8 below Background)	No trend[b]	No trend[d]	No	Annual
UCD1-069	Carbon-14	5 of 7 below Baseline	No trend[b]	No trend[d]	Yes	Biennial[h]
UCD1-069	Chloroform	All at or below Baseline	NA[d]	NA[e]	Yes	Biennial
UCD1-069	Iron	All at or below Baseline (all but 1st sample of 7 below Background)	No trend[c]	No trend[d]	No	Annual
UCD1-069	Manganese	All at or below Baseline (all but 1st sample of 7 below Background)	No trend[c]	NA[e] or NA[f]	Yes	Biennial
UCD1-069	Uranium-238	6 of 8 below Baseline (1 of 8 below Background)	No trend[c]	No trend[d]	Yes	Biennial[h]
UCD1-070	Gross beta	All at or below Baseline (8 of 9 below Background)	No trend[c]	No trend[d]	No	Annual
UCD1-070	Uranium-238	All at or below Baseline (2 of 8 below Background)	No trend[c]	No trend[d]	Yes	Biennial
UCD1-071	Benzene	All at or below Baseline	NA[d]	NA[e]	Yes	Biennial
UCD1-071	Gross beta	8 of 9 at or below Baseline (3 of 9 below Background)	No trend[c]	No trend[d]	No	Annual
UCD1-071	Manganese	All at or below Baseline (all but 1st sample of 7 below Background)	No trend[c]	Deceasing trend[d]	Yes	Biennial
UCD1-071	Uranium-238	All at or below Baseline	No trend [c]	No trend[d]	Yes	Biennial

Table C-3 (continued). DOE New Well Constituents Five-Year Summary and Comparison to Background and Baseline, Laboratory for Energy-Related Health Research/Old Campus Landfill, University of California, Davis

Monitoring Well	Constituent	Five-Year Comparison of Results with Baseline/Background[a]	Five-Year Trend Analysis		Baseline Below WQC or Background?[b]	Proposed Monitoring Frequency
			Mann-Kendall Test Result	Visual Test Result		
Baseline Historically Above Background						
UCD1-072	Gross beta	All at or below Baseline (6 of 9 below Background)	No trend[c]	No trend[d]	No	Annual
UCD1-072	Chloroform	4 of 7 below Baseline, most recent 3 above	Increasing trend	Increasing trend[d]	Yes	Annual
UCD1-072	Chromium	All at or below Baseline	No trend[c]	No trend[d]	No	Annual
UCD1-072	Chromium (hexavalent)	7 of 8 below Baseline, most recent above	No trend[c]	No trend[d]	No	Annual
UCD1-072	Formaldehyde	All at or below Baseline	NA[d]	No trend[d]	Yes	Biennial
UCD1-072	Uranium-238	7 of 9 below Baseline (3 of 9 below Background)	No trend[c]	No trend[d]	Yes	Biennial[h]

Notes:

[a] Data from 2011 through 2015; monitoring results compared to baseline when baseline is above background.

[b] "No" indicates that baseline level is either below the WQC or, if above the WQC, is at or below the background level. WQC is primary Maximum Contaminant Level (MCL) or, if none established, either the secondary MCL, California Notification Level, or EPA Regional Screening Level. See Attachment C-4.

[c] Insufficient evidence to identify a significant trend at 1% significance level (DOE 2010).

[d] Time series plots were prepared and inspected for visual evidence of trends.

[e] Analyte not detected with sufficient frequently to provide reliable trend test result; trace concentration detected in two or fewer samples.

[f] Analyte not detected in samples collected from well; trend test is not applicable.

[g] Once every 2 years.

[h] Will be maintained at annual frequency if 2016 result exceeds baseline.

Abbreviations:

NA = not applicable to the comparison

Table C-4. 2017–2020 DOE Sampling Plan, Laboratory for Energy-Related Health Research/Old Campus Landfill, University of California, Davis

	Constituent																								
Well Name	**1,1-Dichloroethane**	**Aluminum**	**Americium-241**	**Benzene**	**Beta, Gross**	**Carbon-14**	**Cesium-137**	**Chlordane**	**Chloroform**	**Chromium, Hexavalent**	**Chromium, Total**	**Dieldrin**	**Formaldehyde**	**Iron**	**Manganese**	**Mercury**	**Molybdenum**	**Nickel**	**Nitrate (as nitrogen)**	**Radium-226**	**Selenium**	**Silver**	**Strontium-90**	**Uranium-238**	**Zinc**
UCD1-013								A				A													
UCD1-021		B	B			B													A	A					
UCD1-023						B										B			B						B
UCD1-054							D			B	B					B	B					B	B		
UCD1-068		B	B		A	B			B	A	B[a]		B					B	B	B	B[a]			B	
UCD1-069	B	A			A	B[a]			B				B	A	B		B		A			B		B[a]	
UCD1-070					A	B[a]										B			B					B	B
UCD1-071		B		B	A		D			A	A				B	B	B					B	B	B	
UCD1-072		B	B		A	B			A	A	A		B						A	B[a]				B[a]	

Notes:

monitoring-only constituent

new well constituent

constituent of concern

[a] Maintain at annual frequency if 2016 sample exceeds baseline

Abbreviations:

A = annual

B = biennial (once every 2 years, to be sampled in 2018 and 2020)

D = discontinued (based on updated background and groundwater impact evaluation (see Appendix F)

C1.1 DOE Constituents of Concern Analysis

The Five-Year COC data and trend analyses are summarized in Table C-1. The RD/RAWP (DOE 2010) specifies which COCs are to be monitored in each well, with a total of 31 well-specific COCs identified. Of these, 10 well-specific COCs have historical baseline concentrations above background and 21 well-specific COCs have historical baseline concentrations below or the same as background. These two types of COCs were evaluated separately and are discussed below.

C1.1.2 Well-Specific COCs with Baseline Above Background

Trend analyses were performed for each well-specific COC with baseline above background to determine if a significant increase in concentration has occurred. As shown in Table C-1, most results were at or below baseline levels and the trend analyses indicate no increasing trends. On the basis of visual inspection, the concentration of carbon-14 in well UCD1-023 appears to be decreasing; however, the Mann-Kendall test did not indicate this trend. On the basis of non-increasing or decreasing trends and baseline below MCL or other WQC, carbon-14 in wells UCD1-023 and UCD1-070, mercury in wells UCD1-054 and UCD1-071, selenium in well UCD1-068, and molybdenum in well UCD1-071 are proposed for biennial (once every 2 years) monitoring starting in 2017 (Tables C-1 and C-4).). Because selenium in well UCD1-068 and carbon-14 in well UCD1-070 have had one or more result above baseline in the five-year period, these well-specific COCs will be maintained at an annual frequency if the 2016 results are above baseline.

The two most recent nitrate results for well UCD1-021 were above baseline, but no increasing trend was indicated. Based on these results, continued annual monitoring through 2020 is proposed for nitrate in well UCD1-021. Continued annual monitoring is also proposed for nitrate in well UCD1-072 and chromium (both total and hexavalent) in well UCD1-071 because the baseline concentrations for these well-specific COCs are above both MCLs and background concentrations.

C1.1.3 Well-Specific COCs with Baseline at or Below Background or Not Detected

Monitoring data for well-specific COCs having baseline concentrations at or below background (or not detected) were compared to background, and trend analyses were performed to determine if any significant increases occurred. As shown in Table C-1, most results were below or the same as background. Additionally, no upward trend for 20 of these COCs was identified. However, the visual test for nitrate in well UCD1-069 suggested an increasing trend, although the Mann-Kendall test did not support the visual test result. From an evaluation of these results, continued annual monitoring through 2020 is currently planned for nitrate in well UCD1-069; however, quarterly sampling may be proposed based on future results.

Although no trend is indicated, recent results for radium-226 (Ra-226) in well UCD1-021 have been above baseline levels; as such, continued annual monitoring is proposed for this well-specific COC. Ra-226 was also reported above background and baseline in one result from well UCD1-068 in 2014 (see plot in Attachment C-2), but the laboratory reported unusually high analysis error (±0.816 picocurie per liter [pCi/L]; previously reported error was less than ±0.4 pCi/L). The laboratory reanalyzed the sample using a longer counting time and obtained a

more accurate result (0.199 ± 0.297 pCi/L) below baseline (0.324 pCi/L) and well below background (1.17 pCi/L). Ra-226 has been below background throughout its monitoring history in well UCD1-068 and is currently below baseline; as such, biennial monitoring is proposed. Ra-226 in well UCD1-072 was reported slightly above baseline in one recent sample. If the 2016 result is also above baseline, monitoring for this well-specific COC will be maintained at the annual schedule; otherwise, monitoring will be biennial.

Several formaldehyde results for well UCD1-069 were above background and baseline (see plot in Attachment C-2), but these results were qualified "UJ" (nondetect) by the data validation chemist because the concentrations were due to laboratory contamination. Formaldehyde is a common laboratory contaminant that off-gasses from many building materials. Based on this, biennial monitoring is proposed for formaldehyde in well UCD1-069. Biennial monitoring is also proposed to start in 2017 for all other well-specific COCs with baseline below background (Tables C-1 and C-4).

C1.2 DOE Monitoring-Only Constituents Analysis

Four well-specific MOCs have historical baseline concentrations above background, and 13 well-specific MOCs have baseline concentrations below or the same as background (Table C-2). The well-specific MOCs that were historically above-background had concentrations consistently at or below baseline during the five-year review period; trend analyses showed no concentration trends. With the exception of aluminum in well UCD1-069, these well-specific MOCs are proposed for biennial monitoring starting in 2017 (Table C-4). Continued annual monitoring is proposed for aluminum in well UCD1-069 because its baseline concentration is above both the MCL and background.

Of the 13 historically below-background well-specific MOCs, 12 have concentrations consistently at or below background throughout the five-year review period and show no concentration trends. With the exception of chlordane and dieldrin in well UCD1-013, these well-specific MOCs are proposed for biennial monitoring starting in 2017 (Table C-4). Continued annual monitoring is proposed for chlordane and dieldrin in well UCD1-013 because baseline concentrations (which are the laboratory reporting limits) are above both the WQCs and background. Chromium in well UCD1-068 had two results above baseline and one result above background during the five-year period; however, no trend was indicated. Chromium in well UCD1-068 is therefore proposed for biennial monitoring starting in 2017; although if 2016 results are above baseline, monitoring will be maintained as annual.

As shown on the graphs in Attachment C-2, the 2015 annual results for zinc in well UCD1-023 (which is one of the 14 well-specific MOCs with baseline below background) and in well UCD1-070 (one of the four well-specific MOCs with baseline above background) were above baseline by almost a factor of 4 each. Dixon's outlier test in Pro UCL version 5.0 (EPA 2015) was used to test these data, and the test results indicated the 2015 zinc data were outliers. The cause of the outlier results was not identified during data validation. The samples were reanalyzed by the laboratory within holding time, and both reanalysis results were below background and baseline. The reanalysis results were not outliers based on Dixon's test results. The original results were assumed incorrect and not used in this evaluation.

C1.3 DOE New Well Constituents Analysis

As shown in Table C-3, the baseline concentrations for all 24 well-specific NWCs were above background. Of these well-specific NWCs, results for 17 have been consistently at or below baseline during the five-year review period. Two of these (gross beta in well UCD1-068 and manganese in well UCD1-071) appear to have decreasing concentration trends. Some formaldehyde results for wells UCD1-068 and UCD1-072 were above background and baseline (see plots in Attachment C-2), but these results were qualified UJ (non-detect) by the data validation chemist because the concentrations were due to laboratory contamination. The majority of results for the remaining seven well-specific NWCs have also been below baseline during the five-year period, and results for six of these seven well-specific NWCs indicate no concentration trend. One well-specific NWC, chloroform in well UCD1-072, appears to be increasing based on trend analysis and has had concentrations above baseline in the three most recent samples. From a review of the criteria in the RD/RAWP (DOE 2010), these results should trigger increased frequency to quarterly for chloroform in UCD1-072. However, the concentrations detected are all low and close to the reporting limit (1.5 micrograms per liter or less compared with the 0.5 microgram per liter reporting limit; see Attachment C-2), and given analytic uncertainty do not represent a substantial concentration increase. Therefore, continued annual monitoring is currently planned for chloroform in well UCD1-072; however, quarterly frequency will be proposed if the increasing trend continues. As shown in Table C-3, continued annual monitoring is also proposed for gross beta in four wells, hexavalent chromium in well UCD1-068, chromium (both total and hexavalent) in well UCD1-072, and iron in well UCD1-069 because the well-specific baseline concentrations are above both the WQCs and background levels. Biennial monitoring is proposed for all other NWCs starting in 2017; however, for those constituents with one or more result above baseline during the five-year period, sampling will be maintained at annual frequency if the 2016 monitoring result also exceeds baseline (Tables C-3 and C-4).

C1.4 Summary of Proposed Monitoring Changes

Based on this analysis, no well-specific constituent is recommended for removal from the monitoring program, but monitoring for most DOE Area groundwater well-specific constituents can be reduced to biennial (Table C-4) and still provide adequate data to evaluate potential groundwater impacts. Of the 72 well-specific constituents monitored:

- Only chloroform in well UCD1-072 shows an increasing trend by both the Mann-Kendall and visual tests. Nitrate in well UCD1-069 also appears to be increasing, although the Mann-Kendall test does not indicate a trend. These two well-specific constituents will remain on an annual monitoring frequency through 2020; monitoring frequency may be increased to quarterly if the upward trend continues.
- Based on recent detections above baseline, nitrate and Ra-226 in well UCD1-021 will be maintained on an annual sampling frequency through 2020.
- Fifteen well-specific constituents with baseline above MCL or other WQC and also above background (chlordane and dieldrin in well UCD1-013, gross beta in five wells, hexavalent chromium and chromium in wells UCD1-071 and UCD1-072, hexavalent chromium in well UCD1-068, nitrate in well UCD1-072, aluminum in well UCD1-069, and iron in well UCD1-069) will also be maintained at annual sampling frequency through 2020.

- Seven additional well-specific constituents (chromium and selenium in well UCD1-068; uranium-238 and carbon-14 in well UCD1-069; carbon-14 in well UCD1-070; and uranium-238 and Ra-226 in well UCD1-072) will be maintained at annual monitoring frequency only if 2016 results are above baseline; otherwise, frequency will be reduced to biennial (Table C-4).
- The remaining well-specific constituents will be reduced to biennial monitoring for 2017 through 2020.

Trend analysis for the next Five-Year Review in 2020 will include the following:

- Testing of all monitoring data collected from 2011 through 2020 at the 1% alpha significance level (applicable for n≥5 [Gilbert 1987, Table A18]), and
- Testing of the Five-Year Review period annually monitored data only (i.e., 2016-2020 data) at the 5% alpha significance level (applicable for n≥4 [Gilbert 1987, Table A18]).
- Visual trend evaluation for both data sets.

C2.0 References

DOE (U.S. Department of Energy), 2010. *Remedial Design/Remedial Action Work Plan for the Former Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis*, LMS/LEH/S05822, Office of Legacy Management, November.

EPA (U.S. Environmental Protection Agency), 2006. *Data Quality Assessment: Statistical Methods for Practitioners*, EPA QA/G-9S, EPA/240/B-06/003, Washington, DC, February.

EPA (U.S. Environmental Protection Agency), 2015. *Statistical Software ProUCL 5.0.00 for Environmental Applications for Data Sets with and without Nondetect Observations*, http://www2.epa.gov/land-research/proucl-software, accessed April 30, 2015.

Gilbert, R.O., 1987. *Statistical Methods for Environmental Pollution Monitoring,* Pacific Northwest Laboratory, Library of Congress Catalog Card Number 86-26758.

Weiss (Weiss Associates), 2013. *Final Multi-Year Sampling Plan for the Laboratory for Energy-Related Health Research/South Campus Disposal Site*, University of California, Davis, University of California, Davis, March 18.

Weiss (Weiss Associates), 2014. *Draft 2014–2016 Multi-Year Sampling Plan for the Laboratory for Energy-Related Health Research/South Campus Disposal* Site, *University of California, Davis*, October 2.

Attachment C-1

2011–2016 Sampling Program Summaries

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DOE Areas 2011 Groundwater Monitoring Plan - Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

		Radiological Analytes					Chemical Analytes												
Monitoring Wells	Area Monitored	Americium-241	Carbon-14	Cesium-137	Radium-226	Strontium-90	alpha-Chlordane, gamma-Chlordane, Dieldrin	Aluminum	Chromium (Hexavalent)	Chromium (Total)	Formaldehyde	Mercury	Molybdenum	Nickel	Nitrates (as Nitrogen)	Selenium	Silver	Zinc	Electrical Conductivity
UCD1-013	Eastern Dog Pens	---	---	---	---	---	MOC	---	---	---	---	---	---	---	---	---	---	---	MOC
UCD1-018[1]	Background	BGD	BGD	BGD	BGD	BGD	---	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD
UCD1-021	DSS 5 and Ra/Sr System	MOC	COC	---	COC	---	---	MOC	---	---	---	---	---	---	COC	---	---	---	MOC
UCD1-023	Southwest Trenches	---	COC	---	---	---	---	---	---	---	---	MOC	---	---	COC	---	---	MOC	MOC
UCD1-054	Dry Wells A-E Area	---	---	COC	---	COC	---	---	COC	COC	---	COC	COC	---	---	---	COC	---	MOC
UCD1-063[1]	Background	BGD	BGD	BGD	BGD	BGD	---	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD
UCD1-068[1]	DSS 4 and Ra/Sr System	MOC	COC	---	COC	---	---	MOC	---	MOC	---	---	---	MOC	COC	COC	---	---	MOC
UCD1-069[1]	DSS 3	---	---	---	---	---	---	MOC	---	---	COC	---	COC	---	COC	---	MOC	---	MOC
UCD1-070[1]	Southwest Trenches	---	COC	---	---	---	---	---	---	---	---	MOC	---	---	COC	---	---	MOC	MOC
UCD1-071[1]	Dry Wells A-E Area and DSS 1	---	---	COC	---	COC	---	MOC	COC	COC	---	COC	COC	---	---	---	COC	---	MOC
UCD1-072[1]	DSS 6 and Ra/Sr System	MOC	COC	---	COC	---	---	MOC	---	---	---	---	---	---	COC	---	---	---	MOC
UCD1-073[1]	Background	BGD	BGD	BGD	BGD	BGD	---	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD	BGD

Notes:

[1] Samples from monitoring well received full-suite analysis during the first and second quarters of 2011, in addition to the constituents indicated on the table. Full-suite analysis included metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, total chromium, hexavalent chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, zinc), VOCs plus formaldehyde, SVOCs, polychlorinated biphenyls, pesticides, nitrate (as nitrogen), and nine radionuclides (americium-241, carbon-14, cesium-137, radium-226, strontium-90, tritium, uranium-235/-236, and uranium-238), plus gross alpha and gross beta.

Table modified from Table 3-1 in the Remedial Design/Remedial Action Workplan (DOE, 2010)

Constituents of Concern (COC) are the constituents of concern for groundwater, as documented in the DOE Record of Decision, as specified on Table 1-4 in the Remedial Design/Remedial Action Workplan (DOE, 2010). COCs were sampled quarterly in 2011.

Monitoring-only constituents (MOC) are constituents that have a low probability of impacting groundwater quality in the future, as specified on Table 1-5 in the Remedial Design/Remedial Action Workplan (DOE, 2010). MOCs were sampled during the first and second quarters of 2011.

BGD	background
COC	constituent of concern
MOC	monitoring-only constituent

Acronyms/Abbreviations:

--- - constituent not monitored in this well

DOE - United States Department of Energy

DSS - domestic septic system

Ra/Sr - radium/strontium

SVOC - semi volatile organic compound

VOC - volatile organic compound

References:

United States Department of Energy (DOE), 2010. *Remedial Design/Remedial Action Work Plan for the Former Laboratory for Energy-Related Health Research Federal Facility*, University of California, Davis, November.

2012 DOE Sampling Plan - Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

Well Name	1,1-Dichloroethane	Aluminum	Americium-241	Benzene	Beta, Gross	Carbon-14	Cesium-137	Chlordane	Chloroform [b]	Chromium, Hexavalent	Chromium, Total [b]	Copper	Dieldrin	Formaldehyde	Iron	Manganese	Mercury	Molybdenum	Nickel	Nitrate (as Nitrogen) [b]	Potassium-40 [c]	Radium-226	Selenium	Silver	Strontium-90	Uranium-238	Zinc
	Constituent																										
UCD1-013								A					A														
UCD1-018[a]		S	A		S	S	S		Q	S	S		S	S	S	S	Q	S	A	S	A	S	Q	S	S	S	A
UCD1-021		A	A			S														S		S					
UCD1-023						S											A			S							A
UCD1-054							S			S	S						S	S						S	S		
UCD1-063[a]		S	A		S	S	S			Q	S	S		S	S	S	Q	S	A	S	A	S	Q	S	S	S	A
UCD1-068		A	A		S	S			S	S	A			S					A	S		S	Q			S	
UCD1-069	S	S			S	S			S			S		S	S	S		S		S	A			A		S	
UCD1-070					S	S											A			S	A					S	A
UCD1-071		A		S	S		S			Q	S					S	Q	S			A			S	S	S	
UCD1-072		S	A		S	S			S	S	S			S						S	A	S				S	
UCD1-073[a]		S	A		S	S	S			Q	S	S		S	S	S	Q	S	A	S	A	S	Q	S	S	S	A

Notes:

monitoring-only constituent
additional constituent
constituent of concern

A - annual
Q - quarterly
S - semi-annual
[a] Well is considered "background"
[b] Analytes locations are shown graphically on Figures 3, 5, and 7
[c] Potassium-40 is a naturally-occuring constituent and is being investigated as a possible reason for elevated gross beta in on-Site wells.

2013 DOE Areas Constituents - Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

Monitoring Wells	Area Monitored	Radiological Analytes							Chemical Analytes																	Electrical Conductivity
		Americium-241	Gross Beta	Carbon-14	Cesium-137	Radium-226	Strontium-90	Uranium-238	1,1-Dichloroethane	alpha-Chlordane, gamma-Chlordane, Dieldrin	Aluminum	Benzene	Chloroform	Chromium (Hexavalent)	Chromium (Total)	Formaldehyde	Mercury	Iron	Manganese	Molybdenum	Nickel	Nitrates (as Nitrogen)	Selenium	Silver	Zinc	
UCD1-013	Eastern Dog Pens	---		---	---	---	---	---	---	MOC	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	MOC
UCD1-021	DSS 5 and Ra/Sr System	MOC	---	COC	---	COC	---	---	---	---	MOC	---	---	---	---	---	---	---	---	---	---	COC	---	---	---	MOC
UCD1-023	Southwest Trenches	---	---	COC	---	---	---	---	---	---	---	---	---	---	---	---	MOC	---	---	---	---	COC	---	---	MOC	MOC
UCD1-054	Dry Wells A-E Area	---	---	---	COC	---	COC	---	---	---	---	---	---	COC	COC	---	COC	---	---	COC	---	---	---	COC	---	MOC
UCD1-068	DSS 4 and Ra/Sr System	MOC	NWC	COC	---	COC	---	NWC	---	---	MOC	---	NWC	NWC	MOC	NWC	---	---	---	---	MOC	COC	COC	---	---	MOC
UCD1-069	DSS 3	---	NWC	NWC	---	---	---	NWC	NWC	---	MOC	---	NWC	---	---	COC	---	NWC	NWC	COC	---	COC	---	MOC	---	MOC
UCD1-070	Southwest Trenches	---	NWC	COC	---	---	---	NWC	---	---	---	---	---	---	---	---	MOC	---	---	---	---	COC	---	---	MOC	MOC
UCD1-071	Dry Wells A-E Area and DSS 1	---	NWC	---	COC	---	COC	NWC	---	---	MOC	NWC	---	COC	COC	---	COC	---	NWC	COC	---	---	---	COC	---	MOC
UCD1-072	DSS 6 and Ra/Sr System	MOC	NWC	COC	---	COC	---	NWC	---	---	MOC	---	NWC	NWC	NWC	NWC	---	---	---	---	---	COC	---	---	---	MOC

Notes:

Constituents of Concern (COC) for groundwater are documented in the DOE Record of Decision and specified on Table 1-4 in the Remedial Design/Remedial Action Workplan (DOE, 2010).

Monitoring-only constituents (MOC) have a low probability of impacting groundwater quality in the future, as specified on Table 1-5 in the Remedial Design/Remedial Action Workplan (DOE, 2010).

New well constituents (NWCs) are compounds that are potentially present above background in wells UCD1-068 through -072 based on samples collected shortly after the wells were installed in 2011.

COC	constituent of concern
MOC	monitoring-only constituent
NWC	new well constituent

Acronyms/Abbreviations:

--- - constituent not monitored in this well

DOE - United States Department of Energy

DSS - domestic septic system

Ra/Sr - radium/strontium

References:

United States Department of Energy (DOE), 2010. *Remedial Design/Remedial Action Work Plan for the Former Laboratory for Energy-Related Health Research Federal Facility* , University of California, Davis, November.

2014 - 2016 DOE Sampling Plan - Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

Well Name	1,1-Dichloroethane	Aluminum	Americium-241	Benzene	Beta, Gross	Carbon-14	Cesium-137	Chlordane	Chloroform [b]	Chromium, Hexavalent	Chromium, Total [b]	Dieldrin	Formaldehyde	Iron	Manganese	Mercury	Molybdenum	Nickel	Nitrate (as Nitrogen) [b]	Radium-226	Selenium	Silver	Strontium-90	Uranium-238	Zinc
	Constituent																								
UCD1-013								A				A													
UCD1-021		A	A			A													A	A					
UCD1-023						A										A			A						A
UCD1-054							A			A	A					A	A					A	A		
UCD1-055					A[a]																				
UCD1-058					D																				
UCD1-061					A[a]																				
UCD1-068		A	A		A	A			A	A	A		A					A	A	A	A			A	
UCD1-069	A	A			A	A			A				A	A	A		A		A			A		A	
UCD1-070					A	A										A			A					A	A
UCD1-071		A		A	A		A			A	A				A	A	A					A	A	A	
UCD1-072		A	A		A	A			A	A	A		A						A	A				A	

Notes:

monitoring-only constituent
new well constituent
constituent of concern

A - annual
D - discontinued
[a] Gross beta "background" sample; 2014 only.
[b] Analytes/locations are shown graphically on Figures 6, 8, and 10

Attachment C-2

Data Analysis Graphs

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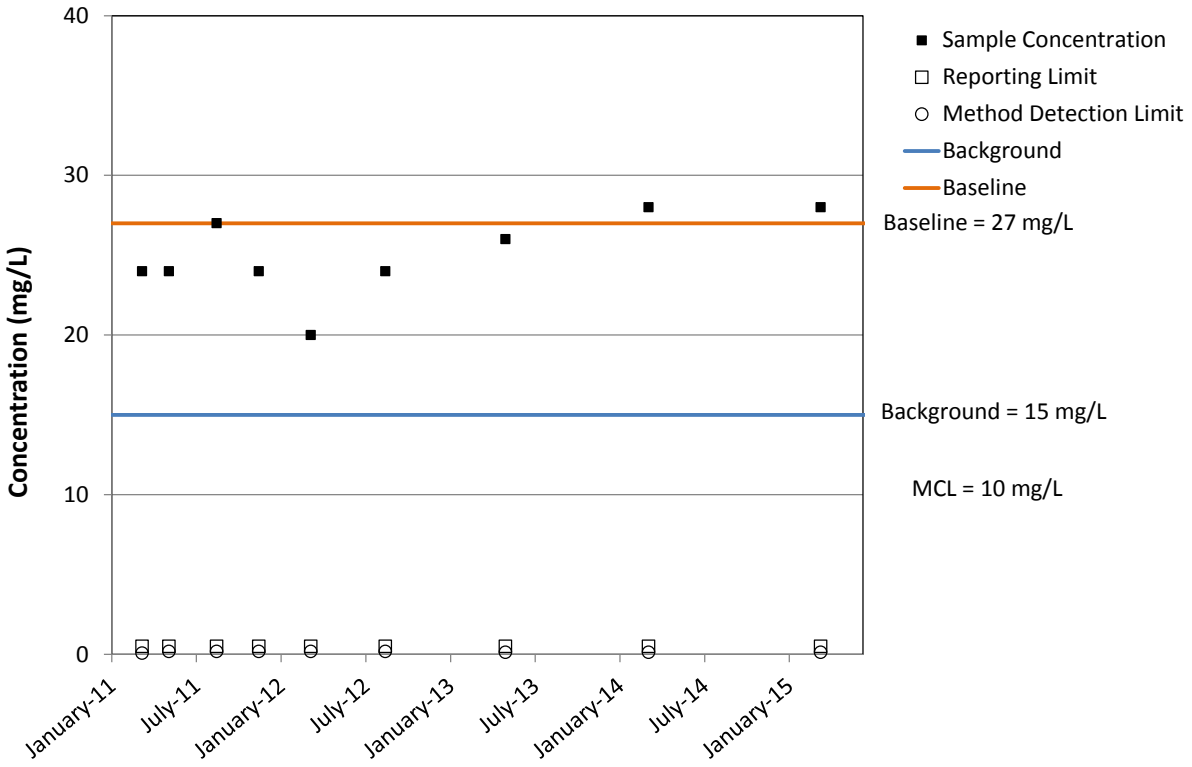
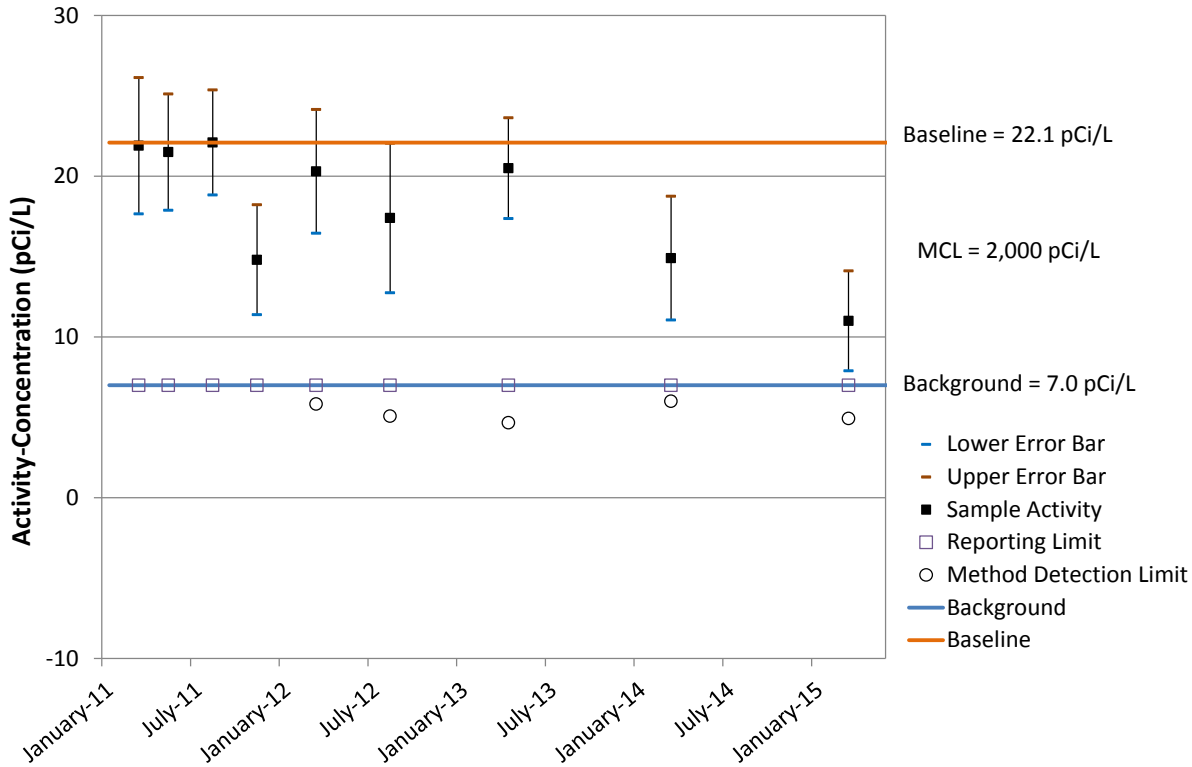


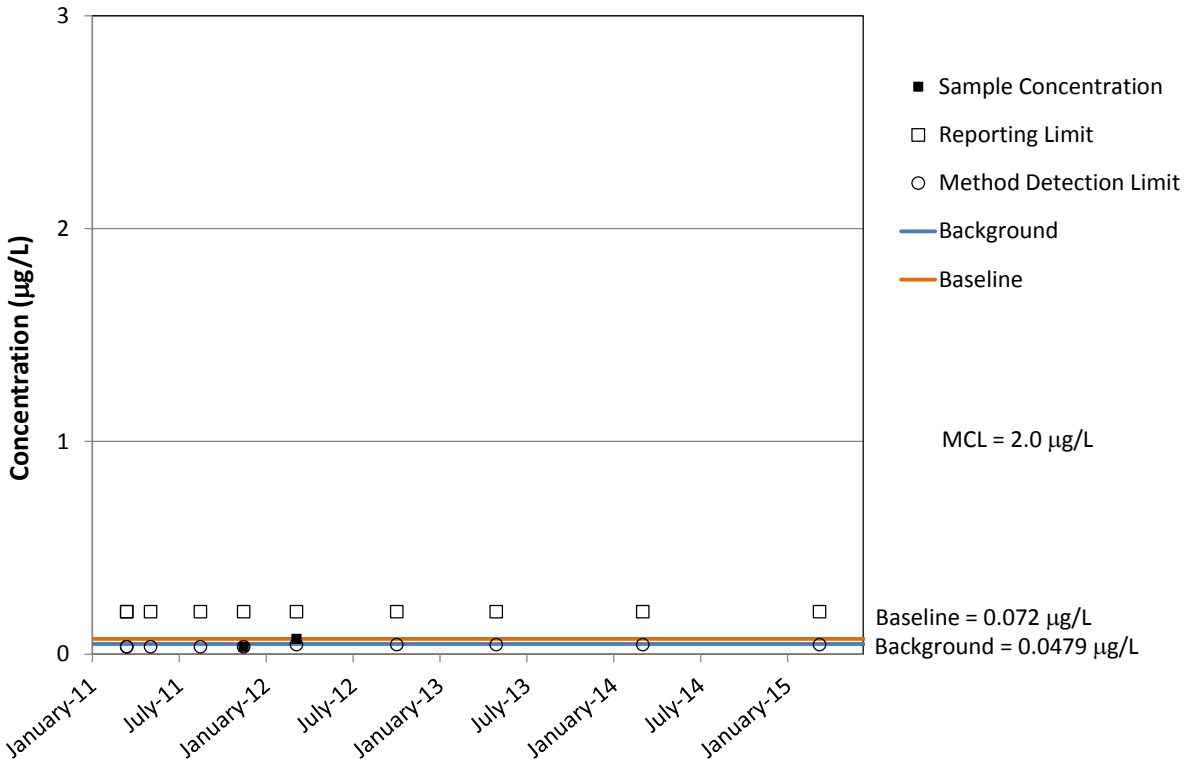
Nitrate in Well UCD1-021

MCL = maximum contaminant level
mg/L = milligrams per liter
not detected if sample concentration not shown



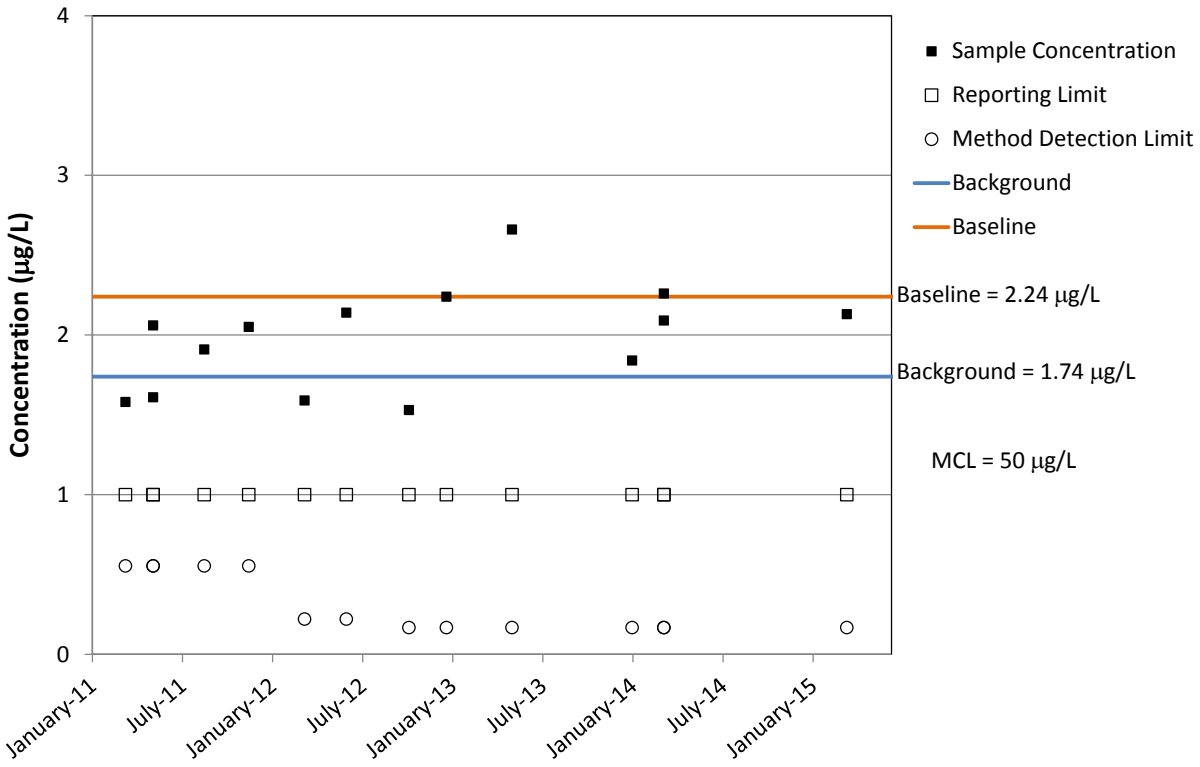
Carbon-14 in Well UCD1-023

MCL = maximum contaminant level
pCi/L = picocuries per liter



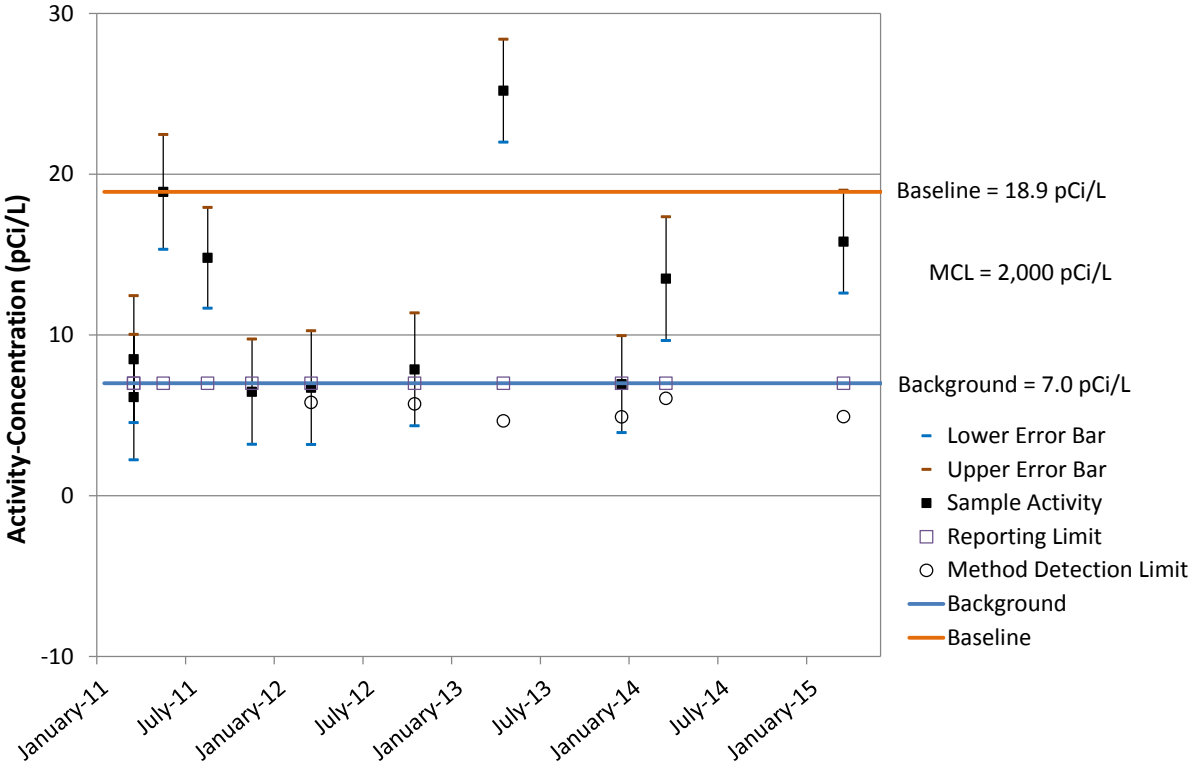
Mercury in Well UCD1-054

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



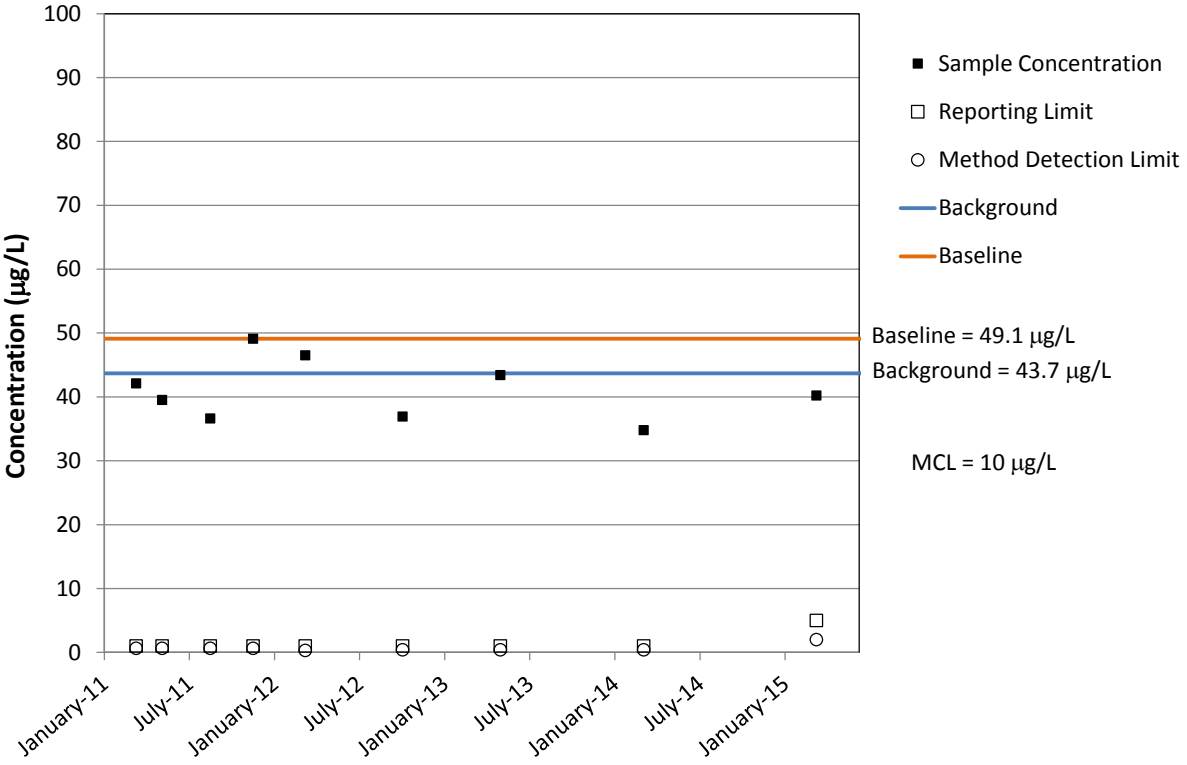
Selenium in Well UCD1-068

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



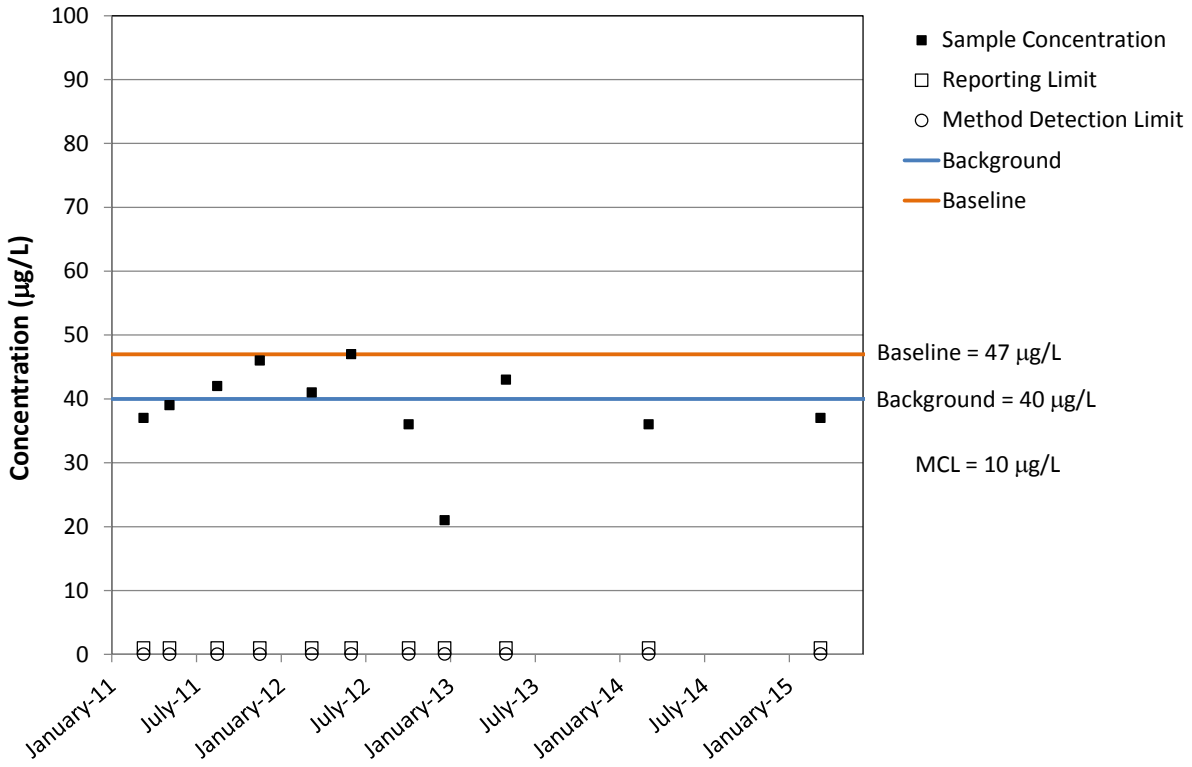
Carbon-14 in Well UCD1-070

MCL = maximun contaminant level



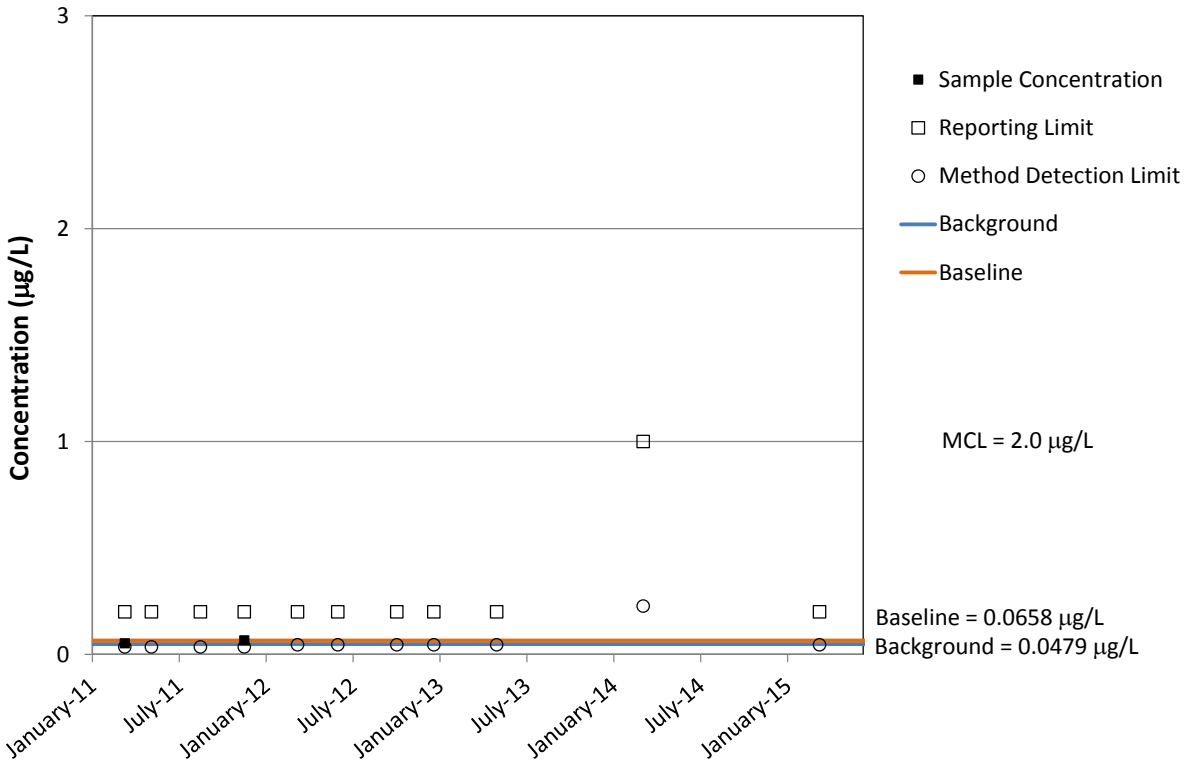
Chromium in Well UCD1-071

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



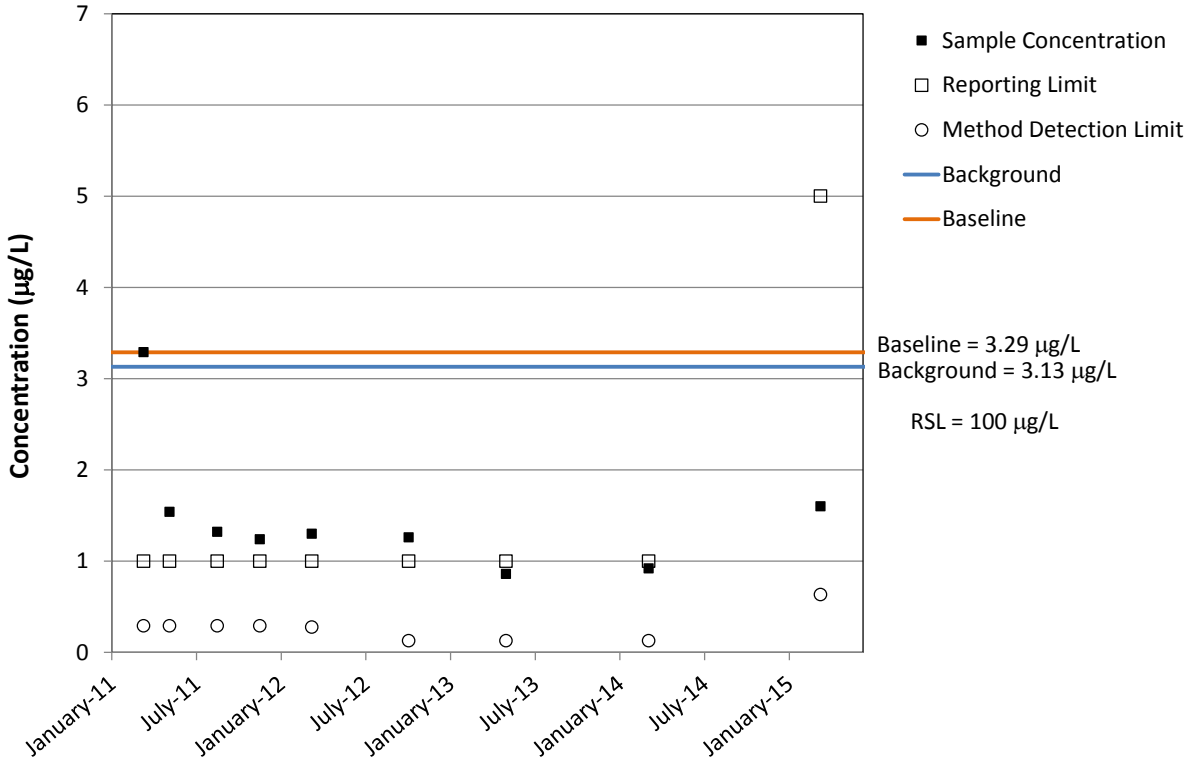
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

Hexavalent Chromium in Well UCD1-071



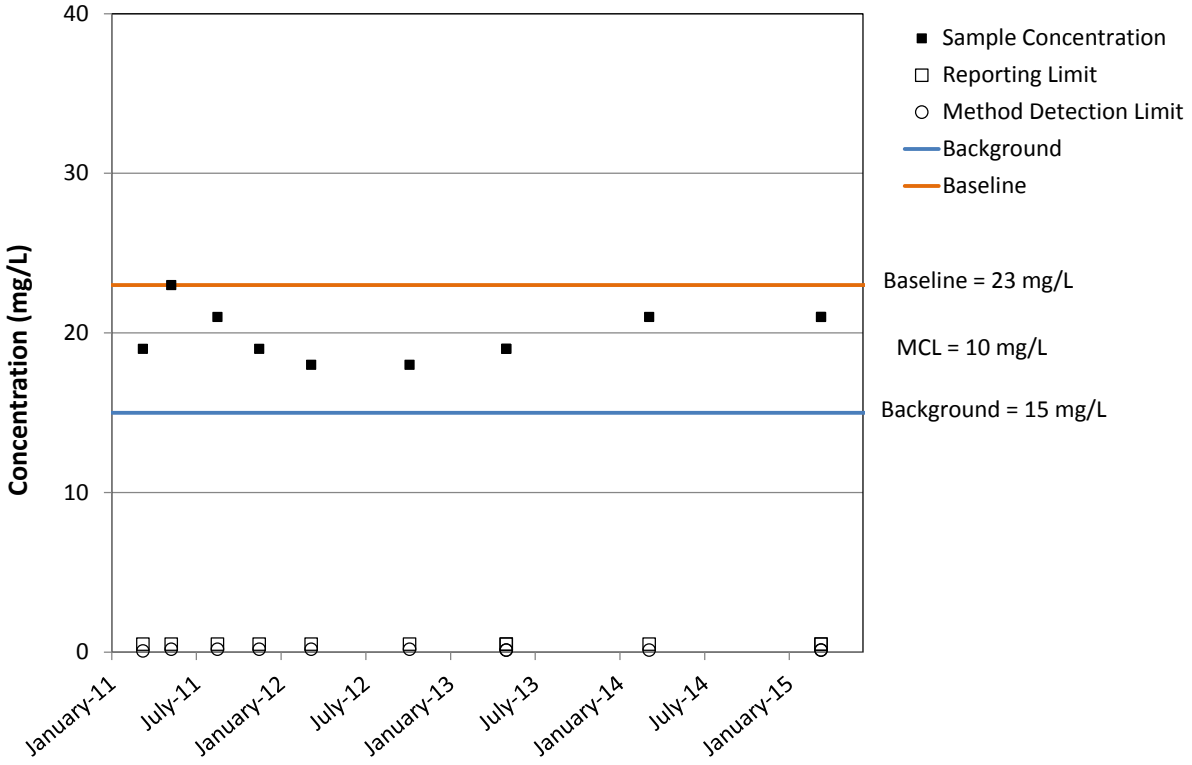
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

Mercury in Well UCD1-071



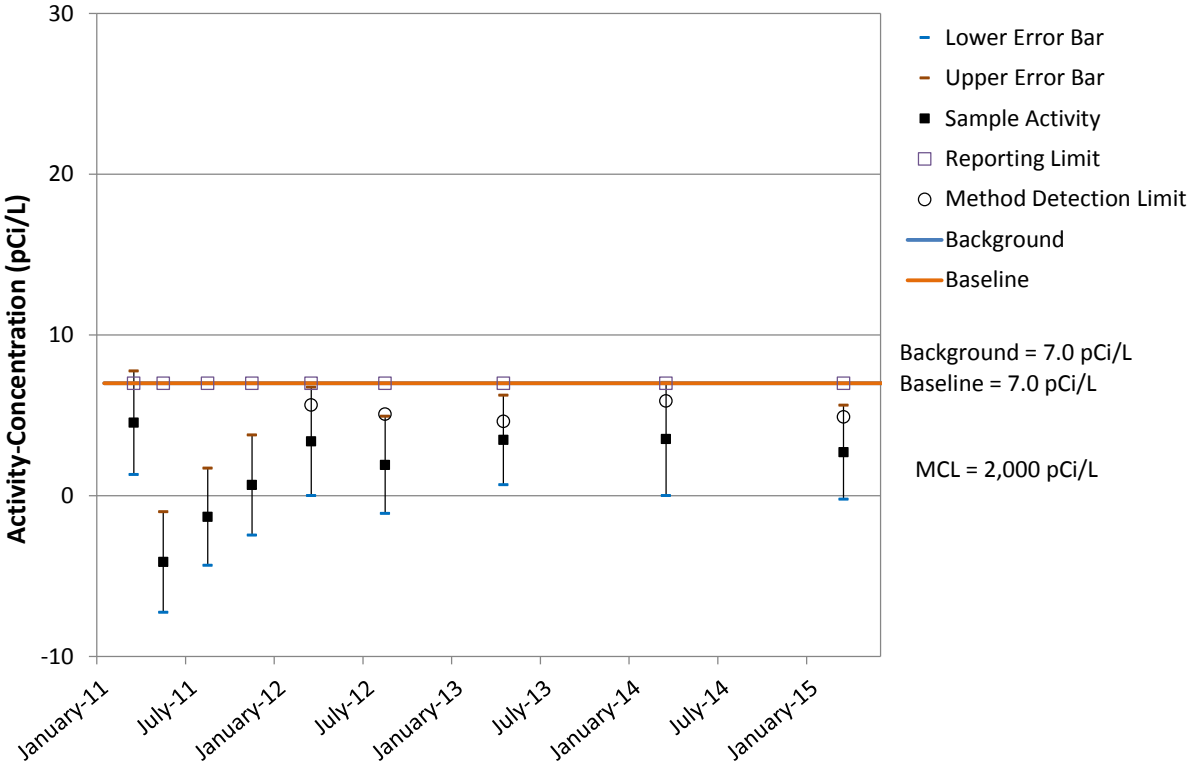
Molybdenum in Well UCD1-071

RSL = regional screening level
µg/L = micrograms per liter
not detected if sample concentration not shown



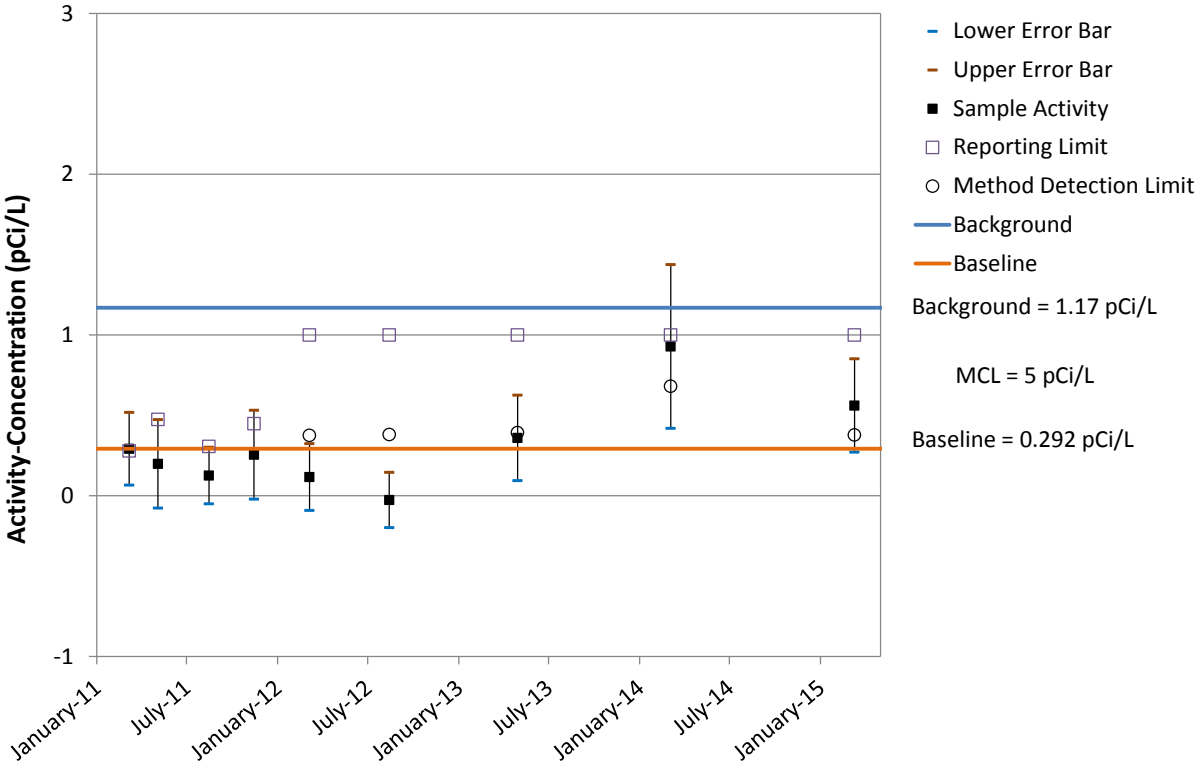
Nitrate in Well UCD1-072

MCL = maximum contaminant level
mg/L = milligrams per liter
not detected if sample concentration not shown



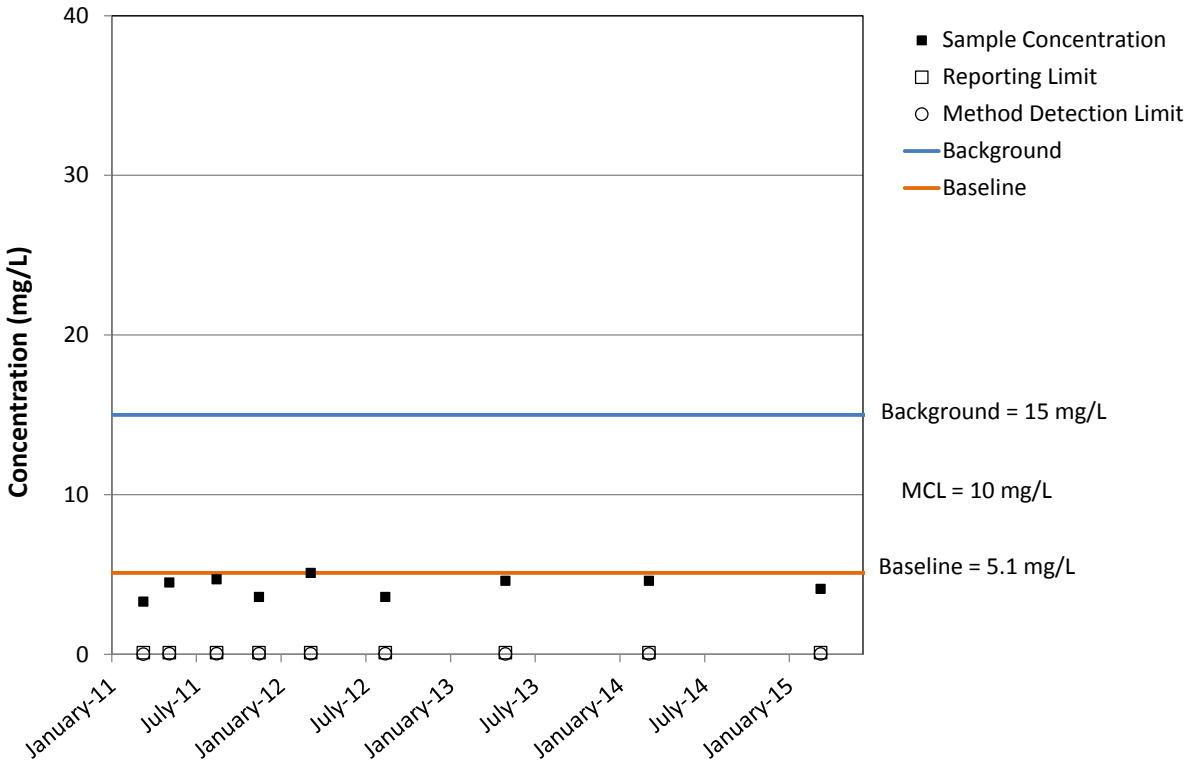
Carbon-14 in Well UCD1-021

MCL = maximum contaminant level
pCi/L = picocuries per liter



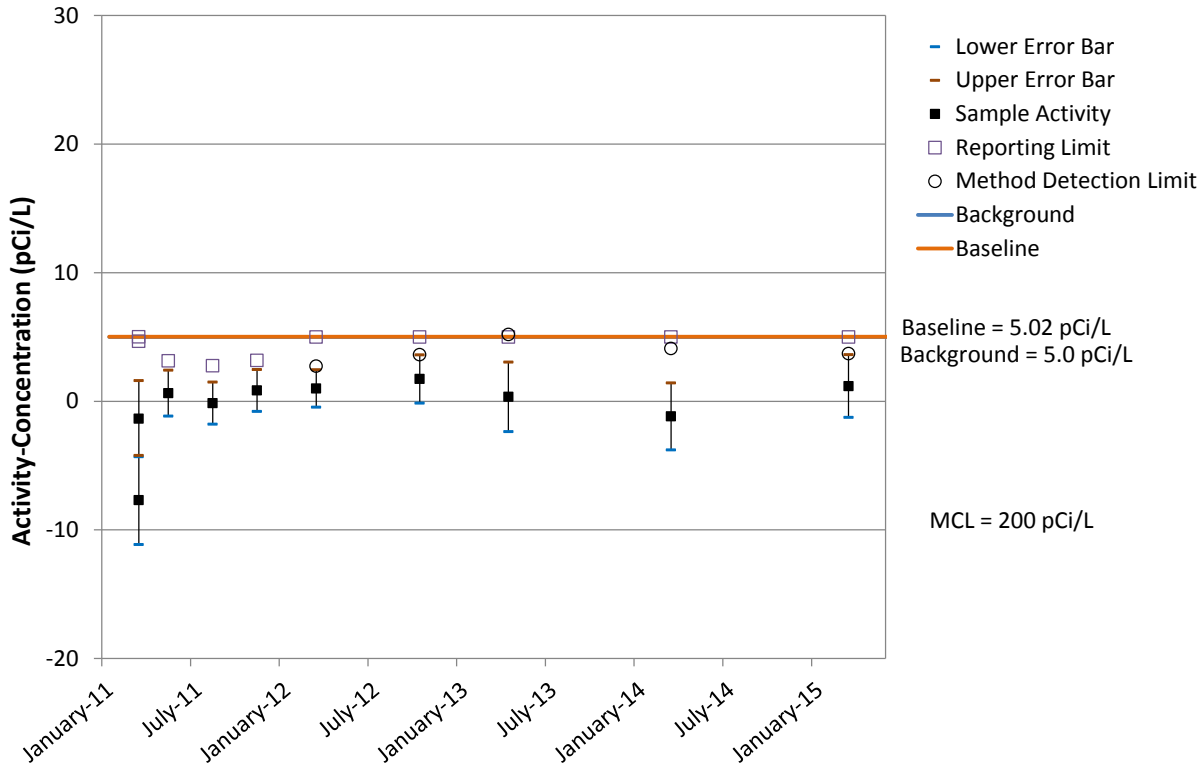
Radium-226 in Well UCD1-021

MCL = maximum contaminant level
pCi/L = picocuries per liter



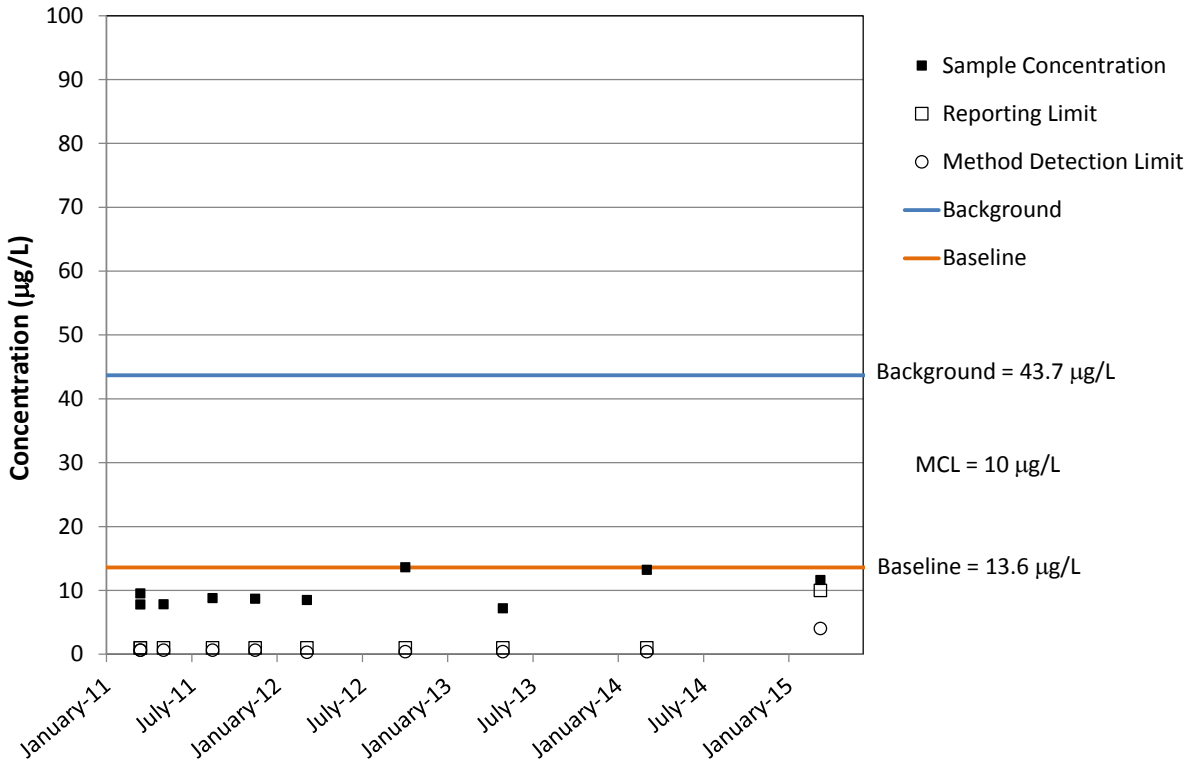
Nitrate in Well UCD1-023

MCL = maximum contaminant level
mg/L = milligrams per liter
not detected if sample concentration not shown



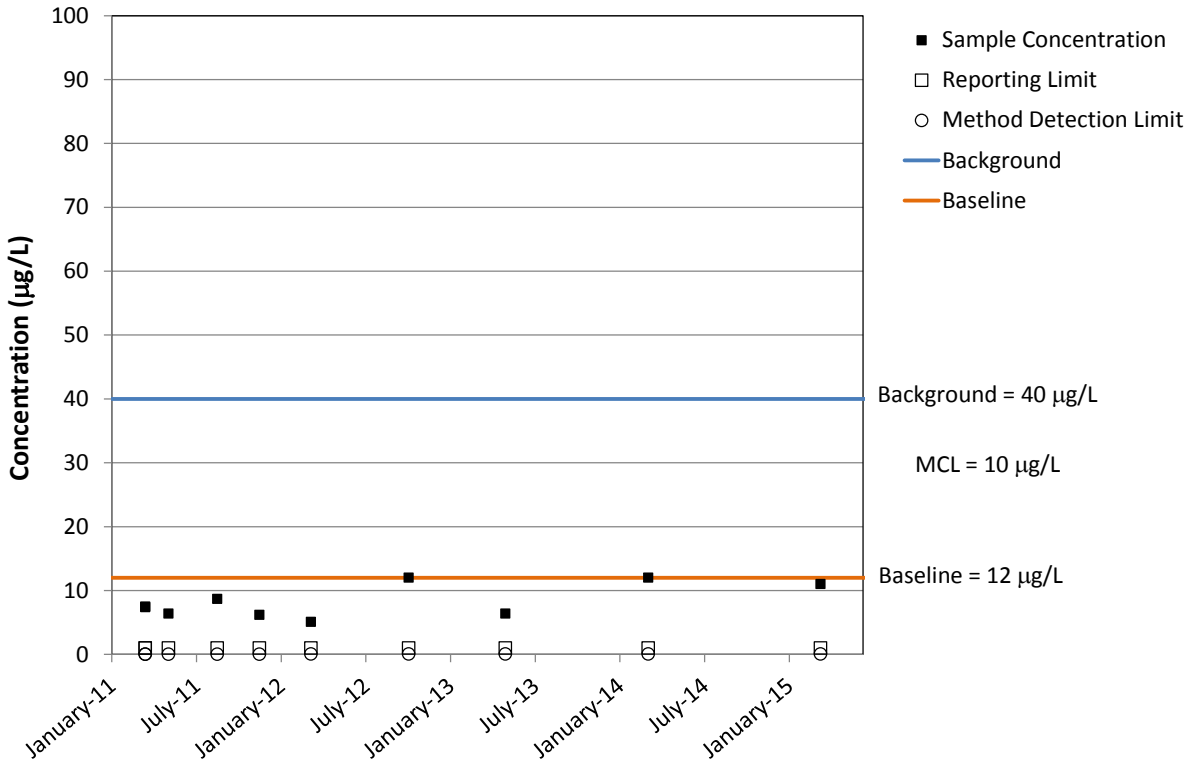
Cesium-137 in Well UCD1-054

MCL = maxiimum contaminant level
pCi/L = picocuries per liter



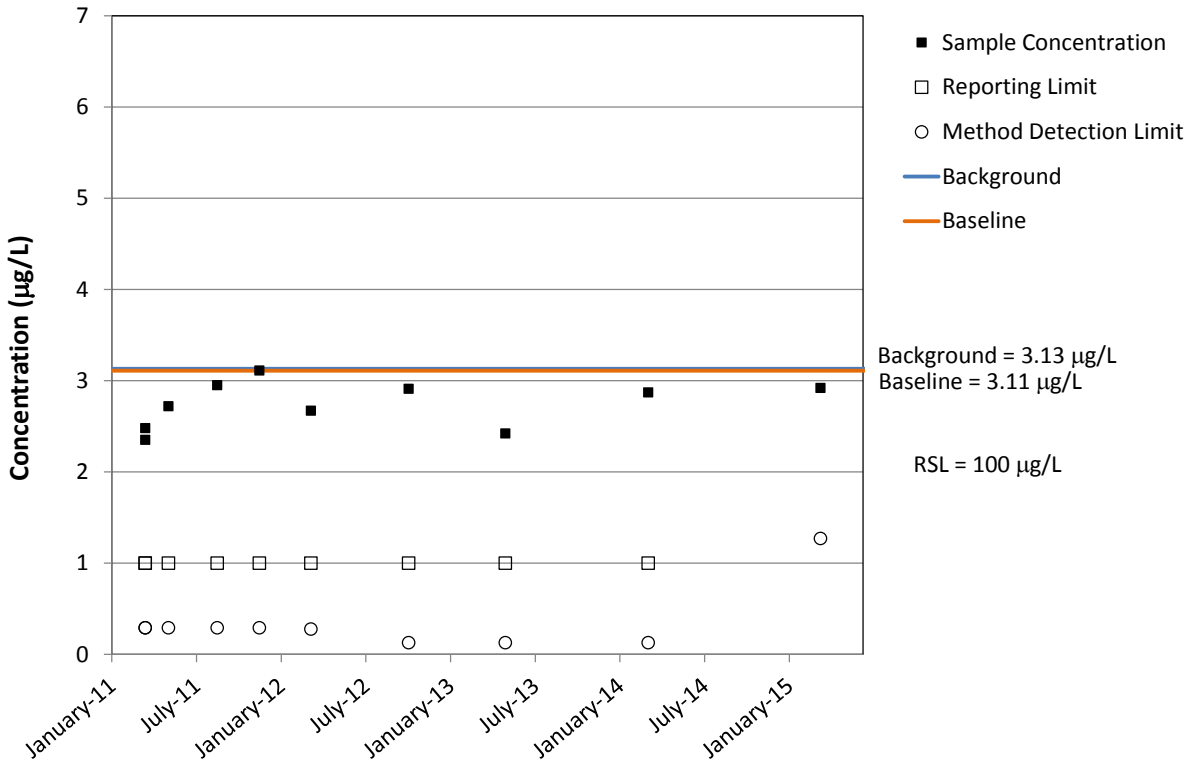
Chromium in Well UCD1-054

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



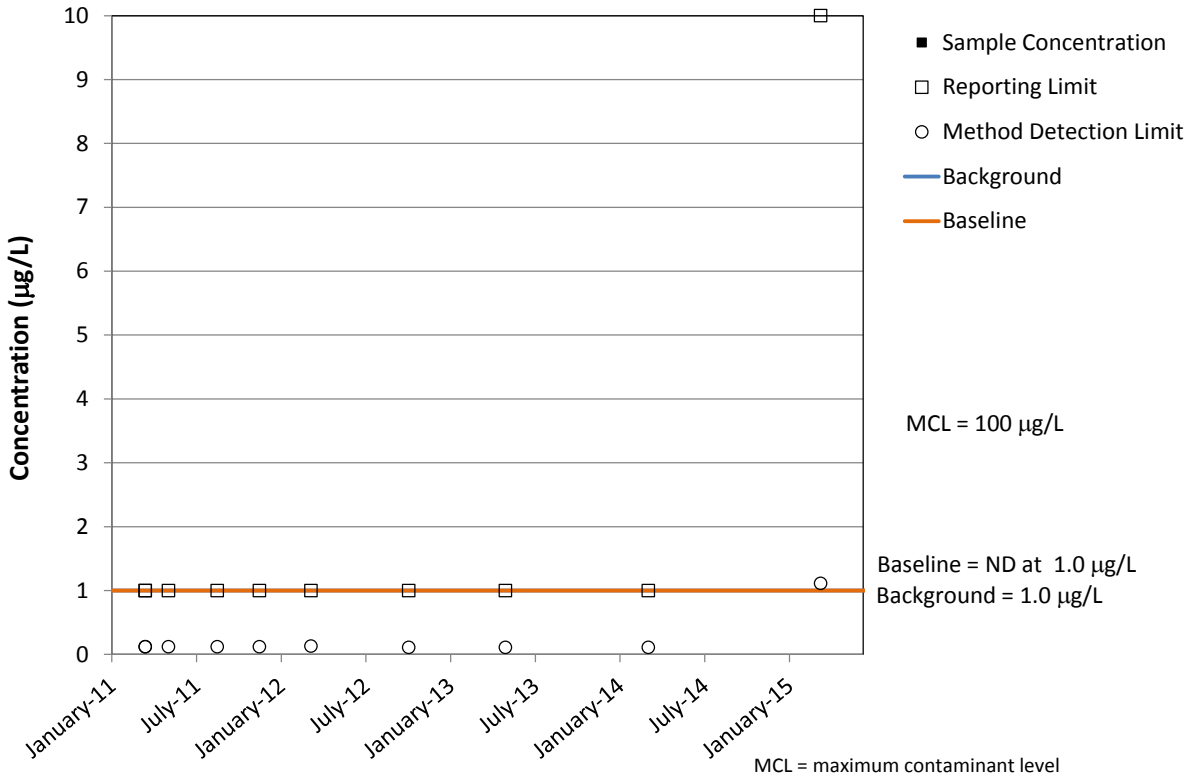
Hexavalent Chromium in Well UCD1-054

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



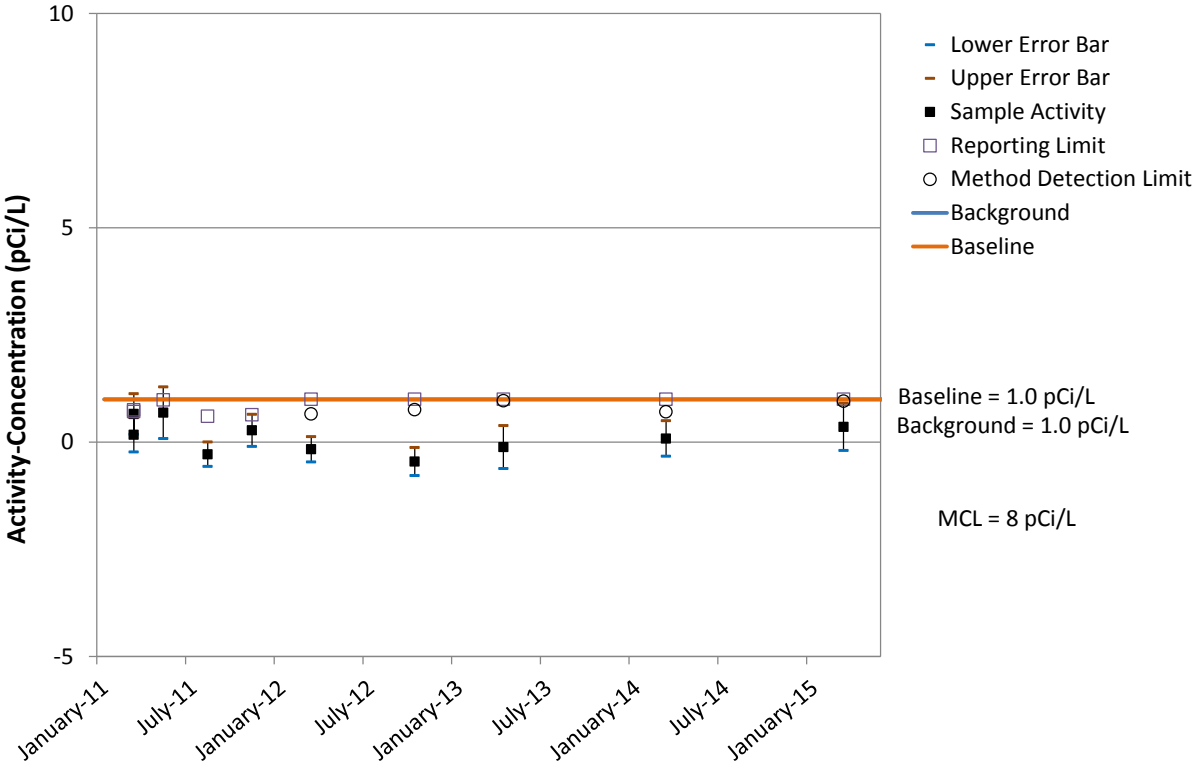
RSL = regional screening level
µg/L = micrograms per liter
not detected if sample concentration not shown

Molybdenum in Well UCD1-054



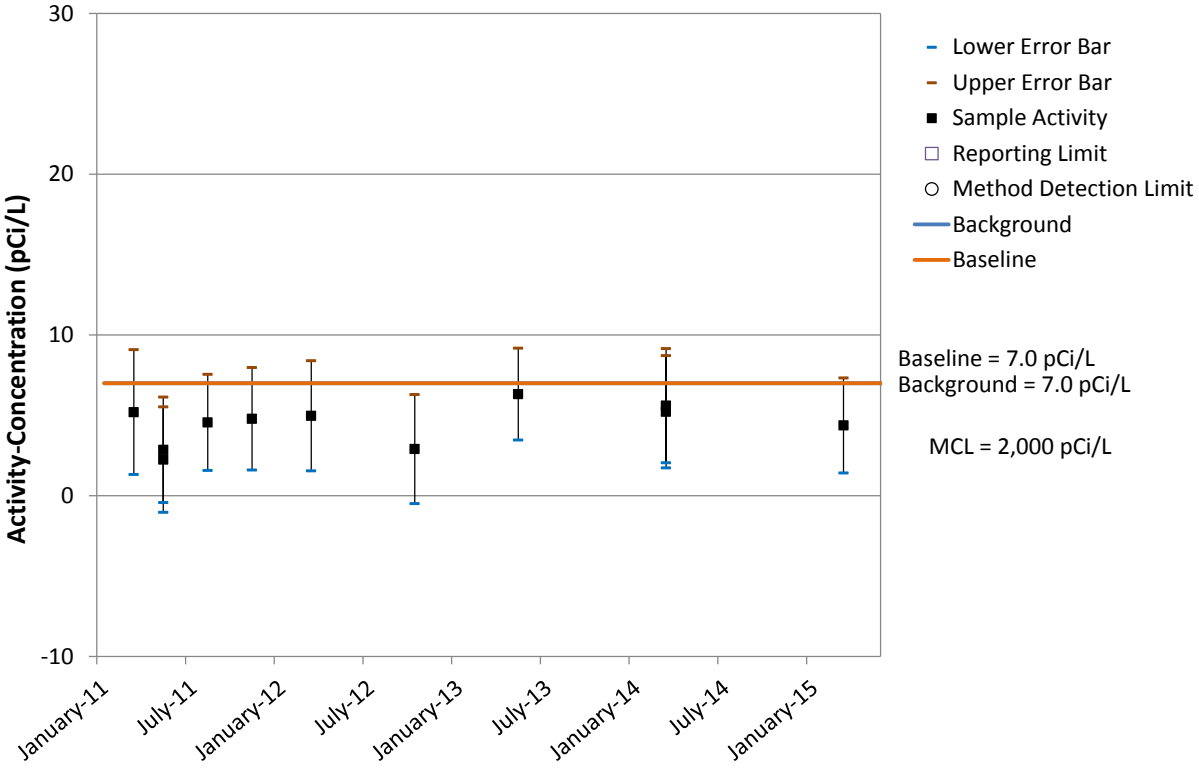
MCL = maximum contaminant level
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown

Silver in Well UCD1-054



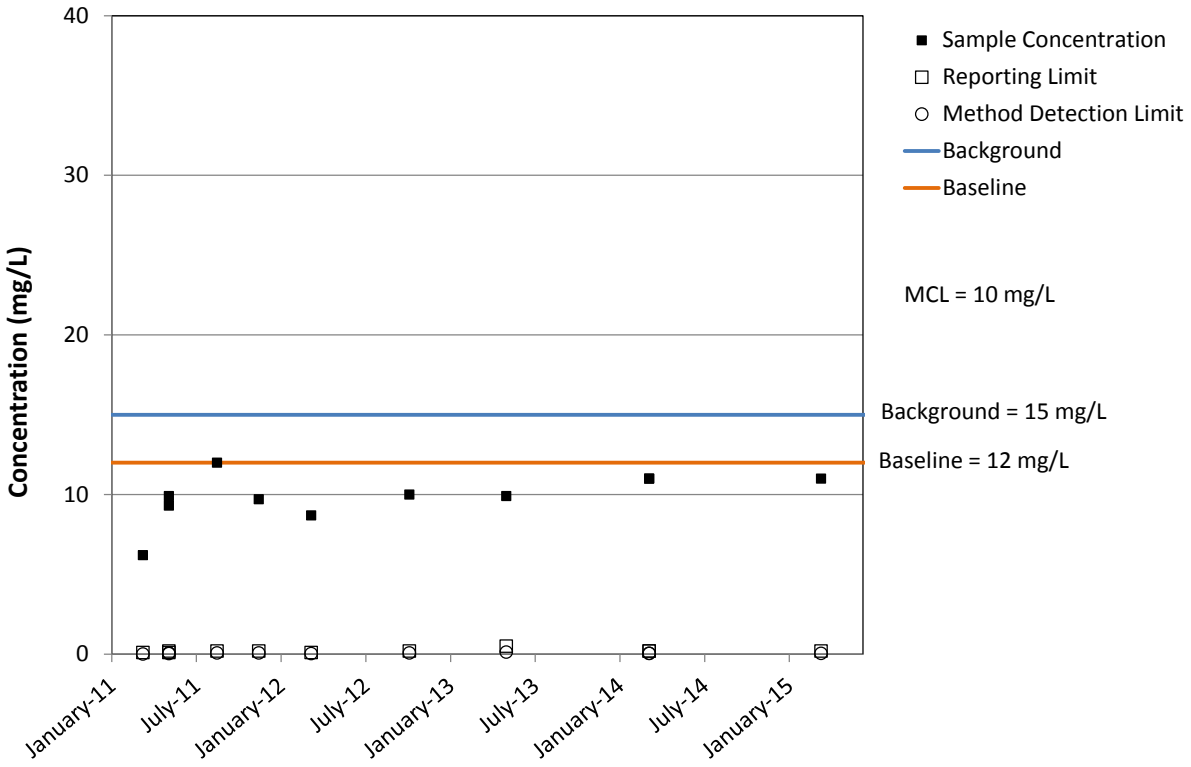
Strontium-90 in Well UCD1-054

MCL = maximum contaminant level



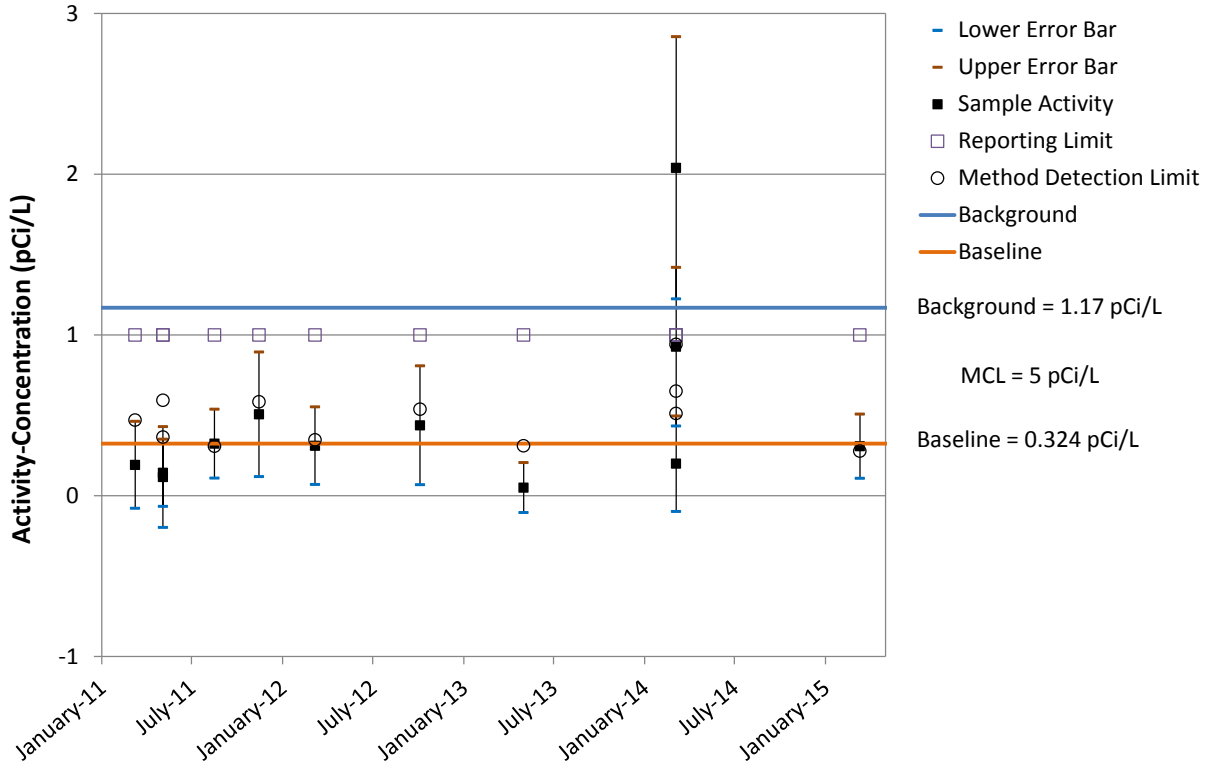
Carbon-14 in Well UCD1-068

MCL = maximum contaminant level
pCi/L = picocuries per liter



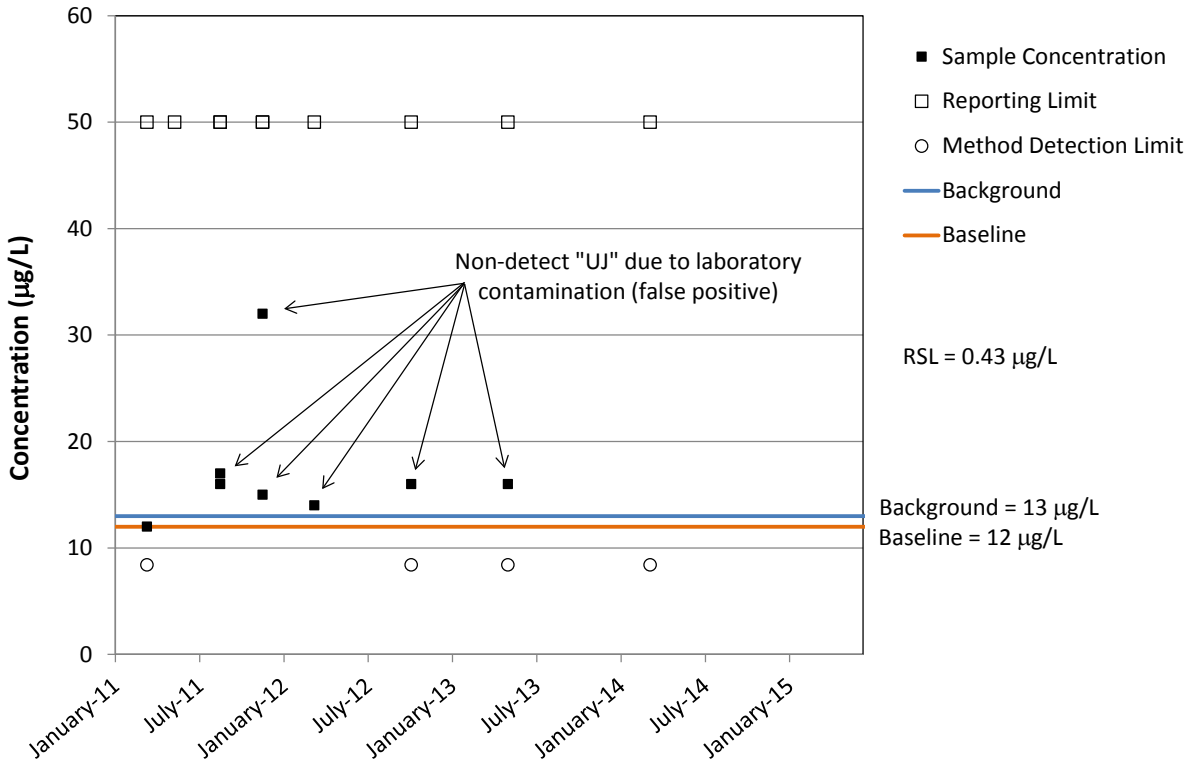
Nitrate in Well UCD1-068

MCL = maximum contaminant level
mg/L = milligrams per liter
not detected if sample concentration not shown



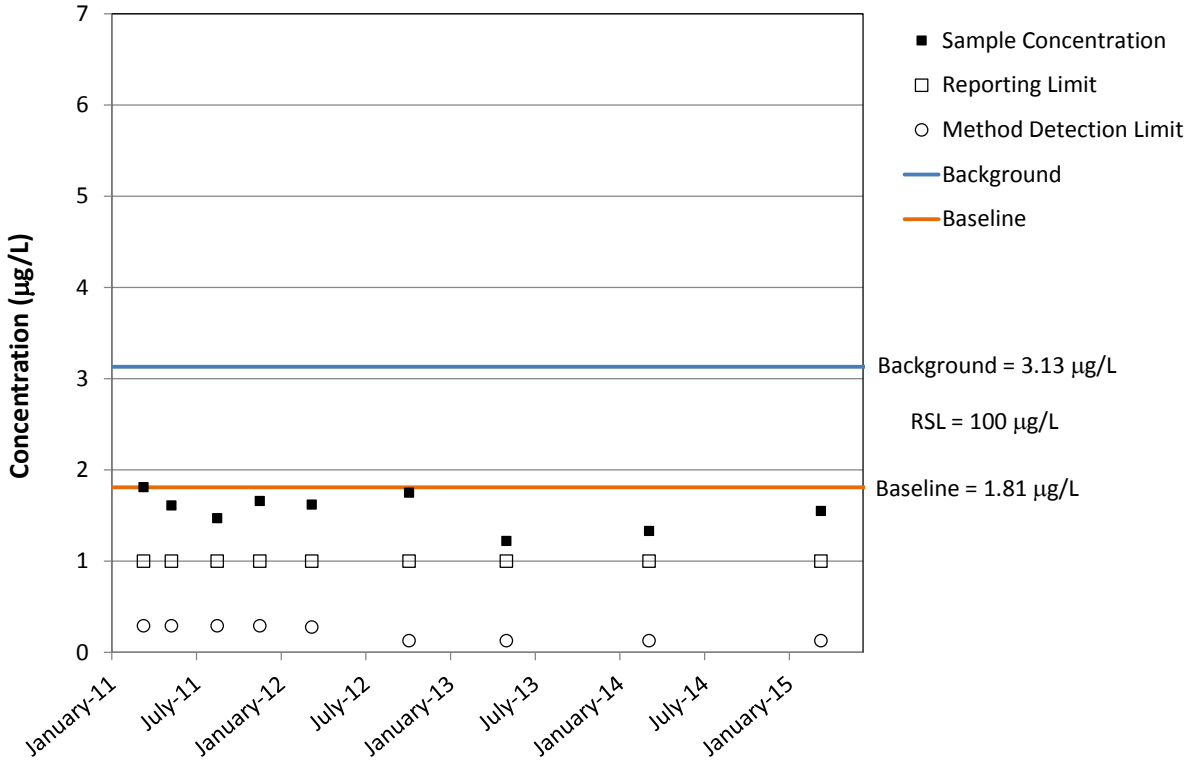
Radium-226 in Well UCD1-068

MCL = maximum contaminant level
pCi/L = picocuries per liter



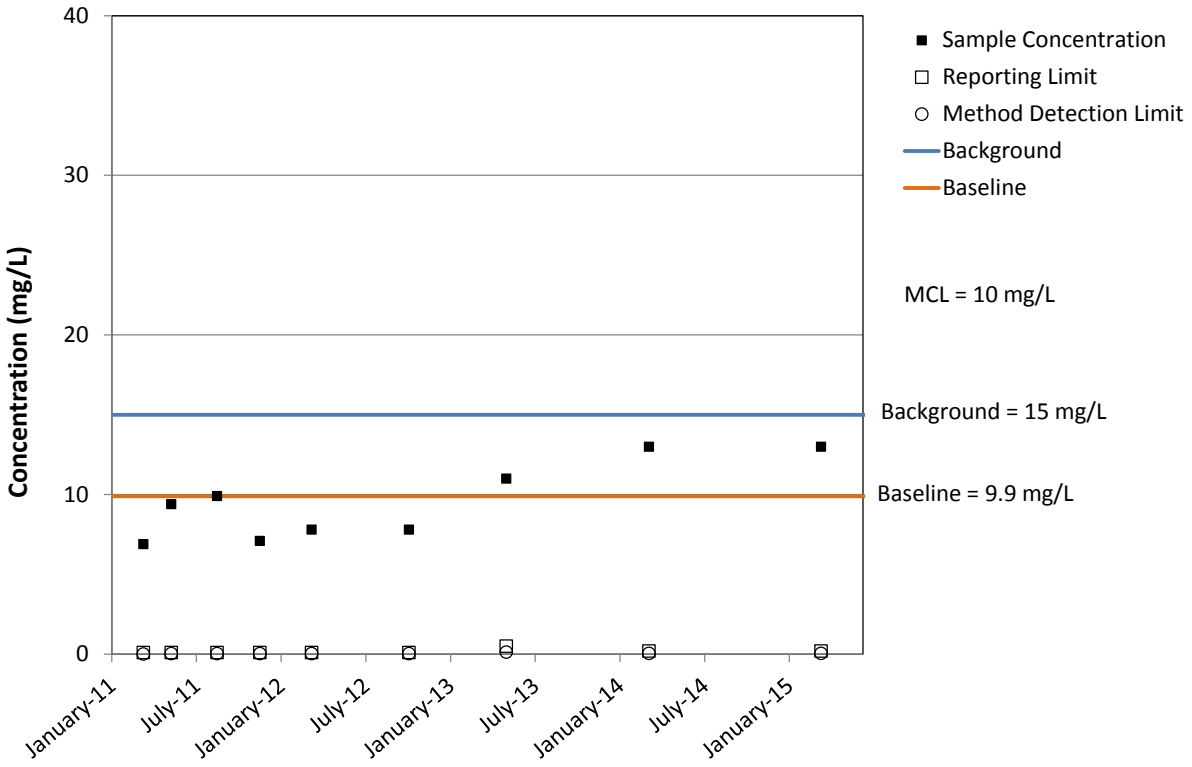
RSL = regional screening level
µg/L = micrograms per liter
not detected if sample concentration not shown

Formaldehyde in Well UCD1-069



RSL = regional screening level
µg/L = micrograms per liter
not detected if sample concentration not shown

Molybdenum in Well UCD1-069



Nitrate in Well UCD1-069

MCL = maximum contaminant level
mg/L = milligrams per liter
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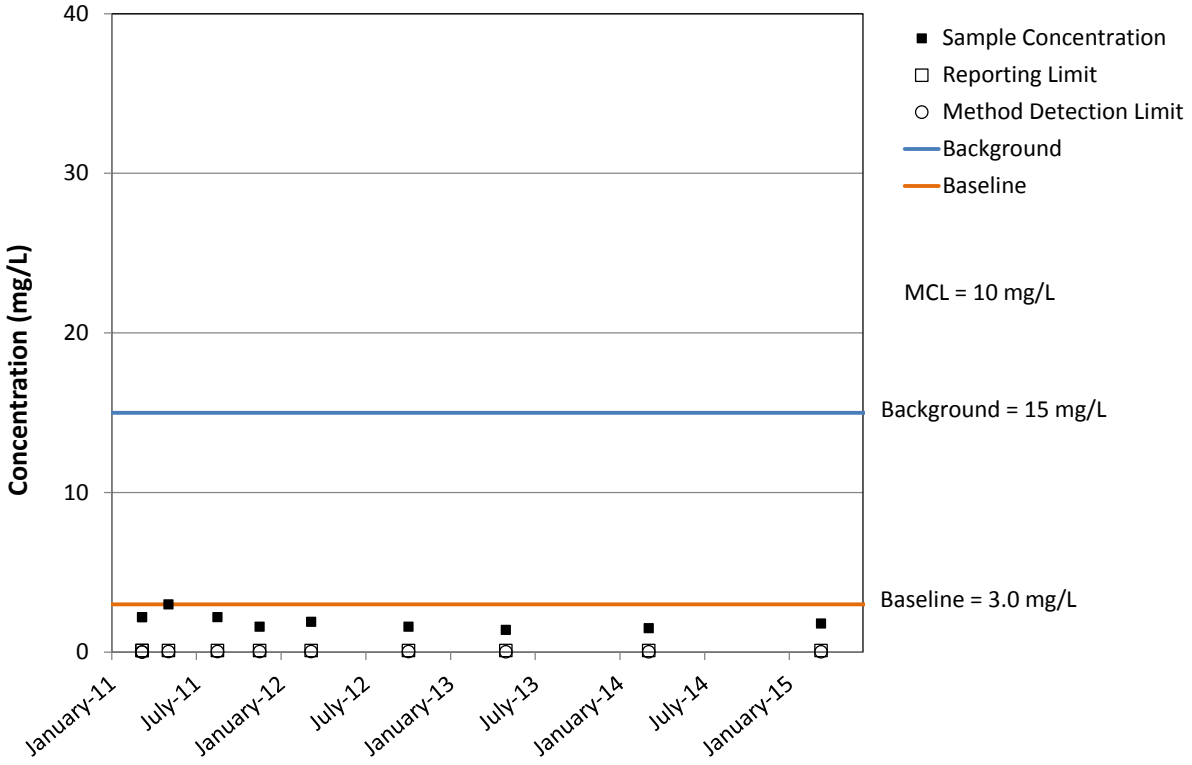
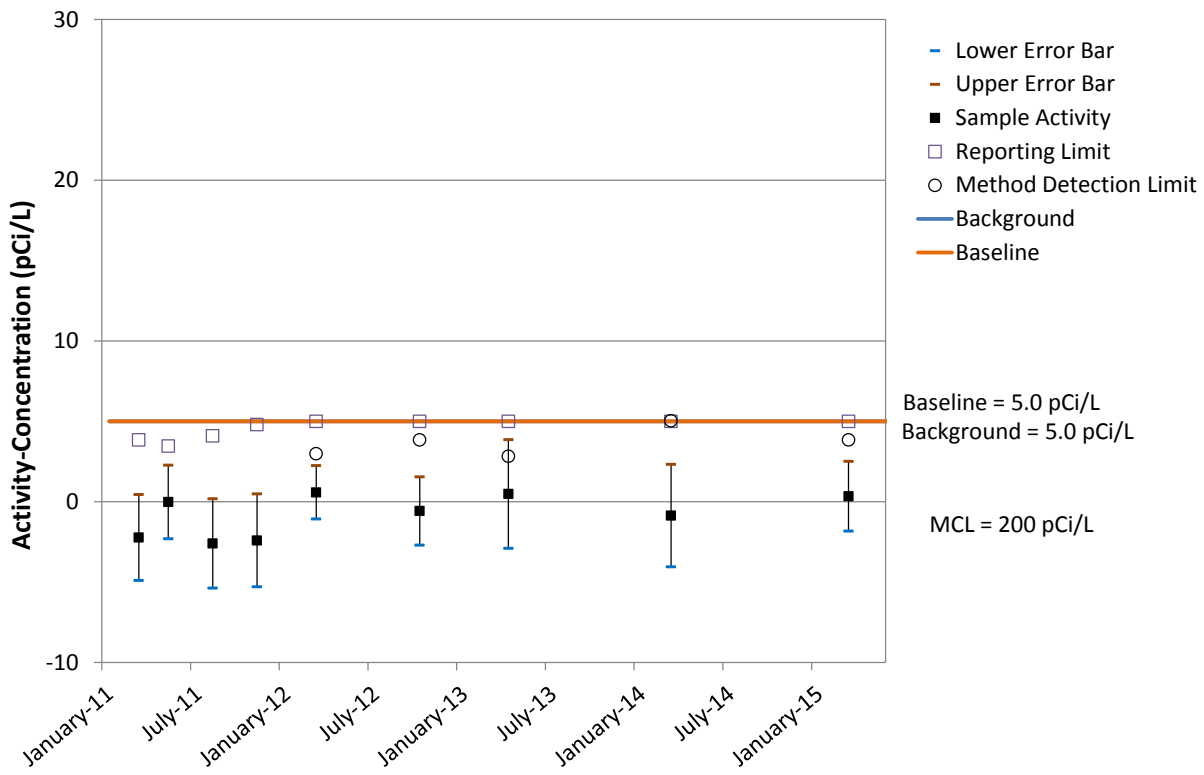


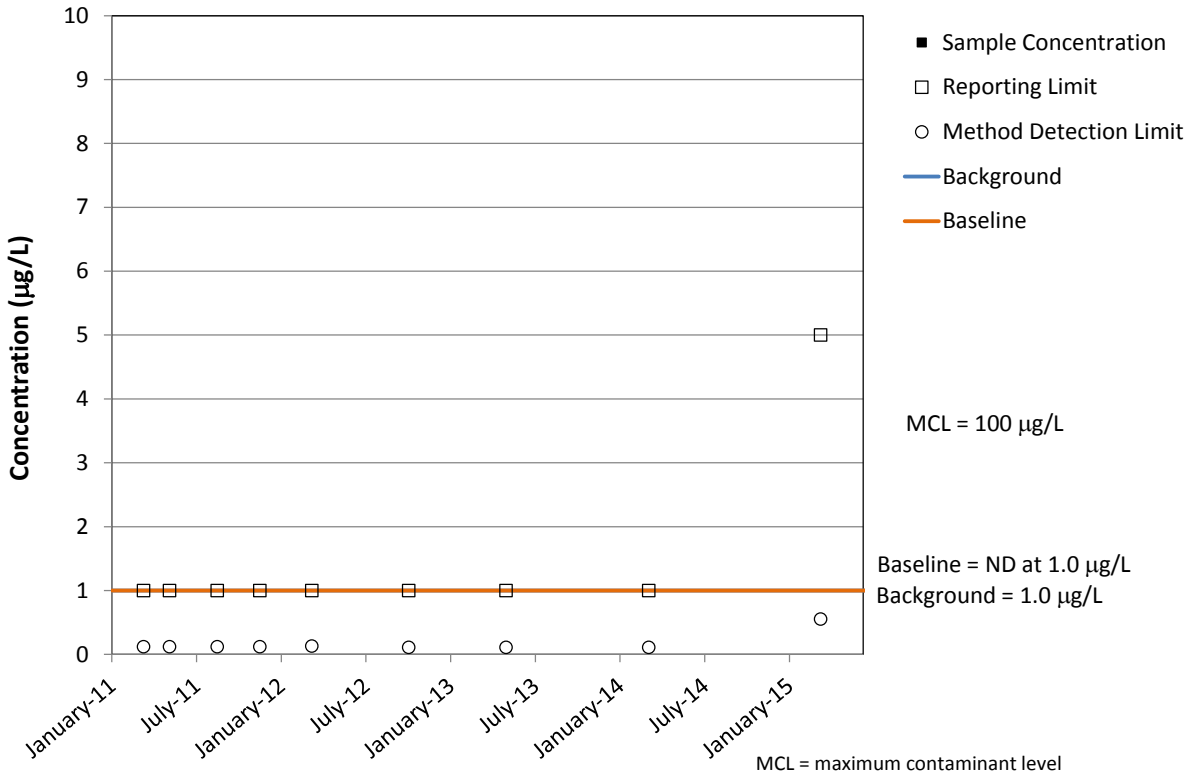
Nitrate in Well UCD1-070

MCL = maximum contaminant level
mg/L = milligrams per liter
not detected if sample concentration not shown



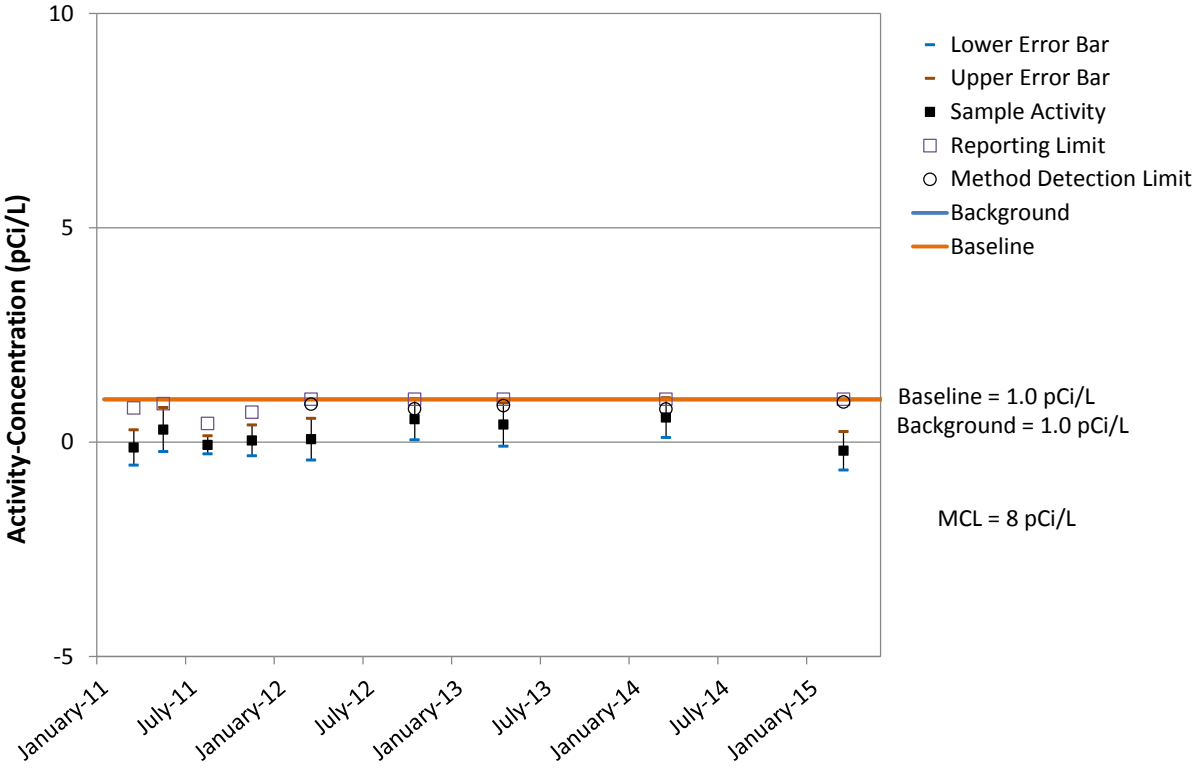
Cesium-137 in Well UCD1-071

MCL = maximum contaminant level
pCi/L = picocuries per liter



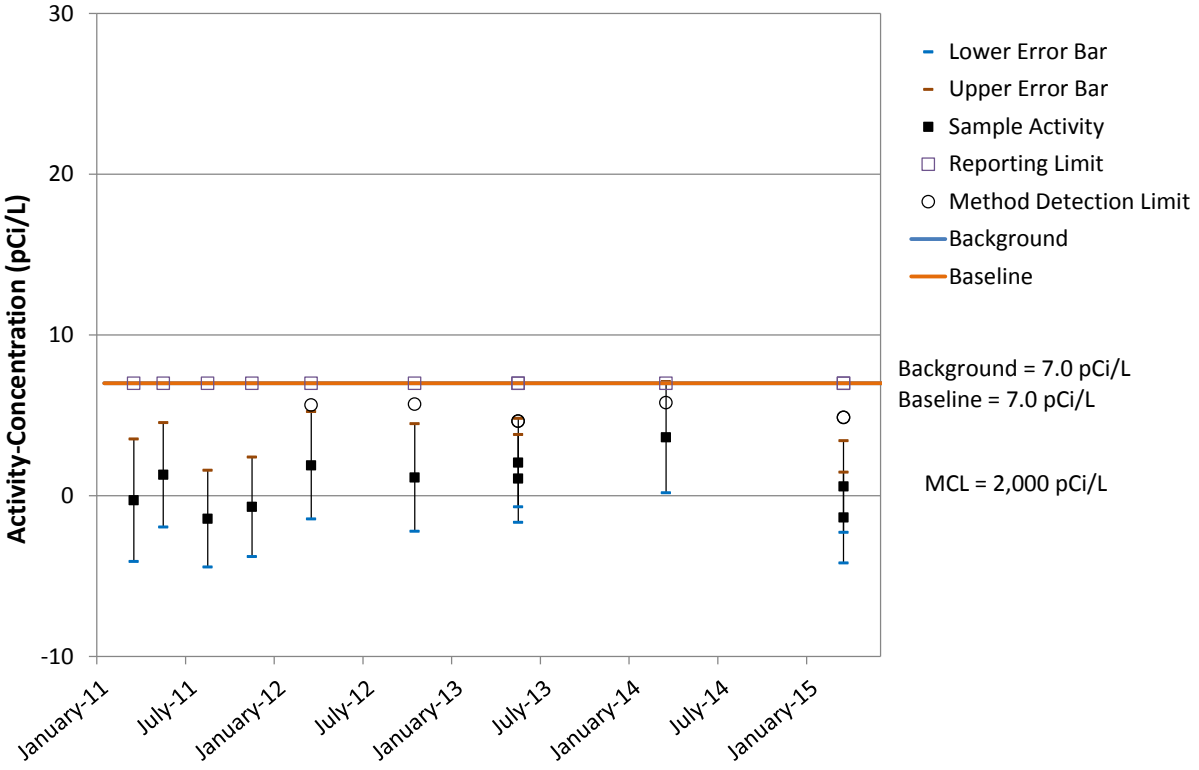
Silver in Well UCD1-071

MCL = maximum contaminant level
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown



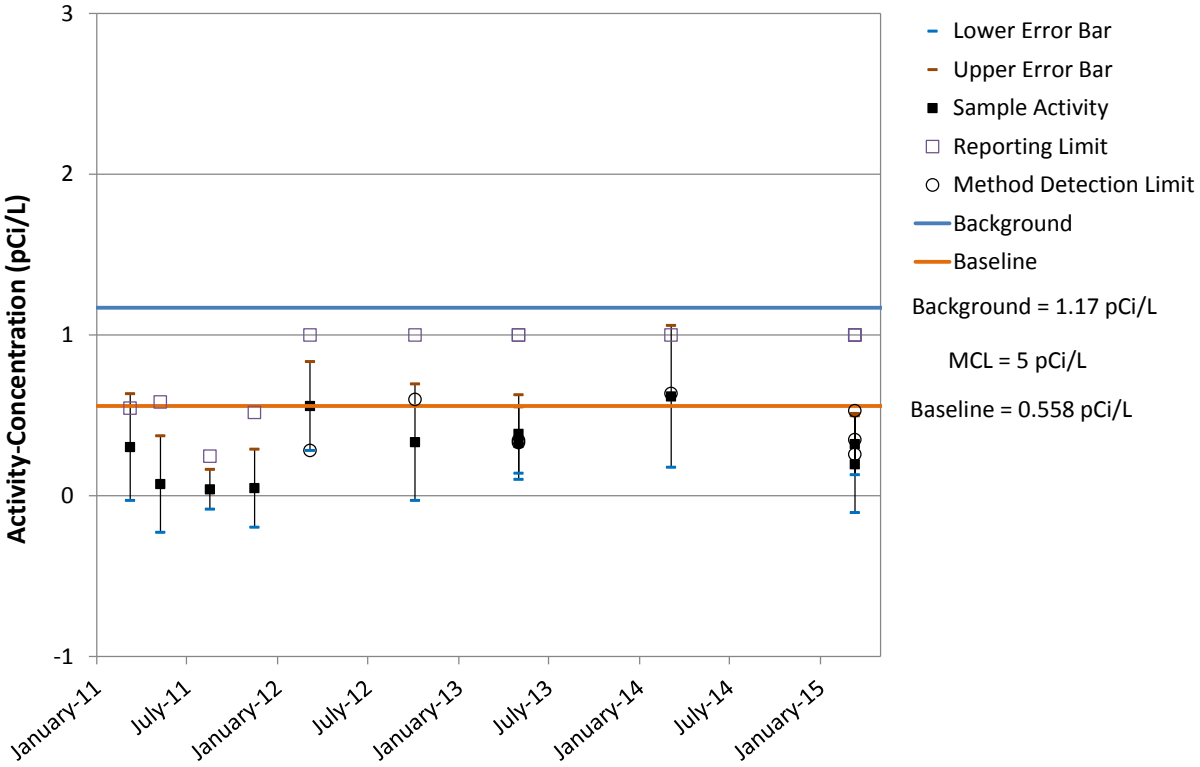
Strontium-90 in Well UCD1-071

MCL = maximum contaminant level
pCi/L = picocuries per liter



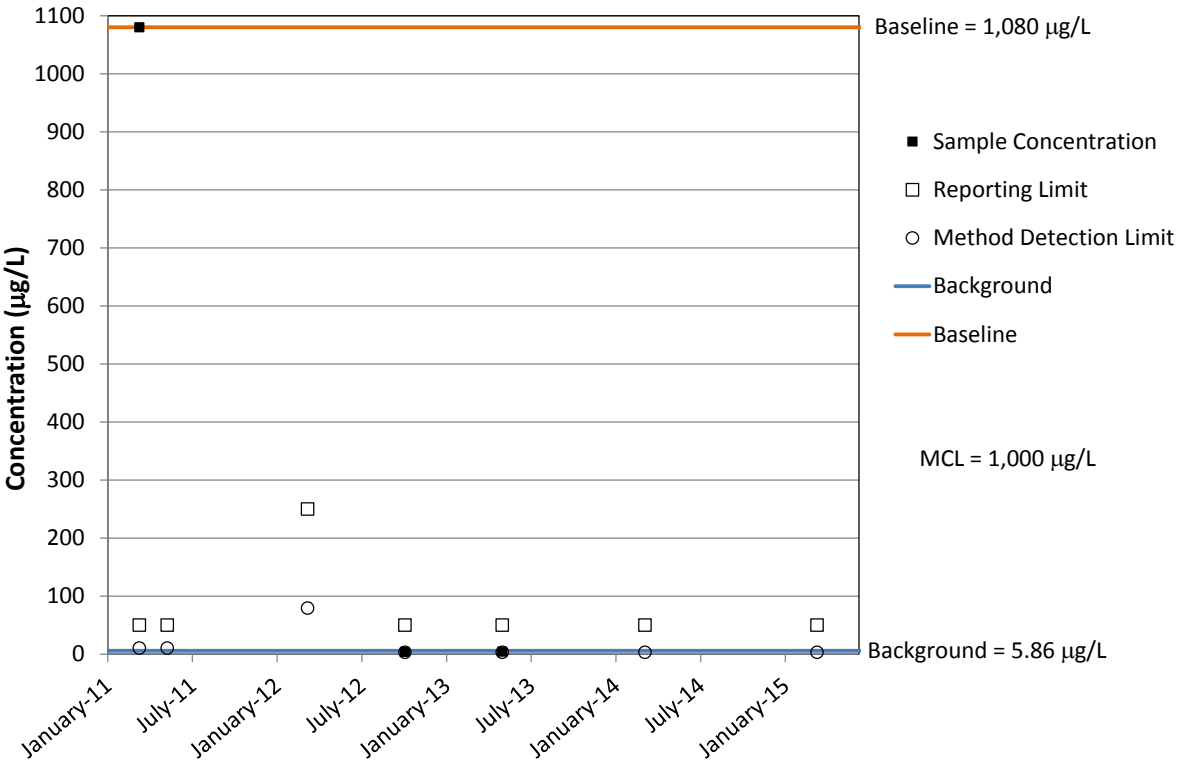
Carbon-14 in Well UCD1-072

MCL = maximum contaminant level
pCi/L = picocuries per liter



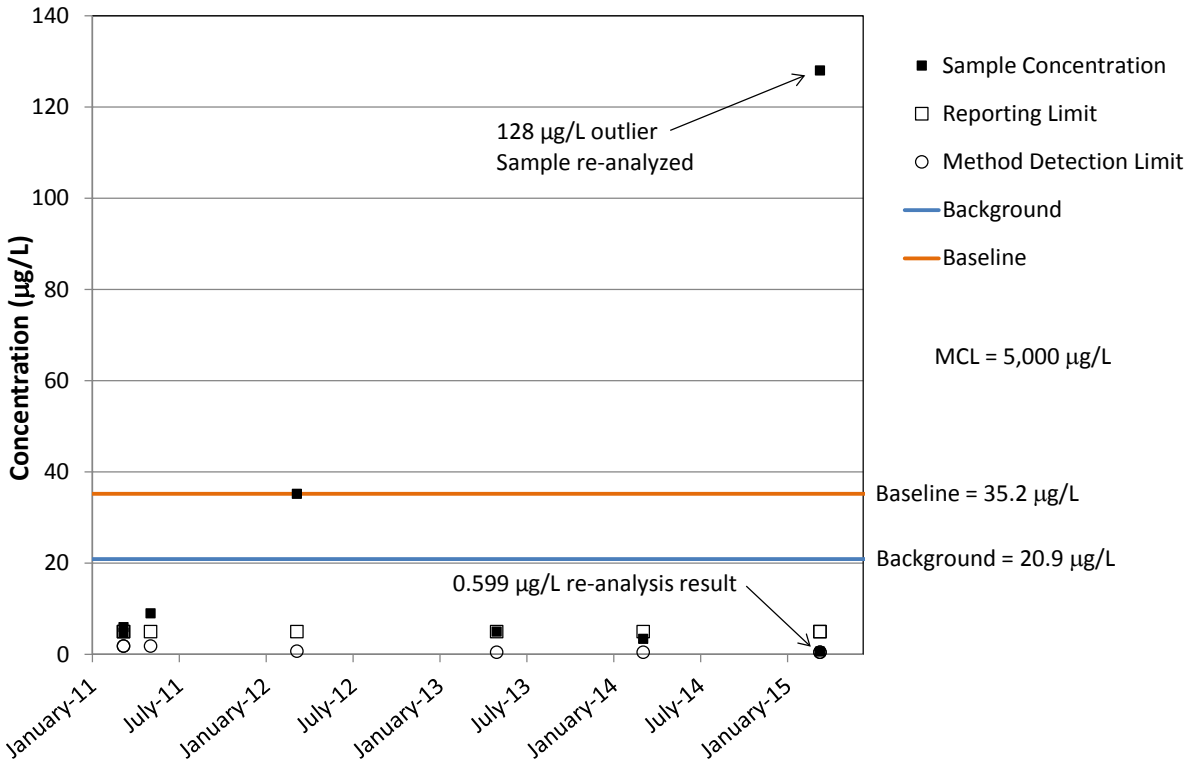
Radium-226 in Well UCD1-072

MCL = maximum contaminant level
pCi/L = picocuries per liter



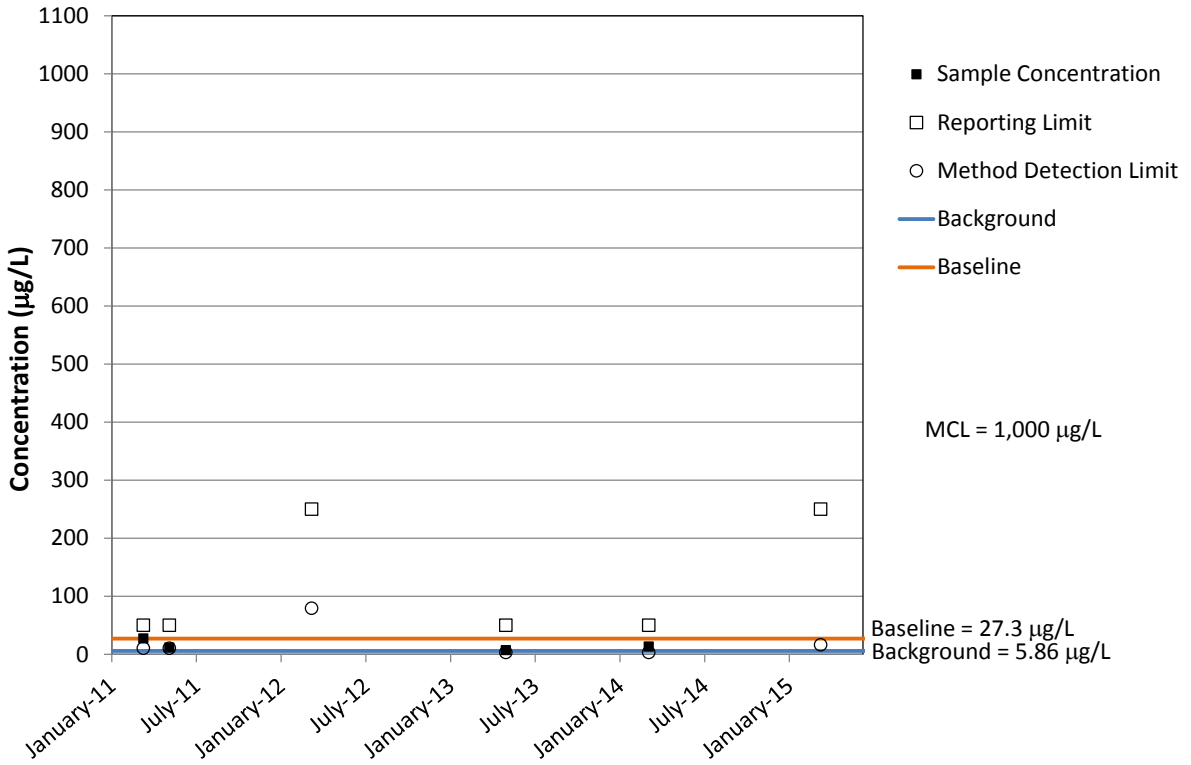
Aluminum in Well UCD1-069

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



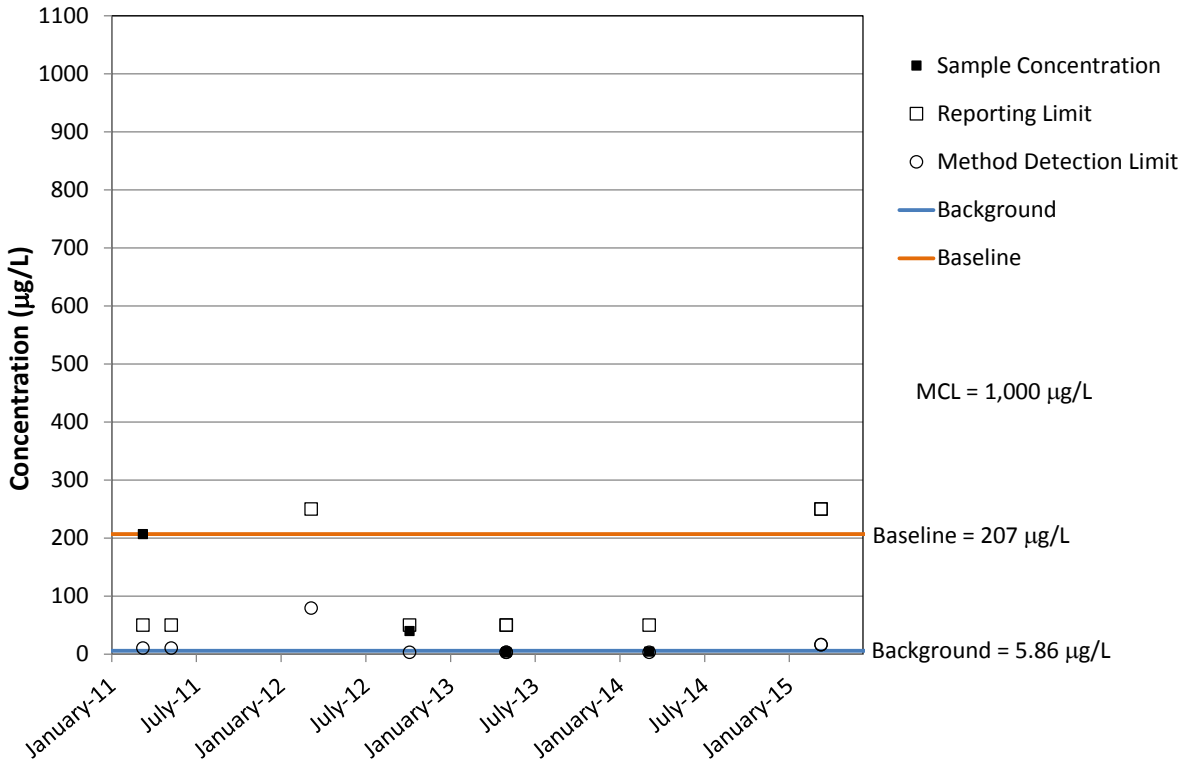
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

Zinc in Well UCD1-070



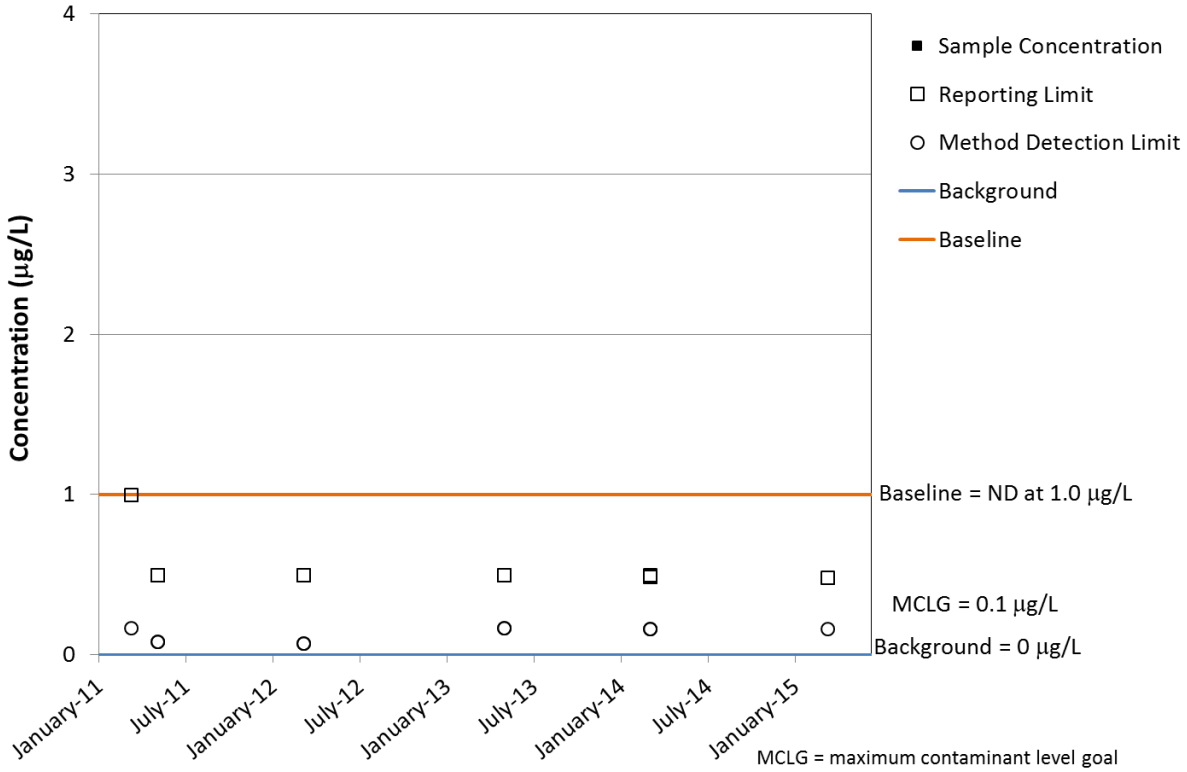
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

Aluminum in Well UCD1-071



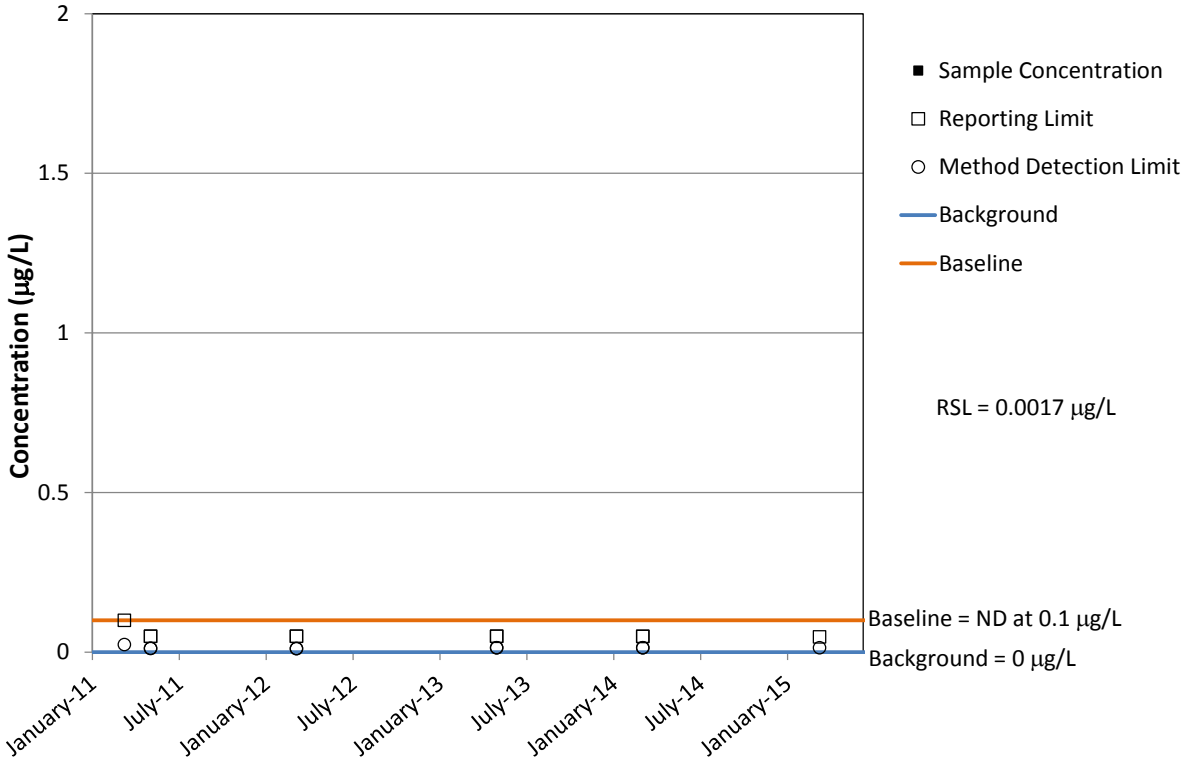
Aluminum in Well UCD1-072

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



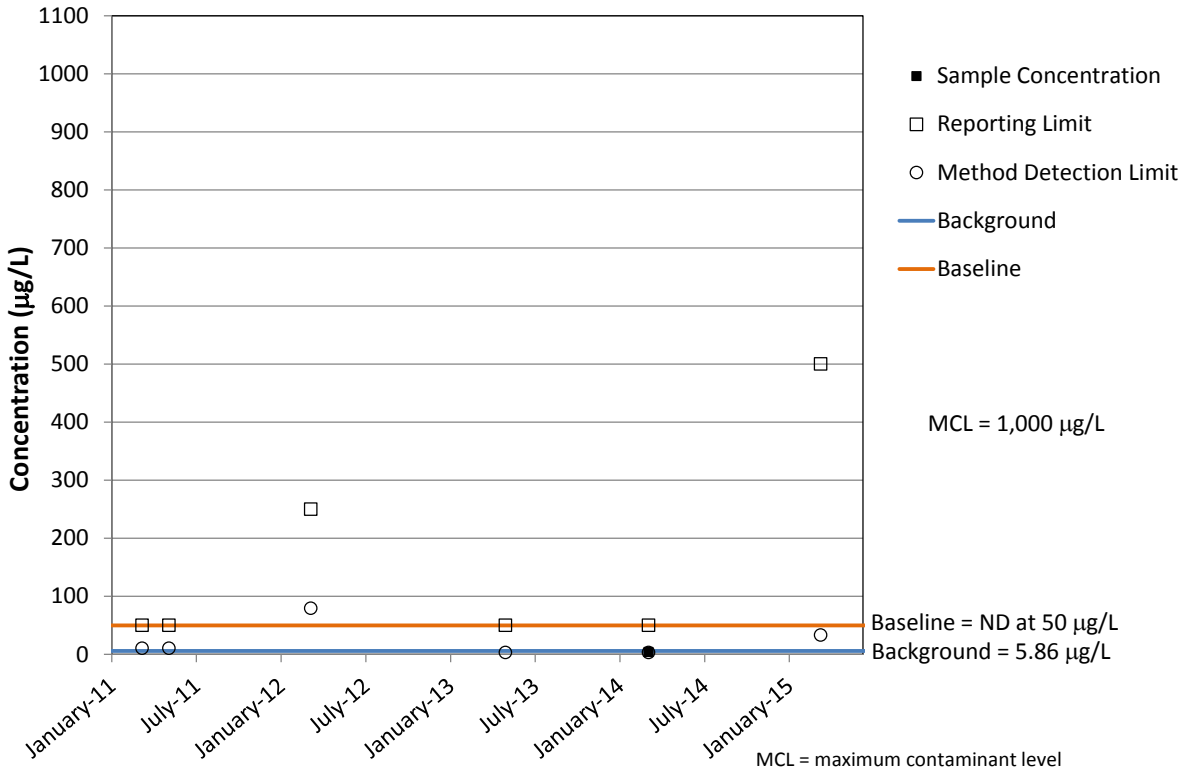
Chlordane in Well UCD1-013

MCLG = maximum contaminant level goal
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown



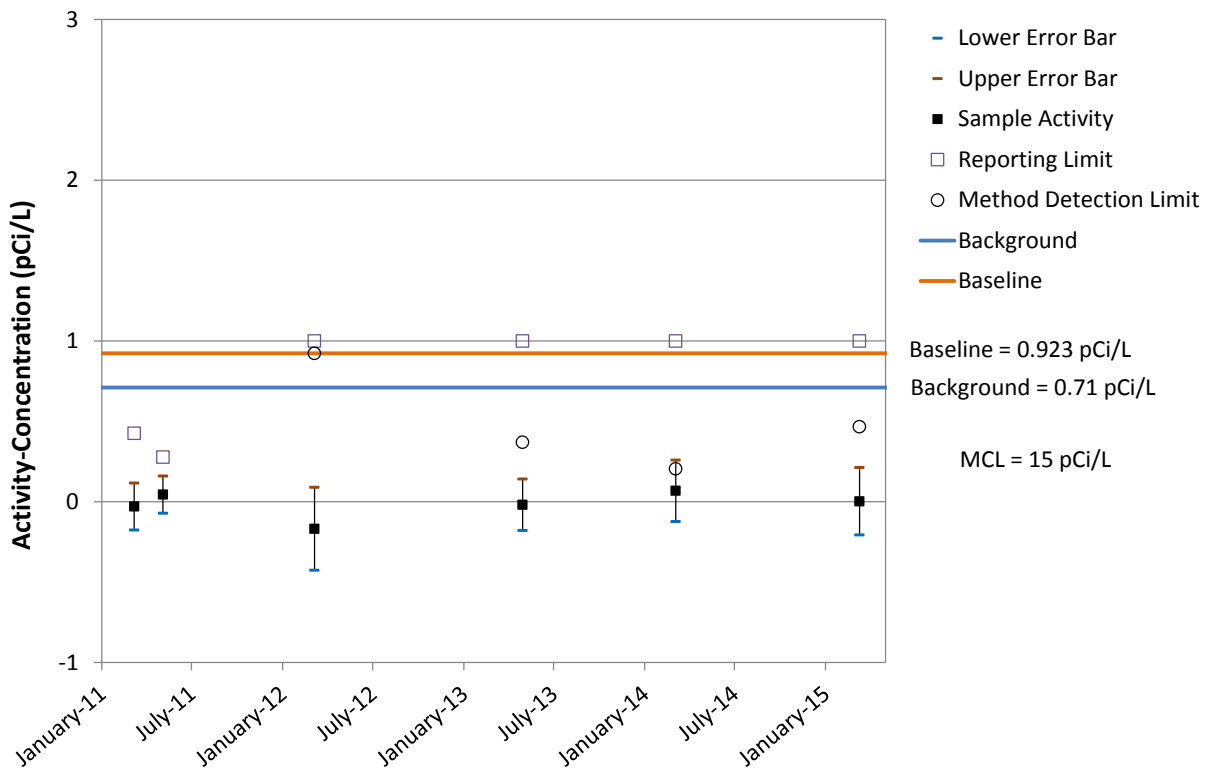
RSL = regional screening level
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown

Dieldrin in Well UCD1-013



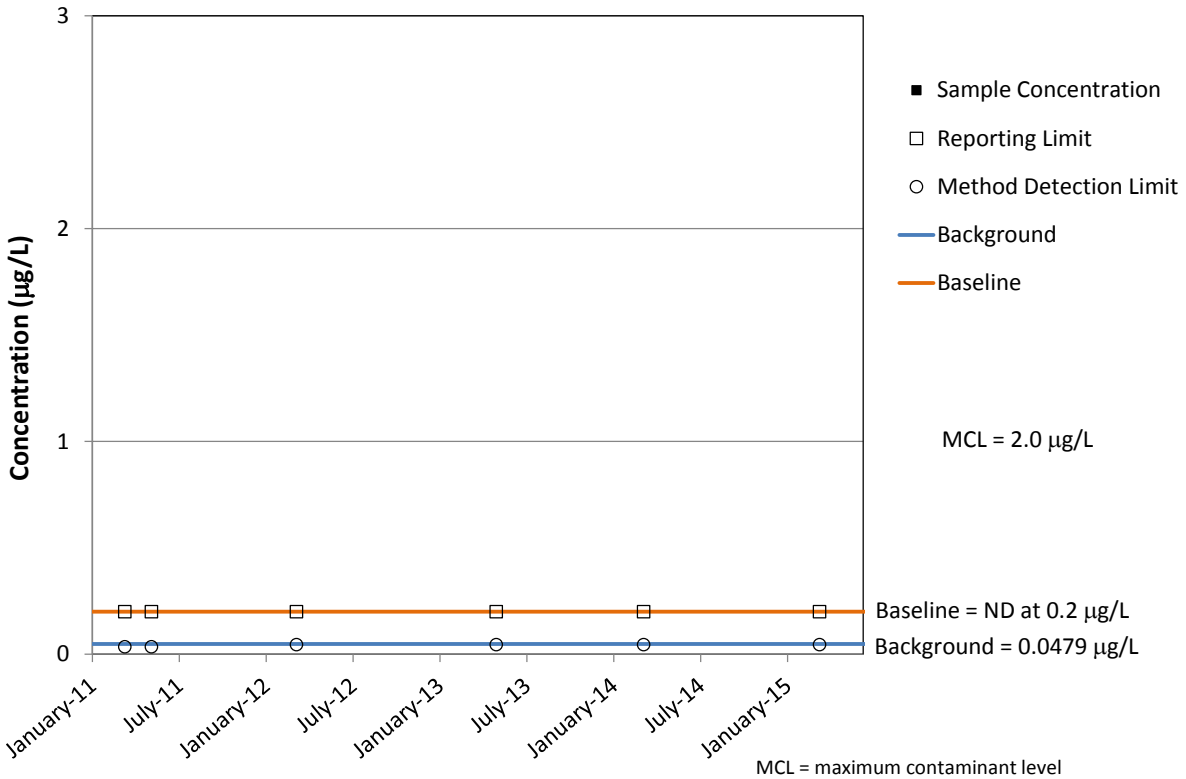
MCL = maximum contaminant level
ND = not detected
µg/L = micrograms per liter
not detected if sample concentration not shown

Aluminum in Well UCD1-021



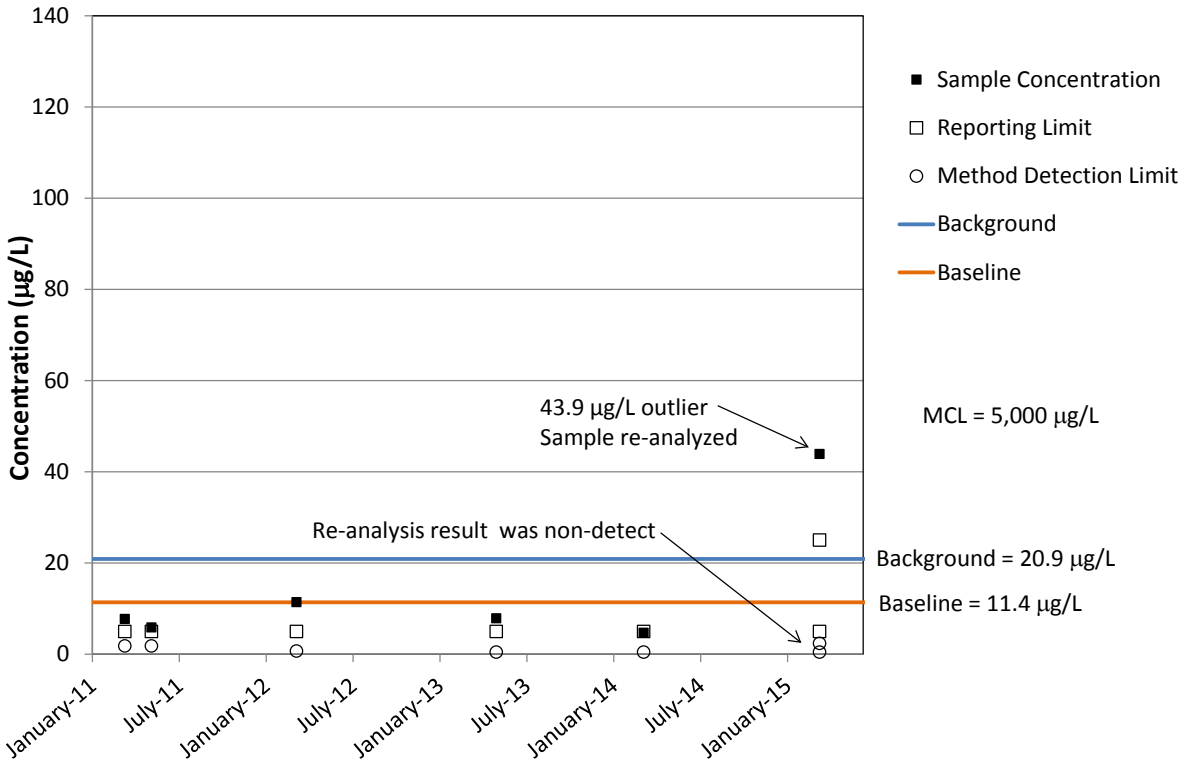
Americium-241 in Well UCD1-021

MCL = maximum contaminant level
pCi/L = picocuries per liter



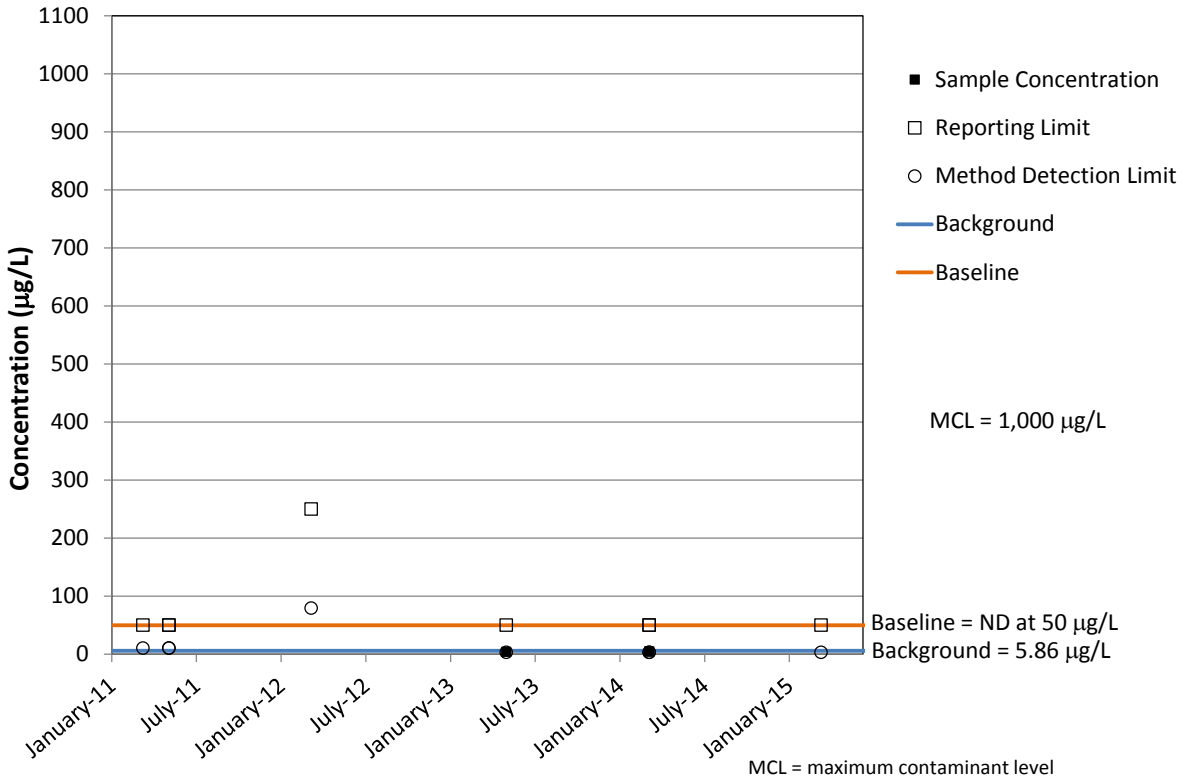
Mercury in Well UCD1-023

MCL = maximum contaminant level
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown



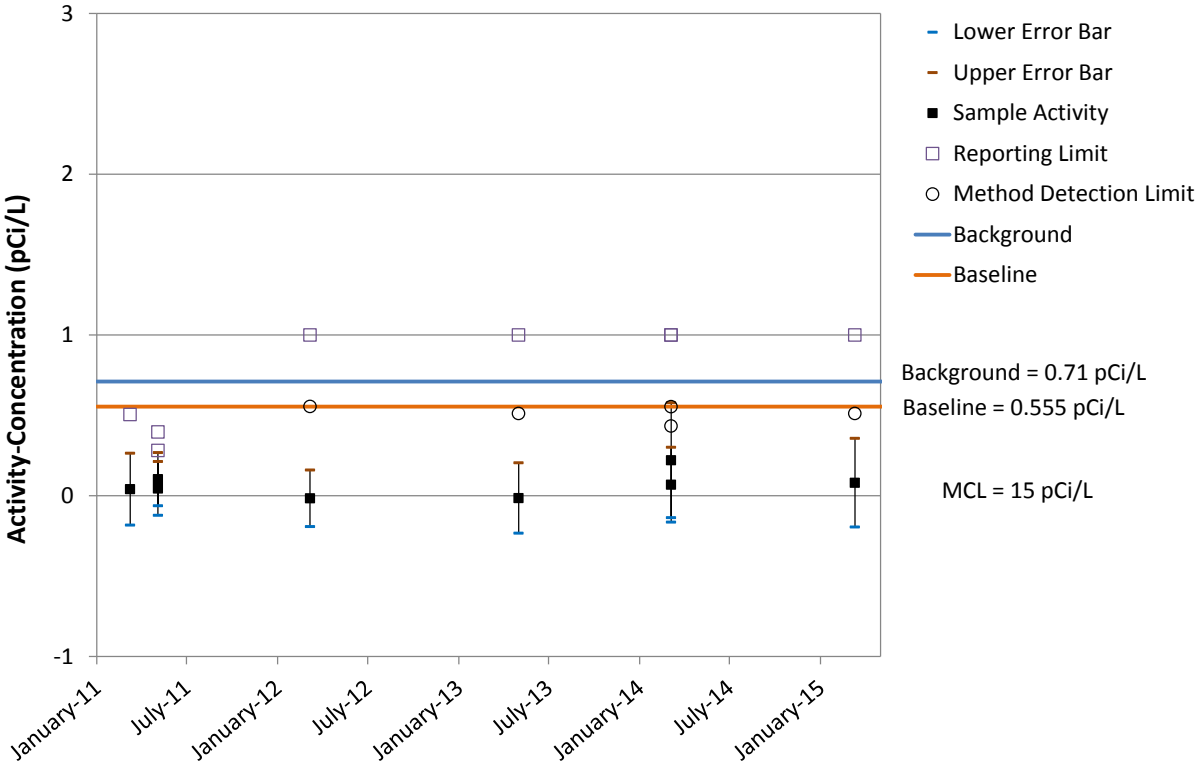
Zinc in Well UCD1-023

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



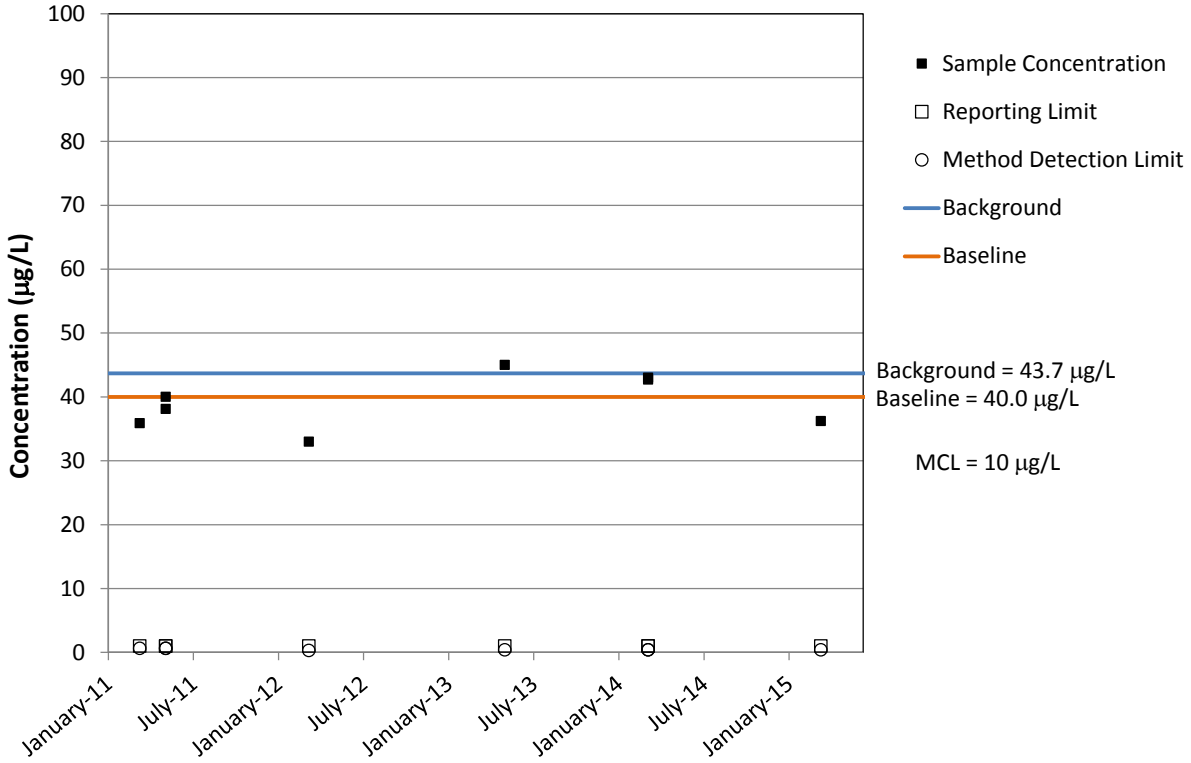
Aluminum in Well UCD1-068

MCL = maximum contaminant level
ND = not detected
µg/L = micrograms per liter
not detected if sample concentration not shown



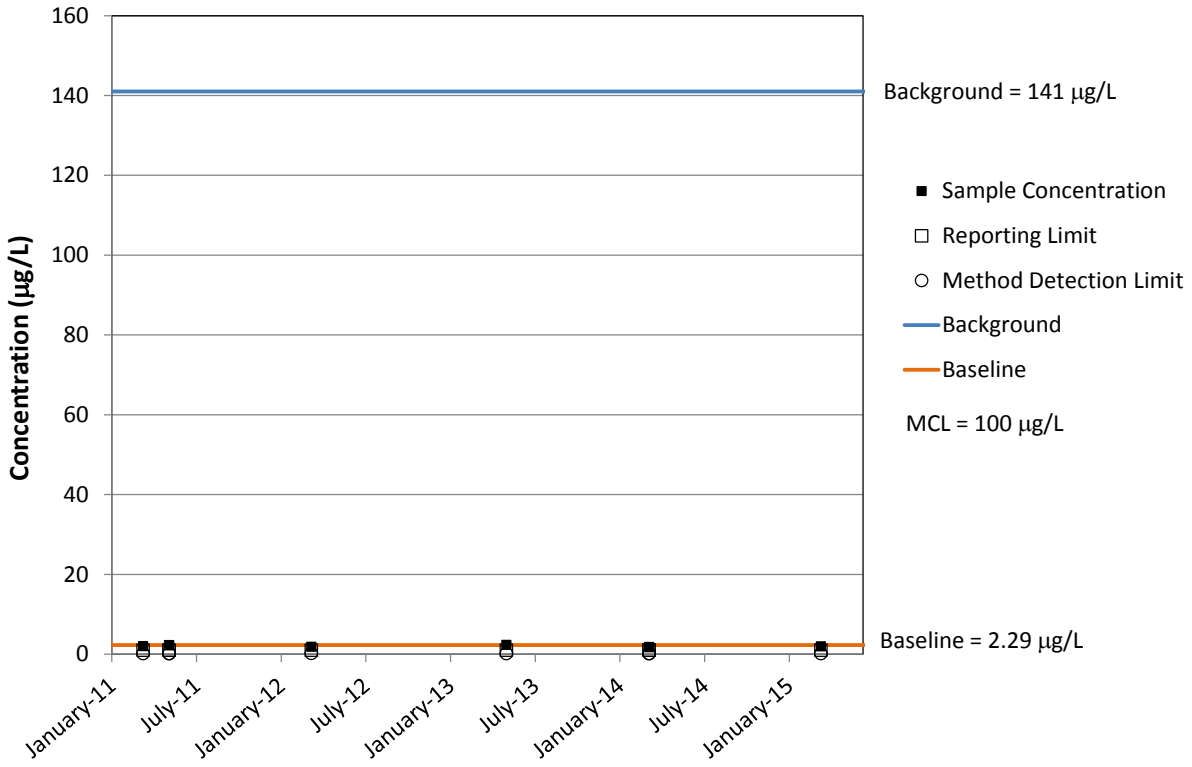
Americium-241 in Well UCD1-068

MCL = maximum contaminant level
pCi/L = picocuries per liter



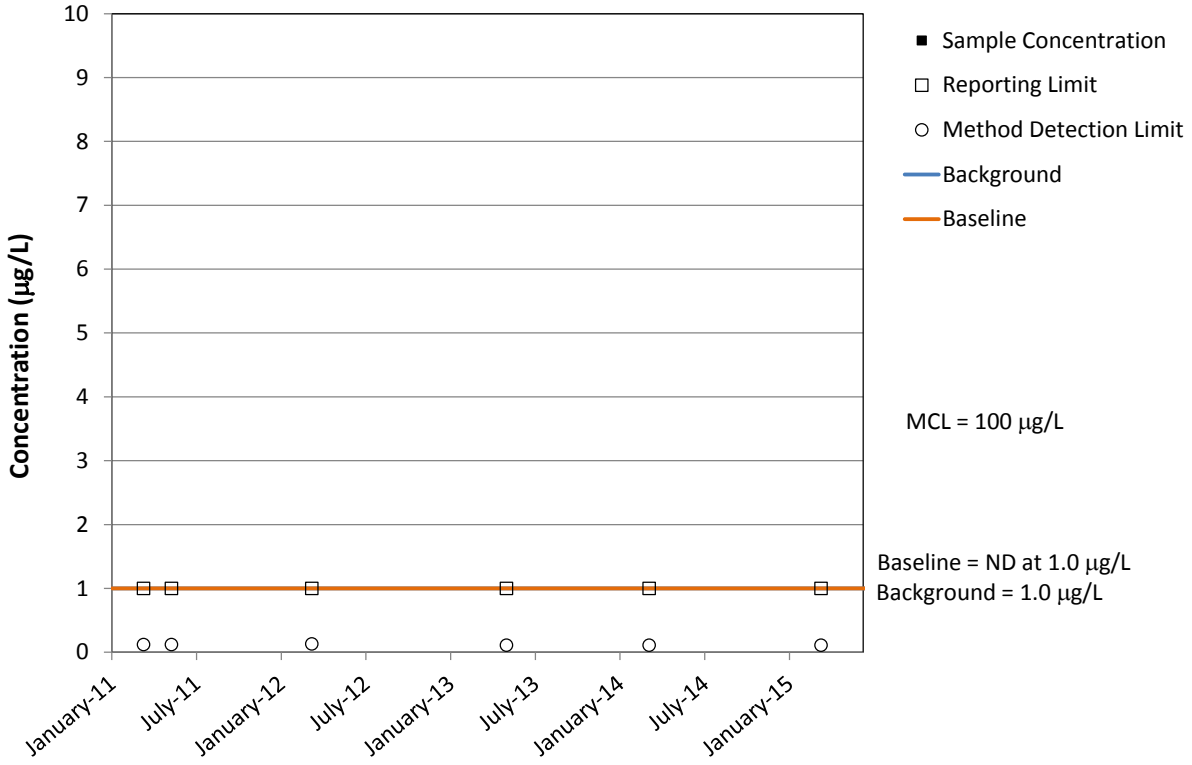
Chromium in Well UCD1-068

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



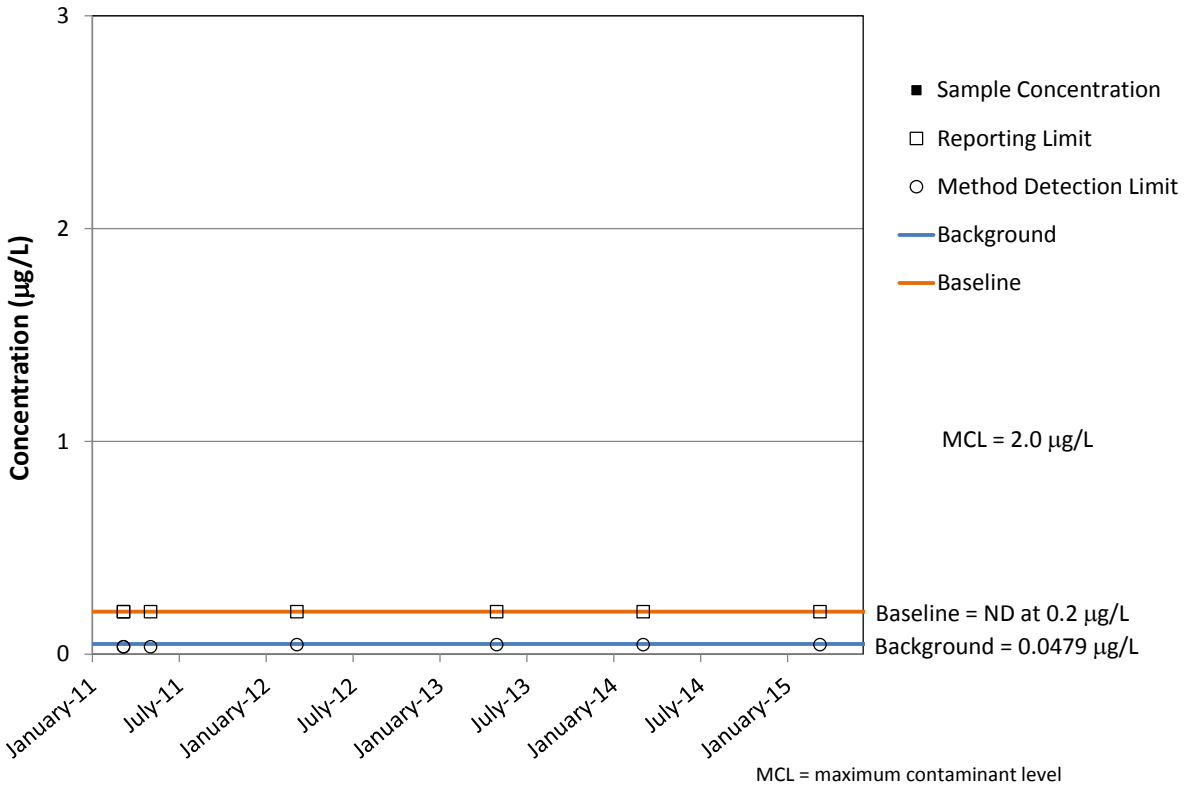
Nickel in Well UCD1-068

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



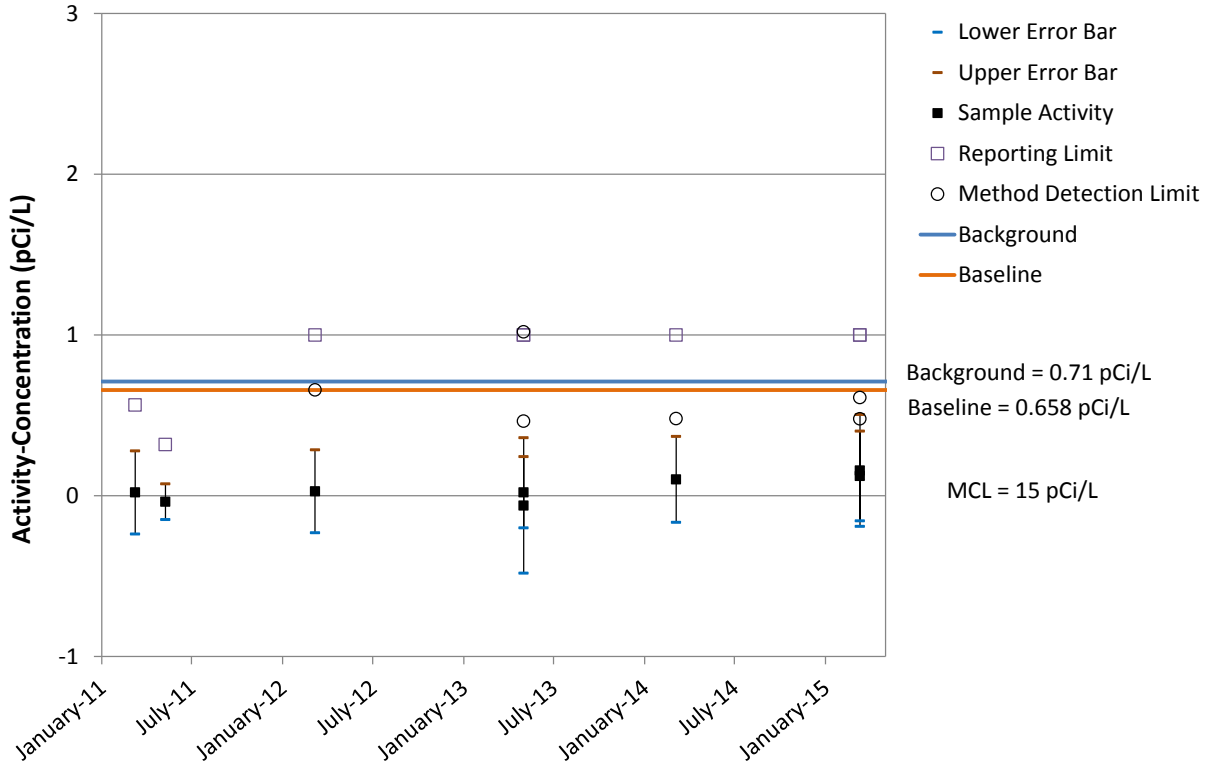
Silver in Well UCD1-069

MCL = maximum contaminant level
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown



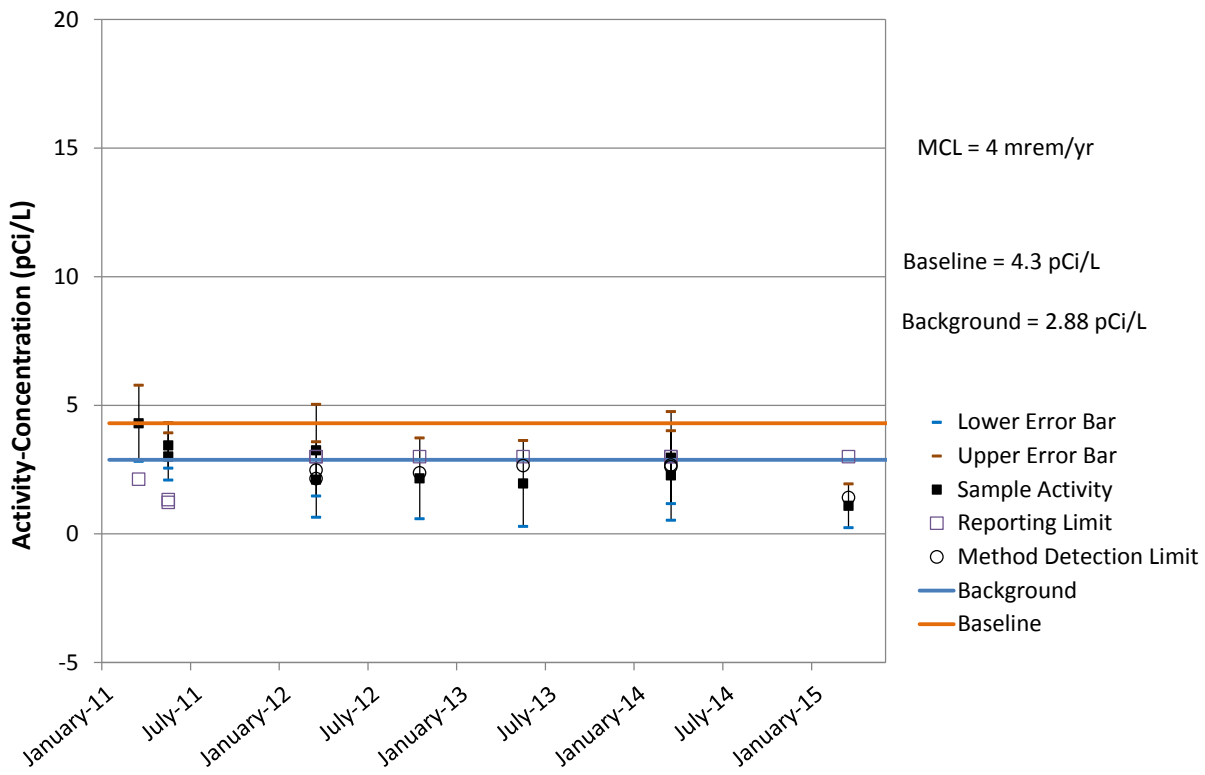
MCL = maximum contaminant level
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown

Mercury in Well UCD1-070



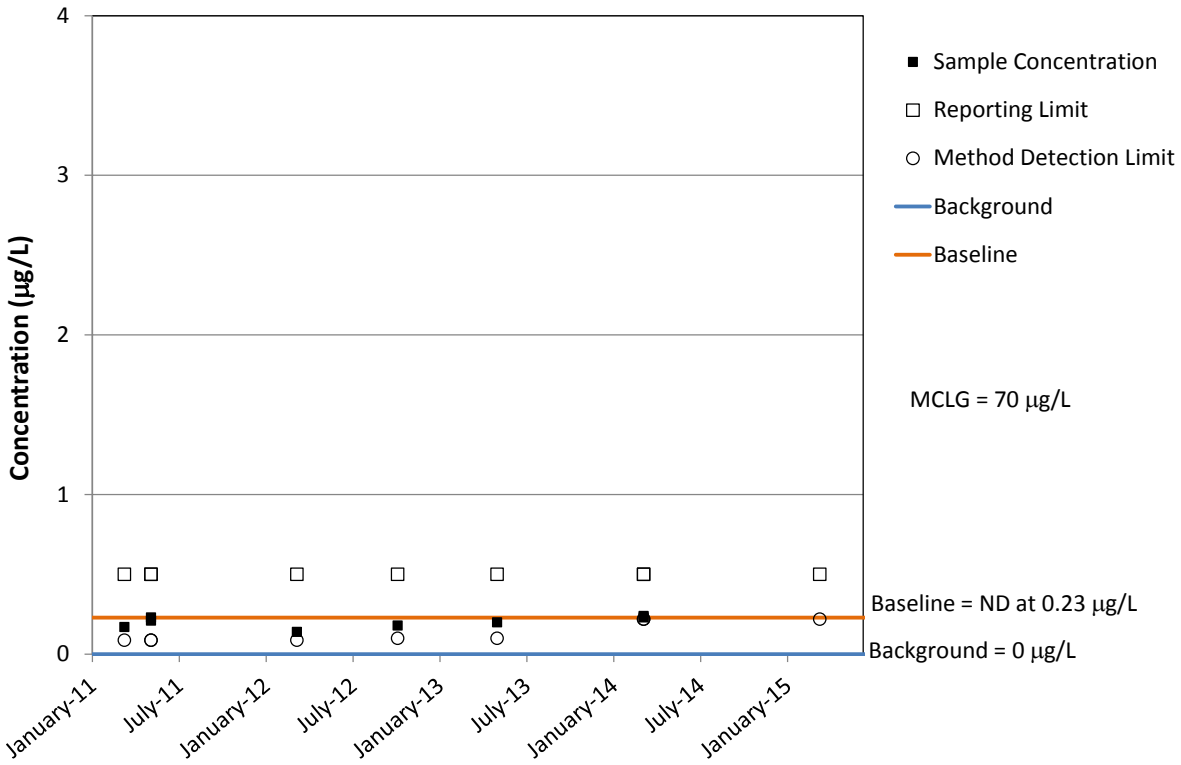
MCL = maximum contaminant level
pCi/L = picocuries per liter

Americium-241 in Well UCD1-072



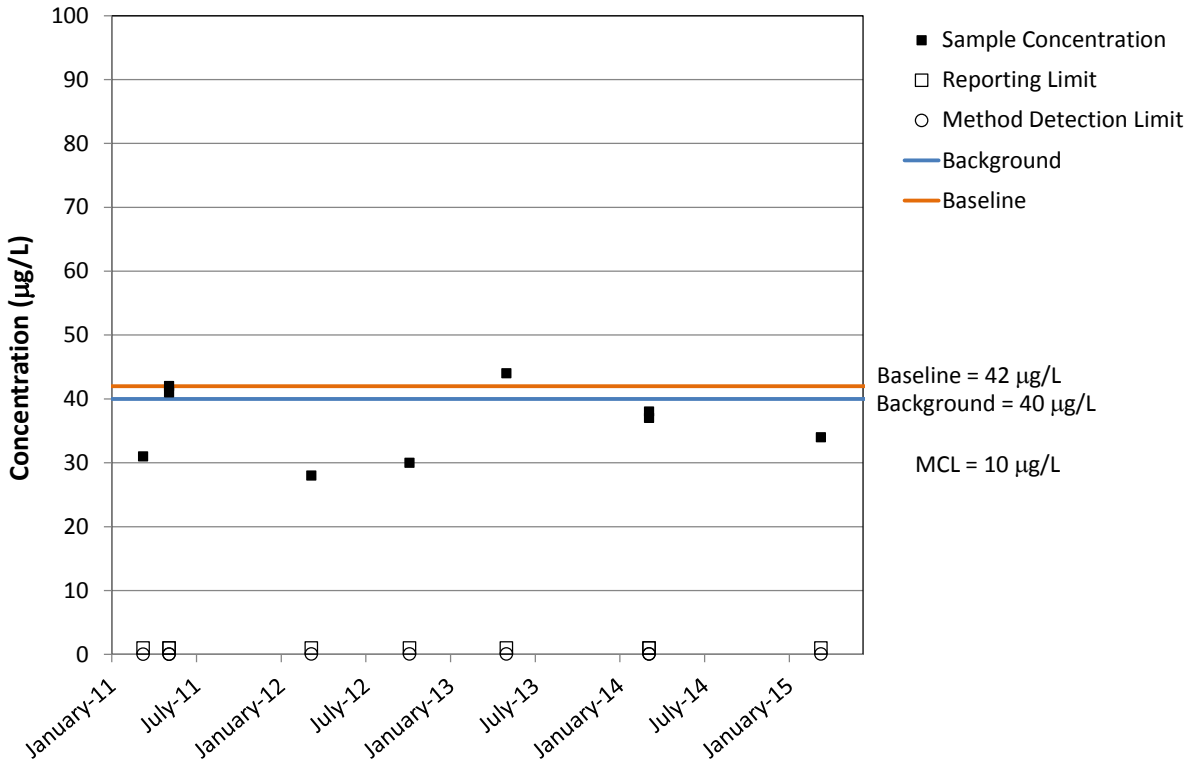
Beta, Gross in Well UCD1-068

MCL = maximum contaminant level



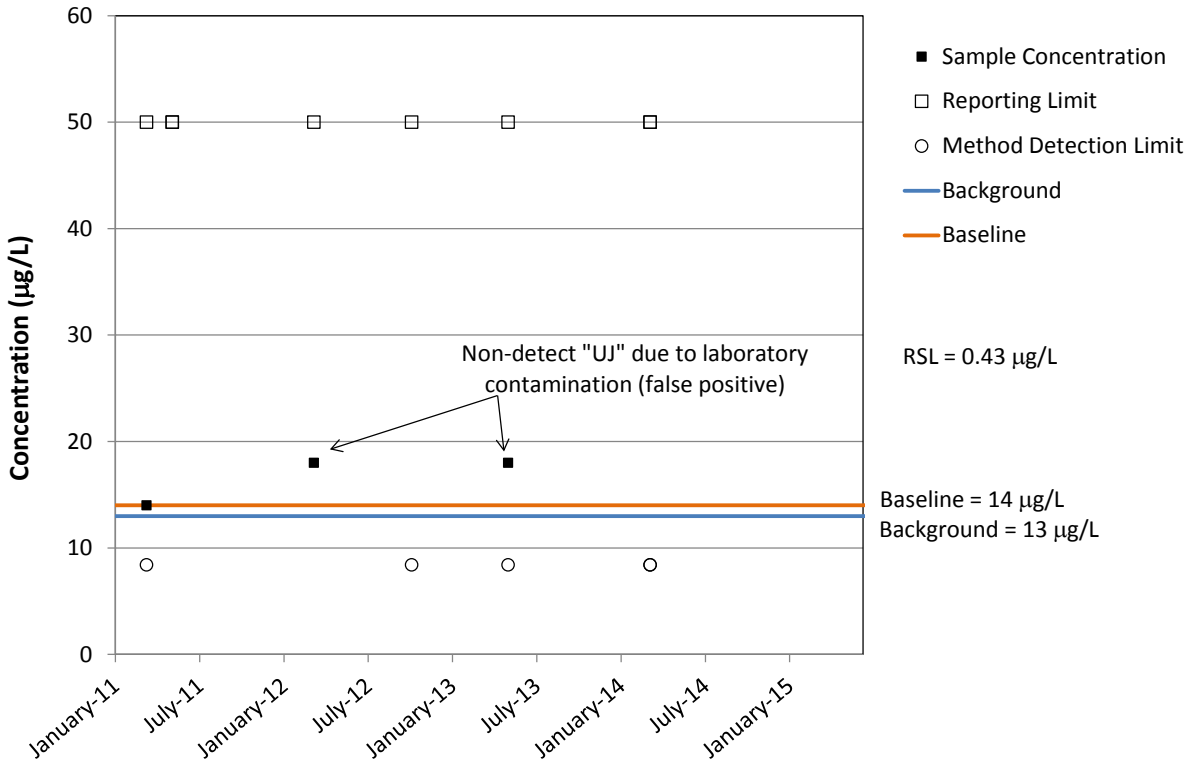
Chloroform in Well UCD1-068

MCLG = maximum contaminant level goal
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown



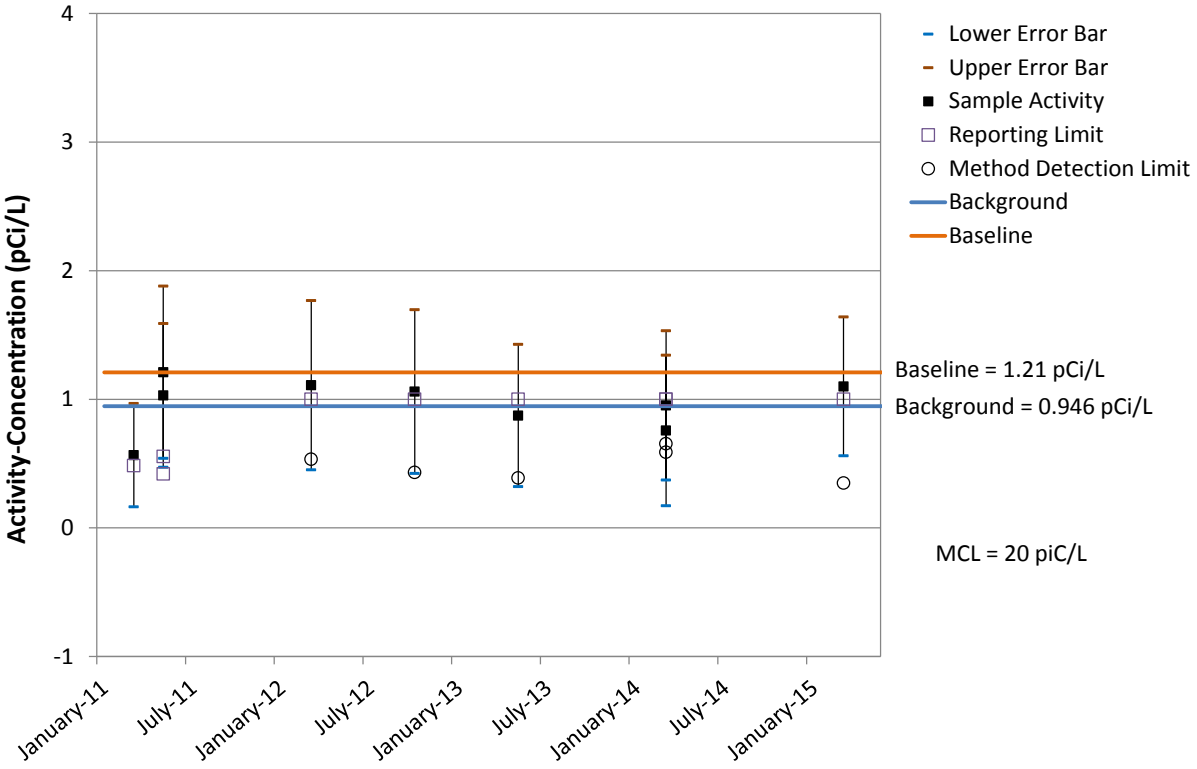
Hexavalent Chromium in Well UCD1-068

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



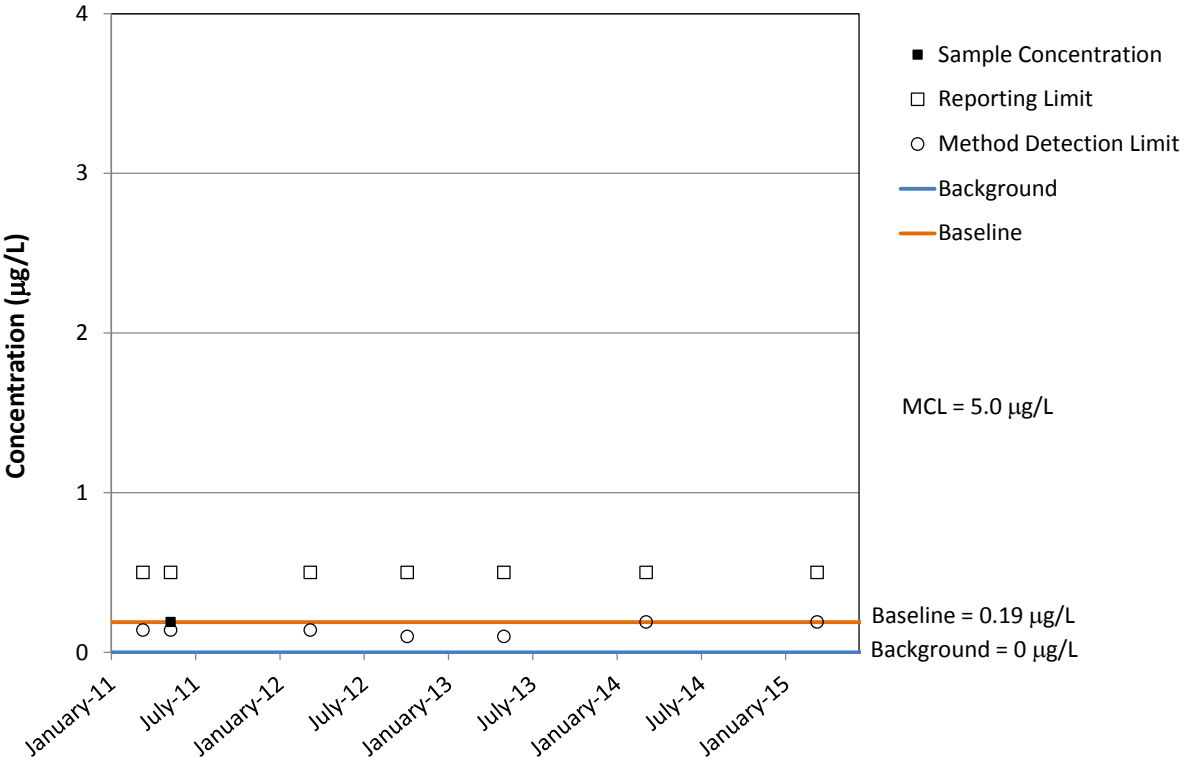
Formaldehyde in Well UCD1-068

RSL = regional screening level
µg/L = micrograms per liter
not detected if sample concentration not shown



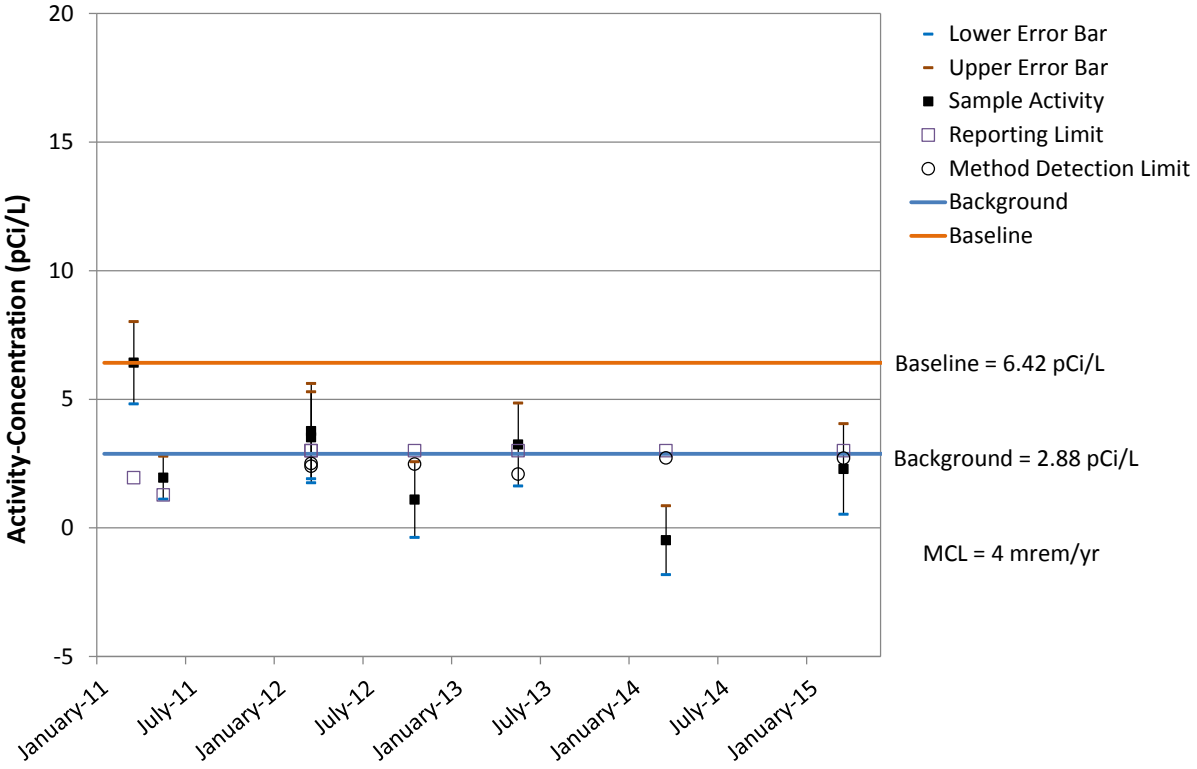
Uranium-238 in Well UCD1-068

MCL = maximum contaminant level
pCi/L = picocuries per liter



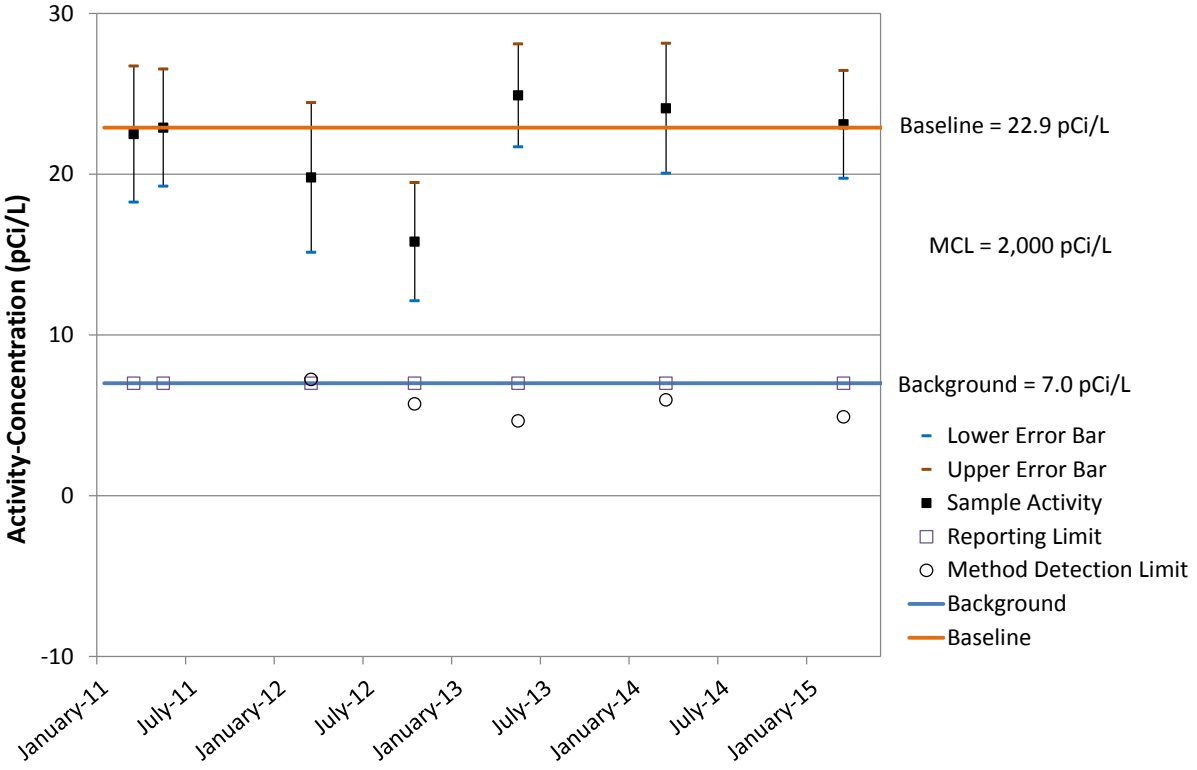
1,1-Dichloroethane in Well UCD1-069

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



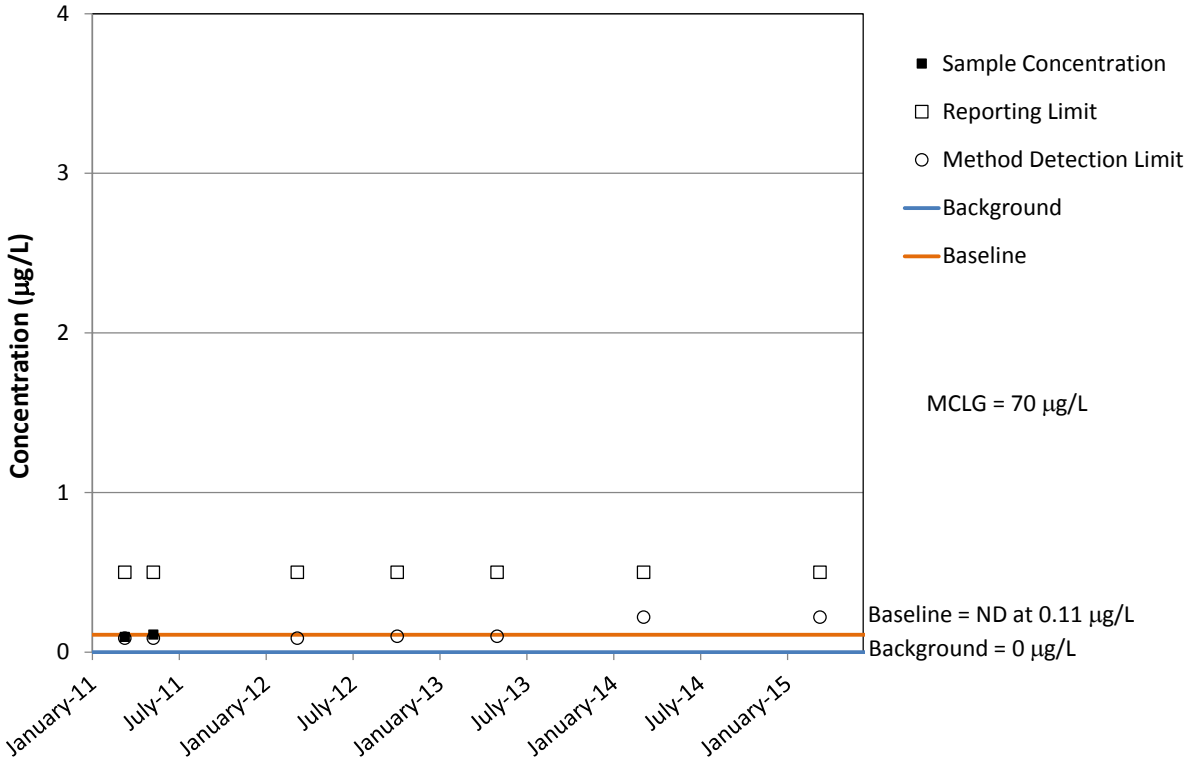
Beta, Gross in Well UCD1-069

MCL = maximum contaminant level
pCi/L = picocuries per liter



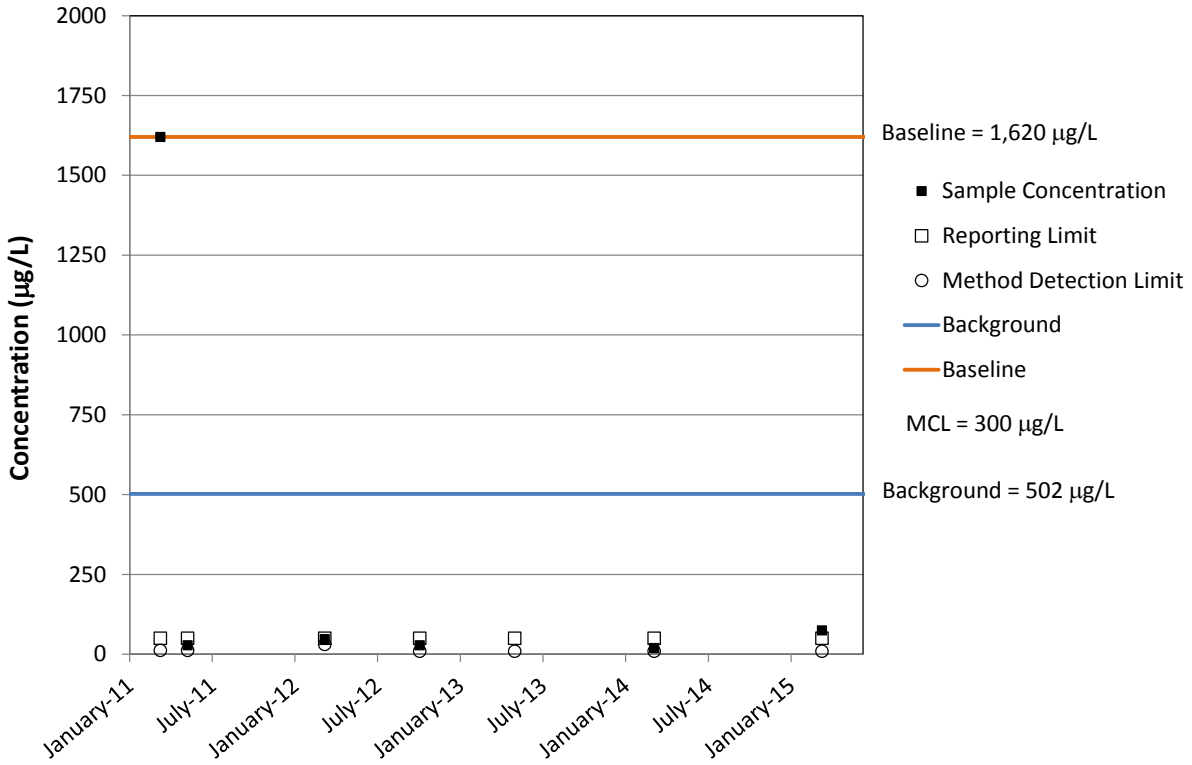
Carbon-14 in Well UCD1-069

MCL = maximum contaminant level
pCi/L = picocuries per liter



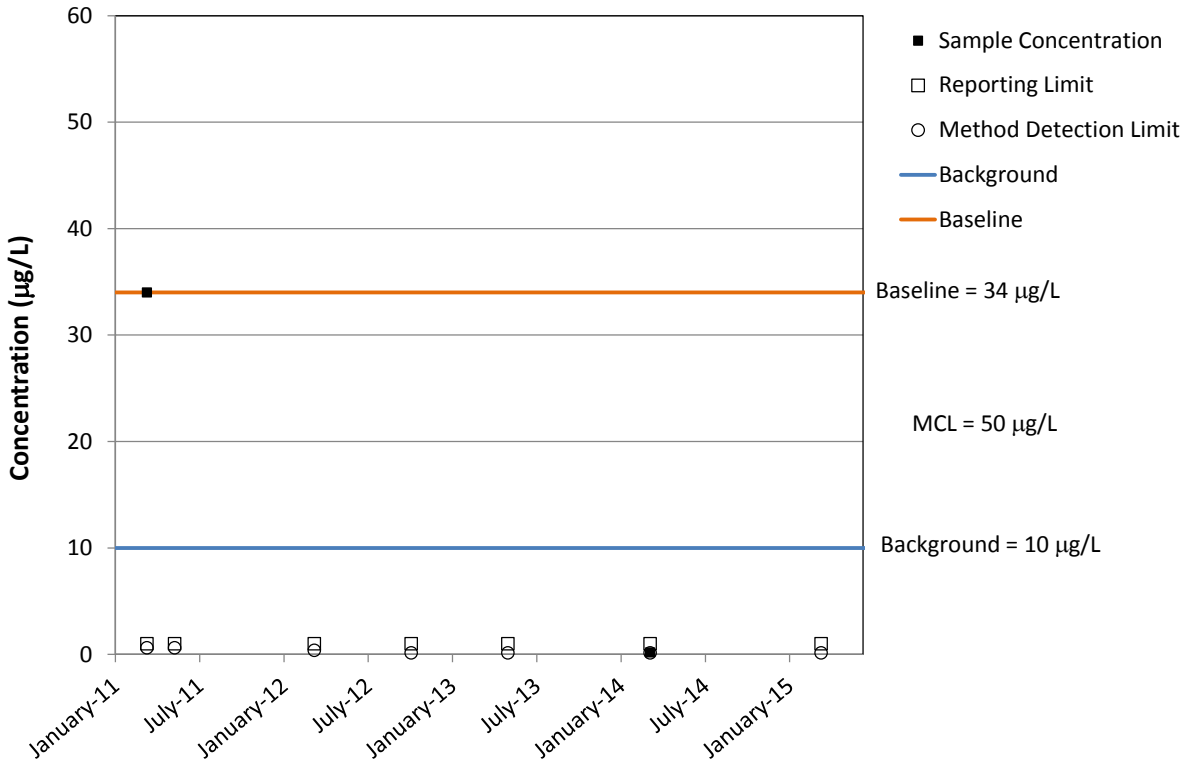
MCLG = maximum contaminant level goal
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown

Chloroform in Well UCD1-069



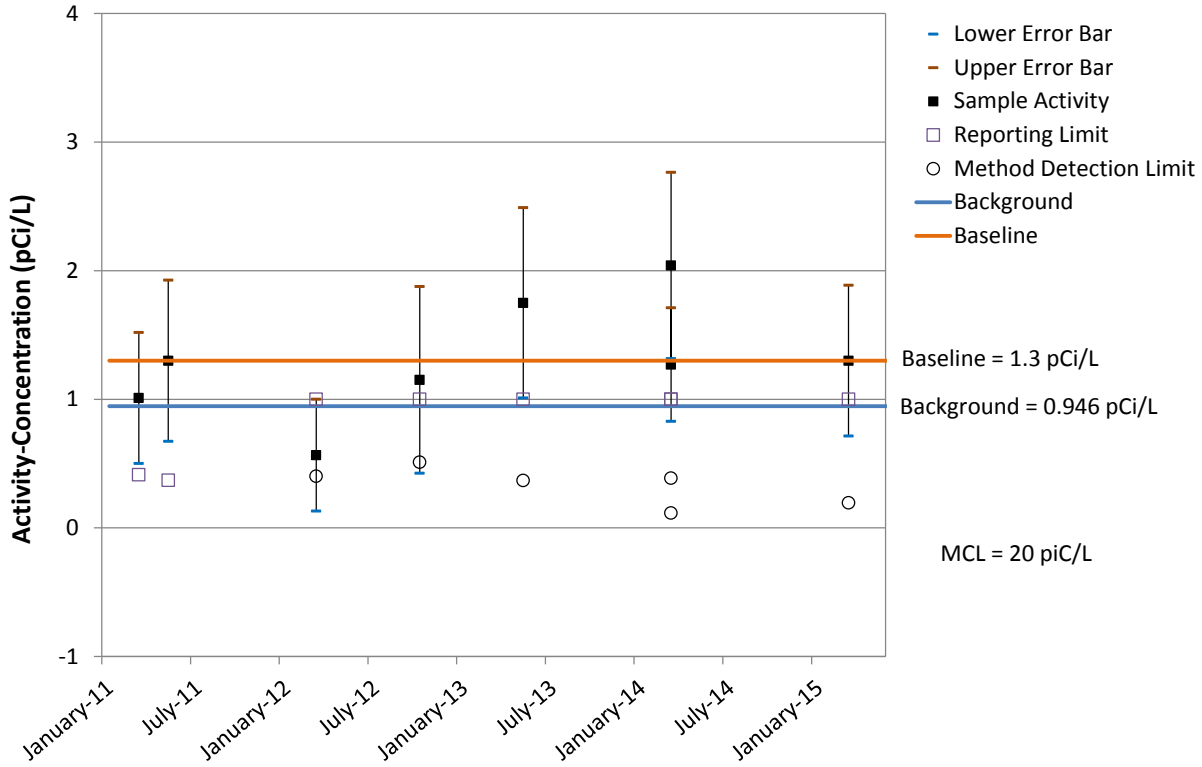
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

Iron in Well UCD1-069



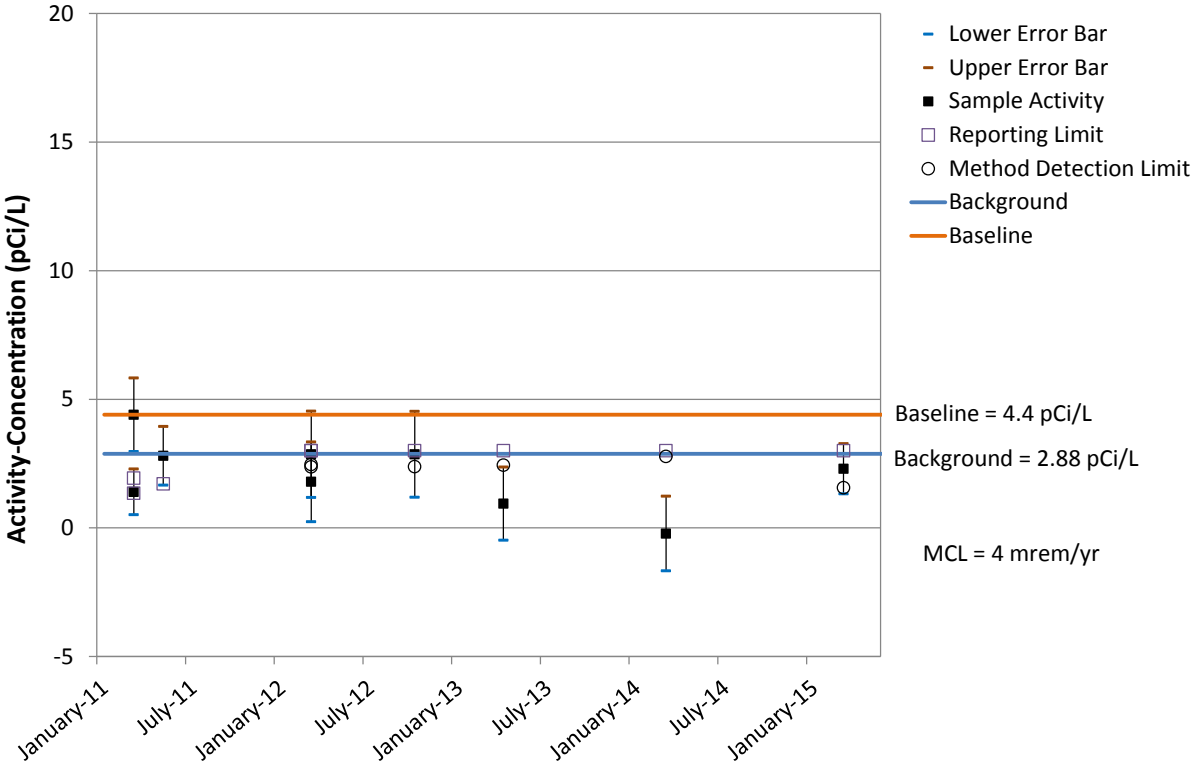
Manganese in Well UCD1-069

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



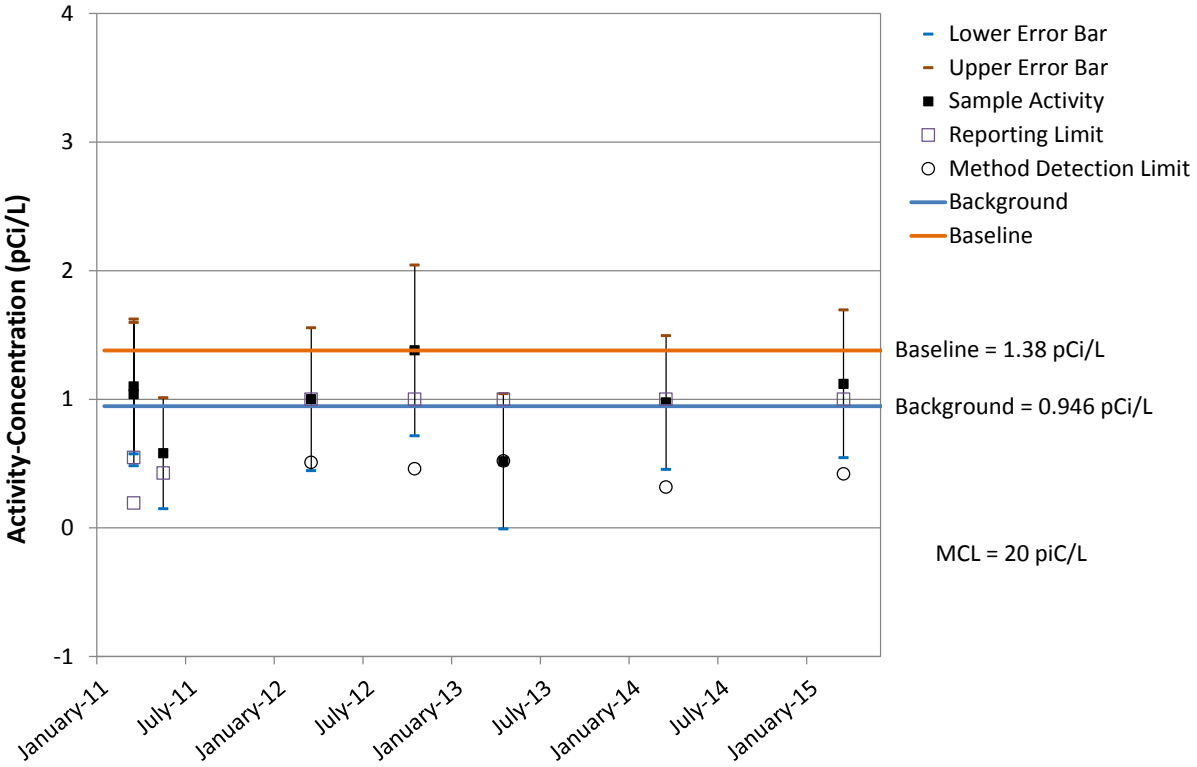
Uranium-238 in Well UCD1-069

MCL = maximum contaminant level
pCi/L = picocuries per liter



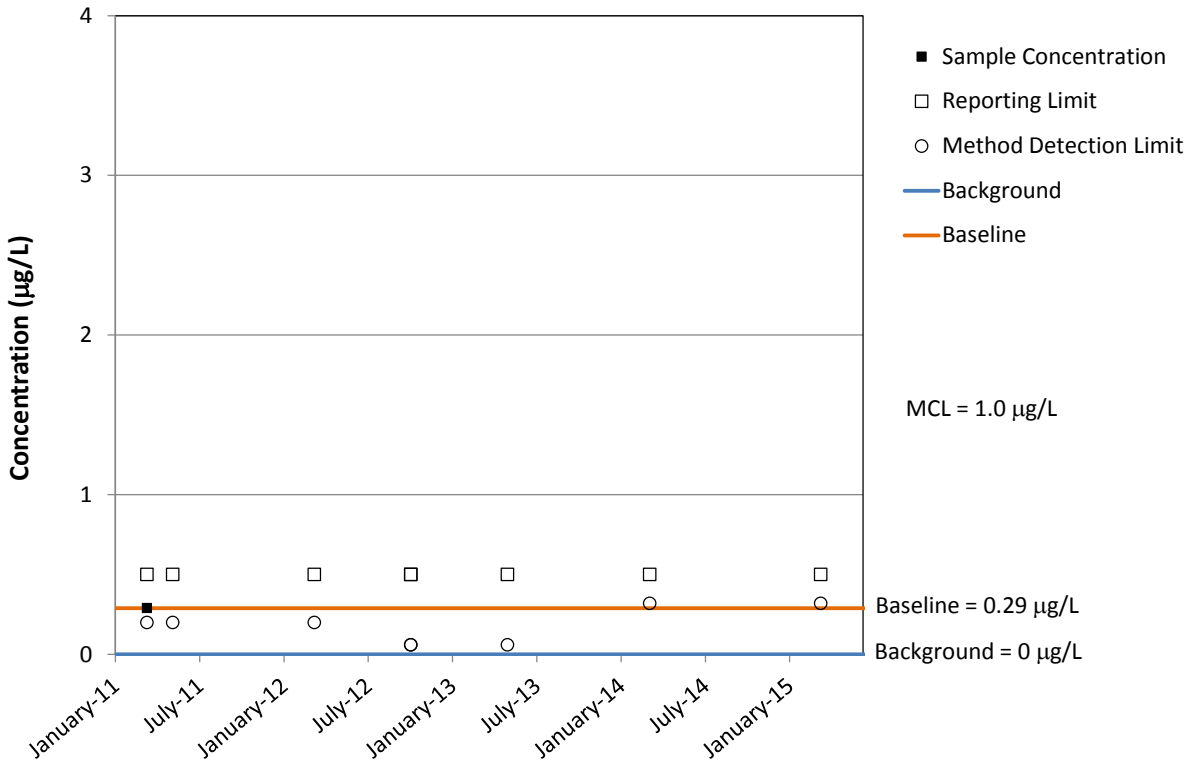
Beta, Gross in Well UCD1-070

MCL = maximum contaminant level
pCi/L = picocuries per liter



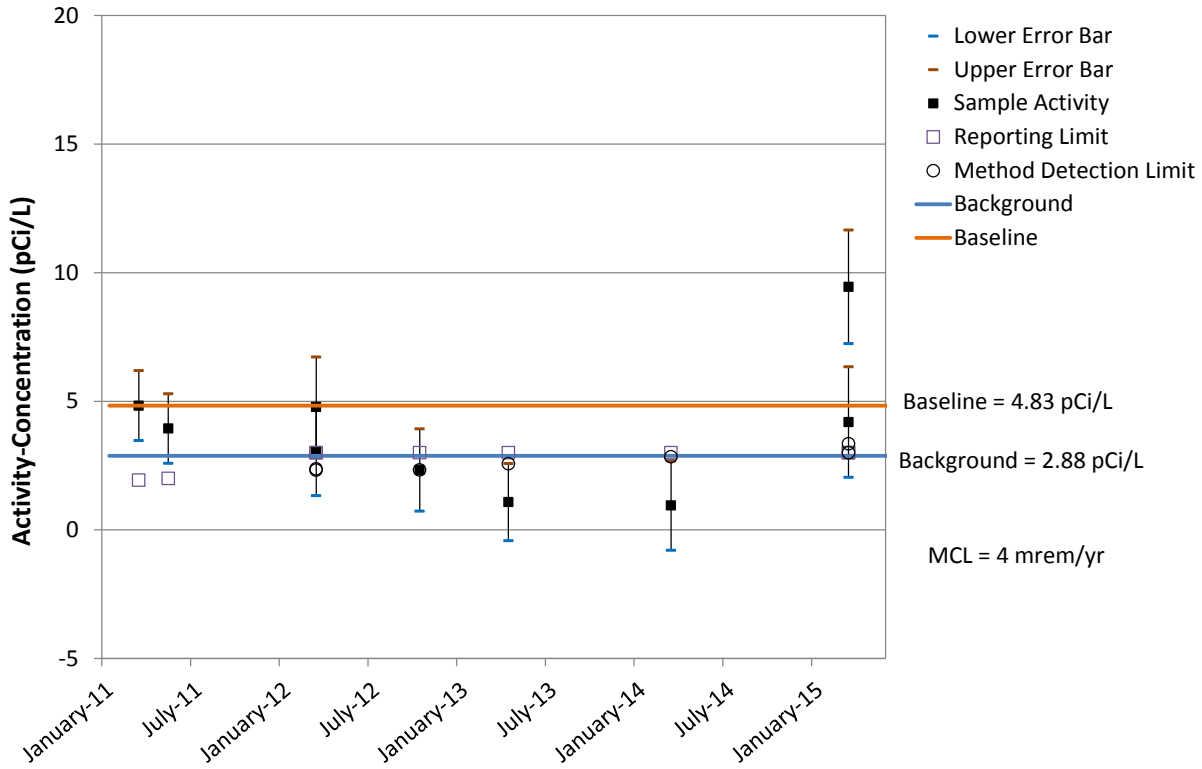
Uranium-238 in Well UCD1-070

MCL = maximum contaminant level
pCi/L = picocuries per liter



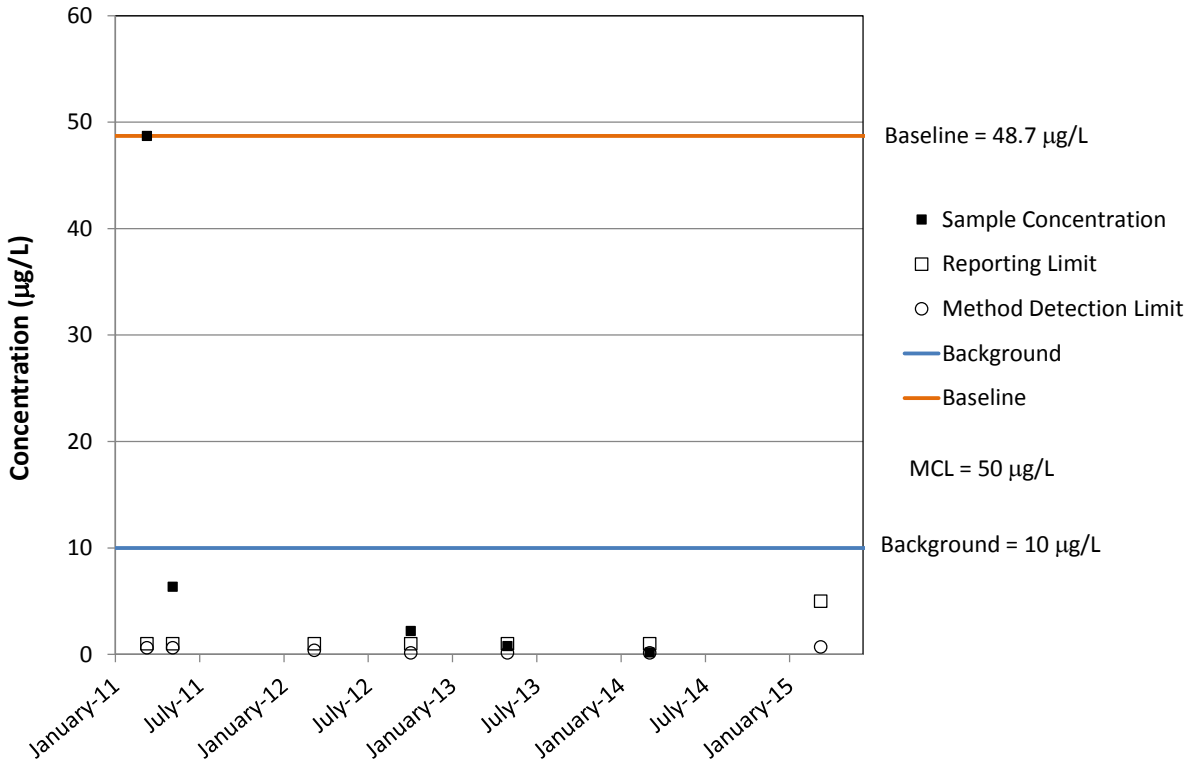
Benzene in Well UCD1-071

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



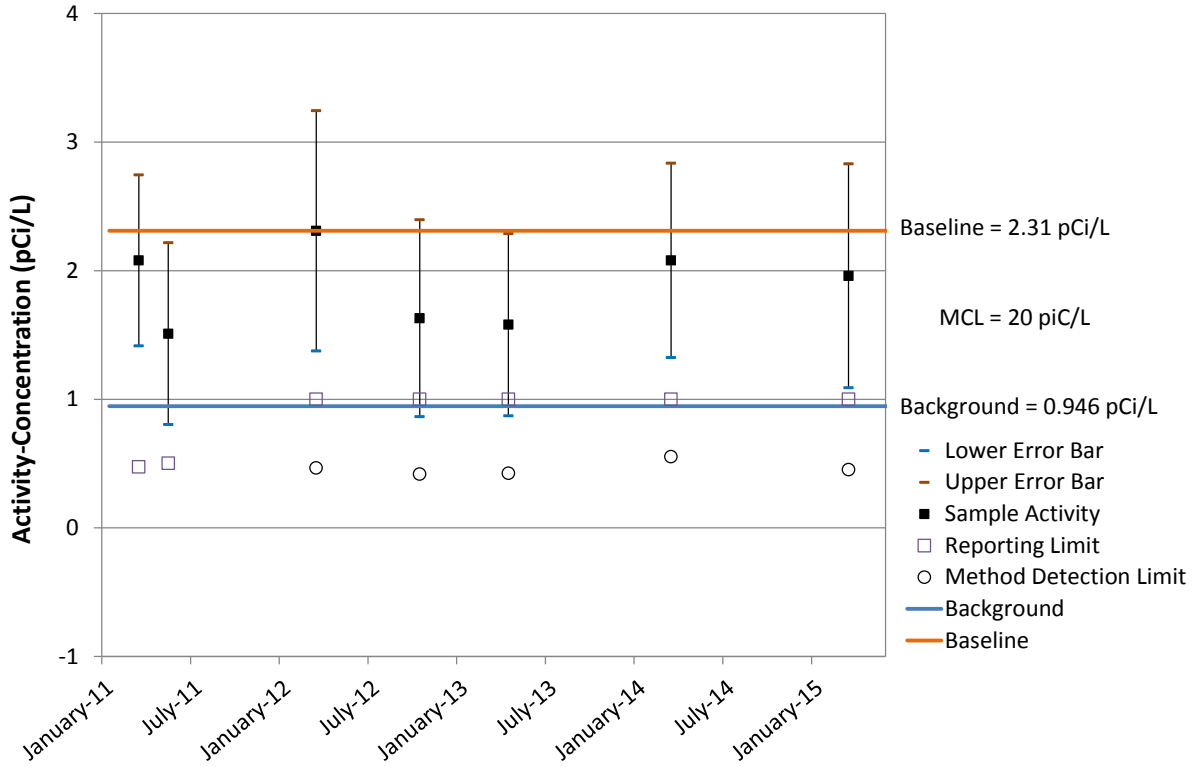
Beta, Gross in Well UCD1-071

MCL = maximum contaminant level
pCi/L = picocuries per liter



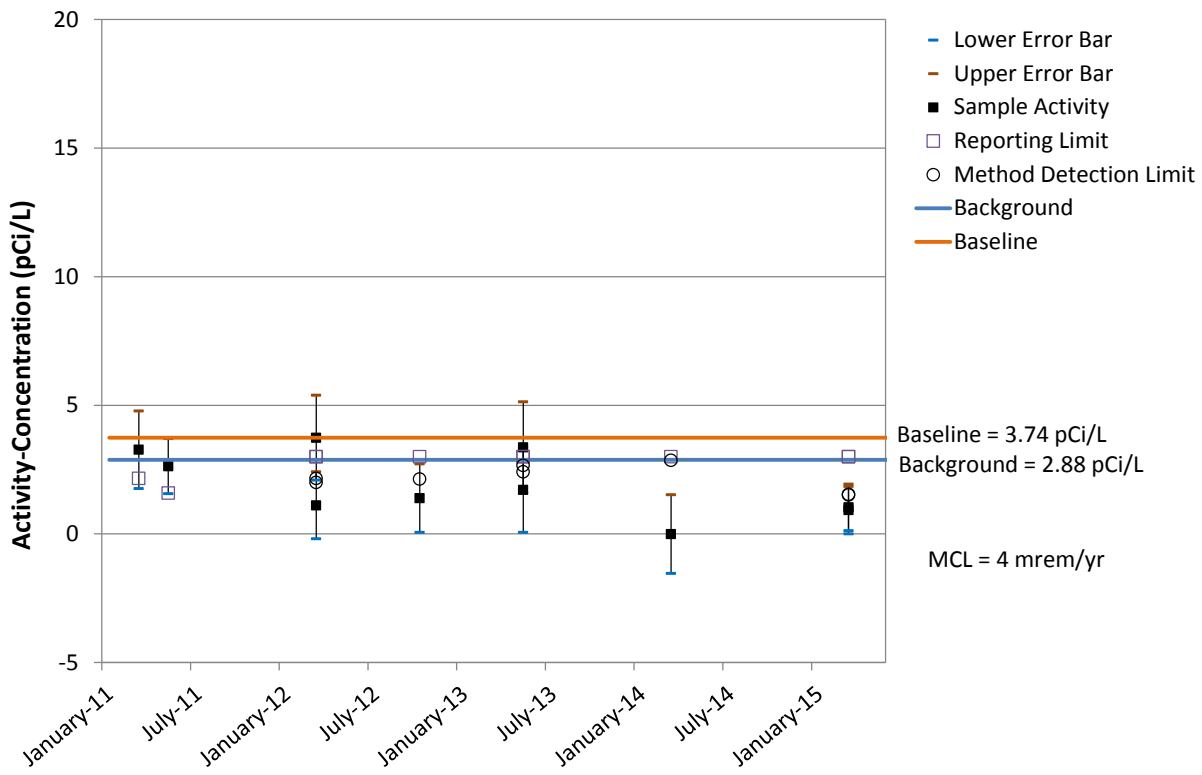
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

Manganese in Well UCD1-071



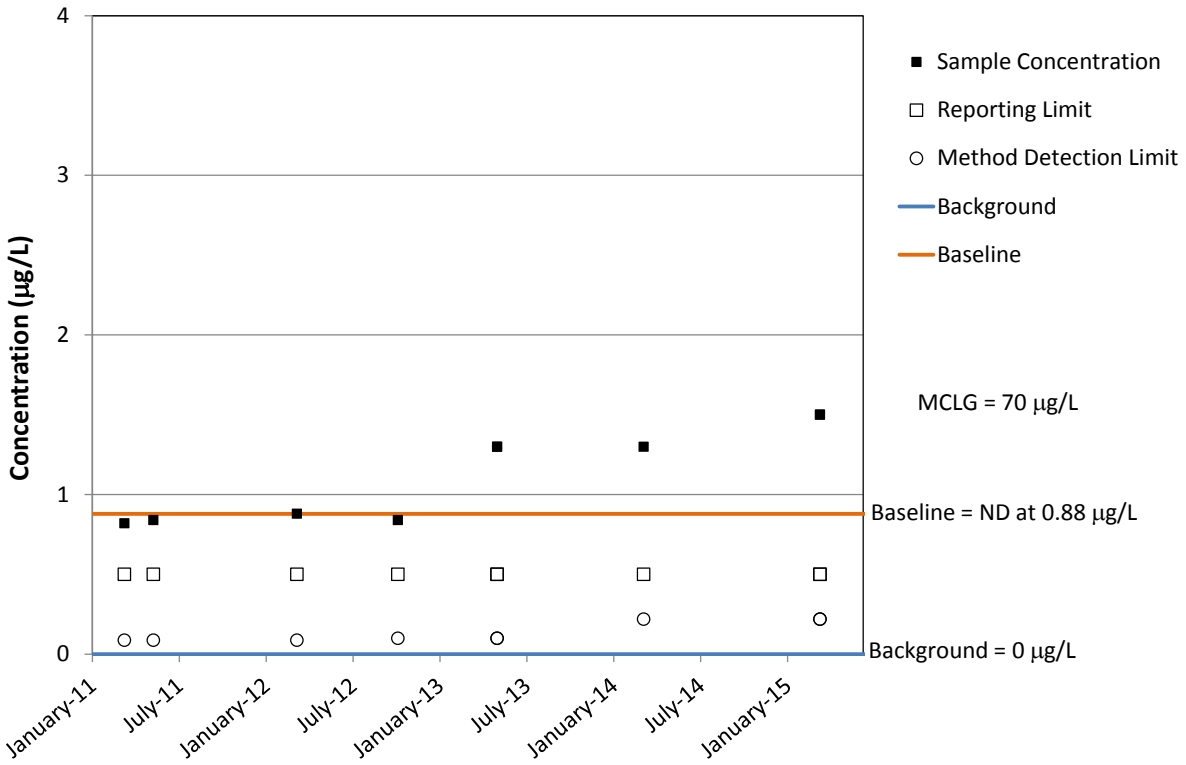
MCL = maximum contaminant level
pCi/L = picocuries per liter

Uranium-238 in Well UCD1-071



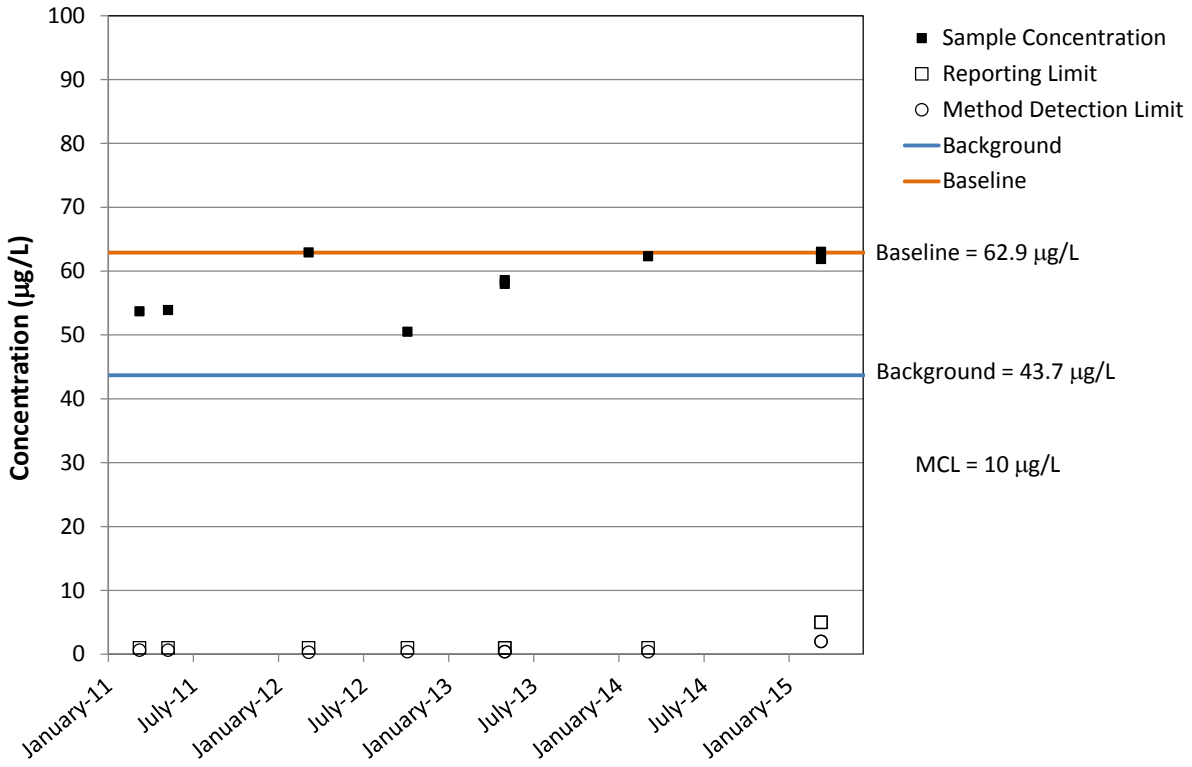
Beta, Gross in Well UCD1-072

MCL = maximum contaminant level
pCi/L = picocuries per liter



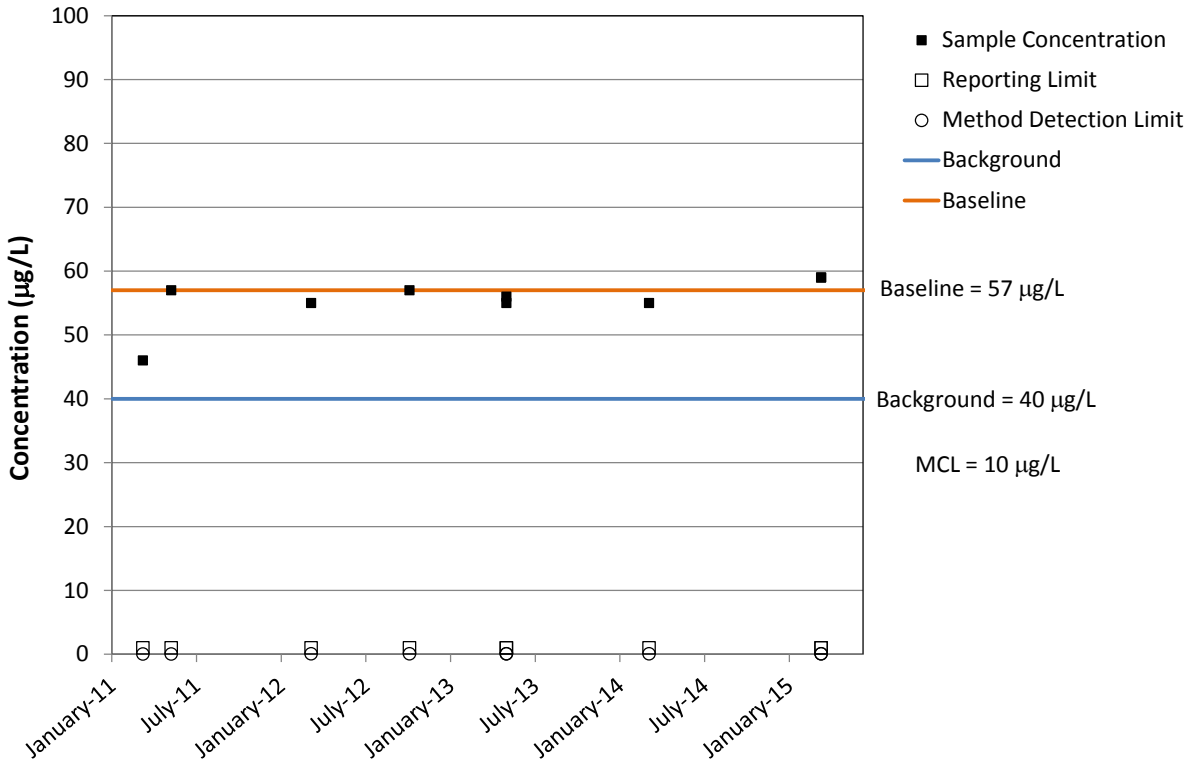
Chloroform in Well UCD1-072

MCLG = maximum contaminant level goal
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown



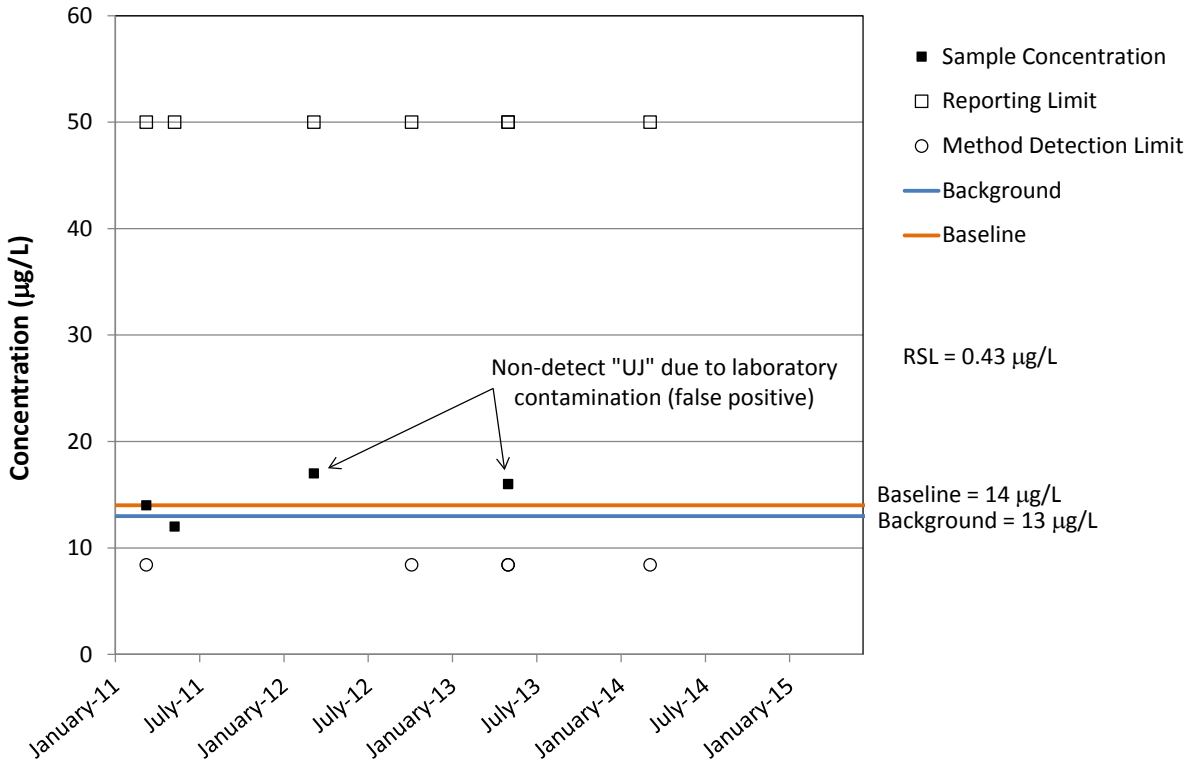
Chromium in Well UCD1-072

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



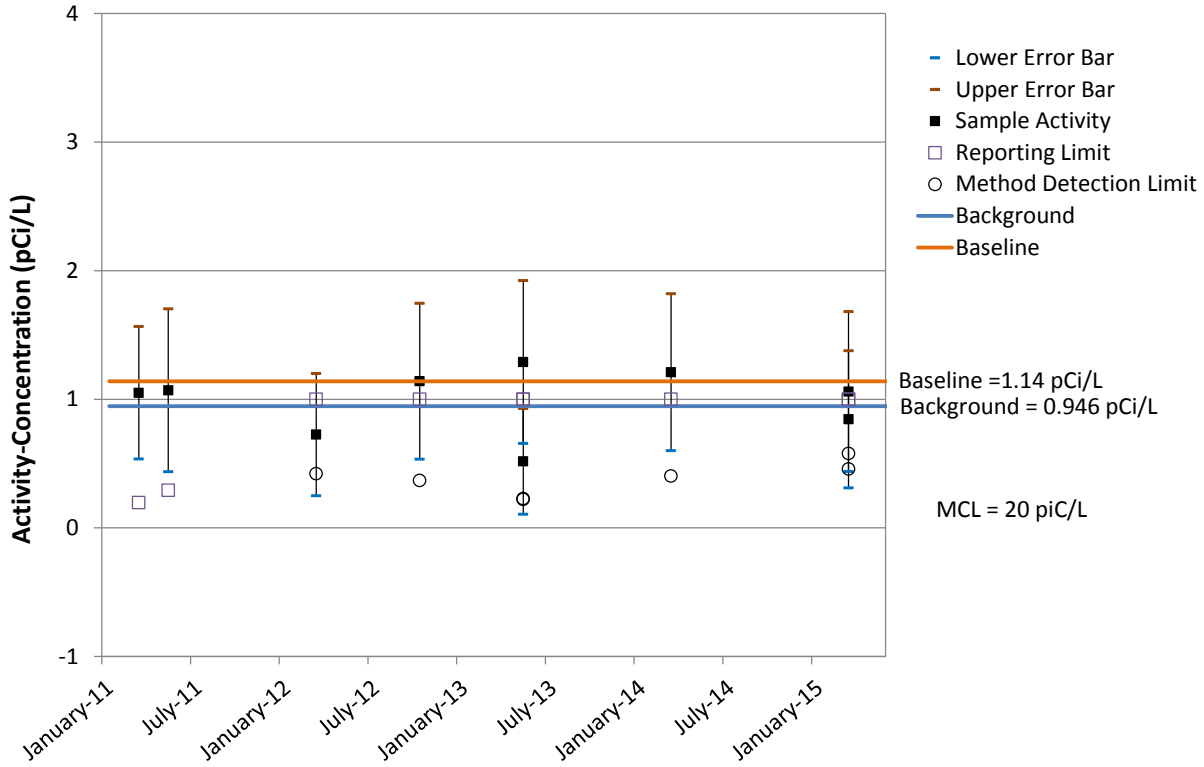
Hexavalent Chromium in Well UCD1-072

MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



RSL = regional screening level
µg/L = micrograms per liter
not detected if sample concentration not shown

Formaldehyde in Well UCD1-072



Uranium-238 in Well UCD1-072

MCL = maximum contaminant level
pCi/L = picocuries per liter

Attachment C-3

Mann-Kendall Trend Test Results

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Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/1/2015 5:47:46 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Nitrate as NUCD1-021

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	20.000000
Maximum	28.000000
Mean	25.000000
Geometric Mean	24.879203
Median	24.000000
Standard Deviation	2.5495098

Mann-Kendall Test

Test Value (S)	15.000000
Tabulated p-value	0.0900000
Standard Deviation of S	9.0737717
Standardized Value of S	1.5429086
Approximate p-value	0.0614265

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/1/2015 5:53:18 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Carbon-14UCD1-023

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	11.000000
Maximum	22.100000
Mean	18.266667
Geometric Mean	17.837084
Median	20.300000
Standard Deviation	3.9430318

Mann-Kendall Test

Test Value (S)	-20.00000
Tabulated p-value	0.0220000
Standard Deviation of S	9.5916630
Standardized Value of S	-1.980887
Approximate p-value	0.0238020

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:09:08 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

SeleniumUCD1-068

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	1.5300000
Maximum	2.6600000
Mean	1.9733333
Geometric Mean	1.9488605
Median	1.9800000
Standard Deviation	0.3276107

Mann-Kendall Test

Test Value (S)	26.000000
Tabulated p-value	0.0430000
Standard Deviation of S	14.583095
Standardized Value of S	1.7143137
Approximate p-value	0.0432356

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:46:38 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Carbon-14UCD1-070

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	10
Number Values Reported (n)	10
Minimum	6.4700000
Maximum	25.200000
Mean	12.350000
Geometric Mean	11.005475
Median	10.680000
Standard Deviation	6.3975134

Mann-Kendall Test

Test Value (S)	7.0000000
Tabulated p-value	0.3000000
Standard Deviation of S	11.180340
Standardized Value of S	0.5366563
Approximate p-value	0.2957525

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:54:39 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ChromiumUCD1-071

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	34.800000
Maximum	49.100000
Mean	41.011111
Geometric Mean	40.771562
Median	40.200000
Standard Deviation	4.7477480

Mann-Kendall Test

Test Value (S)	-6.000000
Tabulated p-value	0.3060000
Standard Deviation of S	9.5916630
Standardized Value of S	-0.521286
Approximate p-value	0.3010838

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:55:25 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Chromium (Hexavalent)UCD1-071

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	11
Number Values Reported (n)	11
Minimum	21.000000
Maximum	47.000000
Mean	38.636364
Geometric Mean	37.912841
Median	39.000000
Standard Deviation	7.0038950

Mann-Kendall Test

Test Value (S)	-7.000000
Tabulated p-value	0.3240000
Standard Deviation of S	12.767145
Standardized Value of S	-0.469956
Approximate p-value	0.3191931

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:57:56 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

MolybdenumUCD1-071

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	0.8590000
Maximum	3.2900000
Mean	1.4811111
Geometric Mean	1.3717234
Median	1.3000000
Standard Deviation	0.7207818

Mann-Kendall Test

Test Value (S)	-16.00000
Tabulated p-value	0.0600000
Standard Deviation of S	9.5916630
Standardized Value of S	-1.563858
Approximate p-value	0.0589254

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 12:05:39 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Nitrate as NUCD1-072

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	18.000000
Maximum	23.000000
Mean	19.888889
Geometric Mean	19.826384
Median	19.000000
Standard Deviation	1.6914819

Mann-Kendall Test

Test Value (S)	-1.000000
Tabulated p-value	0.5400000
Standard Deviation of S	9.1469485
Standardized Value of S	0
Approximate p-value	0.5000000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/1/2015 5:52:05 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Radium-226UCD1-021

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	-0.026400
Maximum	0.9280000
Mean	0.3119556
Geometric Mean	N/A
Median	0.2550000
Standard Deviation	0.2846512

Mann-Kendall Test

Test Value (S)	8.0000000
Tabulated p-value	0.2380000
Standard Deviation of S	9.5916630
Standardized Value of S	0.7298004
Approximate p-value	0.2327561

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:14:33 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Nitrate as NUCD1-023

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	3.3000000
Maximum	5.1000000
Mean	4.2333333
Geometric Mean	4.1925444
Median	4.5000000
Standard Deviation	0.6123724

Mann-Kendall Test

Test Value (S)	6.0000000
Tabulated p-value	0.3060000
Standard Deviation of S	9.4868330
Standardized Value of S	0.5270463
Approximate p-value	0.2990807

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:17:52 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ChromiumUCD1-054

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	7.2000000
Maximum	13.600000
Mean	9.7811111
Geometric Mean	9.5439372
Median	8.6900000
Standard Deviation	2.3777166

Mann-Kendall Test

Test Value (S)	8.0000000
Tabulated p-value	0.2380000
Standard Deviation of S	9.5916630
Standardized Value of S	0.7298004
Approximate p-value	0.2327561

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:18:53 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Chromium (Hexavalent)UCD1-054

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	5.1000000
Maximum	12.000000
Mean	8.3611111
Geometric Mean	7.9916999
Median	7.4500000
Standard Deviation	2.6783598

Mann-Kendall Test

Test Value (S)	8.0000000
Tabulated p-value	0.2380000
Standard Deviation of S	9.4868330
Standardized Value of S	0.7378648
Approximate p-value	0.2302983

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:21:31 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

MolybdenumUCD1-054

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	2.4150000
Maximum	3.1100000
Mean	2.7761111
Geometric Mean	2.7666251
Median	2.8700000
Standard Deviation	0.2399971

Mann-Kendall Test

Test Value (S)	6.0000000
Tabulated p-value	0.3060000
Standard Deviation of S	9.5916630
Standardized Value of S	0.5212860
Approximate p-value	0.3010838

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:02:55 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Nitrate as NUCD1-068

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	6.2000000
Maximum	12.000000
Mean	9.7888889
Geometric Mean	9.6445944
Median	9.9000000
Standard Deviation	1.6578936

Mann-Kendall Test

Test Value (S)	17.000000
Tabulated p-value	0.0600000
Standard Deviation of S	9.5393920
Standardized Value of S	1.6772557
Approximate p-value	0.0467462

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:06:40 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Radium-226UCD1-068

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	0.0505000
Maximum	0.5630000
Mean	0.3135556
Geometric Mean	0.2568326
Median	0.3110000
Standard Deviation	0.1705655

Mann-Kendall Test

Test Value (S)	6.0000000
Tabulated p-value	0.3060000
Standard Deviation of S	9.5916630
Standardized Value of S	0.5212860
Approximate p-value	0.3010838

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:40:57 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

MolybdenumUCD1-069

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	1.2200000
Maximum	1.8100000
Mean	1.5577778
Geometric Mean	1.5468469
Median	1.6100000
Standard Deviation	0.1908388

Mann-Kendall Test

Test Value (S)	-12.00000
Tabulated p-value	0.1300000
Standard Deviation of S	9.5916630
Standardized Value of S	-1.146829
Approximate p-value	0.1257261

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:41:45 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Nitrate as NUCD1-069

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	6.9000000
Maximum	13.000000
Mean	9.5444444
Geometric Mean	9.2904698
Median	9.4000000
Standard Deviation	2.3770313

Mann-Kendall Test

Test Value (S)	22.000000
Tabulated p-value	0.0120000
Standard Deviation of S	9.4868330
Standardized Value of S	2.2135944
Approximate p-value	0.0134283

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:47:33 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Nitrate as NUCD1-070

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	1.4000000
Maximum	3.0000000
Mean	1.9111111
Geometric Mean	1.8603976
Median	1.8000000
Standard Deviation	0.4986092

Mann-Kendall Test

Test Value (S)	-20.00000
Tabulated p-value	0.0220000
Standard Deviation of S	9.4868330
Standardized Value of S	-2.002776
Approximate p-value	0.0226007

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 12:06:46 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Radium-226UCD1-072

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	0.0399000
Maximum	0.6180000
Mean	0.2872000
Geometric Mean	0.1961836
Median	0.3030000
Standard Deviation	0.2108953

Mann-Kendall Test

Test Value (S)	12.000000
Tabulated p-value	0.1300000
Standard Deviation of S	9.5916630
Standardized Value of S	1.1468293
Approximate p-value	0.1257261

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:27:39 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

AluminumUCD1-069

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	4.0500000
Maximum	1080.0000
Mean	212.64714
Geometric Mean	48.290101
Median	50.000000
Standard Deviation	391.55775

Mann-Kendall Test

Test Value (S)	-6.000000
Tabulated p-value	0.1910000
Standard Deviation of S	6.3770422
Standardized Value of S	-0.784063
Approximate p-value	0.2165017

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:50:09 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ZincUCD1-070

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	6
Number Values Reported (n)	6
Minimum	0.5990000
Maximum	35.200000
Mean	9.7581667
Geometric Mean	5.0817848
Median	5.1750000
Standard Deviation	12.762268

Mann-Kendall Test

Test Value (S)	-9.000000
Tabulated p-value	0.0680000
Standard Deviation of S	5.3229065
Standardized Value of S	-1.502938
Approximate p-value	0.0664275

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:51:33 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

AluminumUCD1-071

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	6
Number Values Reported (n)	6
Minimum	7.1500000
Maximum	250.00000
Mean	93.225000
Geometric Mean	35.131112
Median	20.350000
Standard Deviation	121.62468

Mann-Kendall Test

Test Value (S)	2.0000000
Tabulated p-value	0.3600000
Standard Deviation of S	5.2281290
Standardized Value of S	0.1912730
Approximate p-value	0.4241559

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:59:56 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

AluminumUCD1-072

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	3.5350000
Maximum	250.00000
Mean	114.94643
Geometric Mean	45.146917
Median	50.000000
Standard Deviation	115.09582

Mann-Kendall Test

Test Value (S)	-4.000000
Tabulated p-value	0.2810000
Standard Deviation of S	6.5828059
Standardized Value of S	-0.455733
Approximate p-value	0.3242911

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:15:47 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ZincUCD1-023

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	6
Number Values Reported (n)	6
Minimum	4.7000000
Maximum	11.400000
Mean	7.0916667
Geometric Mean	6.7604068
Median	6.8000000
Standard Deviation	2.4937876

Mann-Kendall Test

Test Value (S)	-5.000000
Tabulated p-value	0.2350000
Standard Deviation of S	5.3229065
Standardized Value of S	-0.751469
Approximate p-value	0.2261852

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:26:56 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ChromiumUCD1-068

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	6
Number Values Reported (n)	6
Minimum	33.000000
Maximum	45.000000
Mean	38.666667
Geometric Mean	38.445917
Median	37.625000
Standard Deviation	4.5521057

Mann-Kendall Test

Test Value (S)	3.0000000
Tabulated p-value	0.3600000
Standard Deviation of S	5.3229065
Standardized Value of S	0.3757346
Approximate p-value	0.3535571

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:54:21 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

NickelUCD1-068

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	6
Number Values Reported (n)	6
Minimum	1.7750000
Maximum	2.3400000
Mean	2.0325000
Geometric Mean	2.0223723
Median	1.9950000
Standard Deviation	0.2238247

Mann-Kendall Test

Test Value (S)	-3.000000
Tabulated p-value	0.3600000
Standard Deviation of S	5.3229065
Standardized Value of S	-0.375735
Approximate p-value	0.3535571

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:23:27 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Beta, GrossUCD1-068

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	1.0900000
Maximum	4.3000000
Mean	2.5757143
Geometric Mean	2.3923248
Median	2.6150000
Standard Deviation	1.0137736

Mann-Kendall Test

Test Value (S)	-17.00000
Tabulated p-value	0.0050000
Standard Deviation of S	6.6583281
Standardized Value of S	-2.403006
Approximate p-value	0.0081305

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:25:40 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ChloroformUCD1-068

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.1400000
Maximum	0.5000000
Mean	0.2350000
Geometric Mean	0.2162960
Median	0.2000000
Standard Deviation	0.1210716

Mann-Kendall Test

Test Value (S)	13.000000
Tabulated p-value	0.0350000
Standard Deviation of S	6.6583281
Standardized Value of S	1.8022542
Approximate p-value	0.0357527

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 10:53:22 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Chromium (Hexavalent)UCD1-068

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	28.000000
Maximum	44.000000
Mean	35.142857
Geometric Mean	34.703945
Median	34.000000
Standard Deviation	6.0602137

Mann-Kendall Test

Test Value (S)	3.0000000
Tabulated p-value	0.3860000
Standard Deviation of S	6.6583281
Standardized Value of S	0.3003757
Approximate p-value	0.3819453

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:25:15 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Uranium-238UCD1-068

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.5650000
Maximum	1.1200000
Mean	0.9546429
Geometric Mean	0.9320316
Median	1.0600000
Standard Deviation	0.2050298

Mann-Kendall Test

Test Value (S)	-3.000000
Tabulated p-value	0.3860000
Standard Deviation of S	6.6583281
Standardized Value of S	-0.300376
Approximate p-value	0.3819453

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:35:24 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Beta, GrossUCD1-069

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	-0.481000
Maximum	6.4200000
Mean	2.5941429
Geometric Mean	N/A
Median	2.2900000
Standard Deviation	2.1734964

Mann-Kendall Test

Test Value (S)	-9.000000
Tabulated p-value	0.1190000
Standard Deviation of S	6.6583281
Standardized Value of S	-1.201503
Approximate p-value	0.1147781

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:37:19 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Carbon-14UCD1-069

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	15.800000
Maximum	24.900000
Mean	21.871429
Geometric Mean	21.656862
Median	22.900000
Standard Deviation	3.1159345

Mann-Kendall Test

Test Value (S)	5.0000000
Tabulated p-value	0.2810000
Standard Deviation of S	6.6583281
Standardized Value of S	0.6007514
Approximate p-value	0.2740028

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:38:39 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

IronUCD1-069

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	19.100000
Maximum	1620.0000
Mean	266.61429
Geometric Mean	63.623731
Median	47.000000
Standard Deviation	597.07266

Mann-Kendall Test

Test Value (S)	-3.000000
Tabulated p-value	0.3860000
Standard Deviation of S	6.6583281
Standardized Value of S	-0.300376
Approximate p-value	0.3819453

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:39:41 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ManganeseUCD1-069

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.1790000
Maximum	34.000000
Mean	5.5970000
Geometric Mean	1.2943372
Median	1.0000000
Standard Deviation	12.528283

Mann-Kendall Test

Test Value (S)	-9.000000
Tabulated p-value	0.1190000
Standard Deviation of S	5.2599113
Standardized Value of S	-1.520938
Approximate p-value	0.0641377

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:43:48 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Uranium-238UCD1-069

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.5650000
Maximum	1.7500000
Mean	1.2471429
Geometric Mean	1.1814045
Median	1.3000000
Standard Deviation	0.3991225

Mann-Kendall Test

Test Value (S)	8.0000000
Tabulated p-value	0.1190000
Standard Deviation of S	6.5828059
Standardized Value of S	1.0633763
Approximate p-value	0.1438057

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:45:23 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Beta, GrossUCD1-070

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	-0.222000
Maximum	2.9000000
Mean	1.9865714
Geometric Mean	N/A
Median	2.3250000
Standard Deviation	1.1859241

Mann-Kendall Test

Test Value (S)	-13.00000
Tabulated p-value	0.0350000
Standard Deviation of S	6.6583281
Standardized Value of S	-1.802254
Approximate p-value	0.0357527

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:49:09 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Uranium-238UCD1-070

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.5170000
Maximum	1.3800000
Mean	0.9488571
Geometric Mean	0.9013944
Median	1.0000000
Standard Deviation	0.3043312

Mann-Kendall Test

Test Value (S)	1.0000000
Tabulated p-value	0.5000000
Standard Deviation of S	6.6583281
Standardized Value of S	0
Approximate p-value	0.5000000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:53:19 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Beta, GrossUCD1-071

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.9460000
Maximum	6.8200000
Mean	3.4080000
Geometric Mean	2.7561095
Median	3.9100000
Standard Deviation	2.1151031

Mann-Kendall Test

Test Value (S)	-9.000000
Tabulated p-value	0.1190000
Standard Deviation of S	6.6583281
Standardized Value of S	-1.201503
Approximate p-value	0.1147781

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:56:15 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ManganeseUCD1-071

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.1810000
Maximum	48.700000
Mean	9.1717143
Geometric Mean	2.4157314
Median	2.2000000
Standard Deviation	17.580889

Mann-Kendall Test

Test Value (S)	-11.00000
Tabulated p-value	0.0680000
Standard Deviation of S	6.6583281
Standardized Value of S	-1.501879
Approximate p-value	0.0665642

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 11:59:05 AM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Uranium-238UCD1-071

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	1.5100000
Maximum	2.3100000
Mean	1.8785714
Geometric Mean	1.8570813
Median	1.9600000
Standard Deviation	0.3056920

Mann-Kendall Test

Test Value (S)	0
Tabulated p-value	0.5000000
Standard Deviation of S	6.5828059
Standardized Value of S	N/A
Approximate p-value	N/A

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 12:00:56 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Beta, GrossUCD1-072

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	-0.007310
Maximum	3.2700000
Mean	1.8883129
Geometric Mean	N/A
Median	2.4250000
Standard Deviation	1.1431189

Mann-Kendall Test

Test Value (S)	-15.00000
Tabulated p-value	0.0150000
Standard Deviation of S	6.6583281
Standardized Value of S	-2.102630
Approximate p-value	0.0177491

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 12:02:08 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ChloroformUCD1-072

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.8200000
Maximum	1.5000000
Mean	1.0685714
Geometric Mean	1.0371302
Median	0.8800000
Standard Deviation	0.2872530

Mann-Kendall Test

Test Value (S)	17.000000
Tabulated p-value	0.0050000
Standard Deviation of S	6.5064071
Standardized Value of S	2.4591145
Approximate p-value	0.0069640

Statistically significant evidence of an increasing trend at the specified level of significance.

p Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 12:03:54 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

ChromiumUCD1-072

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	50.500000
Maximum	62.900000
Mean	57.721429
Geometric Mean	57.528742
Median	58.300000
Standard Deviation	5.0563374

Mann-Kendall Test

Test Value (S)	9.0000000
Tabulated p-value	0.1190000
Standard Deviation of S	6.6583281
Standardized Value of S	1.2015028
Approximate p-value	0.1147781

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 12:04:47 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Chromium (Hexavalent)UCD1-072

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	46.000000
Maximum	59.000000
Mean	54.928571
Geometric Mean	54.780427
Median	55.500000
Standard Deviation	4.1875666

Mann-Kendall Test

Test Value (S)	7.0000000
Tabulated p-value	0.1910000
Standard Deviation of S	6.5064071
Standardized Value of S	0.9221679
Approximate p-value	0.1782205

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	7/2/2015 12:07:30 PM
From File	qry_5-YrTrendTest_v2.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

Uranium-238UCD1-072

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.7250000
Maximum	1.2100000
Mean	1.0072143
Geometric Mean	0.9951325
Median	1.0500000
Standard Deviation	0.1622636

Mann-Kendall Test

Test Value (S)	3.0000000
Tabulated p-value	0.3860000
Standard Deviation of S	6.6583281
Standardized Value of S	0.3003757
Approximate p-value	0.3819453

Insufficient evidence to identify a significant trend at the specified level of significance.

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Attachment C-4

Baseline Comparison with Background and Water-Quality Criteria

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Monitoring Well	Constituent	Units	Baseline Concentration	Background Concentration[a]	Water Quality Criterion (WQC)[b]	WQC Reference	Baseline Below WQC or at/below Background?[c]
Constituents of Concern							
UCD1-021	Carbon-14	pCi/L	<7	<7	2,000	MCL (SWRCB 2015a)	Yes
UCD1-021	Nitrate as N	mg/L	27	15	10	MCL (SWRCB 2015a)	**No**
UCD1-021	Radium-226	pCi/L	0.292 J	1.17	5	MCL (SWRCB 2015a)	Yes
UCD1-023	Carbon-14	pCi/L	22.1	<7	2,000	MCL (SWRCB 2015a)	Yes
UCD1-023	Nitrate as N	mg/L	5.1	15	10	MCL (SWRCB 2015a)	Yes
UCD1-054	Cesium-137	pCi/L	<5.02	<5	200	MCL (EPA 2000)	Yes
UCD1-054	Chromium	µg/L	13.6	43.7	10	California EPA MCL[d] (SWRCB 2015a)	Yes
UCD1-054	Chromium (Hexavalent)	µg/L	12	40	10	California EPA MCL (SWRCB 2015a)	Yes
UCD1-054	Mercury	µg/L	0.072 J	0.0479 J	2	MCL (SWRCB 2015a)	Yes
UCD1-054	Molybdenum	µg/L	3.11	3.13	100	RSL (EPA 2015)	Yes
UCD1-054	Silver	µg/L	<1	<1	100	Secondary MCL (SWRCB 2006)	Yes
UCD1-054	Strontium-90	pCi/L	<1	<1	8	MCL (SWRCB 2015a)	Yes
UCD1-068	Carbon-14	pCi/L	<7	<7	2,000	MCL (SWRCB 2015a)	Yes
UCD1-068	Nitrate as N	mg/L	12	15	10	MCL (SWRCB 2015a)	Yes
UCD1-068	Radium-226	pCi/L	0.324	1.17	5	MCL (SWRCB 2015a)	Yes
UCD1-068	Selenium	µg/L	2.24	1.74	50	MCL (SWRCB 2015a)	Yes
UCD1-069	Formaldehyde	µg/L	12 J	13 J	100	California Notification Level (SWRCB 2015b)	Yes
UCD1-069	Molybdenum	µg/L	1.81	3.13	100	RSL (EPA 2015)	Yes
UCD1-069	Nitrate as N	mg/L	9.9	15	10	MCL (SWRCB 2015a)	Yes
UCD1-070	Carbon-14	pCi/L	18.9	<7	2,000	MCL (SWRCB 2015a)	Yes
UCD1-070	Nitrate as N	mg/L	3	15	10	MCL (SWRCB 2015a)	Yes
UCD1-071	Cesium-137	pCi/L	<5	<5	200	MCL (EPA 2000)	Yes
UCD1-071	Chromium	µg/L	49.1	43.7	10	California EPA MCL[d] (SWRCB 2015a)	**No**
UCD1-071	Chromium (Hexavalent)	µg/L	47	40	10	California EPA MCL (SWRCB 2015a)	**No**

Monitoring Well	Constituent	Units	Baseline Concentration	Background Concentration[a]	Water Quality Criterion (WQC)[b]	WQC Reference	Baseline Below WQC or at/below Background?[c]
UCD1-071	Mercury	µg/L	0.0658 J	0.0479 J	2	MCL (SWRCB 2015a)	Yes
UCD1-071	Molybdenum	µg/L	3.29	3.13	100	RSL (EPA 2015)	Yes
UCD1-071	Silver	µg/L	<1	<1	100	Secondary MCL (SWRCB 2006)	Yes
UCD1-071	Strontium-90	pCi/L	<1	<1	8	MCL (SWRCB 2015a)	Yes
UCD1-072	Carbon-14	pCi/L	<7	<7	2,000	MCL (SWRCB 2015a)	Yes
UCD1-072	Nitrate as N	mg/L	23	15	10	MCL (SWRCB 2015a)	**No**
UCD1-072	Radium-226	pCi/L	0.558 J	1.17	5	MCL (SWRCB 2015a)	Yes
Monitoring-only Constituents							
UCD1-013	Chlordane	µg/L	<1	0	0.1	MCL (SWRCB 2015a)	**No**
UCD1-013	Dieldrin	µg/L	<0.1	0	0.0018	RSL (EPA 2015)	**No**
UCD1-021	Aluminum	µg/L	<50	5.86 J	1,000	MCL (SWRCB 2015a)	Yes
UCD1-021	Americium-241	pCi/L	<0.923	<0.71	15	MCL (EPA 2000)	Yes
UCD1-023	Mercury	µg/L	<0.2	0.0479 J	2	MCL (SWRCB 2015a)	Yes
UCD1-023	Zinc	µg/L	11.4	20.9	5,000	Secondary MCL (SWRCB 2006)	Yes
UCD1-068	Aluminum	µg/L	<50	5.86 J	1,000	MCL (SWRCB 2015a)	Yes
UCD1-068	Americium-241	pCi/L	<0.555	<0.71	15	MCL (EPA 2000)	Yes
UCD1-068	Chromium	µg/L	40	43.7	10	California EPA MCL[d] (SWRCB 2015a)	Yes
UCD1-068	Nickel	µg/L	2.29	141	100	MCL (SWRCB 2015a)	Yes
UCD1-069	Aluminum	µg/L	1080	5.86 J	1,000	MCL (SWRCB 2015a)	**No**
UCD1-069	Silver	µg/L	<1	<1	100	Secondary MCL (SWRCB 2006)	Yes
UCD1-070	Mercury	µg/L	<0.2	0.0479 J	2	MCL (SWRCB 2015a)	Yes
UCD1-070	Zinc	µg/L	35.2	20.9	5,000	Secondary MCL (SWRCB 2006)	Yes
UCD1-071	Aluminum	µg/L	27.3 J	5.86 J	1,000	MCL (SWRCB 2015a)	Yes
UCD1-072	Aluminum	µg/L	207	5.86 J	1,000	MCL (SWRCB 2015a)	Yes
UCD1-072	Americium-241	pCi/L	<0.658	<0.71	15	MCL (EPA 2000)	Yes

Monitoring Well	Constituent	Units	Baseline Concentration	Background Concentration[a]	Water Quality Criterion (WQC)[b]	WQC Reference	Baseline Below WQC or at/below Background?[c]
New Well Constituents							
UCD1-068	Chloroform	µg/L	0.23 J	0	70	MCL (EPA 2006)	Yes
UCD1-068	Chromium (Hexavalent)	µg/L	42	40	10	California EPA MCL (SWRCB 2015a)	**No**
UCD1-068	Formaldehyde	µg/L	14 J	13 J	100	California Notification Level (SWRCB 2015b)	Yes
UCD1-068	Gross Beta	pCi/L	4.3	2.88 J	NA (4 mrem/yr)	MCL (SWRCB 2015a)	**No**
UCD1-068	Uranium-238	pCi/L	1.21	0.946 J	20	MCL (SWRCB 2015a)	Yes
UCD1-069	1,1-Dichloroethane	µg/L	0.19 J	0	5	MCL (SWRCB 2015a)	Yes
UCD1-069	Carbon-14	pCi/L	22.9	<7	2000	MCL (SWRCB 2015a)	Yes
UCD1-069	Chloroform	µg/L	0.11 J	0	70	MCL (EPA 2006)	Yes
UCD1-069	Gross Beta	pCi/L	6.42	2.88 J	NA (4 mrem/yr)	MCL (SWRCB 2015a)	**No**
UCD1-069	Iron	µg/L	1620	502	300	Secondary MCL (SWRCB 2006)	**No**
UCD1-069	Manganese	µg/L	34	10	50	Secondary MCL (SWRCB 2006)	Yes
UCD1-069	Uranium-238	pCi/L	1.3	0.946 J	20	MCL (SWRCB 2015a)	Yes
UCD1-070	Gross Beta	pCi/L	4.4 J	2.88 J	NA (4 mrem/yr)	MCL (SWRCB 2015a)	**No**
UCD1-070	Uranium-238	pCi/L	1.38	0.946 J	20	MCL (SWRCB 2015a)	Yes
UCD1-071	Benzene	µg/L	0.29 J	0	1	MCL (SWRCB 2015a)	Yes
UCD1-071	Gross Beta	pCi/L	4.83	2.88 J	NA (4 mrem/yr)	MCL (SWRCB 2015a)	**No**
UCD1-071	Manganese	µg/L	48.7	10	50	Secondary MCL (SWRCB 2006)	Yes
UCD1-071	Uranium-238	pCi/L	2.31	0.946 J	20	MCL (SWRCB 2015a)	Yes
UCD1-072	Chloroform	µg/L	0.88	0	70	MCL (EPA 2006)	Yes
UCD1-072	Chromium	µg/L	62.9	43.7	10	California EPA MCL[d] (SWRCB 2015a)	**No**
UCD1-072	Chromium (Hexavalent)	µg/L	57	40	10	California EPA MCL (SWRCB 2015a)	**No**
UCD1-072	Formaldehyde	µg/L	14 J	13 J	100	California Notification Level (SWRCB 2015b)	Yes
UCD1-072	Gross Beta	pCi/L	3.74	2.88 J	NA (4 mrem/yr)	MCL (SWRCB 2015a)	**No**
UCD1-072	Uranium-238	pCi/L	1.14	0.946 J	20	MCL (SWRCB 2015a)	Yes

Notes:
[a] Groundwater background determined from wells UCD1-018 and UCD1-063 monitoring data collected in 2011 and 2012 (Weiss 2014)
[b] WQC Selection priority: California Primary MCL, EPA Primary MCL, Secondary MCL, California Notification Level, EPA RSL.
[c] "No" indicates that baseline level is either below the WQC, or, if above the WQC, is at or below the background level.
[d] Based on an assumption that total chromium is 100 percent hexavalent.

Abbreviations:
EPA = U.S. Environmental Protection Agency
J = estimated value
MCL = Maximum Contaminant Level
µg/L = micrograms per liter
mg/L = milligrams per liter
mrem/yr = millirem per year
NA = not available
pCi/L = picocuries per liter
RSL = Regional Screening Level
SWRCB = State Water Regional Control Board
WQC = water-quality criterion

References:
EPA (U.S. Environmental Protection Agency), 2000. Soil Screening Guidance for Radionuclides: User's Guide, EPA/540-R-00-007, October.

EPA (U.S. Environmental Protection Agency), 2006. National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule, Federal Register 40 *Code of Federal Regulations* Parts 9, 141, and 142, January 4.

EPA (U.S. Environmental Protection Agency), 2015. Risk-Based Screening Table-Generic Tables. http://www.epa.gov/risk/risk-based-screening-table-generic-tables, November.

SWRCB (State Water Resource Control Board), 2006. California Code of Regulation Title 22. Division 4. Environmental Health Chapter 15. Domestic Water Quality and Monitoring Regulations Article 16, Secondary Water Standards, http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/recentlyadoptedregulations/R-21-03-finalregtext.pdf, accessed January 18, 2016.

SWRCB (State Water Resource Control Board), 2015a. Comparison of MCLs and PHGs for Regulated Contaminants in Drinking Water, Download page for California and Federal Drinking Water Standards (MCLs), Detection Limits for Purposes of Report (DLRs) and Public Health Goals (PHGs), http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.shtml, last updated September 23, 2015, accessed January 15, 2016.

SWRCB (State Water Resource Control Board), 2015b. Division of Drinking Water (DDW), Drinking Water Notification Levels and Response Levels: An Overview, http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf, accessed January 18, 2016.

Weiss (Weiss Associates), 2014. Final 2012 Comprehensive Annual Water Monitoring Report for the Laboratory for Energy-Related Health Research/Old Campus Landfill Superfund Site, University of California, Davis, February 6.

Appendix D

Site Inspection Documentation

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D1.0 Site Inspection Documentation

On June 16, 2015, a walk-through inspection of monuments that define the DOE Areas subject to land-use restrictions (Figure D-1) was performed by the following:

- Tim Utterback, Bob Devany, and Bill McIlvride of Weiss Associates (Weiss)
- Linda Tegelman of Stoller Newport News Nuclear, Inc., a wholly owned subsidiary of Huntington Ingalls Industries, Inc.
- Michael Anderson of TechLaw (for David Stensby of the U.S. EPA)
- Sue Fields of the University of California, Davis (UC Davis)
- Durin Linderholm of the California Regional Water Quality Control Board (CRWQCB)
- Jeff Wong and Rajiv Misra of the California Department of Public Health, Radiologic Health Branch (CDPH)

A sign-in list for these individuals is provided in Attachment D-1.

All 24 monuments were in good condition except monument M19 (Figure D-1), which was not located and presumed lost as a result of surface soil disturbance by heavy machinery at the northwest corner of the Eastern Dog Pens (EDPs) Area. The affected area is approximately 1 to 2 inches deep by 25 feet long by 22 feet wide as shown in Figure D-2. Less than approximately 3 cubic yards of soil is mounded near the center of the scraped area. The trunk of a fallen tree is lying about 5 feet south of the scraped area. The anchorage location of monument M19 was found during the day of the walk-through inspection. On September 29, 2015, Hunter Surveying, a California-licensed land surveyor, reinstalled monument M19 at its previous location.

D1.1 Inspection of Domestic Septic System 4 Area for Prohibited Land Uses

On June 16, 2015, the above-listed group performed a walk-through inspection of the Domestic Septic System (DSS) 4 Area. As required by the *Covenant to Restrict Use of Property, Environmental Restriction* (DTSC 2014), no residential use, use for day care for children, or cultivation of crops for human consumption was observed in the DSS 4 Area.

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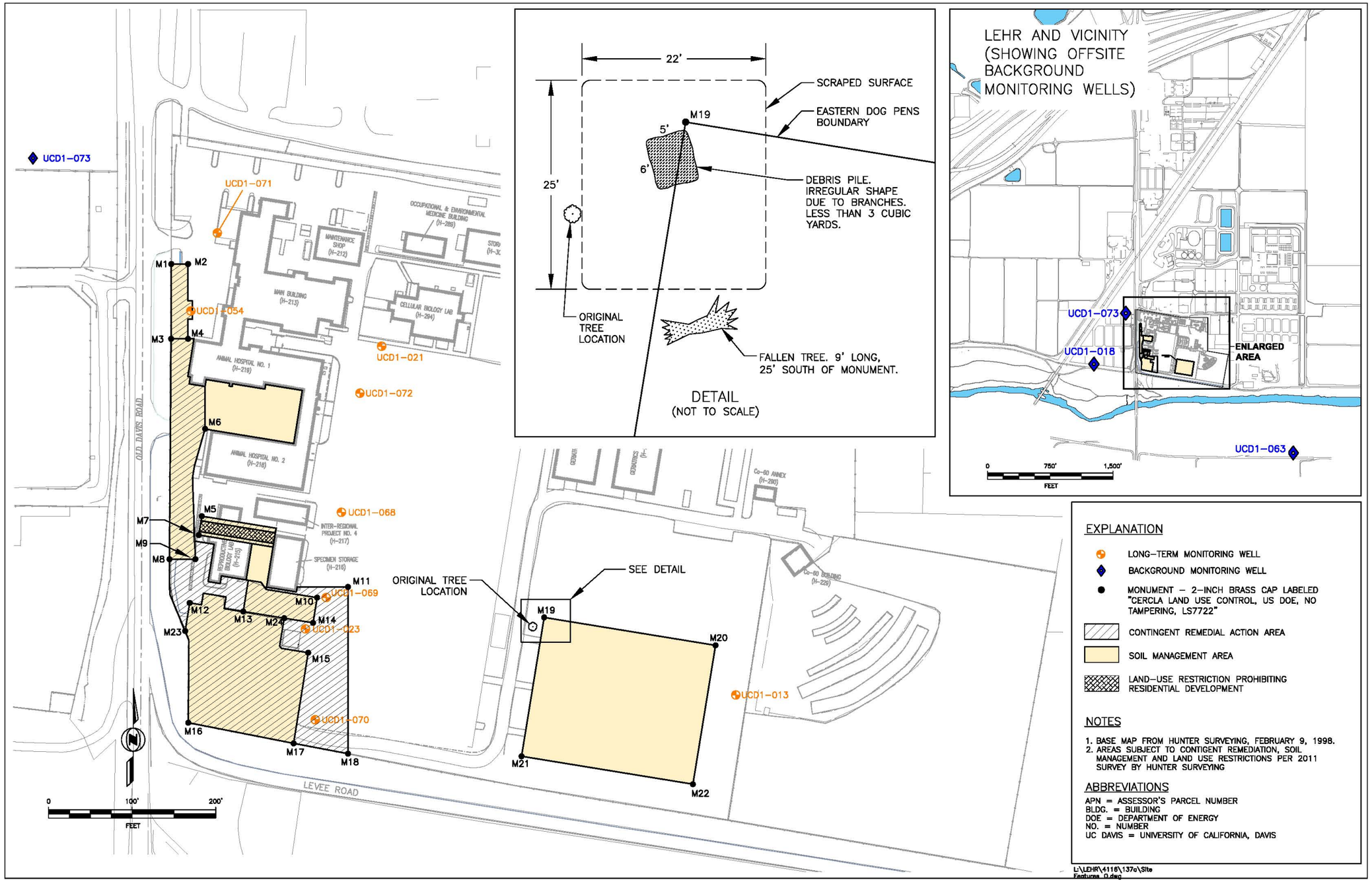

Figure D-1. DOE Areas Subject to Land-Use Restrictions, Survey Monuments, and Groundwater Monitoring Wells

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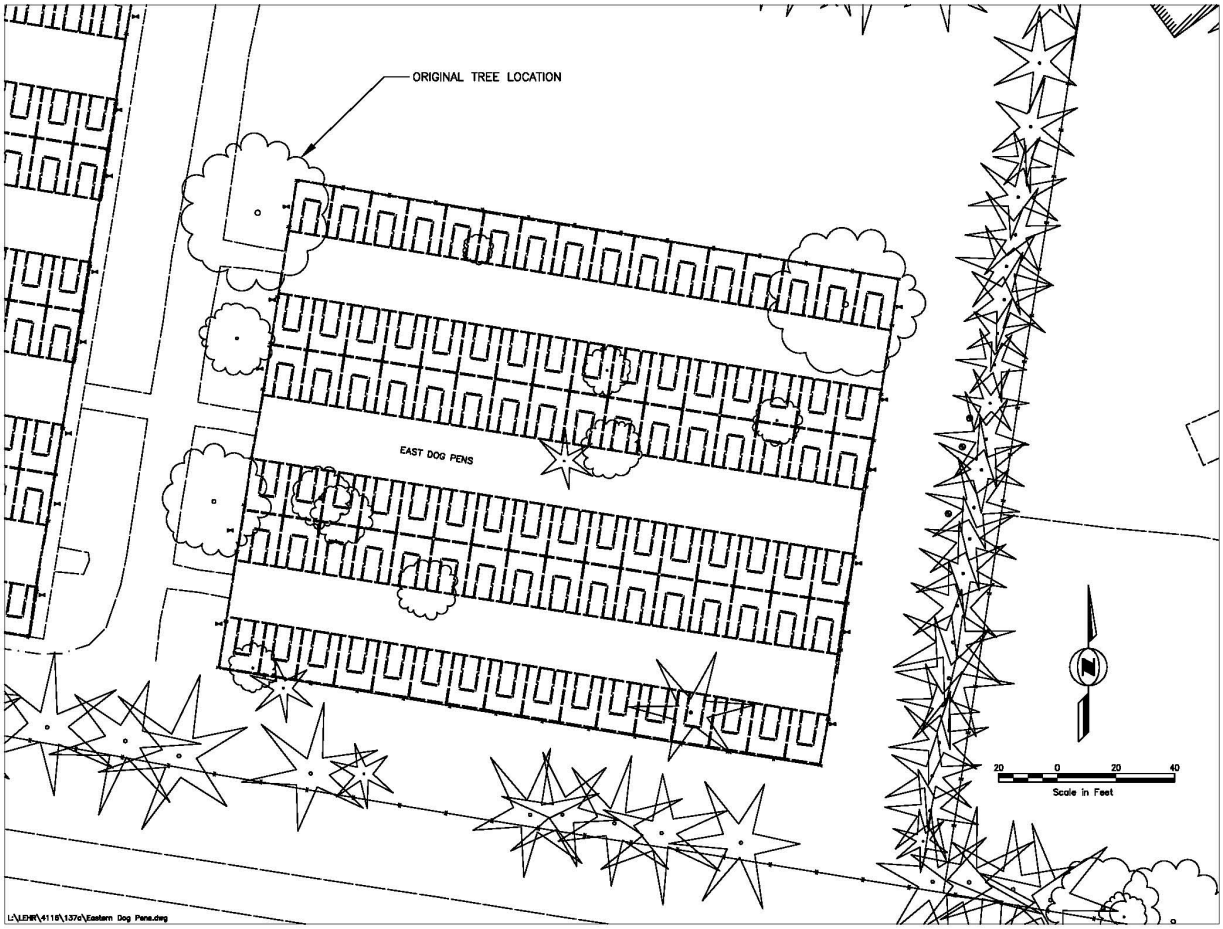

Figure D-2. 1998 Survey Map Showing Tree Originally Located to the West of the Eastern Dog Pens Area

D1.2 Inspections of DOE Areas for Compliance with Requirements of the Soil Management Plan

On June 16, 2015, the above-listed group performed a walk-through inspection of the DOE areas subject to land-use restrictions to look for signs of soil disturbance. Minor soil disturbance associated with a fallen tree was found in the northwest corner of the EDPs. Before the tree fell, it was located outside the west boundary of the EDPs as shown in the surveyors map prepared in 1998 (Figure D-2). Easting and northing coordinates obtained from the surveyors map indicate that the trunk was approximately 8 to 10 feet west (outside) of the EDPs fence. The tree was dead when it fell into the northwest corner of the EDPs.

As shown in the photograph below, the tree sheared at ground surface and did not bring soil or roots to the surface.

The volume and depth of the EDPs soil disturbance were less than the quantities that would require a permit according to the specifications in the Soil Management Plan in Appendix A of the *Remedial Design/Remedial Action Work Plan* (DOE 2010) (disturbed depths less than 1 foot and soil displaced less than 5 cubic yards). No soil disturbance events that would require a permit have occurred during the five-year period. Attachment D-2 provides the inspection checklist; Attachment D-3 provides photographs of the survey monuments; and Attachment D-4 provides photographs documenting the area inspections.

During this reporting period, no permit-required soil-disturbing activities occurred within the DOE areas subject to land-use restrictions; therefore, no inspections were necessary to comply with the requirements of the Soil Management Plan (DOE 2010).

D1.3 Inspections of Groundwater Monitoring Wells

On June 16, 2015, the above-listed group performed a walk-through inspection of groundwater monitoring wells UCD1-013, UCD1-018, UCD1-021, UCD1-023, UCD1-054, UCD1-063, and wells UCD1-068 through UCD1-073 (Figure D-1). Photographs from these well inspections are provided in Attachment D-5. None of the wells showed evidence of tampering.

- Wells with standpipe completions (UCD1-013, UCD1-018, UCD1-063, UCD1-070, and UCD1-073) were observed to be secured with functioning padlocks.
- Wells UCD1-054, UCD1-068, UCD1-069, UCD1-071, and UCD1-072 have surface completions and were observed to be secured with bolts.
- Wells UCD1-021 and UCD1-023 have surface completions and screw-on lids.

Well UCD1-021 has surface cracks and chips in the cement pad, but the underlying structural cement around the vault appears to be sound. Some minor well maintenance issues were noted during the June 16, 2015, inspection:

- The plaque on the lid of well UCD1-069 is missing due to vault replacement. The vault was replaced due to damage from grounds maintenance equipment.
- Well UCD1-071 requires a new vault gasket and longer bolts.

On September 1, 2015, a new plaque was installed on the lid of well UCD1-069. A new vault gasket was installed at well UCD1-071 on November 3, 2015. It was noted that the existing bolts fit properly after the vault lid gasket was replaced. Photographs of the completed well maintenance items are provided in Attachment D-6.

D2.0 Conclusions

The results of the June 16, 2015, walk-through inspection indicate that the remedy is functioning as designed and is protective of human health, the environment, and groundwater resources. During the Five-Year Review period, no permit-required soil-disturbing activities occurred within the DOE Areas subject to land-use restrictions. The monitoring wells have required minor maintenance such as lock lubrication, bolt replacement, and thread cleaning. Damage occurred at one well (UCD1-069) and one monument (M19), but the repairs were inexpensive and simple.

The land-use restrictions could be optimized by installing bollards or flexible ground-mount delineators at current flush-mount wells located in fields with tall vegetation (UCD1-068, UCD1-069, and UCCD1-072). Flexible ground-mount delineators with explanatory signage could be installed at monuments located in fields with tall vegetation (M11 and M19 thru M22). The precise language on the explanatory signage will be presented in the update to the Soil Management Plan.

D3.0 References

DTSC (California Department of Toxic Substances Control), 2014. *Covenant to Restrict Use of Property, Environmental Restriction (Re: Portions of County of Solano Assessor's Parcel No. 110-05-04 UC Davis, Laboratory for Energy-related Health Research/Old Campus Landfill (LEHR/OCL) Superfund Site*, Site Code 100424), Solano County Recorder's Office Document Number 201400051822, July 11.

DOE (U.S. Department of Energy), 2010. *Remedial Design/Remedial Action Work Plan for the Former Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis*, LMS/LEH/S05822, Office of Legacy Management, November.

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Attachment D-1

Sign-In Sheet

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3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency RWQCB
Contact Doris Lindenheim (Name) | Eng. Geologist (Title) | 6/16/15 (Date) | 916-464-4657 (Phone no.)
Problems, suggestions; Report attached

Agency EPA
Contact Michael Anderson for Tech Law (Name) | David Stensby Consultant (Title) | 6/16/15 (Date) | 415 762 0564 (Phone no.)
Problems, suggestions; Report attached

Agency UC DAVIS
Contact Sue Fields (Name) | PM (Title) | 6/16/15 (Date) | 530 752 3044 (Phone no.)
Problems, suggestions; Report attached

Agency CA Dept Public Health
Contact Jeff Wong (Name) | Health Physicist (Title) | 6/16/15 (Date) | 510-620-3423 (Phone no.)
Rajiv Mishra Health Phy. 06/16/2015 530-902-7398
Problems, suggestions; Report attached

4. **Other interviews** (optional) Report attached.

Bill McTurnee - Weiss Associates
Bob Devany - Weiss Associates
Linda Tegelman - SN3 (Stoller)
Tim Utterback - Weiss Associates

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Attachment D-2

Site Inspection Checklist

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Five-Year Review Site Inspection Checklist

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION	
Site name: United States Department of Energy Areas at the Laboratory for Energy-Related Health Research/South Campus Superfund Site	**Date of inspection:** June 16, 2015
Location and Region: UC Davis Center for Health and the Environment. Old Davis Road, Davis, California	**EPA ID:** CA2890190000
Agency, office, or company leading the five-year review: US Department of Energy	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ■ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls
- ■ Groundwater monitoring
- ■ Contingent remediation

Other _____

Attachments: ■ Inspection team roster attached ■ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager:** Sue Fields (Name) — Environmental Manager, UC Davis EHS (Title) — June 30, 2015 (Date)

   Interviewed at site at office ■ by phone Phone no. 530-752-3044

   Problems, suggestions; Report attached See Appendix D, Interviews

2. **Center for Health and the Environment Staff:**

Name	Title	Date
Kent Pinkerton	Director	June 26, 2015
Sue Russell	Chief Admin Officer	June 26, 2015
Shanie McCarty	EHS Specialist I	June 30, 2015

   Interviewed at site at office by phone Phone no. See Appendix D, Interviews

   Problems, suggestions; Report attached See Appendix D, Interviews

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds. or other city and county offices, etc.) Fill in all that apply.

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems, suggestions; Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems, suggestions; Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems, suggestions; Report attached _____
_____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems, suggestions; Report attached _____
_____

4. **Other interviews** (optional) See Appendix D, Interviews, for transcripts and summary.

Ardie Dehghani, Campus Engineer, UC Davis Design and Construction Management

Cary Avery, Associate Director, UC Davis Grounds and Landscape Services

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

O&M manual	□ Readily available	□ Up to date	■ N/A
As-built drawings	□ Readily available	□ Up to date	■ N/A
Maintenance logs	□ Readily available	□ Up to date	■ N/A

Remarks

2. **Soil Management Plan**

■ Readily available ■ Up to date □ N/A

Remarks

3. **Land Use Covenant**

■ Readily available ■ Up to date □ N/A

Remarks

Site-Specific Health and Safety Plan	■ Readily available	■ Up to date	□ N/A
Emergency response plan	■ Readily available	■ Up to date	□ N/A

Remarks

O&M and OSHA Training Records ■ Readily available ■ Up to date □ N/A

Remarks

4. **Permits and Service Agreements**

Air discharge permit	□ Readily available	□ Up to date	■ N/A
Effluent discharge	□ Readily available	□ Up to date	■ N/A
Waste disposal, POTW	□ Readily available	□ Up to date	■ N/A
Other permits _____	□ Readily available	□ Up to date	■ N/A

Remarks

Gas Generation Records □ Readily available □ Up to date ■ N/A

Remarks

Settlement Monument Records □ Readily available □ Up to date ■ N/A

Remarks

Groundwater Monitoring Records ■ Readily available ■ Up to date N/A

Remarks

5.	**Leachate Extraction Records**	□ Readily available	□ Up to date	■ N/A
	Remarks _____			
6.	**Discharge Compliance Records**			
	Air	□ Readily available	□ Up to date	■ N/A
	Water (effluent)	□ Readily available	□ Up to date	■ N/A
	Remarks			
7.	**Daily Access/Security Logs**	□ Readily available	□ Up to date	■ N/A
	Remarks _____			

IV. O&M COSTS ■ Addressed in Five-Year Review Report

1. **O&M Organization**

State in-house	Contractor for State
■ PRP in-house	Contractor for PRP
Federal Facility in-house	Contractor for Federal Facility

Other _____

V. ACCESS AND INSTITUTIONAL CONTROLS ■ Applicable □ N/A

A. Monuments - A monument is in adequate condition if it is found without displacement or destruction of the inscribed location point or markings.

1.	**Monument M1**	■ Monument is adequate	□ Monument is inadequate	□ N/A
	Remarks _____			
2.	**Monument M2**	■ Monument is adequate	□ Monument is inadequate	□ N/A
	Remarks			
3.	**Monument M3**	■ Monument is adequate	□ Monument is inadequate	□ N/A
	Remarks _____			
4.	**Monument M4**	■ Monument is adequate	□ Monument is inadequate	□ N/A
	Remarks _____			
5.	**Monument M5**	■ Monument is adequate	□ Monument is inadequate	□ N/A
	Remarks _____			
6.	**Monument M6**	■ Monument is adequate	□ Monument is inadequate	□ N/A
	Remarks _____			

7.	**Monument M7** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
8.	**Monument M8** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
9.	**Monument M9** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
10.	**Monument M10** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
11.	**Monument M11** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
12.	**Monument M12** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
13.	**Monument M13** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
14.	**Monument M14** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
15.	**Monument M15** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
16.	**Monument M16** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
17.	**Monument M17** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
18.	**Monument M18** Remarks	■ Monument is adequate	□ Monument is inadequate	□ N/A
19.	**Monument M19** Remarks Monument missing. Tape-measured former M19 location and installed temporary marker.	□ Monument is adequate	■ Monument is inadequate	□ N/A

20.	**Monument M20** Remarks _____	■ Monument is adequate	□ Monument is inadequate	□ N/A
21.	**Monument M21** Remarks _____	■ Monument is adequate	□ Monument is inadequate	□ N/A
22.	**Monument M22** Remarks _____	■ Monument is adequate	□ Monument is inadequate	□ N/A
23.	**Monument M23** Remarks _____	■ Monument is adequate	□ Monument is inadequate	□ N/A
24.	**Monument M24** Remarks _____	■ Monument is adequate	□ Monument is inadequate	□ N/A

B. General

1.	**Vandalism/trespassing** Remarks _____	□ Location shown on site map	■ No vandalism evident	
2.	**Land use changes on site** Remarks _____	□ Yes	■ No	□ N/A
3.	**Land use changes off site** Remarks _____	□ Yes	■ No	□ N/A
4.	**Evidence of structures, utilities or other features obstructing access to the Contingent Remedial Action support areas** Remarks _____	□ Yes	■ No	□ N/A
5.	**Evidence of Soil Disturbance in Southwest Trenches Area** Remarks _____	□ Yes	■ No	□ N/A
6.	**Evidence of Soil Disturbance in Domestic Septic System 3 Area** Remarks _____	□ Yes	■ No	□ N/A
7.	**Evidence of Soil Disturbance in Domestic Septic System 4 Area** Remarks _____	□ Yes	■ No	□ N/A
8.	**Evidence of Soil Disturbance in Ra/Sr Treatment Systems Area** Remarks _____	□ Yes	■ No	□ N/A

9. **Evidence of Soil Disturbance in Dry Wells A - E Area** □ Yes ■ No □ N/A
Remarks _____

10. **Evidence of Soil Disturbance in Eastern Dog Pens Area** ■ Yes □ No □ N/A
Remarks
An area of surface soil in the northwest corner of the Eastern Dog Pens was apparently moved by heavy machinery. The area is approximately 1 to 2 inches deep by 25 feet long by 22 feet wide. Less than approximately 3 cubic yards of soil is mounded near the center of scraped area. The trunk of a fallen tree is laying about 5 feet south of the scraped area.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented	□ Yes	■ No	□ N/A
Site conditions imply ICs not being fully enforced	□ Yes	■ No	□ N/A

Type of monitoring (*e.g.*, self-reporting, drive-by) Walk-through inspections
Frequency Annual and as needed in the event of soil disturbing activities
Responsible party/agency United States Department of Energy
Contact Cliff Carpenter (Name) Site Manager (Title) _____ (Date) 304) 413-0807 (Phone No.)

Reporting is up-to-date	■ Yes	□ No	□ N/A
Reports are verified by the lead agency	■ Yes	□ No	□ N/A
Specific requirements in deed or decision documents have been met	■ Yes	□ No	□ N/A
Violations have been reported	□ Yes	■ No	□ N/A

Other problems or suggestions: □ Report attached
None

2. **Adequacy** ■ ICs are adequate □ ICs are inadequate □ N/A
Remarks

VI. GENERAL SITE CONDITIONS

A. Roads ■ Applicable □ N/A

1. **Roads damaged** □ Location shown on site map ■ Roads adequate □ N/A
Remarks _____

B. Other Site Conditions

Remarks: None

Modified From OSWER No. 9355.7

VII. LANDFILL COVERS	□ Applicable ■ N/A
VIII. VERTICAL BARRIER WALLS	□ Applicable ■ N/A
IX. GROUNDWATER/SURFACE WATER REMEDIES	■ Applicable □ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines	□ Applicable ■ N/A
B. Surface Water Collection Structures, Pumps, and Pipelines	□ Applicable ■ N/A
C. Treatment System	□ Applicable ■ N/A
D. Monitoring Data	
1. Monitoring Data ■ Is routinely submitted on time □ Is of acceptable quality	
2. Monitoring data suggests: □ Groundwater plume is effectively contained □ Contaminant concentrations are declining Remarks groundwater is monitored for impact by solid waste units and evaluated annually; no substantive changes based on five-year data	
E. Monitored Natural Attenuation	□ Applicable ■ N/A
F. Long-Term Groundwater Monitoring	■ Applicable □ N/A
1. **Monitoring Well UCD1-013** ■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition ■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A Remarks _____	
2. **Monitoring Well UCD1-018** ■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition ■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A Remarks _____	
3. **Monitoring Well UCD1-021** ■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition ■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A Remarks No lock. Well is flush-mount with screw-on lid. Lid was secure.	
4. **Monitoring Well UCD1-023** ■ Properly secured ■ Functioning ■ Routinely sampled ■ Good condition ■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A Remarks No lock. Well is flush-mount with screw-on lid. Lid was secure.	
5. **Monitoring Well UCD1-054** ■ Properly secured ■ Functioning ■ Routinely sampled ■ Good condition ■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A Remarks No lock. Well is flush-mount with bolt-on lid. Lid was secure.	

Modified From OSWER No. 9355.7-03B-P

6. **Monitoring Well UCD1-063**
■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition
■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A

Remarks _____

7. **Monitoring Well UCD1-068**
■ Properly secured ■ Functioning ■ Routinely sampled ■ Good condition
■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A

Remarks No lock. Well is flush-mount with bolt-on lid. Lid was secure.

8. **Monitoring Well UCD1-069**
■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition
■ Found ■ Needs Maintenance □ Plaques are adequate □ N/A

Remarks No lock. Well is flush-mount with bolt-on lid. Lid was secure. Plaque on lid is missing due to vault replacement. New plaque received from manufacturer; awaiting installation. Vault was replaced due to damage from grounds maintenance equipment.

9. **Monitoring Well UCD1-070**
■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition
■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A

Remarks _____

10. **Monitoring Well UCD1-071**
□ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition
■ Found ■ Needs Maintenance ■ Plaques are adequate □ N/A

Remarks Needs new vault gasket and longer bolts.

11. **Monitoring Well UCD1-072**
■ Properly secured ■ Functioning ■ Routinely sampled ■ Good condition
■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A

Remarks No lock. Well is flush-mount with bolt-on lid. Lid was secure.

12. **Monitoring Well UCD1-073**
■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition
■ Found □ Needs Maintenance ■ Plaques are adequate □ N/A

Remarks _____

X. OTHER REMEDIES □ Applicable ■ N/A

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Remedy is intended to accomplish protection of human health, the environment, and groundwater resources from small quantities of contamination in soil remaining after excavations of buried waste and contaminated soil. Remedy is functioning as designed. Land-use controls were implemented to prevent soil disturbance and protect human health and the environment. Groundwater monitoring program data indicate concentrations in groundwater are generally stable or declining.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Operations and maintenance (O&M) consists of maintaining survey monuments and wells as prescribed in the *Covenant to Restrict Use of Property*, Solano County Recorders Office Document Number 201400051822. Wells have required minor maintenance such as bolt replacement, thread cleaning, concrete apron repairs, and vault replacement. The plaque attached to the lid on well UCD1-069 was lost due to impact by grounds maintenance equipment. The lost plaque has been re-manufactured and is awaiting installation. One monument (M19) was recently damaged due to grounds maintenance work in the northwest corner of the Eastern Dog Pens. The anchorage location of monument M19 was found and replacement is planned. O&M issues encountered during the five- year period have been routine and easily manageable. The O&M program is protective of the remedy.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost of scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

Project costs have been low due to the simplicity and effectiveness of the remedy. Concentrations in groundwater have been generally stable or gradually declining. Constituent concentrations have occasionally been above baseline or background on some sample events and then returned below baseline or background when re-sampled. Contingent remedial action has not been necessary. No soil disturbance events that would require a permit have occurred. The volume and depth of the soil that was scraped by heavy equipment in the northwest corner of the Eastern Dog Pens was less than the Soil Management Plan criteria for requiring a permit.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

The land use controls could be optimized by installing bollards or flexible ground-mount delineators at current flush-mount wells located in fields with tall vegetation (UCD1-068, UCD1-069, and UCCD1-072). Bollards or flexible ground-mount delineators with explanatory signage could be installed at monuments located in fields with tall vegetation (M11 and M19 thru M22).

Attachment D-3

Photographs of Survey Monuments

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Monument 1, northwest corner of Dry Wells A–E Area.

View northwest; monument 1 within orange ring in foreground; entrance sign in background.

Monument 2, northeast corner of Dry Wells A–E Area.

View northwest; monument 2 within orange ring in foreground; retracted entrance gate in background.

Monument 3, southwest corner of Dry Wells A–E Area.

View west; monument 3 within orange ring; west perimeter fence behind.

Monument 4, southeast corner of Dry Wells A–E Area.

View east; monument 4 within orange ring; Building H219 behind.

Monument 5, northwest corner of Domestic Septic System 4.

View east; monument 5 within orange ring; Building H215 in background.

Monument 6, adjacent to northwest corner of Building H-218; Radium/Strontium Treatment Systems Area.

View east; monument 6 within orange ring in foreground; corner of Building H218 behind right.

Monument 7, southwest corner of Domestic Septic System 4.

View east; monument 7 within orange ring; Building H215 in background.

Monument 8, southwest corner of radium-226 leach trench; Radium/Strontium Treatment Systems Area.

View southwest; monument 8 within orange ring; west perimeter fence behind.

Monument 9, southeast corner of radium-226 leach trench; Radium/Strontium Treatment Systems Area.

View east; monument 9 within orange ring; Building H215 in background.

Monument 10, northeast corner of former leach field in Domestic Septic System 3 Area.

View west; monument 10 within orange ring; Building H216 in background.

Monument 11, northeast corner of Eastern Remediation Support Area.

View west; monument 11 within orange ring in foreground; Building H216 in background.

Monument 12, northwest corner of Southwest Trenches Area.

View south; monument 12 within orange ring in foreground; water hydrant in background.

Monument 13, southwest corner of Domestic Septic System 3, at northern perimeter of Southwest Trenches Area.

View north; monument 13 within orange ring at edge of concrete swale: Building H215 in background.

Monument 14, southeast corner of Domestic Septic System 3.

View southwest; monument 14 within orange ring in foreground; Well UCD1-023 and trailer shed in background.

Monument 15, eastern corner of Southwest Trenches Area.

View south; monument 15 within orange ring in foreground; former Western Dog Pens silt fence to left and trailer shed fence behind right.

Monument 16, southwest corner of Southwest Trenches Area.

View southwest; monument 16 within orange ring: southwest corner post of perimeter fence behind.

Monument 17, southeast corner of Southwest Trenches Area.

View south; monument 17 within orange ring;
south perimeter fence behind; North Levee in background.

Monument 18, southeast corner of Eastern Remediation Support Area.

View south; monument 18 within orange ring;
foot of North Levee in background; burrow mound in foreground.

Monument 19 temporary marker, northwest corner of Eastern Dog Pens Area.

View southeast; field crew setting temporary marker at measured location of monument 19.

Monument 20, northeast corner of Eastern Dog Pens Area.

View southwest; monument 20 within orange ring; Eastern Dog Pens Area in background.

Monument 21, southwest corner of Eastern Dog Pens Area.

View northeast; monument 21 within orange ring; Eastern Dog Pens Area in background.

Monument 22, southeast corner of Eastern Dog Pens Area.

View east; monument 22 within orange ring; Eastern Dog Pens Area to immediate left; Cobalt-60 Area fence behind.

Monument 23, western perimeter point of Southwest Trenches Area.

View northwest; monument 23 within orange ring; west perimeter fence behind.

Monument 24, northeast corner of Southwest Trenches Area, at southern perimeter of Domestic Septic System 3.

View southeast; monument 24 within orange ring on edge of concrete swale. Waste bin and trailer shed behind; rose planter behind right.

Attachment D-4

Photographs of DOE Areas

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View southeast over Southwest Trenches Area: North Levee in background.

View east over Southwest Trenches Area: storage shed to left; North Levee to right; Western Dog Pens Area and UC Davis Southern Trenches Area in background.

View north over northwest corner of Southwest Trenches Area.

View south over Southwest Trenches Area: North Levee in background.

View southeast over Southwest Trenches Area.

View west over Southwest Trenches Area: shoulder of Old Davis Road in background.

View northwest; well UCD1-070 in foreground.

View north over Southwest Trenches Area.

View south from center of Southwest Trenches Area.

View east from center of Southwest Trenches Area.

View east over former leach field part of Domestic Septic System 3 Area: Building H-216 to left; storage unit to right; Western Dog Pens Area in background.

View east over eastern half of Domestic Septic System 3 Area.

View west over former leach field part of Domestic Septic System 3 Area: Buildings H-215 and H-216 to right; Southwest Trenches Area to left; shoulder of Old Davis Road in background.

View south over septic tank part of Domestic Septic System 3 Area: Building H-216 to left; Building H-215 to right.

View north over septic tank part of Domestic Septic System 3 Area: Building H-216 to right; Domestic Septic System 4 Area in background.

View south over east end of Domestic Septic System 3 leach field: trailer in background.

View east: Building H-216 in background, standing north/left of tree.

View east: Building H-216 in background, standing south/right of tree.

View north over Domestic Septic System 4 septic tank location and east end of leach field: Building H-215 to left, Building H-216 to right; Building H-217 in background.

View west over east end of Domestic Septic System 4 leach field: Building H-215 in background.

View east over Domestic Septic System 4 septic tank location: Building H-216 in background.

View east over western portion of Domestic Septic System 4 Area: Building H-215 in background.

View north over southern portion of Radium/Strontium Treatment Systems Area: Building H-215 right: Buildings H-218 and H-219 in background.

View north over middle portion of Radium/Strontium Treatment Systems Area: Building H-218 near upper right-hand corner, Building H-219 in background.

View south over southern portion of Radium/Strontium Treatment Systems Area: Building H-215 to left.

View north over northern portion of Radium/Strontium Treatment Systems Area: Building H-219 to right.

View south over middle-south portion of Radium/Strontium Treatment Systems Area: Building H-218 to left; west perimeter fence to right.

View east over middle portion of Radium/Strontium Treatment Systems Area: Building H-218 to right; Building H-219 to left.

View south over Domestic Septic System 2 area within Radium/Strontium Treatment Systems Area: Building H-218 behind.

View west over middle-west portion of Radium/Strontium Treatment Systems Area.

Roof-level view west over middle portion of Radium/Strontium Treatment Systems Area: Building H-219 to right, Building H-218 to left.

Roof-level view southwest over Domestic Septic System 2 area within middle portion of Radium/Strontium Treatment Systems Area: Building H-218 in background.

Roof-level view northwest over middle portion of Radium/Strontium Treatment Systems Area: Building H-219 in background.

View south over northern portion of Radium/Strontium Treatment Systems Area.

View north over Dry Wells A–E Area; Old Davis Road to left.

View south over Dry Wells A–E Area: Building H-219 in background/left; facility entrance gate in lower right-hand corner.

View west over Dry Wells A–E Area: site entrance gate and Old Davis Road in background.

View southwest over Dry Wells A–E Area: Old Davis Road in background.

View northeast over southwest corner of Eastern Dog Pens Area from North Levee.

View east over Eastern Dog Pens Area.

View southeast over Eastern Dog Pens Area from northwest corner.

View south over Eastern Dog Pens Area.

View southwest over Eastern Dog Pens Area from northeast corner.

View west over Eastern Dog Pens Area.

View northwest into southeast corner of Eastern Dog Pens Area from North Levee; partially obscured by trees.

View north over Eastern Dog Pens Area from North Levee.

Attachment D-5

Photographs of Monitoring Wells

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UCD1-013 Wellhead.

UCD1-013 Wellhead Plaque.

UCD1-013 Interior.

UCD1-013 Interior Plaque.

UCD1-018 Wellhead.

UCD1-018 Wellhead Plaque.

UCD1-018 Interior.

UCD1-018 Interior Plaque..

UCD1-021 Wellhead.

UCD1-021 Wellhead Plaque.

UCD1-021 Interior.

UCD1-021 Interior Plaque.

UCD1-023 Wellhead.

UCD1-023 Wellhead Plaque.

UCD1-023 Interior.

UCD1-023 Interior Plaque.

UCD1-054 Wellhead.

UCD1-054 Wellhead Plaque.

UCD1-054 Interior.

UCD1-054 Interior Plaque.

UCD1-063 Wellhead.

UCD1-063 Wellhead Plaque.

UCD1-063 Interior.

UCD1-063 Interior Plaque.

UCD1-068 Wellhead.

UCD1-068 Wellhead Plaque.

UCD1-068 Interior.

UCD1-068 Interior Plaque.

UCD1-069 Wellhead with new concrete apron and lid.

New UCD1-069 Wellhead Plaque (awaiting installation).

UCD1-069 Interior with new vault.

UCD1-069 Interior Plaque.

UCD1-070 Wellhead.

UCD1-070 Wellhead Plaque.

UCD1-070 Interior.

UCD1-070 Interior Plaque.

UCD1-071 Wellhead.

UCD1-071 Wellhead Plaque.

UCD1-071 Interior.

UCD1-071 Interior Plaque.

UCD1-072 Wellhead.

UCD1-072 Wellhead Plaque.

UCD1-072 Interior.

UCD1-072 Interior Plaque.

UCD1-073 Wellhead.

UCD1-073 Wellhead Plaque.

UCD1-073 Interior.

UCD1-073 Interior Plaque.

Attachment D-6

Photographs of Completed Well Maintenance Items

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UCD1-069 Wellhead with new plaque.

UCD1-069 close-up view of new plaque.

UCD1-071 Wellhead with new gasket (to the right)

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Appendix E

Interviews Summary and Transcripts

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Table E-1 provides a list of the individuals who were interviewed via telephone conversation between June 26 and July 1, 2015, as well as others who were approached but declined to be interviewed. The questionnaire used for the interview process and the transcripts from recorded responses from those interviewed are included in Attachment E-1.

Table E-1. Individuals Interviewed for the Five-Year Review

Individual	Title	Role on DOE LEHR Project	Response to Interview Request
Cary Avery	Associate Director of Grounds and Landscape Services, UC Davis	Grounds maintenance	Yes
Ardie Dehghani	Campus Engineer, UC Davis DCM	Construction oversight	Yes
Sue Fields	Environmental Manager, UC Davis EH&S Unit	UC Davis Project Manager	Yes
Shanie McCarty	EH&S Specialist I, UC Davis CHE	Works at CHE, which is onsite	Yes
Kent Pinkerton	Director, UC Davis CHE	Works at CHE, which is onsite	Yes
Sue Russell	Chief Administrative Officer, UC Davis CHE	Works at CHE, which is onsite	Yes
Mary Rust	Neighboring Landowner	Member of Former DSCSOC	Declined[a]
David Stensby	Remedial Project Manager	EPA Region 9	Declined[b]
Durin Linderholm	Engineering Geologist	CRWQCB	Declined[b]
John Bystra	Project Manager	DTSC	Declined[b]

Notes:
[a] Stated that she no longer lives in the area and is not up to date on LEHR activities.
[b] Indicated that they have no additional input beyond that provided through regular meetings and document review.

Abbreviations:
CHE = Center for Health and the Environment
CRWQCB = California Regional Water Quality Control Board
DCM = Design and Construction Management
DSCSOC = Davis South Campus Superfund Oversight Committee
DOE = U.S. Department of Energy
DTSC California Department of Toxic Substances Control
LEHR = Laboratory for Energy-Related Health Research
EH&S = Environmental Health & Safety
UC Davis = University of California, Davis

In summary, the responses provided by those interviewed indicated the following:

- All respondents felt that the LEHR DOE Areas remedy is adequately protective, and none were aware of any changes in laws or regulations within the past 5 years that would affect the protectiveness and effectiveness of the remedy.
- All respondents felt that they were adequately informed about the remedy and land-use restrictions, trained on their responsibilities regarding the remedy implementation (as appropriate), and were well aware of where to obtain information about the remedy. All respondents indicated that the UC Davis EH&S Unit is their primary source of information.

- In terms of impact the DOE remedy has had on the community, two UC Davis respondents mentioned concerns related to Pacific Gas & Electric's plan to install a new high-pressure gas line adjacent to the site and the associated disruption to groundwater that could potentially impact the remedy. Two UC Davis respondents also mentioned community concerns that the remedy was overly protective and costly. One respondent mentioned past community concern about the groundwater plume, but stated that his understanding is that DOE has been very detailed in following that plume and its progress and has provided information on the plume to the public in regular meetings.
- When asked about complaints, violations, incidents, or activities involving the DOE Areas and remedy, one or more respondents mentioned:
  - Several years ago someone representing the State was planning to drill a soil boring to assess the Putah Creek levee adjacent to the site. The UC Davis EH&S Unit was notified and helped the State representative select a location that would not interfere with the DOE Areas remedy.
  - A land-survey monument for the DOE Areas remedy was recently lost and some surface soil was disturbed when a fallen tree at the Eastern Dog Pens Area was cleared out. The UC Davis EH&S Unit was notified and confirmed that no soil disturbance requiring notification had occurred. At the time of the interview, the EH&S Unit was in the planning stages for replacing the missing monument and improving the visibility for those monuments needing it.
  - The California Department of Health Services recently asked the UC Davis EH&S Unit where they could place a shade structure at the site. A meeting was scheduled for July to select a location that would not impact any of the restricted areas.

Attachment E-1

Transcripts from Recorded Interviews

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INTERVIEW RECORD		
Site Name: United States Department of Energy Areas at the Laboratory for Energy-Related Health Research/South Campus Superfund Site, UC Davis, California	EPA ID No.: CA2890190000	
Subject: Remedial Action Five Year Review	Date: June 26, 2015	Time: 9:30 AM

Type: ■ Telephone ☐ Visit ☐ Completed Form ☐ Other _____

Location of Visit: N/A

Contact Made By:		
Name: Mary Stallard	**Title: Sr Project Hydrogeologist**	**Organization: Weiss Associates**
Individual Contacted:		
Name: Cary Avery	**Title: Associate Director**	**Organization: Grounds and Landscape Services, UC Davis**

Telephone No: 530-752-4206, 916-870-7676	**Street Address:**
E-Mail Address: cgavery@ucdavis.edu	**City, State, Zip:**

Question 1: What has been your involvement in the Laboratory for Energy-Related Health Research/South Campus Superfund Site (LEHR) to date? How long have you worked on or been associated with the LEHR Site?

Response 1: My only involvement has been from the landscape maintenance standpoint which really is limited to fire prevention, just mowing down the weeds upon request.

How long involved? I have been associated with the site probably for 29 years, I have a crew that goes out there when requested just to either … if a tree limb falls they'll pick it up but mainly to "weed-eat" the weeds down or to mow the weeds … that's pretty much it.

Question 2: Do you have specific knowledge of the remediation project at the United States Department of Energy (DOE) Areas of LEHR? If so, what is your general impression of the project and do you feel that the DOE remedy is sufficiently protective of human health and the environment?

Response 2: Yes, just in terms of restrictions … on the land use.

General impression of the project? Yes, my general impression is that they've done a good job of managing it and I believe they have protected the human health and environment of the area.

Question 3: Has the DOE remedy had an effect on the community? Are you aware of any concerns?

Response 3: I'm not aware of any concerns from the community from my standpoint as the landscape manager on campus and I don't know of any effects it's had on the community.

Question 4: Are you aware of any events, incidents, or activities at the DOE Areas of LEHR such as vandalism, trespassing or emergency responses from local authorities? If so, please provide details.

Response 4: No, I'm not aware of any of those activities.

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INTERVIEW RECORD
Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process? *Response 5:* Yes, I'm aware of the restrictions and I know that if there is a need for soil disturbance that there's a permit application that needs to be submitted to environmental health and safety on campus 30 days prior to any soil disturbance for approval. Yes, I know that needs to go through EHS here on campus. So it needs need to be submitted to them 30 days prior and they need to be contacted to submit the application/permit.
Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection? *Response 6:* Yes.
Question 7: Do you feel well informed about the activities and progress at the DOE Areas of LEHR? If not, what can DOE do to keep you better informed? *Response 7:* I feel like we've been informed and EHS meets with us yearly to go over any changes. So yes … I felt very, very informed. No recommendations.
Question 8: Do you know where to get information about the DOE areas of LEHR? *Response 8:* Yes. What I would do is contact EHS. They would provide me with the information needed. *Instance where you couldn't reach someone / other avenues for getting information?* For what we provide the campus, I couldn't ever see a situation where I'd have to do that; like I said, normally we only visit the site upon request from EHS … for fire prevention and that sort of thing. We don't normally go there on a regular basis. *So generally EHS requesting you do work there*? Yes, that's always the case
Question 9: Have there been routine communication or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the DOE Remedy at the LEHR Site? If so, please give their purpose and results. *Response 9:* Yes, and that happens yearly with EHS. We do like a yearly in case any of the folks, the employee/personnel would change, we only have 3 or 4 people that would go out there so the representative has be meeting on a yearly basis and just going over the protocol.

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INTERVIEW RECORD
Question 10: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses. *Response 10:* No. No complaints at all. *Incidents?* No … we had actually just one incident like a month ago where there was a scrape …what appeared to be a scrape from the mower where somebody questioned us but that's been the only thing and there was really no soil disturbance; it's just where the blade hit a rock or something and there was a little bit of a scrape. *When that happened – details*? Basically, somebody from EHS contacted us and asked us if we knew anything about it. We didn't off the top … I talked to the supervisor and he said the only thing he could think of was when they mowed it the blade might have scraped the surface where it looked like somebody was trying to dig but it really, quite frankly was it was nothing. So that's been the only incident ever in my 29 years here that anything has ever been questioned and it looked like maybe the back of the mower might have scraped the ground or the blade and that's it …and it really wasn't in the restricted area. But they were contacted immediately and we followed up and there was really nothing to it. *Who contacted EHS?* I don't know. I don't really know. They sent me an email saying do you know anything about it, we followed it, we looked at … it was really nothing. I mean, we're not even talking about a quarter-of-an-inch scrape over like maybe 3 or 4 inches, that's it. Nothing.
Question 11: Have there been any significant changes in laws or regulations since the DOE remedy's start-up in 2011? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts. *Response 11:* No, no laws that I'm aware of that have anything for us … in terms of landscaping.
Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR? *Response 12:* No … not really. I think they've done a good job of managing it. <u>*Reiterating*</u> *Scraping related to a tree limb that came into play?* I think that was one of the concerns, that's a separate thing. There was a tree limb that came down and I think that when they cut the limb to pull the brush, I think there was a concern about some scraping there but no soil was really disturbed. Dragged it … basically we have a "claw" on the end of the chipper that might have pulled it and so the brush might have just scraped a little bit on the soil but really nothing significant.

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INTERVIEW RECORD		
Site Name: United States Department of Energy Areas at the Laboratory for Energy-Related Health Research/South Campus Superfund Site, UC Davis, California	EPA ID No.: CA2890190000	
Subject: Remedial Action Five Year Review	Date: July 1, 2015	Time: 9:00 AM

Type: ■ Telephone ☐ Visit ☐ Completed Form ☐ Other _____

Location of Visit:

Contact Made By:		
Name: Mary Stallard	**Title: Sr Project Hydrogeologist**	**Organization: Weiss Associates**
Individual Contacted:		
Name: Ardie Dehghani	**Title: Campus Engineer**	**Organization: UC Davis Design and Construction Management (DCM)**

Telephone No: 530-754-1008, 530-304-1088	**Street Address:**
E-Mail Address: adehghani@ucdavis.edu	**City, State, Zip:**

Question 1: What has been your involvement in the Laboratory for Energy-Related Health Research/South Campus Superfund Site (LEHR) to date? How long have you worked on or been associated with the LEHR Site?

Response 1: My involvement is there is a project advisory committee for the LEHR site; I am a member of the project advisory committee on campus. I represent the capital side of the house so if there was an improvement that would require capital project to implement, it would come to our office. I've been involved in the project a little over 3 years, maybe 4.

Question 2: Do you have specific knowledge of the remediation project at the United States Department of Energy (DOE) Areas of LEHR? If so, what is your general impression of the project and do you feel that the DOE remedy is sufficiently protective of human health and the environment?

Response 2: Based on … I have not met directly with DOE. I've read a few of the information that's been shared through our internet folks. It seems like they are extremely protective … so hope that helps.

Question 3: Has the DOE remedy had an effect on the community? Are you aware of any concerns?

Response 3: I think there are just a couple of small areas. One is that we are served our natural gas system is served – through PG&E infrastructure system. They have been trying to get a new gas line across this area and they've been having difficulty getting it through so that's the only area I know. And then the other concern I think because of DOE being extremely protective, the cost of correction seems to be a little bit out of reality a little bit …we hope that we go back and forth to make sure we do the right thing at the end.

Only concern I would have would be to making sure that we implement necessary things to do the right protection but also be conscientious of the cost that we have to spend.

Question 4: Are you aware of any events, incidents, or activities at the DOE Areas of LEHR such as vandalism, trespassing or emergency responses from local authorities? If so, please provide details.

Response 4: I don't have any knowledge of that area.

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INTERVIEW RECORD
Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process? *Response 5:* Yes, our EHS representatives have a structured guideline. They meet with our design and construction management team that are responsible for implementing any capital project on campus annually to update and remind people of the areas that are protected so any work that may be scheduled in that area would be coordinated through EHS. So yes, we have a lot of knowledge of our restrictions and requirement for initiating any disturbance.
Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection? *Response 6:* I believe so … yes. Again, similar to before, we may be a little extremely protective, but absolutely, yes.
Question 7: Do you feel well informed about the activities and progress at the DOE Areas of LEHR? If not, what can DOE do to keep you better informed? *Response 7:* All of my knowledge is through our EHS folks and I believe that they've (the DOE) have done a very good job of informing and reaching out to the public, at least recently, but that's the extent I know.
Question 8: Do you know where to get information about the DOE areas of LEHR? *Response 8:* Yes. Two locations – one would be, of course, from DOE sites (websites) to mainly from our local campus representatives, our EHS folks.
Question 9: Have there been routine communication or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the DOE Remedy at the LEHR Site? If so, please give their purpose and results. *Response 9:* Our office implemented a few monitoring wells this past couple years at the project site, so as far as the direct involvement and site visit would have been specifically regarding the construction of the monitoring wells. But besides that, the rest of it would be through annual training by EHS in regards to the site. *When were wells installed?* It was done in 2014; it completed towards the end of 2014.
Question 10: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses. *Response 10:* Not to my knowledge. The only complaint has been PG&E in trying to get their pipe across, but not necessarily because of violation. They're trying to identify an effective way to get their pipe across the site. No other information or knowledge I have in regard to complaints or violation.
Question 11: Have there been any significant changes in laws or regulations since the DOE remedy's start-up in 2011? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts. *Response 11:* This is very outside of my area expertise. I don't know much about this one.

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INTERVIEW RECORD
Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR? *Response 12:* Not really. I think the only area is identifying ways to complete the protection sooner than later. There's been a number of different options on the table how DOE would advise which one they would consider incorporating to make this site safe.

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INTERVIEW RECORD		
Site Name: United States Department of Energy Areas at the Laboratory for Energy-Related Health Research/South Campus Superfund Site, UC Davis, California	EPA ID No.: CA2890190000	
Subject: Remedial Action Five Year Review	Date: June 30, 2015	Time: 9:00 AM

Type: ■ Telephone ☐ Visit ☐ Completed Form ☐ Other _____

Location of Visit:

Contact Made By:		
Name: Mary Stallard	**Title: Sr Project Hydrogeologist**	**Organization: Weiss Associates**
Individual Contacted:		
Name: Sue Fields	**Title: Environmental Manager**	**Organization: UC Davis Environmental Health and Safety (EHS)**

Telephone No: 530-752-3044 **E-Mail Address: smfields@ucdavis.edu**	**Street Address:** **City, State, Zip:**

Question 1: What has been your involvement in the Laboratory for Energy-Related Health Research/South Campus Superfund Site (LEHR) to date? How long have you worked on or been associated with the LEHR Site?

Response 1: In my role as the project manager for UC Davis, I've been in that role for the last 9 years on the project.

Question 2: Do you have specific knowledge of the remediation project at the United States Department of Energy (DOE) Areas of LEHR? If so, what is your general impression of the project and do you feel that the DOE remedy is sufficiently protective of human health and the environment?

Response 2: Yes, I do have specific knowledge and my general impression is that it's quite adequate. The actions that are and have been undertaken to protect the public health and the environment; that my general impression is good about the adequacy of the controls.

Question 3: Has the DOE remedy had an effect on the community? Are you aware of any concerns?

Response 3: I don't believe there is any direct effect on the community. Only concern I'm aware of is the challenge with PG&E needing to run a new high-pressure gas line adjacent to the site and that is a concern for DOE as well as UC in regards to whether they're going to disrupt groundwater at depth that could potentially impact the project.

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INTERVIEW RECORD
Question 4: Are you aware of any events, incidents, or activities at the DOE Areas of LEHR such as vandalism, trespassing or emergency responses from local authorities? If so, please provide details. *Response 4:* No, I'm not aware of any events … are we bounding this by the last year? [No, last 5 years] We did have a situation where we caught it that a state-agency had hired someone to assess the levies and they had proposed a well … a boring in the old southwest trenches area and our controls worked and we were able to communicate with them and get them to move it out of the sensitive area. So that's the only event, probably 3 or 4 years ago now. *How did that work – notification triggered?* They coordinated with … it's been awhile and I don't quite recall, but everybody knows to call me if anybody is planning to do anything out at the LEHR site. And so I got a call that somebody had been contacted by the consultant to site a well there and they said, "you better talk to the LEHR program manager" and we got that resolved. I think it was just a phone call from a colleague.
Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process? *Response 5:* Yes, I'm aware of the restrictions and the permitting process and how to go about initiating that.
Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection? *Response 6:* Yes, I understand there's really no health concerns with normal activities at the site, and again we have good controls in place to make sure nobody inadvertently picks things up or would do anything that would expose them to any residual materials there. I think they're adequate.
Question 7: Do you feel well informed about the activities and progress at the DOE Areas of LEHR? If not, what can DOE do to keep you better informed? *Response 7:* Yes, I do feel well informed.
Question 8: Do you know where to get information about the DOE areas of LEHR? *Response 8:* Yes, I do. I have access to all the materials DOE keeps online as well as our site library of documents.

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INTERVIEW RECORD

Question 9: Have there been routine communication or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the DOE Remedy at the LEHR Site? If so, please give their purpose and results.

Response 9: We provide quarterly reports to the DOE regarding all the activities that UC has taken in implementing the remedy. And their purpose is to keep DOE informed about the implementation of the project. We frequently do site visits and inspections for assuring that there is no incidents occurring or we do storm water reconnaissance, storm water sampling; we regularly re-con the site just to assure things are secure and there's no soil disturbance occurring. And so the results of that are that we have a good sense that there have been no incursions at the site over the last 5 year predominately.

Annual / Bi-annual meetings @ CEH? As part of our implementation involves annual training to site stakeholders so we accomplish the annual briefing to a diverse group of campus colleagues that anybody who might be in the business of overturning soil or planning projects, that we keep the planning office, the design and construction management, facilities, grounds, that we keep everybody in the loop and provide annual briefings on the progress of the site and what the restrictions are. That's required by the remedy, by the ROD.

Question 10: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

Response 10: Yes, there's three … one of them is the incident I mentioned earlier that happened several years ago where the state had hired somebody to put in a boring to assess the levee; we got that in the right spot so that definitely required a response by our office to help them locate that in the best place.

We recently had lost a monument due to a tree falling at the eastern dog pens and the destruction of the monument inadvertently by grounds as they were trying to get the tree out of there and downsize the limbs and all that. That one we dealt with – there wasn't any soil excavation or anything but we did lose the monument so we're actually going to respond with obviously replacing the monument and then putting a little more robust markers on all our monuments that are out in the vegetated areas

We were recently asked where someone could site a shade structure out there for these RVs that they park out there on a regular basis. With the California Department of Health Services, it's their vehicles so we'll be working with them in July, we have a meeting out there in July to figure out where we might be able to locate a shade structure without impacting any of the sensitive area.

Results will be that we'll maintain compliance with the ROD.

Question 11: Have there been any significant changes in laws or regulations since the DOE remedy's start-up in 2011? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

Response 11: Not to my knowledge … I can't think of anything that has impacted the protectiveness or effectiveness of the remedy.

Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR?

Response 12: No, I do not.

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INTERVIEW RECORD		
Site Name: United States Department of Energy Areas at the Laboratory for Energy-Related Health Research/South Campus Superfund Site, UC Davis, California	EPA ID No.: CA2890190000	
Subject: Remedial Action Five Year Review	Date: June 26, 2015	Time: 10:30 AM

Type: ■ Telephone ☐ Visit ☐ Completed Form ☐ Other _____

Location of Visit:

Contact Made By:		
Name: Mary Stallard	**Title: Sr Project Hydrogeologist**	**Organization: Weiss Associates**
Individual Contacted:		
Name: Shanie McCarty	**Title: EHS Specialist 1**	**Organization: UC Davis Center for Health and the Environment (CHE)**

Telephone No: 530-752-1345, 530-979-0324	**Street Address:**
E-Mail Address:smmccarty@ucdavis.edu	**City, State, Zip:**

Question 1: What has been your involvement in the Laboratory for Energy-Related Health Research/South Campus Superfund Site (LEHR) to date? How long have you worked on or been associated with the LEHR Site?

Response 1: I've worked at LEHR site for 17 years … and the last 12 years has been as the facilities manager here at Center for Health and Environment. I am basically the liaison for EHS and the CHE facility. I get information from EHS and I generally send that to my supervisors through Sue Russell, who sends it out amongst the people that are involved here at CHE. And we just keep in touch with the EHS for all the communication from Weiss and EHS for all the site and meeting schedules.

Question 2: Do you have specific knowledge of the remediation project at the United States Department of Energy (DOE) Areas of LEHR? If so, what is your general impression of the project and do you feel that the DOE remedy is sufficiently protective of human health and the environment?

Response 2: Yes, I have knowledge of the project and I feel that the site personnel and the employees that are here at CHE are informed and protected. I don't think the project is putting anyone at risk. I've attended the LEHR meetings and meet frequently with either Sue Fields or … used to be Jim Aborn, and some of the other people that work with Weiss to discuss the work that's being done and what's going on in case anybody needs to know anything out here before they go out there. Yeah, I feel that we're kept well informed and I don't think there's any hazards to anybody out there.

Question 3: Has the DOE remedy had an effect on the community? Are you aware of any concerns?

Response 3: If we're talking recently … I don't think it's had much of an impact as it did in prior years. I did go to the meeting in February when this all came about … the site description and history stuff that came out, and there weren't as many people there and there really didn't seem to be any specific concerns from anybody that lives in this area.

I think in the last 5 years it's really died down … I mean people are informed and they know what's going on in this area. But their concerns have lessened to a degree with the work that DOE and LEHR are doing.

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INTERVIEW RECORD
Question 4: Are you aware of any events, incidents, or activities at the DOE Areas of LEHR such as vandalism, trespassing or emergency responses from local authorities? If so, please provide details. *Response 4:* Nothing here specifically that had anything to do with the DOE areas of LEHR. We had a robbery of the generator and a couple small pieces of equipment but they weren't on … at one of the specific DOE areas, it was outside of the area. Other than that, no … nothing else that I'm aware of.
Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process? *Response 5:* Yes, I am aware of the restrictions on the soil disturbance here and we have a copy of SOP regarding soil disturbance and a copy of the soil disturbance permit application is on my computer so that if anybody comes in I know how to direct them where to go for that. *How/When to Initiate?* Yes. *What is your understanding of when that should be?* Every time … as far as the restrictions on the soil disturbance, I pretty much go to my map and pretty much every area that's on here has some kind of restriction on the soil so if anything comes up, then I'm always contacting EHS, Sue Fields in particular, to make sure that if anything's going on …but we really don't have anything going on so it's nothing that we generally do. Generally Weiss that comes in and they are aware of their restrictions.
Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection? *Response 6:* Yeah, their restrictions are adequate and we don't really have public walking out here. The employees and the students on-site do not enter restricted areas and they pretty much know which those areas are. And they're not easily accessible so it's not really a problem.
Question 7: Do you feel well informed about the activities and progress at the DOE Areas of LEHR? If not, what can DOE do to keep you better informed? *Response 7:* Yeah, I think that we are well informed about the activities. EHS, specifically Sue Fields and Jim Aborn, have always let us know or forwarded emails, Weiss has always let us in on what's going on, keeping us informed about the activities and the progress out here. And then like I said, when I receive it, generally my supervisor, Sue Russell, and I receive it at the same time or if I receive something and she doesn't, I send it to her and then she has a specific list of employees here on-site that she sends it out to know that have a need to know. But yeah, I think we're well informed. *Recommendations for improvement?* No, not really. Like I said, most of those areas are not areas that we venture into. Weiss and EHS always let us know if something is going on out here, and most of the time there will be something they need my assistance in procuring something or some place to place something, so I'm always informed about it. So I don't think there's anything that can be done better unless someone were to go out into the field and proclaim something. But other than that, I think that we're OK.

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INTERVIEW RECORD
Question 8: Do you know where to get information about the DOE areas of LEHR? *Response 8:* Yes, through EHS … and the contacts for the project have always been Jim Aborn and in the last couple of years, Sue Fields. And like I said, they keep us informed and if we have any questions we immediately contact them. I also have contacts at Weiss & Associates … Bob Devany, and then people that work under there, Tim Utterback, Bill McIlvride. So I have their cell phone numbers, they have mine, and we keep in touch, and like I said, sometimes there's things that need so they contact me for it. *You need information but couldn't get in a timely manner?* No, there have been times that I needed information for outside things like facility meetings to get through an area like maybe a gate or something, and I've always been able in a reasonable timely manner to find the person that knew what the answer was, or to get access if we needed it. So, no … like I said, I have everybody's cell phone so if one person doesn't answer the next one does. I think that we're OK that way.
Question 9: Have there been routine communication or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the DOE Remedy at the LEHR Site? If so, please give their purpose and results. *Response 9:* There's routine communications between us and the EHS again. We do generally meet at least a couple of times a year to go over if anything has changed on maps … stuff like that. Or where or when there are site visits here with other true EHS or DOE inspections that we do, would be something like when the fire department comes through, or stuff like that, there are areas that we go through. The only thing by our office … like I said, we get maps and updates and those meetings are with director and Sue Russell and myself and then someone from EHS or someone from EHS and Weiss all together.
Question 10: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses. *Response 10:* Are we talking about from anybody? I'm not aware of any complaints or violations. *Incidents?* The only thing is recently there was a question about a marker and I think that it was just "moved" through natural occurrences. I don't think it was anything else. So that's the only thing that I was asked a question by EHS for that. *Outcome details?* No, I think like I said, it was a marker that was disturbed but I think they found that and were able to place the cone where the marker should have been. And they're working on getting different markers now – something more easily seen, visible and so we'll know if they get moved or blown away for some reason.
Question 11: Have there been any significant changes in laws or regulations since the DOE remedy's start-up in 2011? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts. *Response 11:* I am not aware of any significant changes since 2011 … as they relate to me and what I do out here on the site.
Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR? *Response 12:* No, I really don't. I feel that EHS and Weiss do a very good job of keeping us informed regarding the activities going on and if for some reason something slips through the cracks and one of us misses an email or doesn't get the word, I'm always out here and I'm outside various times of the days so I usually pick up on stuff, and I think they keep us well informed on it and I really don't have any concerns about it.

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INTERVIEW RECORD		
Site Name: United States Department of Energy Areas at the Laboratory for Energy-Related Health Research/South Campus Superfund Site, UC Davis, California	EPA ID No.: CA2890190000	
Subject: Remedial Action Five Year Review	Date: June 30, 2015	Time: 9:30 AM

Type: ■ Telephone ☐ Visit ☐ Completed Form ☐ Other _____

Location of Visit:

Contact Made By:		
Name: Mary Stallard	**Title: Sr Project Hydrogeologist**	**Organization: Weiss Associates**
Individual Contacted:		
Name: Kent Pinkerton	**Title: Director**	**Organization: UC Davis Center for Health and the Environment (CHE)**

Telephone No: 530-752-8334	**Street Address:**
E-Mail Address: kepinkerton@ucdavis.edu	**City, State, Zip:**

Question 1: What has been your involvement in the Laboratory for Energy-Related Health Research/South Campus Superfund Site (LEHR) to date? How long have you worked on or been associated with the LEHR Site?

Response 1: I came to this site in the summer of 1986 when this facility was still referred to as the Laboratory for Energy-Related Health Research. I came as a faculty member in the Department of Anatomy in the School of Veterinary Medicine and this was my research location for everything that I did and have done here at UC Davis. So I have been here at this site for almost 29 years.

Question 2: Do you have specific knowledge of the remediation project at the United States Department of Energy (DOE) Areas of LEHR? If so, what is your general impression of the project and do you feel that the DOE remedy is sufficiently protective of human health and the environment?

Response 2: Yes, I have had specific knowledge of this remediation project that has been here, conducted under the auspices of the US DOE. As a faculty member we were fully informed of the past radiation use that had been conducted here at this site and we were given lots of information about areas that we could go into and areas that we would be restricted from entering since the represented sites were the decontamination or the removal of the radiation was going to take place. So in all instances, we were given more than adequate information that allowed for us to avoid any potential conditions on our going into an area that would be dangerous or that would be problem in the environment we were working in.

Question 3: Has the DOE remedy had an effect on the community? Are you aware of any concerns?

Response 3: Well, as far as I have been aware, there have been some concerns that because of some of the potential for radiation or materials that were used that might have entered into the ground and might have gotten into the groundwater, that that was an issue. I don't think it was actually an issue of radiation but perhaps more of the potential for nitrates that might have entered into the groundwater. And so I know that was a concern perhaps for the surrounding area although we are almost exclusively surrounded by farm land and much of that is property of the UC Davis; but the crops from Putah Creek … that's private agricultural area. My understanding is that everyone in this area has received bottled water for drinking, at least that has been the practice as far as I've known in the 29 years that I've been here. So I would say that the only concerns that I'm aware might have been concerns for groundwater contamination and the plume that might have come from this area … in terms of the water plume underground has been the only concern that I've been aware of. My understanding is that DOE has been very detailed in following that plume, its progress, and has recorded that to the public/regular meeting.

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INTERVIEW RECORD
Question 4: Are you aware of any events, incidents, or activities at the DOE Areas of LEHR such as vandalism, trespassing or emergency responses from local authorities? If so, please provide details. *Response 4:* I am not aware of any vandalism at all that's ever occurred here at this site, that has anything to do with DOE. We may have had some potential vandalism but probably internally that might have been scratches on cars or the loss of personal computer. But that had nothing to do with DOE or the fact that they were here at this site.
Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process? *Response 5:* I'm not familiar with the specific details although I was aware that where the dog kennel runs were much of that dirt was actually removed and transported elsewhere. That's really all that I'm aware of.
Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection? *Response 6:* Yes, I think that we've been given sufficient information about this and that there really has been sufficient restrictions that's been placed that have been adequate to protect workers, students or the public.
Question 7: Do you feel well informed about the activities and progress at the DOE Areas of LEHR? If not, what can DOE do to keep you better informed? *Response 7:* I think so. In terms of being informed of the activities, I think we were always given the information, especially when Weiss was here. They were part of that superfund cleanup, I assume, and so we were aware of their presence and what they were doing. We didn't really get into the details of that kind of information. Although there might have been regular public meetings, there were no meetings specifically for faculty or staff other than the fact that we were well informed about what was going on and it was our own prerogative to go to any of the public meetings that were being held. *Any suggestions for DOE to be better informed?* No, I think they did a very adequate job of keeping us informed. As staff, we were informed about these public hearings and invited to come and so I think that those types of activities that occurred on occasion … I don't' know how often, maybe once a year, seemed to be quite reasonable. So I really don't have any suggestion of how DOE could have provided better access to the information.
Question 8: Do you know where to get information about the DOE areas of LEHR? *Response 8:* I think there is a website for this. Certainly one of the things that we do know is that our facility manager here at the CHE is very well informed about any of the activities for the remediation of the site, the activities that were going on so if we had specific question we could always go to the facility manager to be able to discuss with her what the ongoing activities would be. I think also we were provided with maps on occasion to show what was being done, what was being proposed to be done and also we've had some contact with Jim Aborn and Sue Fields – they have always been very open and available to provide us with information that we might need about the site.

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INTERVIEW RECORD
Question 9: Have there been routine communication or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the DOE Remedy at the LEHR Site? If so, please give their purpose and results. *Response 9:* I think that there have been meetings that have been held at our site to talk about what was going on; again, these were conducted primarily by Sue Fields for us.
Question 10: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses. *Response 10:* I've been the Director for the CHE for more than 10 years and I'm not aware of any complaints that we've ever had regarding any activities here at the site.
Question 11: Have there been any significant changes in laws or regulations since the DOE remedy's start-up in 2011? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts. *Response 11:* I'm really not aware of any kind of changes that have occurred in terms of laws or regulations since 2011. Certainly they have not in any way affected the effectiveness or feeling protected from anything that might be still problematic with the site.
Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR? *Response 12:* No … just simply to thank them. In the 29 years that I've been here, this has been an interesting place to work, since it was declared as Superfund site, which is kind of unusual experience, but I now understand the reason for that and I'm really happy, that as far as I understand from all reports, that we pretty much are free of contamination, with the exception of non-DOE instances. I think this is reflected, not on DOE, but I think we had a dump site here from years ago for the university for low-level radiation contamination that were put in open trenches and I'm assuming that's still here but is not a DOE responsibility.

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INTERVIEW RECORD		
Site Name: United States Department of Energy Areas at the Laboratory for Energy-Related Health Research/South Campus Superfund Site, UC Davis, California	EPA ID No.: CA2890190000	
Subject: Remedial Action Five Year Review	Date: June 26, 2015	Time: 10:00 AM

Type: ■ Telephone ☐ Visit ☐ Completed Form ☐ Other _____

Location of Visit:

Contact Made By:		
Name: Mary Stallard	**Title: Sr Project Hydrogeologist**	**Organization: Weiss Associates**
Individual Contacted:		
Name: Sue Russell	**Title: Chief Administrative Officer**	**Organization: UC Davis Center for Health and the Environment (CHE)**

Telephone No: 530-752-7281	**Street Address:**
E-Mail Address:sarussell@ucdavis.edu	**City, State, Zip:**

Question 1: What has been your involvement in the Laboratory for Energy-Related Health Research/South Campus Superfund Site (LEHR) to date? How long have you worked on or been associated with the LEHR Site?

Response 1: I've been on the site for 8½ years as the Assistant Director and Chief Administrative Officer for the Center for Health and the Environment, which is on the LEHR site, and I am the liaison for EHS and our facility manager, Shanie McCarty. I help disseminate information, I keep the employee's informed of all the communications from EHS and Weiss regarding work being done on the site and being scheduled.

Question 2: Do you have specific knowledge of the remediation project at the United States Department of Energy (DOE) Areas of LEHR? If so, what is your general impression of the project and do you feel that the DOE remedy is sufficiently protective of human health and the environment?

Response 2: I have knowledge of the project, I feel the employees and others on the site are informed and protected and I do not feel that the project is putting anyone at risk. I attended the LEHR general meeting in February, I meet frequently with EHS and my facilities manager and the center director to discuss the work being done.

Feel the remedy is protective? To the best of my limited knowledge … I've put out all the "cautions" that I get and I keep people informed and I have provided information when there is a general meeting. I provide information to everyone on the site, and so I think we … people know what the involvement is and what the remediation is

Question 3: Has the DOE remedy had an effect on the community? Are you aware of any concerns?

Response 3: Well I did attend the meeting in February where this was discussed and what the choices for remedies were and at that time there did not seem to be any specific concerns from the community. The biggest concerns seemed to be that it was perhaps "over-much" rather than not doing enough to protect the community. That was my impression from that meeting.

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INTERVIEW RECORD
Question 4: Are you aware of any events, incidents, or activities at the DOE Areas of LEHR such as vandalism, trespassing or emergency responses from local authorities? If so, please provide details. *Response 4:* In the 8 years that I've been here, there has not been any vandalism that I was aware of. We did have a robbery of … not a break-in but actually things that were being stored outside – a generator and some several small items that were stolen in February. There was a police response to that but again, no evidence of a break-in and this was all in areas surrounding laboratories so it wasn't out in the actual restricted area. *No other events/incidents?* Nothing else … no that was the only I think that the police were out on the site.
Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process? *Response 5:* I am aware of the restrictions on soil disturbance and I have a copy of the standard operating procedure regarding soil disturbance. If anyone wants to do anything out in that area, we work with our facility manager onsite and EHS to make sure that everything is done properly. *Name of the Facility Manager?* Shanie McCarty … so we work very closely together because sometimes notices come to her as she's also the safety officer and sometimes they come to me and we just always make sure that we keep each other informed, and then follow-up, we keep the director and other employees out here informed.
Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection? *Response 6:* I feel the restrictions are adequate. The public, the employees and students onsite do no enter any restricted areas and our site is totally fenced with a locked gate when it's not normal working hours. So public access is fairly well restricted to just the people that work out here and I feel the restrictions are adequate.
Question 7: Do you feel well informed about the activities and progress at the DOE Areas of LEHR? If not, what can DOE do to keep you better informed? *Response 7:* I feel that EHS and Weiss keep us well informed regarding any activities that are going on or planned. As soon as I receive any of that information, I distribute it to the employees onsite, making sure that the center director and facility manager are aware when there's going to be people onsite. *DOE to improve?* I feel like I'm aware whenever anyone's going to be out drilling, whenever there's going to be any activity on the site so I think that we're being kept well informed.

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INTERVIEW RECORD
Question 8: Do you know where to get information about the DOE areas of LEHR? *Response 8:* Yes, my contact for the project was initially Jim Aborn, and now Sue Fields; and Jim Aborn spent a lot of time actually out on this site, has had actual office space out here and they have kept us well informed. If we have any questions at all we immediately contact Sue Fields and we can get information on whatever's going on. *Unable to get info?* I can say that we've always been able to find out if somebody is out there drilling and we've always known about it in advance when there's site visits coming. And they actually hold their LEHR meetings onsite in our conference so I feel like we're kept very well informed about what's going on.
Question 9: Have there been routine communication or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the DOE Remedy at the LEHR Site? If so, please give their purpose and results. *Response 9:* Routine communications… our facility manager, Shanie McCarty is in routine contact with EHS regarding the site. We receive notices from EHS whenever there is a proposed site visit, and representatives from EHS bring out maps and updates and meet with the director, the CEO and the facility manager at least annually and more often if needed if things are changing. We have always met with a representative from EHS and they always bring maps out to show us what has been going on and what's going on and that's at least annually. *Annual meetings?* At least once a year either Sue Fields or Jim Aborn have come out here and met with the director, myself and the facility manager and showed us the maps, showed us what areas are involved, showed us what's going on or anything new that was happening.
Question 10: Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses. *Response 10:* I'm not aware of any complaints or violations; nothing to speak to here.
Question 11: Have there been any significant changes in laws or regulations since the DOE remedy's start-up in 2011? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts. *Response 11:* I'm sorry, but I'm not aware of any changes since 2011.
Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR? *Response 12:* No, I actually feel that EHS does a good job of keeping us informed regarding the activities that are going on. And they are always in good communication; we don't ever feel like something is happening that we weren't told or weren't involved in … so I don't have any concerns on that. I have never felt that we were kept in the dark or that anything was going on that we weren't involved in. I feel like everyone was obviously doing their job Weiss was communicating with EHS, EHS was communicating with us.

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Appendix F

Potential Groundwater Impact Reevaluation

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Constituents remaining in the unsaturated soil at the U.S. Department of Energy (DOE) Areas at the Laboratory for Energy-Related Research (LEHR) have the potential to impact groundwater quality. The potential impacts of residual soil contamination on groundwater have been evaluated by DOE and presented in the *DOE Areas Remedial Investigation Report* (RI) (DOE 2003) and in the *Final 2012 Comprehensive Annual Water Monitoring Report for the Laboratory for Energy-Related Health Research/Old Campus Landfill Superfund Site, University of California, Davis* (Weiss 2014). The RI provides a list of constituents, originally termed designated-level (DL) constituents of potential concern (COPCs) and now referred to simply as constituents of concern (COCs), that may be present in soil in concentrations that pose a threat to groundwater. These DL COPCs were developed using (1) samples collected and analyzed during removal actions; (2) confirmation samples collected after the removal action; and (3) additional data collected during the groundwater impact analysis (DL analysis). These values are presented as Remediation Goals for the Protection of Groundwater in Table 2–8 of the *Record of Decision for DOE Areas at the Laboratory for Energy-Related Health Research, University of California, Davis* (ROD) (DOE 2009). While monitoring as part of the DOE remedy has shown no indications of ongoing groundwater impacts from the DOE Areas (see Appendix C), the DL analysis was reevaluated for the Five-Year Review to account for any changes in the drinking-water maximum contaminant levels (MCLs) or LEHR background values that might affect the monitoring program or the protectiveness of the remedy.

The DL analysis approach used for the Southwest Trenches Area and the Radium/Strontium (Ra/Sr) Treatment System Area is described in detail in the *Final Work Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas for the Laboratory for Energy-Related Health Research* (Weiss 2000); *Final Southwest Trenches Area 1998 Removal Action Confirmation Report for the Laboratory for Energy-Related Health Research* (Weiss 2001); and the RI (DOE 2003).

The DL approach used for the Domestic Septic System 3 (DSS 3) and DSS 5 was based on deionized water waste extraction test results for selected soil samples as documented in Appendix C of the *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment (Part B-Risk Characterization for DOE Areas)* (Risk Characterization Report) (DOE 2005). These DL analyses used three water-quality goals to determine the soils' potential to degrade water quality: (1) groundwater background, (2) MCLs, and (3) tap-water preliminary remediation goals (PRGs) for those constituents without MCLs.

As indicated in Table F-1, groundwater background at the time of the Risk Characterization Report (DOE 2005) was defined by the maximum concentration of each COC detected through 2004 in hydrostatic unit (HSU)-1 well UCD-1-018, located upgradient of the DOE Areas of the LEHR. As part of this Five-Year Review, HSU-1 groundwater background has been updated using wells UCD1-018 and UCD1-063 monitoring data collected in 2011 and 2012. Additional detail on the groundwater analyses is provided in the *Final 2012 Comprehensive Annual Water Monitoring Report for the Laboratory for Energy-Related Health Research/Old Campus Landfill Superfund Site*, *University of California, Davis* (Weiss 2014). Table F-1 also lists the regulatory levels at the time of the Risk Characterization Report and the current regulatory levels. The only groundwater COCs for which regulatory levels have changed in the past 10 years are those of hexavalent chromium and molybdenum.

Table F-1. Five-Year Review of Groundwater Basis for Designated Levels in DOE Areas

Groundwater COC	Units	HSU-1 Background at Time of SWRA	Current HSU-1 Background[a]	Regulatory Level at Time of SWRA	Current Regulatory Level	Current Regulatory-Level References
Carbon-14	pCi/L	3.5	7	2,000	2,000	MCL (SWRCB 2015a)
Cesium-137	pCi/L	1	5	200	200	MCL (SWRCB 2015a)
Total chromium	µg/L	25	43.7	50	10	California EPA MCL[b] (SWRCB 2015a)
Chromium (hexavalent)	µg/L	39.4	40	50	10	California EPA MCL (SWRCB 2015a)
Formaldehyde	µg/L	1,140	13	100	100	California Notification Level (SWRCB 2015b)
Mercury	µg/L	0.1	0.0479	2	2	MCL (SWRCB 2015a)
Molybdenum	µg/L	14.9	3.13	180	100	RSL (EPA 2015a)
Nitrate as N	mg/L	25.1	15	10	10	MCL (SWRCB 2015a)
Radium-226	pCi/L	1.14	1.17	5	5	Public Health Goals (SWRCB 2015a)
Selenium	µg/L	5.67	1.74	50	50	MCL (SWRCB 2015a)
Silver	µg/L	5	1	100	100	Secondary MCLs (EPA 2015b)
Strontium-90	pCi/L	1.7	1	8	8	MCL (SWRCB 2015a)

Notes:
[a] Groundwater background determined from wells UCD1-018 and UCD1-063 monitoring data collected in 2011 and 2012 (Weiss 2014).
[b] Based on an assumption that total chromium is 100 percent hexavalent.

Abbreviations:
EPA = U.S. Environmental Protection Agency
µg/L = micrograms per liter
mg/L = milligrams per liter
pCi/L = picocuries per liter
RSL = regional screening level
SWRA = Sitewide Risk Assessment
SWRCB = State Water Resources Control Board

At the time of the Risk Characterization Report (DOE 2005), there was no MCL specifically for hexavalent chromium; therefore, the 50 micrograms per liter (µg/L) California MCL for total chromium was applied to both total chromium and hexavalent chromium results. In July 2014, California established an MCL of 10 µg/L for hexavalent chromium. On the basis of the assumption that the total dissolved chromium in site groundwater is 100 percent hexavalent chromium, this new MCL applies to both total chromium and hexavalent chromium results. During the past 10 years, the PRG (now referred to as regional screening level or RSL) for molybdenum was reduced from 180 to 100 µg/L.

Table F-2 shows the Risk Characterization Report soil remediation goals for the protection of groundwater (which are also in the ROD[1] [DOE 2009]), as well as updated goals calculated for this Five-Year Review based on the revised groundwater background and regulatory values.

[1] See Table 2−8, Remediation Goals for the Protection of Groundwater.

Table F-2. Five-Year Update of Soil Remediation Goals for the Protection of Groundwater

Data Source	Constituents of Concern in Soil[a]	Maximum Soil Concentration[b]	Background Remediation Goal[c]	MCL Remediation Goal[d]
Domestic Septic System 3				
SWRA	Nitrate as N	106	36[e]	36[e]
Five Year Review			36[e]	36[e]
SWRA	Formaldehyde	2.2	0.167	0.0151[f]
Five Year Review			0.0019	0.0151[f]
SWRA	Molybdenum	2.5	<0.26[e]	3.11[g]
Five Year Review			<0.26[e]	1.73[i]
Domestic Septic System 4				
SWRA	Selenium	2.0[h]	4.0	35
Five Year Review			1.23	35
Dry Wells A–E				
SWRA	Chromium	245	181[e]	181[e]
Five Year Review			181[e]	181[e]
SWRA	Hexavalent chromium	1.62	1.3[e]	1.3[e]
Five Year Review			1.3[e]	1.3[e]
SWRA	Mercury	5.3	0.63[e]	0.63[e]
Five Year Review			0.63[e]	0.63[e]
SWRA	Molybdenum	1.3	0.30	3.6[g]
Five Year Review			<0.26[e]	2.0[i]
SWRA	Silver	53.8	0.55[e]	0.83
Five Year Review			0.55[e]	0.83
SWRA	Cesium-137	0.191	0.1	20[j]
Five Year Review			0.5	20[j]
SWRA	Strontium-90	0.176	0.0595	0.28
Five Year Review			0.056[e]	0.28
Radium/Strontium Treatment Systems[k]				
SWRA	Nitrate as N	304	36[e]	36[e]
Five Year Review			36[e]	36[e]
SWRA	Carbon-14	2.41	0.13[e]	2.34[k,l]
Five Year Review			0.13[e]	2.34[k,l]
SWRA	Radium-226	1.72[m]	0.752[e]	1.9
Five Year Review			0.752[e]	1.9
Southwest Trenches				
SWRA	Nitrate as N	909	36[e]	36[e]
Five Year Review			36[e]	36[e]
SWRA	Carbon-14	5.84	0.13[e]	0.292[k,l]
Five Year Review			0.13[e]	0.292[k,l]

Table F-2 (continued). Five-Year Update of Soil Remediation Goals for the Protection of Groundwater

Notes:
Chemical and nonradioactive element concentrations are expressed in milligrams per kilogram (mg/kg); radionuclide concentrations are expressed in picocuries per gram (pCi/g).
[a] Unsaturated soil contaminant with potential to impact groundwater.
[b] Maximum level of the specified constituent detected in soil samples collected from the specified DOE area.
[c] Soil concentration predicted by transport modeling, above which groundwater impacts in excess of site background are possible. The calculated remediation goals are expressed as dry weight.
[d] Soil concentration predicted by transport modeling, above which groundwater impacts above California drinking water maximum contaminant level may occur, unless noted. The calculated remediation goals are expressed as dry weight.
[e] Soil background concentration was selected as the remediation goal because the calculated remediation goal is below the soil background concentration. Calculated remediation goals are presented in the Risk Characterization Report (DOE 2005).
[f] Based on the California Department of Public Health Notification Level of 100 micrograms per liter (*California Health and Safety Code* 116455).
[g] Based on the EPA Region 9 preliminary remediation goal for tap water (EPA 2015b).
[h] Residual selenium soil concentrations exceeded soil background in 23 percent of the samples collected, and modeling suggests that selenium concentrations in the soil are unlikely to impact groundwater at levels that exceed the remediation goals. However, selenium was retained as a COC due to its presence (one result) in a downgradient HSU-1 well at a concentration slightly above groundwater background.
[i] Based on the EPA Region 9 regional screening level for tap water (EPA 2015b).
[j] Based on the 4-millirem-per-year federal MCL for beta particles and photon emitters (EPA 2000).
[k] The Ra/Sr Treatment Systems area is inclusive of DSS 2.
[l] The different MCL remediation goals for the Ra/Sr Treatment Systems and Southwest Trenches areas reflect the observed vertical distribution of contamination in these areas.
[m] The sample containing the maximum radium-226 result in the Ra/Sr Treatment Systems area was re-collected and reanalyzed. The reported maximum value is the average of the initial result (1.81 pCi/g) and the re-collected sample result (1.63 pCi/g).

Abbreviations:
COC = constituent of concern
EPA = United States Environmental Protection Agency
pCi/g = picocuries per gram
SWRA = Sitewide Risk Assessment

As shown in Table F-2, the only changes in the MCL-based soil remediation goals from those presented in the Risk Characterization Report (DOE 2005) are for molybdenum in the DSS 3 area and the Dry Wells A-E area.

The molybdenum MCL remediation goal for the DSS 3 area decreased from the Risk Characterization Report (DOE 2005) value of 3.11 to 1.73 mg/kg and is now below the maximum soil concentration of 2.5 mg/kg that was detected in the area. However, as presented in Appendix C, groundwater molybdenum concentrations for this area (monitoring well UCD1-069) remain below groundwater background and baseline and show no increasing trend over time. The molybdenum MCL remediation goal for the Dry Wells A–E area decreased from 3.6 to 2.0 mg/kg, but both of these concentrations are above the maximum soil concentration detected in this area, so this change has no potential impact on the protectiveness of the remedy. As shown in Table F-2, background-based remediation goals for formaldehyde in the DSS 3 area, selenium in the DSS 4 area, and molybdenum, cesium-137, and strontium-90 in the Dry Wells A–E area changed in response to the new groundwater background levels. For selenium in the DSS 4 area, the background-based goal was previously above but is now below the maximum soil concentration detected in the area (1.23 mg/kg goal compared with 2.0 mg/kg maximum). However, as presented in Appendix C, groundwater selenium concentrations for this area (well UCD1-068) show no increasing trend and are generally below baseline concentrations. For cesium-137 in the Dry Wells A–E area, both the new background-based goal and the

MCL-based goal are now above the maximum soil concentration detected in the area (see Table F-2). Additionally, as presented in Appendix C, groundwater cesium-137 concentrations for this area (wells UCD1-054 and UCD1-071) have been consistently below baseline and background concentrations and show no increasing trend over time. Therefore, cesium-137 is being removed as a groundwater impact COC for the Dry Wells A–E area (see Appendix C). Although groundwater background levels also changed for other COCs and the hexavalent chromium MCL was lowered, these background remediation goals and MCL remediation goal did not change because the calculated remediation goals remained below the soil background concentrations; therefore, the soil background concentrations remain the remediation goals for these COCs.

In conclusion, two MCLs and all of the background concentrations for those constituents identified as groundwater impact COCs have changed over the past 5 years. These changes do not impact the protectiveness of the remedy in terms of potential soil constituent impact on groundwater. After an evaluation of the increase in cesium-137 groundwater background concentration, this constituent is no longer considered a groundwater impact COC for the Dry Wells A–E Area.

References

DOE (U.S. Department of Energy), 2003. *DOE Areas Remedial Investigation Report for the U.S. Department of Energy Areas at the Laboratory for Energy-Related Health Research, University of California at Davis, California,* prepared for the U.S. DOE by Weiss Associates, September 18.

DOE (U.S. Department of Energy), 2005. *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment (Part B-Risk Characterization for DOE Areas), University of California, Davis*, prepared for the U.S. DOE by Weiss Associates, September 30.

DOE (U.S. Department of Energy), 2009. *Record of Decision for DOE Areas at the Laboratory for Energy-Related Health Research, University of California, Davis,* LMS/LEH/S05069, Office of Legacy Management, September.

EPA (U.S. Environmental Protection Agency), 2000. *National Primary Drinking Water Regulations; Radionuclides; Final Rule*, 66 FR 76708, Volume 65, No. 236, December 7.

EPA (U.S. Environmental Protection Agency), 2015a. *Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants*, Pacific Southwest, Region 9. http://www3.epa.gov/region09/superfund/prg/ Accessed June 30, 2015.

EPA (U.S. Environmental Protection Agency), 2015b. *Drinking Water Contaminants, Secondary Drinking Water Regulations: Guidance for Nuisance Chemicals*. http://water.epa.gov/drink/contaminants/secondarystandards.cfm#tabletop. Accessed July 10, 2015.

SWRCB (State Water Resource Control Board), 2015a. *Comparison of MCLs and PHGs for Regulated Contaminants in Drinking Water*, Download page for California and Federal Drinking Water Standards (MCLs), Detection Limits for Purposes of Report (DLRs) and Public Health Goals (PHGs). http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.shtml, last updated February 27, 2015, Accessed July 10, 2015.

SWRCB (State Water Resource Control Board), 2015b. *Division of Drinking Water (DDW), Drinking Water Notification Levels and Response Levels: An Overview*. http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf, Accessed July 10, 2015.

Weiss (Weiss Associates), 2000. *Final Work Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas for the Laboratory for Energy-Related Health Research.*

Weiss (Weiss Associates), 2001. *Final Southwest Trenches Area 1998 Removal Action Confirmation Report for the Laboratory for Energy-Related Health Research.*

Weiss (Weiss Associates), 2014. *Final 2012 Comprehensive Annual Water Monitoring Report for the Laboratory for Energy-Related Health Research/Old Campus Landfill Superfund Site*, *University of California, Davis*, February 6.

Appendix G

COC Risk Recalculation

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G1.0 Introduction

Chemical exposure and toxicity updates for chemical constituents of concern (COCs) for the U.S. Department of Energy (DOE) Areas at the Laboratory for Energy-Related Health Research (LEHR) are discussed in this appendix, followed by updated radiological risk assessment calculations using the most recent version of RESRAD Onsite (ANL 2014).

G1.2 Parameters and Equations for Chemical Exposure and Toxicity

Parameter values and intake equations used in the *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration* (SWRA) (UC Davis 2004) were evaluated and updated to current practice. A record of the updates is presented in detail below.

G1.2.1 Residential Exposure

Child and adult exposures were summed in the SWRA to estimate an age-adjusted adult exposure for hypothetical future onsite residents. Resident adult and child parameter values used in the SWRA were compared to recommended values presented in the California Department of Toxic Substances Control (DTSC) Note 1 default exposure factors (DTSC 2014b) and the U.S. Environmental Protection Agency's (EPA) 2014 Update of standard exposure factors (EPA 2014) when available. Other sources of information such as the *Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment)* (EPA 2004), *Risk Assessment Guidance for Superfund (Part F, Supplemental Guidance for Inhalation Risk Assessment)* (EPA 2009), *EPA Exposure Factors Handbook* 2011 Edition (2011 Handbook) (EPA 2011), *Farm Food Chain Module: Background and Implementation for the Multimedia, Multipathway and Multireceptor Risk Assessment (3MRA) Model for HWIR99* (EPA 1999a), and residential gardening information for the Davis (UC Davis 2008) and Sacramento (UC ANR 2015) areas were used as needed for this evaluation.

G1.2.1.1 Residential Soil Ingestion

The comparison between parameters used in the SWRA (UC Davis 2004) and values recommended in the DTSC's Note 1 and EPA's 2014 Update for the soil ingestion pathway is shown in Table G-1.

The DTSC's Note 1 and EPA's 2014 Update recommend a shorter exposure duration and greater body weight for residential adults compared to the values used in the SWRA. There are no differences in resident child values. EPA's 2014 Update recommends a 24-hour per day exposure time for residents. Residential exposure time was not used in the SWRA, and its absence is equivalent to assuming a 24-hour per day exposure. For this evaluation, no changes were made to the soil ingestion equation or the values used in the SWRA, except the adult exposure duration and body weight were updated to the values recommended in the DTSC's Note 1 and EPA's 2014 Update.

The cancer averaging time of 70 years (or 25,550 days) was not changed for this evaluation. For age-adjusted adults, the non-cancer averaging time is equal to the sum of resident adult and

child exposure durations. The non-cancer averaging time used in this evaluation (26 years or 9,490 days) was 4 years shorter than that of the SWRA because the resident adult exposure duration was reduced by 4 years as shown in Table G-1.

Table G-1. Residential Soil Ingestion Comparison Parameters

2004 Site-wide Risk Assessment Values		Recommended Values from DTSC Note 1 and EPA 2014 Update	
Resident Adult Soil Ingestion Rate (mg/day)	100	Resident Adult Soil Ingestion Rate (mg/day)	100
Resident Child Soil Ingestion Rate (mg/day)	200	Resident Child Soil Ingestion Rate (mg/day)	200
NA[a]	NA	Resident Soil Exposure Time (hours/day)	24
Resident Adult and Child Exposure Frequency (days/year)	350	Resident Adult and Child Exposure Frequency (days/year)	350
Resident Adult Exposure Duration (years)	24	Resident Adult Exposure Duration (years)	20
Resident Child Exposure Duration (years)	6	Resident Child Exposure Duration (years)	6
Resident Adult Body Weight (kilograms)	70	Resident Adult Body Weight (kilograms)	80
Resident Child Body Weight (kilograms)	15	Resident Child Body Weight (kilograms)	15
Averaging Time,[b] cancer (days)	25,550	Averaging Time,[b] cancer (days)	25,550
Age-Adjusted Resident Averaging Time,[c] non-cancer (days)	10,950	Age-Adjusted Resident Averaging Time,[c] non-cancer (days)	9,490

Notes:
[a] See discussion in Section G1.2.1.1.
[b] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.
[c] Averaging Time, non-cancer (days) = 365 days/year × sum of adult and child exposure durations (years).

Abbreviations:
mg/day = milligrams per day
NA = not applicable

G1.2.1.2 Residential Dermal Contact

The parameter value comparison for dermal contact is shown in Table G-2.

Residential adult skin surface area, body weight, and exposure duration were changed to the values given in the DTSC's Note 1 and EPA's 2014 Update. In addition, the residential child skin surface area was changed to the DTSC's Note 1 value of 2,999 square centimeters, which is slightly more conservative than the EPA's 2014 Update value of 2,690 square centimeters. No other changes were made to the dermal contact values used in the SWRA.

The intake equation in the SWRA uses an Event Frequency (events per day) instead of an exposure time in hours per day as given in the EPA's 2014 Update. The intake equation was not modified to incorporate exposure time because an event frequency of once per day is equivalent to an exposure time of 24 hours per day after unit conversion.

A search was conducted to determine if more recent chemical-specific dermal absorption factors were published by the EPA since the SWRA was issued. The most recent document identified in the search was the EPA's Supplemental Guidance for Dermal Risk Assessment (EPA 2004) which was published shortly after the SWRA was issued. These dermal absorption factors

published by the EPA were verified to be the same as those used in the SWRA. No changes to dermal absorption factors were made.

Table G-2. Residential Dermal Contact Comparison Parameters

2004 Site-wide Risk Assessment Values		Recommended Values from DTSC Note 1 and EPA 2014 Update	
Resident Adult Skin Surface Area (cm^2)	5,700	Resident Adult Skin Surface Area (cm^2)	6,032
Resident Child Skin Surface Area (cm^2)	2,800	Resident Child Skin Surface Area (cm^2)	2,900[a]
Resident Adult Soil Adherence Factor (mg/cm^2)	0.07	Resident Adult Soil Adherence Factor (mg/cm^2)	0.07
Resident Child Soil Adherence Factor (mg/cm^2)	0.2	Resident Child Soil Adherence Factor (mg/cm^2)	0.2
Dermal Absorption Factor	Chemical specific[b]	Dermal Absorption Factor	NA
Resident Adult and Child Event Frequency (events/day)	1	Resident Adult and Child Soil Exposure Time (hours/day)	24
Resident Adult and Child Exposure Frequency (days/year)	350	Resident Adult and Child Exposure Frequency (days/year)	350
Resident Adult Exposure Duration (years)	24	Resident Adult Exposure Duration (years)	20
Resident Child Exposure Duration (years)	6	Resident Child Exposure Duration (years)	6
Resident Adult Body Weight (kilograms)	70	Resident Adult Body Weight (kilograms)	80
Resident Child Body Weight (kilograms)	15	Resident Child Body Weight (kilograms)	15
Averaging Time,[c] cancer (days)	25,550	Averaging Time,[c] cancer (days)	25,550
Age-Adjusted Resident Averaging Time,[d] non-cancer (days)	10,950	Age-Adjusted Resident Averaging Time,[d] non-cancer (days)	9,490

Notes:
[a] DTSC Note 1 value used; EPA 2014 Update value of 2,690 cm^2 is less conservative.
[b] See discussion in Section G1.2.1.2.
[c] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.
[d] Averaging Time, non-cancer (days) = 365 days/year × sum of adult and child exposure durations (years).

Abbreviations:
cm^2 = square centimeters
mg/cm^2 = milligrams per square centimeter
NA = not applicable

G1.2.1.3 Residential Plant Ingestion

The DTSC's Note 1 and EPA's 2014 Update do not provide values for home-grown produce ingestion rates, soil-to-plant transfer coefficients, or contaminated plant fraction. Supplemental sources of information were located and used to verify and/or update the plant-specific values as presented below. The comparisons between SWRA values and recent agency recommendations for exposure frequency, exposure duration, body weight, and averaging time follow the plant information.

Home-Grown Produce Ingestion Rates

Onsite residential plant ingestion was divided into aboveground fruit/vegetable and belowground fruit/vegetable categories in the SWRA (UC Davis 2004). Ingestion rates used in the SWRA were reported as kilograms dry weight per day (kg DW/day). More recent ingestion rates for home-produced fruits and vegetables were published in the 2011 Handbook (EPA 2011).

The 2011 Handbook provides ingestion rates for fruits and vegetables separately and according to nine age categories for mean and 95th percentile rates (Table 9-1, 2011 Handbook). The 2011 Handbook's rates are reported as grams wet weight per kilogram body weight per day. Thus, the values provided in the 2011 Handbook require conversion from wet weight to dry weight and must be multiplied by the receptor body weight to convert to kg DW/day. The 2011 Handbook provides a table of mean moisture content for selected fruits and vegetables that can be used to convert wet weight to dry weight. The residential receptor body weights are 80 kilograms per adult and 15 kilograms per child.

A search was conducted to identify likely fruits and vegetables that can be grown in a residential garden in the Davis area. The *Vegetable Planting Guide for the Sacramento Area*, published by the UC Davis Department of Plant Sciences (UC Davis 2008) was reviewed for vegetables and garden fruits. Tomatoes, broccoli, carrots, peppers, corn, lettuce, spinach, green beans, and squash were selected from the Planting Guide as representative vegetables; melons were selected from the Planting Guide as a representative garden fruit. Although corn is a grain, it was selected as a vegetable due to its popularity in residential gardening. The Home Orchard pages on the Sacramento County Master Gardeners website (UC ANR 2015) were reviewed to identify fruit trees that can be grown at a residence in the vicinity of the site. Peaches, plums, apricots, cherries, and nectarines were selected from the Home Orchard information.

Moisture content data are published in Table 9-37 of the 2011 Handbook (EPA 2011) for garden produce including data for raw and cooked states. The most likely ingested state of each produce item (raw or cooked) and its associated moisture content was selected as shown in Attachment G-1. Dry weight conversion factors were determined by averaging the moisture contents for the fruits and vegetables selected above (87 and 89 percent, respectively). The percent dry weight is 1.0 minus the moisture content.

The 95th percentile ingestion rates of home-produced food for populations that garden or farm, adjusted for preparation and post-cooking losses, were obtained from Table 13-1 of the 2011 Handbook (EPA 2011). Table 13-1 values for ages 1 to less than 6 years were averaged to obtain child fruit and vegetable ingestion rates; values for ages 6 and up were averaged to obtain adult fruit and vegetable ingestion rates. The age-averaged values in grams wet weight per kilogram body weight per day were multiplied by the percent dry weight, receptor body weight, and 1 kilogram per 1,000 grams to obtain ingestion rates in kilograms dry weight per day (see Attachment G-1).

A comparison of SWRA plant ingestion rates to the rates determined using the 2011 Handbook data is presented in Table G-3.

Table G-3. Plant Ingestion Rate Comparison Parameters

2004 Site-wide Risk Assessment Values		2011 Handbook Data[a]	
Child (kg DW/day)		Ages birth to <6 years (kg DW/day)	
Aboveground fruit/vegetable	0.0609	Fruit	0.0086
Belowground fruit/vegetable	0.0033	Vegetable	0.0108
Adult (kg DW/day)		Ages 6 to 50+ years (kg DW/day)	
Aboveground fruit/vegetable	0.0179	Fruit	0.0103
Belowground fruit/vegetable	0.0098	Vegetable	0.028

Note:
[a] EPA *Exposure Factors Handbook*, 2011 Edition.

The 2011 Handbook does not distinguish between aboveground and belowground produce. To enable the comparison, aboveground fruit/vegetable ingestion rates from the SWRA were compared to fruit ingestion rates determined from 2011 Handbook data. Likewise, belowground fruit/vegetable ingestion rates from the SWRA were compared to vegetable ingestion rates determined from 2011 Handbook data. Fruit ingestion rates determined from 2011 Handbook data were lower than aboveground fruit/vegetable ingestion rates used in the SWRA. Vegetable ingestion rates determined from the 2011 Handbook data were higher than belowground fruit/ vegetable ingestion rates used in the SWRA. The values calculated from the 2011 Handbook data were used in the risk update.

Soil-to-Plant Transfer Coefficients

One of the parameters used in the SWRA to calculate uptake rates from plant ingestion was the chemical-specific soil-to-plant transfer coefficient ($TC_{s\text{-}p}$), also known as the plant-soil bioconcentration factor (BCF). EPA's Farm Food Chain Module (EPA 1999a) was the source of organic chemical $TC_{s\text{-}p}$ values used in the SWRA. Most of the $TC_{s\text{-}p}$ values were calculated according to the formula

$$TC_{s\text{-}p} = \text{antilog}_{10}\,(1.588 - 0.578 \log_{10} K_{ow})$$

where K_{ow} is the octanol–water partition coefficient.

This formula originates from a bioconcentration study published in the journal *Environmental Science and Technology* (Travis and Arms 1988) and remains widely used to calculate $TC_{s\text{-}p}$ for organic chemicals (LBNL 2007). The organic chemical human health constituents of concern (organic HH COCs) are:

1. Benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*k*)fluoranthene, dibenzo(*a,h*)anthracene, and indeno(1,2,3-*cd*)pyrene at Domestic Septic System 4 (DSS 4)
2. Dieldrin at the Eastern Dog Pens (EDPs)

The organic HH COCs at DSS 4 belong to a class of compounds called polycyclic aromatic hydrocarbons (PAHs), and their TC_{s-p} values reported in the SWRA (Table D.11, Appendix D; UC Davis 2004) were ≤0.02, except for the TC_{s-p} value for benzo(*k*)fluoranthene reported as 1. The TC_{s-p} value for benzo(*k*)-fluoranthene was questioned because it is expected to be chemically similar to the other PAHs.

The Travis and Arms formula was used to verify TC_{s-p} values for organic HH COCs, and the results showed:

1. Benzo(*k*)fluoranthene TC_{s-p} = 0.011
2. TC_{s-p} values from the SWRA were confirmed for benzo(*a*)anthracene, benzo(*a*)pyrene, dibenzo(*a,h*)anthracene, indeno(1,2,3-*cd*)pyrene, and dieldrin
3. Benzo(*b*)fluoranthene TC_{s-p} = 0.018 (SWRA reported TC_{s-p} = 0.01)

The corrected TC_{s-p} values for benzo(*k*)fluoranthene and benzo(*b*)fluoranthene and the confirmed values for the other five organic HH COCs were used in this evaluation. The calculations were performed with a hand calculator and $\log_{10} K_{ow}$ values obtained from the EPA Region 9 table of chemical specific parameters (EPA 2015b).

Contaminated Plant Fraction

The SWRA used a contaminated plant fraction (CPF) of 0.4 referenced to the EPA's *Soil Screening Guidance: User's Guide* (EPA 1996). A review of the Soil Screening Guidance indicated that this value originated from the 1990 version of EPA's *Exposure Factors Handbook*. The 2011 Handbook (EPA 2011) was searched for contaminated plant fractions, but none were readily available. The CPF of 0.4 used in the SWRA was used in this evaluation.

Standard Exposure Parameters in the Plant Ingestion Pathway

Exposure parameters used to calculate uptake for the plant ingestion pathway were discussed above except for exposure frequency, exposure duration, body weight, and averaging time. The comparison between values used in the SWRA and those recommended in the DTSC's Note 1 and EPA's 2014 Update is shown in Table G-4.

Residential adult exposure duration and body weight were changed to the values given in the DTSC's Note 1 and EPA's 2014 Update. No other changes were made from the plant ingestion values used in the SWRA.

Table G-4. Plant Ingestion Pathway Standard Exposure Comparison Parameters

2004 Site-wide Risk Assessment Values		Recommended Values from DTSC Note 1 and EPA 2014 Update	
Resident Adult and Child Exposure Frequency (days/year)	350	Resident Adult and Child Exposure Frequency (days/year)	350
Resident Adult Exposure Duration (years)	24	Resident Adult Exposure Duration (years)	20
Resident Child Exposure Duration (years)	6	Resident Child Exposure Duration (years)	6
Resident Adult Body Weight (kilograms)	70	Resident Adult Body Weight (kilograms)	80
Resident Child Body Weight (kilograms)	15	Resident Child Body Weight (kilograms)	15
Averaging Time,[a] cancer (days)	25,550	Averaging Time,[a] cancer (days)	25,550
Age-Adjusted Resident Averaging Time,[b] non-cancer (days)	10,950	Age-Adjusted Resident Averaging Time,[b] non-cancer (days)	9,490

Notes:
[a] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.
[b] Averaging Time, non-cancer (days) = 365 days/year × sum of adult and child exposure durations (years).

G1.2.1.4 Residential Dust Inhalation

Dust inhalation intake was calculated in the SWRA as milligrams per kilogram-day (mg/kg-day), but inhalation exposure calculations currently calculate risk using an exposure concentration in micrograms per cubic meter ($\mu g/m^3$). As shown in current EPA guidance (EPA 2009), the equation for calculating the inhalation exposure concentration is

$$EC = (CA \times ET \times EF \times ED)/AT,$$

where

EC ($\mu g/m^3$) = exposure concentration,

CA ($\mu g/m^3$) = contaminant concentration in air (CA = CS/PEF discussed below),

ET (hours/day) = exposure time,

EF (days/year) = exposure frequency,

ED (years) = exposure duration, and

AT (lifetime in years × 365 days/year × 24 hours/day) = averaging time.

The inhalation exposure calculation used in the SWRA required a receptor inhalation rate and body weight and did not account for the receptor's exposure time (hours per day). The dust inhalation approach used in the SWRA was dismissed and replaced with the equation above.

The contaminant concentration in air (CA) is calculated using the contaminant concentration in soil (CS) divided by a particulate emission factor (PEF). For hypothetical future residents, the SWRA referenced a PEF published in 2002 by the EPA Region 9 for calculating Preliminary Remediation Goals (PRGs) (7.0×10^7 cubic meters per kilogram [m^3/kg]). The DTSC Note 1 recommends a residential receptor PEF of 1.36×10^9 m^3/kg, but the EPA's 2014 Update does not provide a recommended residential receptor PEF. The DTSC's Note 1 residential receptor PEF was used in this evaluation.

The site-specific residential PEFs for the DSS 4 area and the EDPs are 1.9×10^{10} m^3/kg and 1.2×10^{12} m^3/kg, respectively. Copies of the PEF calculations are included in Attachments G-2a and G-2b, respectively.

Comparisons between values used in the SWRA for dust inhalation and those recommended in the DTSC's Note 1 and EPA's 2014 Update are shown in Table G-5.

Residential adult exposure duration was changed to the value given in the DTSC's Note 1 and EPA's 2014 Update. A resident adult and child exposure time of 24 hours per day was added to satisfy the new calculation approach. No other changes were made to the dust inhalation parameter values.

Table G-5. Residential Dust Inhalation Exposure Comparison Parameters

2004 Site-wide Risk Assessment Values		Recommended Values from DTSC Note 1 and EPA 2014 Update	
Inhalation Rate (m^3/day)	20	Inhalation Rate (m^3/day)	NA[a]
Particulate Emission Factor (m^3/kg)	7.0×10^7	Particulate Emission Factor (m^3/kg)	1.36×10^9 [b]
Resident Adult and Child Air Exposure Time	NA[a]	Resident Adult and Child Air Exposure Time (hours/day)	24
Resident Adult and Child Exposure Frequency (days/year)	350	Resident Adult and Child Exposure Frequency (days/year)	350
Resident Adult Exposure Duration (years)	24	Resident Adult Exposure Duration (years)	20
Resident Child Exposure Duration (years)	6	Resident Child Exposure Duration (years)	6
Averaging Time,[c] cancer (days)	25,550	Averaging Time,[c] cancer (days)	25,550
Age-Adjusted Resident Averaging Time,[d] non-cancer (days)	10,950	Age-Adjusted Resident Averaging Time,[d] non-cancer (days)	9,490

Notes:
[a] Discussed in Section G1.2.1.4.
[b] DTSC Note 1 residential value. No value available in EPA 2014 Update.
[c] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.
[d] Averaging Time, non-cancer (days) = 365 days/year × sum of adult and child exposure durations (years).

Abbreviations:
m^3/day = cubic meters per day
NA = not applicable

G1.2.2 Construction Worker Exposure

Construction worker parameter values used in the SWRA (UC Davis 2004) were referenced to the Supplemental Guidance (EPA 2002). The DTSC's Note 1 provides recommended values for construction worker exposure. Most of the recent exposure data provided in the 2011 Handbook (EPA 2011) and EPA's 2014 Update (EPA 2014) were not readily applicable to the construction worker scenario except increased body weight and skin surface area. The EPA's 2014 Update did not provided recommended values for construction worker exposure and was not used.

G1.2.2.1 Construction Worker Soil Ingestion

The parameter comparison for construction worker soil ingestion pathway is shown in Table G-6. Parameter values used in the SWRA for construction worker soil ingestion were

equivalent to the values recommended in the DTSC Note 1, except body weight. The body weight was changed to 80 kilograms for this evaluation.

Table G-6. Construction Worker Soil Ingestion Comparison Parameters

Exposure Parameter	2004 Site-wide Risk Assessment Values	Recommended Values from DTSC Note 1
Construction Worker Soil Ingestion Rate (mg/day)	330	330
Construction Worker Exposure Frequency (days/year)	250	250
Construction Worker Exposure Duration (years)	1	1
Construction Worker Body Weight (kilograms)	70	80
Construction Worker Averaging Time,[a] cancer (days)	25,550	25,550
Construction Worker Averaging Time,[b] non-cancer (days)	365	365

Notes:
[a] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.
[b] Averaging Time, non-cancer (days) = 365 days/year × exposure durations (years).

Abbreviations:
mg/day = milligrams per day

G1.2.2.2 Construction Worker Dermal Contact

The comparison for construction worker dermal contact is shown in Table G-7. Construction worker skin surface area, soil adherence factor, and body weight were changed to the values given in the DTSC's Note 1. The daily exposure time was updated from an "Event Frequency" of one event per day to the standard worker exposure time of 8 hours per day. The conversion factor in the dermal exposure equation was updated to account for the change from a unitless "Event Frequency" to an exposure time in hours per day.

Table G-7. Construction Worker Dermal Contact Comparison Parameters

Exposure Parameter	2004 Site-wide Risk Assessment Values	Recommended Values from DTSC Note 1
Construction Worker Skin Surface Area (cm^2)	3,300	6,032
Construction Worker Soil Adherence Factor (mg/ cm^2)	0.3	0.8
Dermal Absorption Factor	Chemical specific[a]	NA
Construction Worker Event Frequency (events/day)	1	8
Construction Worker Exposure Frequency (days/year)	250	250
Construction Worker Exposure Duration (years)	1	1
Construction Worker Body Weight (kilograms)	70	80
Construction Worker Averaging Time,[b] cancer (days)	25,550	25,550
Construction Worker Averaging Time,[c] non-cancer (days)	365	365

Notes:
[a] Discussed in Section G1.2.2.2.
[b] Averaging Time, cancer (days) = 365 days/year × 70 year lifetime.
[c] Averaging Time, non-cancer (days) = 365 days/year × exposure durations (years).

Abbreviations:
cm^2 = square centimeter
mg/cm^2 = milligrams per square centimeter

A search was conducted to determine if more recent chemical-specific dermal absorption factors were published by the EPA since the SWRA was issued. The most recent document identified in the search was the EPA's Supplemental Guidance for Dermal Risk Assessment (EPA 2004), which was published shortly after the SWRA was issued. The slightly more recent dermal absorption factors published by the EPA were verified to be the same as those used in the SWRA. No changes to dermal absorption factors were made.

G1.2.2.3 Construction Worker Dust Inhalation

The comparison for construction worker dust inhalation is shown in Table G-8. Dust inhalation intake in units of mg/kg-day was calculated in the SWRA (UC Davis 2004), but current EPA guidance (EPA 2009) involves calculating an inhalation exposure concentration in units of $\mu g/m^3$. The current calculation procedure is presented in Section G1.2.1.4 and no longer uses a receptor inhalation rate or body weight but accounts for the receptor's exposure time (hours per day). The DTSC's Note 1 construction worker PEF of 1×10^6 was used.

Table G-8. Construction Worker Dust Inhalation Comparison Parameters

Exposure Parameters 2004 Site-wide Risk Assessment Values	2004 Site-wide Risk Assessment Values	Recommended Values from DTSC Note 1
Inhalation Rate (m^3/day)	20	NA[a]
Particulate Emission Factor (m^3/kg)	7.0×10^7	1×10^6
Worker Air Exposure Time	NA[a]	8
Construction Worker Exposure Frequency (days/year)	250	250
Construction Worker Exposure Duration (years)	1	1
Construction Worker Body Weight (kilograms)	70	NA[a]
Construction Worker Averaging Time,[b] cancer (days)	25,550	25,550
Construction Worker Averaging Time,[c] non-cancer (days)	365	365

Notes:
[a] Previously discussed in Section G1.2.1.4.
[b] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.
[c] Averaging Time, non-cancer (days) = 365 days/year × exposure durations (years).

Abbreviations:
hr/hr = hour per hour
m^3/day = cubic meters per day
NA = not applicable

G1.3 Toxicity

Cancer slope factors and non-cancer reference doses were tabulated in Tables 5.1 through 6.3 of the SWRA (UC Davis 2004). The SWRA slope factors and reference doses for chemical compounds were compared to values most recently published by the State of California Office of Environmental Health Hazard Assessment (OEHHA 2011); Regional Screening Levels (RSLs) (EPA 2015b) and the EPA Integrated Risk Information System (IRIS) (EPA 2015a). The DTSC's Human Health Risk Assessment Note 3 toxicity criteria (DTSC 2015) were reviewed and no chemical toxicity data for the COCs were found. The comparison of chemical toxicity values is shown in Tables G-9 and G-10 for oral and inhalation toxicities, respectively.

G1.3.1 Oral Cancer Slope Factor

Oral cancer slope factors for PAH compounds were available from the OEHHA and were more conservative or equal to the values used in the SWRA. The OEHHA did not publish an oral slope factor for dieldrin. Oral cancer slope factors were available in the IRIS database for benzo(*a*)-pyrene and dieldrin only, and their toxicity values are the same as those used in the SWRA.

Table G-9. Oral Chemical Toxicity Data

Constituent	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$				Oral Reference Dose (mg/kg-day)			
	2004 SWRA[a]	OEHHA 2011[b]	IRIS 2015[c]	EPA 2015[d]	2004 SWRA[a]	OEHHA 2011[b]	IRIS 2015[c]	EPA 2015[d]
Benzo(*a*)anthracene	7.3E-01	1.2E+00	--	7.3E-01	--	--	--	--
Benzo(*a*)pyrene	7.3E+00	1.2E+01	7.3E+00	7.3E+00	--	--	--	--
Benzo(*a*)fluoranthene	7.3E-01	1.2E+00	--	7.3E-01	--	--	--	--
Benzo(*k*)fluoranthene	1.2E+00	1.2E+00	--	7.3E-02	--	--	--	--
Dibenzo(*a,h*)anthracene	4.1E+00	4.1E+00	--	7.3E+00	--	--	--	--
Indeno(1,2,3-*cd*)pyrene	1.2E+00	1.2E+00	--	7.3E-01	--	--	--	--
Dieldrin	1.6E+01	--	1.6E+01	1.6E+01	5.0E-05	--	5.0E-05	5.0E-05

Notes:
[a] UC Davis 2004.
[b] OEHHA 2011.
[c] EPA 2015a.
[d] EPA 2015b.

Abbreviation:
-- = not available

Table G-10. Inhalation Chemical Toxicity Data

Constituent	Inhalation Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Unit Risk $(\mu g/m^3)^{-1}$		
	2004 SWRA[a]	OEHHA 2011[b]	IRIS 2015[c]	EPA 2015[d]
Benzo(*a*)anthracene	7.3E-01	1.1E-04	NA	1.1E-04
Benzo(*a*)pyrene	7.3E+00	1.1E-03	NA	1.1E-03
Benzo(*a*)fluoranthene	7.3E-01	1.1E-04	NA	1.1E-04
Benzo(*k*)fluoranthene	3.9E-01	1.1E-04	NA	1.1E-04
Dibenzo(*a,h*)anthracene	4.2E+00	1.2E-03	NA	1.2E-03
Indeno(1,2,3-*cd*)pyrene	3.9E-01	1.1E-04	NA	1.1E-04
Dieldrin	1.6E+01	--	4.6E-03	4.6E-03

Notes:
[a] UC Davis 2004.
[b] OEHHA 2011.
[c] EPA 2015a.
[d] EPA 2015b.

Abbreviations:
NA = not applicable -- = not available

Oral cancer slope factors published by the EPA Region 9 for RSLs for benzo(*a*)pyrene and dieldrin are referenced to IRIS, and factors for benzo(*a*)anthracene, benzo(*b*)fluoranthene, benzo(*k*)fluoranthene, dibenzo(*a,h*)anthracene, and indeno(1,2,3-*cd*)-pyrene are referenced to the EPA's Environmental Criteria and Assessment Office. The oral cancer slope factors published by the EPA Region 9 for RSLs for these seven chemicals were less conservative or equal to the values used in the SWRA, except that the value for dibenzo(*a,h*)anthracene was more conservative.

For this evaluation, the most conservative of the recently published oral cancer slope factors from the OEHHA, EPA, and IRIS were selected for the seven chemicals:

1. OEHHA: Benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*k*)-fluoranthene, and indeno(1,2,3-*cd*)pyrene (OEHHA 2011)
2. EPA: Dibenzo(*a,h*)anthracene (EPA 2015b)
3. IRIS: Dieldrin (EPA 2015a)

G1.3.2 Oral Reference Dose

An oral reference dose was available for dieldrin, but not for the six PAH compounds when chemical hazards were estimated in the SWRA (UC Davis 2004). A review of toxicity data published by the OEHHA (2011), EPA (2015b), and IRIS (EPA 2015a) indicates no oral reference dose changes for these chemical COCs.

G1.3.3 Inhalation Cancer Slope Factors and Unit Risk Factors

Risk estimation procedures for inhalation exposure have changed since the SWRA calculations were completed. Inhalation intakes were multiplied by cancer slope factors to estimate risks in the SWRA, but the EPA has since adopted an approach that involves multiplying air "exposure concentrations" by unit risk factors to estimate inhalation risks (EPA 2009). The most recently published inhalation unit risk factors for the seven chemical COCs are shown in Table G-10.

Inhalation unit risk factors were available from the OEHHA for the six PAH compounds but not dieldrin. An Inhalation unit risk factor was published in IRIS for dieldrin but not for the PAHs. Factors published by the EPA Region 9 for RSLs were referenced to the OEHHA and IRIS values. The OEHHA and IRIS unit risk factors were used in this evaluation.

G1.3.4 Non-cancer Inhalation Toxicity Factors

Non-cancer inhalation toxicity values were unavailable from the OEHHA, EPA, or IRIS for the seven chemical COCs.

G1.3.5 Chemical Risk Calculation Results

Table G-11 presents the risk results from the SWRA (US Davis 2004) and the risks updated for this Five-Year Review. The chemical risk calculation spreadsheets are presented in Attachments G-3a through G-3k. Upon recalculation, the total estimated human health risks for the DSS 4 area, the EDPs, and Southwest Trenches were either lower or the same as those calculated in the SWRA. Recalculated risks to hypothetical future residential receptors at DSS 4 were higher than those of the SWRA for three PAH compounds, lower for two PAHs, and unchanged for one PAH.

Table G-11. Human Health Risks by Exposure Route for Contaminants in Soil at the DOE Areas

Cancer Risk by Exposure Route									
	Receptor/Constituent	**Exposure Point Concentration (0–10 ft)[a]**	**Soil Ingestion**	**Soil Dermal Exposure**	**Aboveground Plant Ingestion[b]**	**Belowground Plant Ingestion[b]**	**External Radiation**	**Dust Inhalation**	**Total Cancer Risk**
Domestic Septic System 4, Onsite Resident									
SWRA	Benzo(*a*)anthracene	3.8	4.E-06	1.E-06	9.E-06	1.E-06	NA	3.E-10	2.E-05
Five Year Review			7.E-06	3.E-06	3.E-06	6.E-06	NA	1.E-10	2.E-05
SWRA	Benzo(*a*)pyrene	2.4	3.E-05	7.E-06	3.E-05	5.E-06	NA	2.E-09	7.E-05
Five Year Review			4.E-05	2.E-05	1.E-05	2.E-05	NA	7.E-10	9.E-05
SWRA	Benzo(*b*)fluoranthene	2.7	3.E-06	8.E-07	3.E-06	5.E-07	NA	2.E-10	7.E-06
Five Year Review			5.E-06	2.E-06	2.E-06	4.E-06	NA	8.E-11	1.E-05
SWRA	Benzo(*k*)fluoranthene	1.5	3.E-06	7.E-07	3.E-04	5.E-05	NA	7.E-11	4.E-04
Five Year Review			3.E-06	1.E-06	7.E-07	1.E-06	NA	4.E-11	6.E-06
SWRA	Dibenzo(*a,h*)anthracene	1.1	7.E-06	2.E-06	4.E-06	6.E-07	NA	5.E-10	1.E-05
Five Year Review			1.E-05	5.E-06	1.E-06	3.E-06	NA	3.E-10	2.E-05
SWRA	Indeno(1,2,3-*cd*)pyrene	0.86	2.E-06	4.E-07	1.E-06	1.E-07	NA	4.E-11	4.E-06
Five Year Review			1.E-06	6.E-07	2.E-07	4.E-07	NA	2.E-11	3.E-06
SWRA								Total	**5.E-04**
Five Year Review									**1.E-04**
Domestic Septic System 4, Onsite Construction Worker									
SWRA	Benzo(*a*)pyrene	2.4	8.E-07	3.E-07	NA	NA	NA	7.E-10	**1.E-06**
Five Year Review			1.E-06	7.E-07	NA	NA	NA	2.E-7	**1.E-06**

Cancer Risk by Exposure Route									
	Receptor/Constituent	**Exposure Point Concentration (0–10 ft)[a]**	**Soil Ingestion**	**Soil Dermal Exposure**	**Aboveground Plant Ingestion[b]**	**Belowground Plant Ingestion[b]**	**External Radiation**	**Dust Inhalation**	**Total Cancer Risk**
Eastern Dog Pens, Onsite Resident									
SWRA	Dieldrin	0.019	5.E-07	9.E-08	2.E-06	2.E-07	NA	4.E-11	3.E-06
Five Year Review			4.E-07	1.E-07	3.E-07	6.E-07	NA	2.E-14	1.E-06
SWRA	Strontium-90	0.33[c]	4.E-08	NA	1.E-06	NA	5.E-08	5.E-13	1.E-06
Five Year Review			2.E-08	NA	1.E-06	NA	6.E-08	2E-12	1.E-06
SWRA								Total	**4.E-06**
Five Year Review									**2.E-06**
Southwest Trenches, Onsite Resident									
SWRA	Strontium-90	0.94	1.E-07	NA	3.E-06	NA	2.E-07	2.E-12	**3.E-06**
Five Year Review			7.E-08	NA	3.E-06	NA	2.E-07	6.E-12	**3.E-06**

Notes:
Source of SWRA data from the *Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment*, Tables 7 and 8 (UC Davis 2004).
Constituents and risks are presented here if (1) the constituent is present above site background and if (2) the constituent contributes at least a factor of 1 in 1 million, or greater than 10 percent, to the excess cumulative cancer risk for a DOE area and receptor. Only exposure pathways for contaminants in soil at the DOE areas are presented here. Exposures to groundwater and surface water contaminants are not included because they will be addressed by the UC Davis Feasibility Study.
Chemical concentrations are expressed in milligrams per kilogram, and radionuclide concentrations are expressed in picocuries per gram.
[a] The 95 percent upper confidence limit on the mean or maximum sample concentration.
[b] Home-grown produce; for radionuclides, plant ingestion is not subdivided into aboveground and belowground produce.
[c] Exposure point concentration after Eastern Dog Pens maintenance action.

Abbreviations:
NA = not applicable
SWRA – Site Wide Risk Assessment

Benzo(*k*)fluoranthene at DSS 4 showed the largest change between risk reported in the SWRA (4×10^{-4}) and recalculated risk (6×10^{-6}). The decrease in benzo(*k*)fluoranthene risk was due to a nearly 2 orders of magnitude correction to the soil-to-plant transfer coefficient used in the SWRA. The correction was discussed in detail above.

Increases in estimated risk to hypothetical future residential receptors for three PAH compounds at the DSS 4 area were primarily due to updated oral cancer slope factors (Table G-9) and to a lesser extent changes in assumed plant ingestion rates based on data from the 2011 Handbook (EPA 2011).

Estimated risks to onsite construction workers at DSS 4 showed a slight increase for soil ingestion and a slight decrease for dermal contact, resulting in no net change in total estimated cancer risk.

The estimated risk to hypothetical future residential receptors from dieldrin at the EDPs was slightly lower for soil ingestion, slightly higher for dermal contact, lower for aboveground plant ingestion, and higher for belowground plant ingestion. The decrease in aboveground plant ingestion risk caused an overall threefold decrease in the total risk across pathways.

The dust inhalation risks for chemical constituents were significantly lower upon recalculation as a result of site-specific particulate emission factors determined for DSS 4 and the EDPs. The differences in inhalation risk had no effect on the total cancer risk for each chemical because the other pathway contributions were several orders of magnitude higher.

G2.0 Radiological Risk Calculations

G2.1 Calculations Using RESRAD Onsite

Radiological risks were calculated in the SWRA using Argonne National Laboratory's Residual Radiation computer program RESRAD Onsite version 6.21 (ANL 2002). Risk factors (slope factors) selected in RESRAD Onsite version 6.21 for the SWRA were from the 2001 version of the Health Effects Assessment Summary Tables (HEAST 2001) (EPA 2001). Most values in HEAST 2001 were taken from Federal Guidance Report No. 13 (EPA 1999b). RESRAD Onsite version 7.0 is the most recent update to the Argonne National Laboratory's Residual Radiation computer program. DOE currently uses Dose Coefficient File Package version 3.02 (DCFPAK 3.02) (EPA 2015c) in RESRAD Onsite version 7.0 as the source of risk coefficients for radiation risk assessment at DOE sites.

Strontium-90 (Sr-90) was the only radionuclide identified in the SWRA as a human health COC (for hypothetical residential receptors only). A comparison between Sr-90 risk coefficients used in the SWRA and those available in DCFPAK 3.02 is shown in Table G-12.

Table G-12. Comparison of Strontium-90 Risk Coefficients

Parameter	HEAST 2001[a] Risk Factors Used in SWRA	DCFPAK 3.02[b] Risk Factors
Sr-90 + D, Ground External, 1/year per (pCi/g)	1.96E-08	1.95E-08
Sr-90 + D, Inhalation, $(pCi)^{-1}$	1.13E-10	4.34E-10
Sr-90 + D, Food Ingestion, $(pCi)^{-1}$	9.53E-11	9.53E-11
Sr-90 + D, Soil Ingestion, $(pCi)^{-1}$	1.44E-10	9.53E-11

Notes:
[a] Health Effects Assessment Summary Tables (EPA 2001).
[b] Dose Coefficient File Package version 3.02 (EPA 2015c).

Abbreviations:
pCi/g = picocuries per gram

Food ingestion risk factors are identical and external ground factors are essentially the same between HEAST 2001 and DCFPAK 3.02. The most noticeable change between HEAST 2001 and DCFPAK 3.02 is a 400 percent increase in the inhalation risk factor. The soil ingestion risk factor decreased by 34 percent between HEAST 2001 and DCFPAK 3.02.

Parameter values used in RESRAD Onsite version 6.21 for the SWRA were reviewed, and a copy is included as Attachment G-4. The *"area of contaminated zone"* for the Southwest Trenches (2,428 square meters [m^2]) was incorrect when compared to the area as determined by the land surveyor (1,785 m^2 = 19,222 square feet) (DTSC 2014). The surveyed area was used in this evaluation.

The Southwest Trenches and Eastern Dog Pens areas (0.44 and 0.8 acre, respectively) are small with respect to a realistic exposure scenario. Receptors at this site do not spend significant time at any one of the DOE Areas while the model assumptions are based on receptors remaining in the center of one area on a continuous basis. In addition, the model assumes no soil cover and a 3-meter thick contaminated zone distributed evenly across each area. These model assumptions are consistent with the approved SWRA (UC Davis 2004) and represent conservative overestimates of risk with respect to contaminated area, thickness, and overburden. In reality, the residual soil contamination in most DOE Areas is localized in small pockets under clean fill or overburden.

Home garden plant ingestion rates were calculated using data from the EPA's 2011 Handbook (EPA 2011). The procedure used to determine plant ingestion rates is described above for the chemical risk evaluation. However, plant ingestion inputs for RESRAD Onsite are divided into the following categories:

1. Fruit, grain, and vegetable consumption (FGVC) in kilograms dry weight/year (kg DW/year)
2. Leafy vegetable consumption (LVC) in kg DW/year

The fruit and vegetable ingestion rates provided in the 2011 Handbook (EPA 2011) were combined and redistributed to provide FGVC and LVC ingestion rates for RESRAD input. On the basis of RESRAD Onsite default whole diet ingestion rates, FGVC and LVC make up 92 and 8 percent, respectively, of plant ingestion. The FGVC and LVC calculation is shown in Attachment G-5. A comparison between plant ingestion rates used in the SWRA for RESRAD and those determined for RESRAD in this evaluation is shown in Table G-13.

Table G-13. Comparison of Plant Ingestion Rates

Parameter	2004 SWRA[a]	2011 Handbook[b]
Fruit, grain and vegetable consumption (kg DW/year)	5.1	9.69
Leafy vegetable consumption (kg/DW/year)	5.1	0.84

Notes:
[a] SWRA data from the *Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment* (UC Davis 2004)
[b] EPA data from the EPA's *Exposure Factors Handbook* (EPA 2011)

The comparison of the combined ingestion rates of FGVC and LVC in the SWRA (UC Davis 2004) versus the Five-Year Review updated ingestion rate is 10.2 versus 10.53 kg DW/year. The redistribution results are almost the same for overall fruit and vegetable intake as those in the SWRA. The soil ingestion rate used in the RESRAD calculations for the SWRA was 36.5 grams. This soil ingestion rate was the default in RESRAD Onsite version 6.21 and remains the default in RESRAD Onsite version 7.0. No change to the soil ingestion rate was made in this evaluation.

Respirable dust inhalation parameters such as wind speed were not modified in this evaluation because dust inhalation risk is several orders of magnitude below the other exposure pathway risks and any changes to these parameters would not contribute to the risk.

Sr-90 risk was recalculated for the EDPs and Southwest Trenches Area using RESRAD Onsite version 7.0 with DCFPAK 3.02 risk factors, the corrected land-survey areas, and the updated plant ingestion rates.

G2.2 Radiological Risk Calculation Results

The updated risk calculation results are shown in Table G-11. The estimated risk from Sr-90 in the EDPs is primarily due to plant ingestion, which did not change upon recalculation. Changes in Sr-90 risk for soil ingestion and dust inhalation were due to differences in risk factors between HEAST 2001 and DCFPAK 3.02 (risk factors discussed above). Soil ingestion, external radiation, and dust inhalation did not contribute significantly to the total Sr-90 risk.

Estimated risks from Sr-90 in the Southwest Trenches were similarly dominated by plant ingestion with insignificant contributions from the other pathways.

G2.3 Onsite Researchers and Trespassers

Onsite outdoor and indoor researchers and trespassers were evaluated in the SWRA (UC Davis 2004). The SWRA risk characterization for DOE Areas (DOE 2005) concluded that the COCs did not pose significant risk to these receptors. This section contains an evaluation of current parameter values, intake equations, and toxicity values to determine if recalculation of risks for these receptors would indicate a change to significant risk. Exposure pathways at the DOE areas for these receptors are soil ingestion, dermal contact, and dust inhalation.

EPA's recommended values for soil ingestion rates (EPA 2014) did not change since the SWRA was issued in 2004. The calculation of soil ingestion intake would decrease slightly or remain the same for these receptors because adult body weight is the only value in the intake equation that changed after the EPA's 2014 Update, except exposure time (discussed below). Adult body weight changed from 70 to 80 kilograms (14 percent increase). Body weight is a denominator term in the intake equation, and an increase in body weight results in a soil ingestion intake decrease.

The soil ingestion equation is shown below as

$$\text{Soil Ingestion Intake} = \frac{CS \times IR \times EF \times ED}{BW \times AT}$$

where

CS = concentration in soil

IR = soil ingestion rate

EF = exposure frequency

ED = exposure duration

BW = body weight

AT = averaging time

EPA's recommended values for receptor skin surface area that would be exposed via dermal contact with soil (EPA 2014) changed slightly since the SWRA was issued in 2004. The skin surface area changes are:

1. Children: previous value 2,800 cm^2; current value 2,690 cm^2; 4 percent decrease
2. Adults: previous value 5,700 cm^2; current value 6,032 cm^2; 6 percent increase
3. Workers: previous value 3,300 cm^2; current value 3,470 cm^2; 5 percent increase

Skin surface area is a numerator term in the intake equation, and the decrease in child skin surface area results in a slight decrease in dermal intake. The slight increases in adult and worker skin surface area in the numerator are offset by the larger percent increase in body weight in the denominator, resulting in a slight overall decrease in dermal intake.

Chemical toxicity data used in soil ingestion and dermal contact risk calculations are shown in Table G-9. Oral slope factors apply to both soil ingestion and dermal contact. There was no change in oral slope factors for benzo(*k*)fluoranthene, indeno(1,2,3-*cd*)pyrene, and dieldrin, indicating that the risks to onsite outdoor and indoor researchers and trespassers would remain the same or decrease slightly for these three chemicals due to the slight decreases in soil ingestion intake and dermal intake. Oral slope factors did increase significantly for four PAH compounds:

1. 64 percent increase for benzo(*a*)anthracene, benzo(*a*)pyrene, and benzo(*a*)fluoranthene
2. 78 percent increase for dibenzo(*a,h*)anthracene

Slope factor increases for these four PAHs are significant, but the soil ingestion and dermal contact intake equations used in the SWRA (UC Davis 2004) did not account for exposure time in hours per day. The SWRA calculations used an event frequency of 1 per day, which is equivalent to 1 day per day exposure time (or 24-hours per day). More realistic exposure times would be 8 hours per day for researchers and 2 hours per day for trespassers (homeless encampment not included). The estimated risk would increase by a factor of up to 1.78 due to the slope factor increases, but the estimated risk would decrease by a factor of 0.33 based on realistic exposure times. Combining these two factors ($1.78 \times 0.33 = 0.59$) indicates the overall estimated risk from soil ingestion and dermal contact exposure to benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*a*)fluoranthene, and dibenzo(*a,h*)anthracene would decrease.

The soil ingestion risk factor decreased for Sr-90 (Table G-12). Dermal contact is not an exposure pathway for radionuclides, but external radiation from ground is an open exposure pathway. The current Sr-90 risk factor for external radiation is essentially unchanged from the value used in the SWRA (0.5 percent decrease). Thus, estimated soil ingestion risk and external radiation risk to onsite outdoor and indoor researchers and trespassers from Sr-90 is expected to decrease.

As discussed previously, dust inhalation intake was calculated in the SWRA (UC Davis 2004) for chemicals in units of mg/kg-day, but chemical inhalation exposure calculations currently estimate risk using an exposure concentration in $\mu g/m^3$. Direct comparison of these approaches is not possible, but a review of estimated risks as shown in Table G-11 indicates that inhalation risk does not contribute to the overall receptor risk and recalculated risks decreased substantially upon determining site-specific PEFs. Thus, estimates of chemical inhalation risks to onsite outdoor and indoor researchers and trespassers are expected to decrease significantly and not contribute to the overall risk.

Estimated risks to onsite residents from inhalation of Sr-90 in dust were insignificant compared to soil ingestion and external radiation risks (Table G-11). Estimates of Sr-90 inhalation risks to onsite outdoor and indoor researchers and trespassers are likewise expected to contribute no significant risk.

This evaluation of current parameter values, intake equations, and toxicity values indicates that the existing COCs do not pose significant risks to onsite outdoor or indoor researchers or trespassers.

G3.0 Conclusions

After a Five-Year Review recalculation of human health risks from the soil ingestion, dermal contact, plant ingestion, dust inhalation, and external radiation pathways for the identified COCs, the risks at the DSS 4 area, the EDPs, and the Southwest Trenches are either lower or unchanged from the 2004 SWRA. As such, the current remedy is protective.

G4.0 References

ANL (Argonne National Laboratory), 2002. *RESRAD Onsite*, Version 6.21, Environmental Assessment Division, United States Department of Energy, Argonne, Illinois, September 5.

ANL (Argonne National Laboratory), 2014. *RESRAD Onsite,* Version 7.0, Environmental Assessment Division, United States Department of Energy, Argonne, Illinois, February 25.

DOE (U.S. Department of Energy), 2005. *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment (Part B-Risk Characterization for DOE Areas*), *University of California, Davis*, prepared for the U.S. DOE by Weiss Associates, September 30.

DOE (U.S. Department of Energy), 2010. *Radionuclide Air Emission Annual Report, Calendar Year 2009*, for the Laboratory for Energy-Related Health Research, University of California, Davis, Rev. 0, June 21.

DTSC (California Department of Toxic Substances Control), 2014. *Covenant to Restrict Use of Property, Environmental Restriction* (*Re: Portions of County of Solano Assessor's Parcel No. 110-05-04 UC Davis, Laboratory for Energy-related Health Research/Old Campus Landfill (LEHR/OCL) Superfund Site*, Site Code 100424), Solano County Recorder's Office Document Number 201400051822, July 11.

DTSC (California Department of Toxic Substances Control), 2014b. *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities*, Human and Ecological Risk Office, September 30.

DTSC (California Department of Toxic Substances Control), 2015. *Human Health Risk Assessment Note 3, DTSC-modified Screening Levels (DTSC-SLs)*, Human and Ecological Risk Office, October.

EPA (U.S. Environmental Protection Agency), 1996. *Soil Screening Guidance: User's Guide*, Second Edition, Publication 9355.4-23, July.

EPA (U.S. Environmental Protection Agency), 1999a. *Farm Food Chain Module: Background and Implementation for the Multimedia, Multipathway and Multireceptor Risk Assessment (3MRA) Model for HWIR99*, Office of Solid Waste, Washington, DC, July.

EPA (U.S. Environmental Protection Agency), 1999b. *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, Federal Guidance Report No. 13, EPA 402-R-99-001, September.

EPA (U.S. Environmental Protection Agency), 2001. *Radionuclide Carcinogenicity Slope Factors: Health Effects Assessment Summary Tables (HEAST),* http://www.epa.gov/rpdweb00/heast/index.html#download, April 16, accessed June 29, 2015.

EPA (U.S. Environmental Protection Agency), 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, Office of Solid Waste and Emergency Response, Washington, DC, OSWER 9355.4-24, December.

EPA (U.S. Environmental Protection Agency), 2004. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*, Final, EPA/540/R/99/005.

EPA (U.S. Environmental Protection Agency), 2009. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*, Final, EPA-540-R-070-002.

EPA (U.S. Environmental Protection Agency), 2011. *Exposure Factors Handbook*, 2011 Edition, U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/052F.

EPA (U.S. Environmental Protection Agency), 2014. *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Parameter Values*, OSWER Directive 9200.1-120, February 6.

EPA (U.S. Environmental Protection Agency), 2015a. *Integrated Risk Information System*, http://www.epa.gov/iris/, last updated on Tuesday, June 23, 2015, accessed June 23, 2015.

EPA (U.S. Environmental Protection Agency), 2015b. *Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants, Pacific Southwest, Region 9, Serving: Arizona, California, Hawaii, Nevada, Pacific Islands, Tribal Nations*, http://www.epa.gov/region9/superfund/prg/, June 2015, accessed June 30, 2015.

EPA (U.S. Environmental Protection Agency), 2015c. *Radiation Protection*, Technical Reports, http://www.epa.gov/radiation/federal/techdocs.html, last updated on Monday, June 29, 2015, accessed June 30, 2015.

LBNL (Ernest Orlando Lawrence Berkeley National Laboratory), 2007. *Plant Uptake of Organic Pollutants from Soil: A Critical Review of Bioconcentration Estimates Based on Models and Experiments*, LBNL-60273, January.

State of California Office of Environmental Health Hazard Assessment (OEHHA), 2011. *Appendix A: Hot Spots Unit Risks and Cancer Potency Values*, http://www.oehha.ca.gov/air/hot_spots/2009/AppendixA.pdf, accessed May 13, 2015.

Travis, C.C. and A.D. Arms, 1988. "Bioconcentration of Organics in Beef, Milk, and Vegetation," *Environmental Science and Technology*, 22:271–274.

UC ANR (University of California, Division of Agriculture and Natural Resources), 2015. *University of California Cooperative Extension Master Gardeners of Sacramento County*, http://ucanr.edu/sites/sacmg/, last updated June 8, 2015, accessed June 9, 2015.

UC Davis (University of California, Davis), 2004. *Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment*, University of California, Davis, March.

UC Davis (University of California Davis), 2008. *Vegetable Planting Guide for the Sacramento Area*, UC Davis Department of Plant Sciences, https://www.ucdmc.ucdavis.edu/hr/wellness/_docs/planting_guide.pdf, accessed June 9, 2015.

Attachments G-1 through G-5

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Attachment G-1
Fruit and Vegetable ingestion Rate Calculations, Chemical Intake

Fruits	Moisture Content[1]	State	Resident Age Range	95th Percentile Fruit Ingestion Rate[2] (g WW/kg-day)	Body Weight (EPA 2014) (kg)	Converted Fruit Ingestion Rate[3] (kg DW/day)	SWRA Value (kg DW/day)
honeydew melon	89.82%	raw	Ages Birth to <6 years	4.4	15	0.0086	0.0609
peach	88.87%	raw	Ages 6 to 50+ years	0.99	80	0.0103	0.0179
plum	87.23%	raw					
apricot	86.35%	raw					
cherry	82.25%	raw					
nectarine	87.59%	raw					
Average moisture content	87.02%						
Average dry content	12.98%	100% - Moisture content					

Vegetables	Moisture Content[1]	State	Resident Age Range	95th Percentile Vegetable Ingestion Rate[2] (g WW/kg-day)	Body Weight (EPA 2014) (kg)	Converted Vegetable Ingestion Rate[3] (kg DW/day)	SWRA Value (kg DW/day)
tomato	93.95%	raw					
Broccoli	89.25%	cooked	Ages Birth to <6 years	6.8	15	0.0108	0.0033
carrots	88.29%	raw	Ages 6 to 50+ years	3.3	80	0.028	0.0098
pepper-sweet-green	93.89%	raw					
corn	69.57%	cooked					
lettuce-cos or romaine	94.61%	raw					
spinach	91.40%	raw					
green beans	89.22%	cooked					
summer squash	93.70%	cooked					
Average moisture content	89.32%						
Average dry content	10.68%	100% - Moisture content					

Notes:

[1] Moisture content values from Table 9-37 of EFH 2011 Edition (EPA 2011). Table provides values for raw and cooked. Most likely consumed state of garden item selected.

[2] Values from Table 13-1 of EFH 2011 Edition (EPA 2011), per capita for populations that garden or farm adjusted for preparation and post-cooking losses. Average of 95th percentile values for age range.

[3] Ingestion rates must be converted from grams wet weight per kilogram body weight per day (g WW/kg-day) to kilograms dry weight per day (kg DW/day) for use in the risk assessment intake equation.

Abbreviations

EFH - Exposure Factors Handbook
EPA - United States Environmental Protection Agency
g WW/kg-day - grams wet weight per kilogram body weight per day
kg - kilograms
kg DW/day - kilograms dry weight per day
SWRA - Site-Wide Risk Assessment (UC Davis 2004)

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Attachment G-2a. Values Used for Human Health Risk Assessment Daily Intake Calculations, Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil

Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Hypothetical Future On-Site Resident	Age-Adjusted Adult	DSS 4	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				CF	Conversion Factor	0.000001	kg/mg	-	CS x CF x [($IR_{s,a}$ x $ED_{r,a}$ / BW_a)
				$IR_{s,a}$	Ingestion Rate	100	mg soil/day	UCD 2004	+ ($IR_{s,c}$ x $ED_{r,c}$ / BW_c)] x EF_r / AT
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a}$	Exposure Duration	20	years	DTSC 2014 and EPA 2014	
				BW_a	Body Weight	80	kg	DTSC 2014 and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Based on $ED_{r,a}$ + $ED_{r,c}$, DTSC 2014 and EPA 2014	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
		Child	DSS 4	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				CF	Conversion Factor	0.000001	kg/mg	-	CS x CF x $IR_{s,c}$ x EF_r x $ED_{r,c}$
				$IR_{s,c}$	Ingestion Rate	200	mg soil/day	UCD 2004	/(BW_c x AT)
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,c}$	Exposure Duration	6	years	UCD 2004	
				BW_c	Body Weight	15	kg	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	Based on $ED_{r,c}$, UCD 2004	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	

Attachment G-2b. Values Used for Human Health Risk Assessment Daily Intake Calculations, Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Plants

Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Hypothetical Future On-Site Resident	Age-Adjusted Adult	DSS 4	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				$CR_{ag,a}$	Fruit/Vegetable Ingestion Rate, above ground	0.0103	kg DW/day	Calculated from EPA 2011 Data	CS x CPF x {[$ED_{r,a}$ /BW_a x ($TC_{s\text{-}p,ag}$ x $CR_{ag,a}$
				$CR_{bg,a}$	Fruit/Vegetable Ingestion Rate, below ground	0.028	kg DW/day	Calculated from EPA 2011 Data	+ $TC_{s\text{-}p,bg}$ x $CR_{bg,a}$)] + [$ED_{r,c}$ /BW_c x ($TC_{sp,ag}$ x
				EF_r	Exposure Frequency	350	days/year	UCD 2004	$CR_{ag,c}$ + $TC_{s\text{-}p,bg}$ x $CR_{bg,c}$)]} x EF_r /AT
				$ED_{r,a}$	Exposure Duration	20	years	DTSC 2014 and EPA 2014	
				BW_a	Body Weight	80	kg	DTSC 2014 and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Based on $ED_{r,a}$ + $ED_{r,c}$, DTSC 2014 and EPA 2014	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
				$TC_{s\text{-}p}$	Transfer Coefficient (soil-to-plant)	Note[1]	unitless		
				CPF	Contaminated Plant Fraction	0.40	unitless	UCD 2004	
		Child	DSS 4	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				$CR_{ag,c}$	Fruit/Vegetable Ingestion Rate, above ground	0.0086	kg DW/day	Calculated from EPA 2011 Data	[(CS x $TC_{s\text{-}p}$ x CPF x $CR_{ag,c}$)
				$CR_{bg,c}$	Fruit/Vegetable Ingestion Rate, below ground	0.0108	kg DW/day	Calculated from EPA 2011 Data	+ (CS x $TC_{s\text{-}p}$ x CPF x $CR_{bg,c}$)]
				EF_r	Exposure Frequency	350	days/year	UCD 2004	x EF_r x $ED_{r,c}$ /(BW_c x AT)
				$ED_{r,c}$	Exposure Duration	6	years	UCD 2004	
				BW_c	Body Weight	15	kg	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	Based on $ED_{r,c}$, UCD 2004	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
				$TC_{s\text{-}p}$	Transfer Coefficient (soil-to-plant)	Note[1]	unitless		
				CPF	Contaminated Plant Fraction	0.40	unitless	UCD 2004	

Notes:

[1] Chemical-specific dermal absorption factors for hypothetical future on-site resident shown at the bottom of Table G-2d.

References:

DTSC 2014, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA, 2011, *Exposure Factors Handbook,* 2011 Edition
EPA, 2014, *Human Health Evaluation Manual*
UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Abbreviations:

cm^2 - square centimeters
DSS - Demestic Septic System
DTSC - California Department of Toxic Substances Control
EPA - U.S. Environmental Protection Agency
kg - kilograms
kg DW/day - kilograms dry weight per day
UCD - University of California, Davis

Attachment G-2c. Values Used for Human Health Risk Assessment Daily Intake Calculations, Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Fugitive Dust

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dust Inhalation	Hypothetical Future On-Site Resident	Age-Adjusted Adult	DSS 4	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	EC (ug/m^3) = (CS/PEF) x CF x ET_r x EF_r x ($ED_{r,a}$ + $ED_{r,c}$) / AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	DTSC 2014	
				CF	Conversion Factor	1000	µg/mg	-	
				ET_r	Exposure Time	24	hours/day	EPA 2014	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a}$	Exposure Duration	20	years	DTSC 2014 and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	227,760	hours	Based on $ED_{r,a}$ + $ED_{r,c}$, DTSC 2014 and EPA 2014	
				AT_c	Averaging Time (cancer)	613,200	hours	UCD 2004	
		Child	DSS 4	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	EC (ug/m^3) = (CS/PEF) x CF x ET_r x EF_r x $ED_{r,c}$ / AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	DTSC 2014	
				CF	Conversion Factor	1000	µg/mg	-	
				ET_r	Exposure Time	24	hours/day	EPA 2014	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,c}$	Exposure Duration	6	years	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	52,560	hours	Based on $ED_{r,c}$, UCD 2004	
				AT_c	Averaging Time (cancer)	613,200	hours	UCD 2004	

Abbreviations:

DTSC - California Department of Toxic Substances Control

EPA - United States Environmental Protection Agency

m3/kg - cubic meters per kilogram
mg/kg - milligrams per kilogram

UCD - University of California, Davis
µg/mg - micrograms per milligram

References:

DTSC 2014, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*

EPA, 2014, *Human Health Evaluation Manual*

UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment G-2d. Calculation of Chemical Cancer and Non-cancer Risks, Human Health Risk Assessment Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe:	Future
Receptor Population:	On-Site Resident Adult
Receptor Age:	Age-Adjusted Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake Units	CSF/Unit Risk Value	CSF Units	Cancer Risk	Non-Cancer Hazard Calculations: Intake/Exposure Concentration Value	Intake Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Surface and Subsurface Soil (0-10 feet)	Surface and Subsurface Soil (0-10 feet)	DSS 4	Ingestion	Benzo(a)anthracene	3.80E+00	mg/kg	5.5E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	6.6E-06	1.5E-05	mg/kg-day	NA	mg/kg-day	NA
				Benzo(a)pyrene	2.40E+00	mg/kg	3.5E-06	mg/kg-day	1.2E+01	(mg/kg-day)-1	4.1E-05	9.3E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo(b)fluoranthene	2.70E+00	mg/kg	3.9E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	4.7E-06	1.0E-05	mg/kg-day	NA	mg/kg-day	NA
				Benzo(k)fluoranthene	1.50E+00	mg/kg	2.2E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	2.6E-06	5.8E-06	mg/kg-day	NA	mg/kg-day	NA
				Dibenzo(a,h)anthracene	1.10E+00	mg/kg	1.6E-06	mg/kg-day	7.3E+00	(mg/kg-day)-1	1.2E-05	4.3E-06	mg/kg-day	NA	mg/kg-day	NA
				Indeno(1,2,3-cd)pyrene	8.60E-01	mg/kg	1.2E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	1.48E-06	3.3E-06	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								6.8E-05					0.0E+00
			Dermal	Benzo(a)anthracene	3.80E+00	mg/kg	2.3E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	2.7E-06	6.2E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo(a)pyrene	2.40E+00	mg/kg	1.4E-06	mg/kg-day	1.2E+01	(mg/kg-day)-1	1.7E-05	3.9E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo(b)fluoranthene	2.70E+00	mg/kg	1.6E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	2.0E-06	4.4E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo(k)fluoranthene	1.50E+00	mg/kg	9.0E-07	mg/kg-day	1.2E+00	(mg/kg-day)-1	1.1E-06	NA	mg/kg-day	NA	mg/kg-day	NA
				Dibenzo(a,h)anthracene	1.10E+00	mg/kg	6.6E-07	mg/kg-day	7.3E+00	(mg/kg-day)-1	4.8E-06	NA	mg/kg-day	NA	mg/kg-day	NA
				Indeno(1,2,3-cd)pyrene	8.60E-01	mg/kg	5.2E-07	mg/kg-day	1.2E+00	(mg/kg-day)-1	6.2E-07	NA	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								2.9E-05					0.0E+00
	Plants		Above Ground Plant Ingestion	Benzo(a)anthracene	3.80E+00	mg/kg	2.5E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	3.0E-06	6.7E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo(a)pyrene	2.40E+00	mg/kg	8.7E-07	mg/kg-day	1.2E+01	(mg/kg-day)-1	1.0E-05	2.3E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo(b)fluoranthene	2.70E+00	mg/kg	1.6E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	1.9E-06	4.2E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo(k)fluoranthene	1.50E+00	mg/kg	5.6E-07	mg/kg-day	1.2E+00	(mg/kg-day)-1	6.7E-07	1.5E-06	mg/kg-day	NA	mg/kg-day	NA
				Dibenzo(a,h)anthracene	1.10E+00	mg/kg	1.9E-07	mg/kg-day	7.3E+00	(mg/kg-day)-1	1.4E-06	5.2E-07	mg/kg-day	NA	mg/kg-day	NA
				Indeno(1,2,3-cd)pyrene	8.60E-01	mg/kg	1.6E-07	mg/kg-day	1.2E+00	(mg/kg-day)-1	1.9E-07	4.3E-07	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								1.8E-05					0.0E+00
			Below Ground Plant Ingestion	Benzo(a)anthracene	3.80E+00	mg/kg	4.7E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	5.7E-06	1.3E-05	mg/kg-day	NA	mg/kg-day	NA
				Benzo(a)pyrene	2.40E+00	mg/kg	1.6E-06	mg/kg-day	1.2E+01	(mg/kg-day)-1	2.0E-05	4.4E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo(b)fluoranthene	2.70E+00	mg/kg	3.0E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	3.6E-06	8.0E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo(k)fluoranthene	1.50E+00	mg/kg	1.1E-06	mg/kg-day	1.2E+00	(mg/kg-day)-1	1.3E-06	2.9E-06	mg/kg-day	NA	mg/kg-day	NA
				Dibenzo(a,h)anthracene	1.10E+00	mg/kg	3.6E-07	mg/kg-day	7.3E+00	(mg/kg-day)-1	2.6E-06	9.8E-07	mg/kg-day	NA	mg/kg-day	NA
				Indeno(1,2,3-cd)pyrene	8.60E-01	mg/kg	3.0E-07	mg/kg-day	1.2E+00	(mg/kg-day)-1	3.6E-07	8.1E-07	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								3.3E-05					0.0E+00
	Fugitive Dust		Dust Inhalation	Benzo(a)anthracene	3.80E+00	mg/kg	1.0E-06	$\mu g/m^3$	1.1E-04	$(\mu g/m^3)^{-1}$	1.1E-10	2.7E-06	ug/m^3	NA	$\mu g/m^3$	NA
				Benzo(a)pyrene	2.40E+00	mg/kg	6.3E-07	$\mu g/m^3$	1.1E-03	$(\mu g/m^3)^{-1}$	6.9E-10	1.7E-06	ug/m^3	NA	$\mu g/m^3$	NA
				Benzo(b)fluoranthene	2.70E+00	mg/kg	7.1E-07	$\mu g/m^3$	1.1E-04	$(\mu g/m^3)^{-1}$	7.8E-11	1.9E-06	ug/m^3	NA	$\mu g/m^3$	NA
				Benzo(k)fluoranthene	1.50E+00	mg/kg	3.9E-07	$\mu g/m^3$	1.1E-04	$(\mu g/m^3)^{-1}$	4.3E-11	1.1E-06	ug/m^3	NA	$\mu g/m^3$	NA
				Dibenzo(a,h)anthracene	1.10E+00	mg/kg	2.9E-07	$\mu g/m^3$	1.2E-03	$(\mu g/m^3)^{-1}$	3.46E-10	7.8E-07	ug/m^3	NA	$\mu g/m^3$	NA
				Indeno(1,2,3-cd)pyrene	8.60E-01	mg/kg	2.3E-07	$\mu g/m^3$	1.1E-04	$(\mu g/m^3)^{-1}$	2.48E-11	6.1E-07	ug/m^3	NA	$\mu g/m^3$	NA
			Exp. Route Total								1.3E-09					0.0E+00
		Exposure Point List 1 Total									1.48E-04					0.0E+00

	Dermal Absorption Factor: Cancer	Dermal Absorption Factor: Noncancer	References	Plant Transfer Factors: Above Ground plant/soil	Plant Transfer Factors: Below Ground plant/soil	References
Benzo(a)anthracene	0.13	0.13	UCD 2004	0.02	0.02	UCD 2004
Benzo(a)pyrene	0.13	0.13	UCD 2004	0.011	0.011	UCD 2004
Benzo(b)fluoranthene	0.13	0.13	UCD 2004	0.018	0.018	LBNL 2007
Benzo(k)fluoranthene	0.13		UCD 2004	0.011	0.011	LBNL 2007
Dibenzo(a,h)anthracene	0.13		UCD 2004	0.0053	0.0053	UCD 2004
Indeno(1,2,3-cd)pyrene	0.13		UCD 2004	0.0056	0.0056	UCD 2004

Abbreviations:

CSF - cancer slope factor
DSS - Domestic Septic System
EPC- exposure point concentration
mg/kg - milligrams per kilogram
NA - not applicable
RfC - reference dose, inhalation
RfD - reference dose, dermal
$\mu g/m^3$ - micrograms per cubic meter

References:

Ernest Orlando Lawrence Berekely National Laboratory, 2007, *Plant Update of Organic Pollutants from Soil: A Critical Review of Bioconcentration Estimates Baed on Models and Experiments*

University of California, Davis, 2004, *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment*

Attachment G-2e. Values Used for Human Health Risk Assessment Daily Intake Calculations, Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe: Current/Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name
Ingestion	On-Site Construction Worker	Adult	DSS 4	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				CF	Conversion Factor	0.000001	kg/mg	-	CS x CF x $IR_{s,cw}$ x $EF_{s,cw}$ x ED_{cw}
				$IR_{s,cw}$	Ingestion Rate	330	mg soil/day	UCD 2004	/(BW_a x AT)
				$EF_{s,cw}$	Exposure Frequency	250	days/year	UCD 2004	
				ED_{cw}	Exposure Duration	1	years	UCD 2004	
				BW_a	Body Weight	80	kg	DTSC 2014 and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	365	days	Based on ED_{cw}	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
Dermal	On-Site Construction Worker	Adult	DSS 4	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				CF	Conversion Factor	4.16667E-08	(kg/mg)(day/hours)	-	CS x CF x $SA_{s,cw}$ x $AF_{s,cw}$ x ABS
				$SA_{s,cw}$	Skin Surface Area	6,032	cm^2	DTSC 2014	x $ET_{s,cw}$ x $EF_{s,cw}$ x ED_{cw}
				$AF_{s,cw}$	Soil Adherence Factor	0.8	mg/cm^2-event	DTSC 2014	/(BW_a x AT)
				ABS	Dermal Absorption Factor	Note[1]	unitless	-	
				$ET_{s,cw}$	Soil Exposure Time	8	hours/day	EPA 2014	
				$EF_{s,cw}$	Exposure Frequency	250	days/year	UCD 2004	
				ED_{cw}	Exposure Duration	1	years	UCD 2004	
				BW_a	Body Weight	80	kg	DTSC 2014 and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	365	days	Based on ED_{cw}	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	

Note:
[1] Chemical-specific dermal absorption factors for on-site construction worker shown at the bottom of Table G-2g.

Abbreviations
cm^2 - square centimeters
DTSC - California Department of Toxic Substances Control
EPA - United States Environmental Protection Agency
k - kilogram
kg/mg - kilogram per milligram
mg/kg - milligram per kilogram
UCD - University of California, Davis

References:
DTSC 2014, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA, 2014, *Human Health Evaluation Manual*
UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment G-2f. Values Used for Human Health Risk Assessment Daily Intake Calculations, Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe: Current/Future
Medium: Surface and Subsurface Soil
Exposure Medium: Fugitive Dust

xposure Rou	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dust Inhalation	On-Site Construction Worker	Adult	DSS 4	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	EC ($\mu g/m^3$) = (CS/PEF) x CF
				PEF	Particulate Emission Factor	1.0E+06	m^3/kg	DTSC 2014	x ET_{cw} x $EF_{s,cw}$ x ED_{cw} / AT
				CF	Conversion Factor	1,000	µg/mg	-	
				ET_{cw}	Exposure Time	8	hours/day	DTSC 2014	
				$EF_{s,cw}$	Exposure Frequency	250	days/year	UCD 2004	
				ED_{cw}	Exposure Duration	1	years	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	365	days	Based on ED_{cw}	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	

Abbreviations
DSS - Domestic Septic System
DTSC - California Department of Toxic Substances Control
EPA - U.S. Environmental Protection Agency
m^3/kg - cubic meters per kilogram
mg/kg - milligrams per kilogram
UCD - University of California, Davis
µg/mg - micrograms per milligram

References:
DTSC 2014, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA, 2011, *Exposure Factors Handbook,* 2011 Edition
UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment G-2g. Calculation of Chemical Cancer and Non-cancer Risks, Human Health Risk Assessment Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe: Current/Future
Receptor Population: On-site Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units		Value	Units	Value	Units	
Surface and Subsurface Soil (0-10 feet)	Surface and Subsurface Soil (0-10 feet)	DSS 4	Ingestion	Benzo(a)pyrene	2.40E+00	mg/kg	9.7E-08	mg/kg-day	1.2E+01	(mg/kg-day)-1	1.2E-06	6.8E-06	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								1.2E-06					0.0E+00
			Dermal	Benzo(a)pyrene	2.40E+00	mg/kg	6.1E-08	mg/kg-day	1.2E+01	(mg/kg-day)-1	7.4E-07	4.3E-06	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								7.4E-07					0.0E+00
	Fugitive Dust		Dust Inhalation	Benzo(a)pyrene	2.40E+00	mg/kg	1.9E-04	$\mu g/m^3$	1.1E-03	$(\mu g/m^3)^{-1}$	2.1E-07	1.3E-02	$\mu g/m^3$	NA	$\mu g/m^3$	NA
			Exp. Route Total								2.1E-07					0.0E+00
		Exposure Point List 1 Total									2.1E-06					0.0E+00

Dermal Absorption Factor

	Cancer	Noncancer	Reference
Benzo(a)pyrene	0.13	0.13	UCD 2004

Abbreviations:

CSF - cancer slope factor
DSS - Domestic Septic System
EPC- exposure point concentration
Exp - exposure
mg/kg - milligrams per kilogram
NA - not applicable
RfD - reference dose
RfC - reference dose, inhalation
RfD - reference dose, dermal
μ/m^3 - micrograms per cubic meter

Attachment G-2h. Values Used for Human Health Risk Assessment Daily Intake Calculations, Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil

Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Hypothetical Future On-Site Resident	Age-Adjusted Adult	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				CF	Conversion Factor	0.000001	kg/mg	-	CS x CF x [($IR_{s,a}$ x $ED_{r,a}$ / BW_a)
				$IR_{s,a}$	Ingestion Rate	100	mg soil/day	UCD 2004	+ ($IR_{s,c}$ x $ED_{r,c}$ / BW_c)] x EF_r / AT
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a}$	Exposure Duration	20	years	DTSC 2014 and EPA 2014	
				BW_a	Body Weight	80	kg	DTSC 2014 and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Based on $ED_{r,a}$ + $ED_{r,c}$, DTSC 2014 and EPA 2014	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
		Child	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				CF	Conversion Factor	0.000001	kg/mg	-	CS x CF x $IR_{s,c}$ x EF_r x $ED_{r,c}$
				$IR_{s,c}$	Ingestion Rate	200	mg soil/day	UCD 2004	/(BW_c x AT)
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,c}$	Exposure Duration	6	years	UCD 2004	
				BW_c	Body Weight	15	kg	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	Based on $ED_{r,c}$, UCD 2004	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	

Attachment G-2i. Values Used for Human Health Risk Assessment Daily Intake Calculations, Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Plants

Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Hypothetical Future On-Site Resident	Age-Adjusted Adult	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				$CR_{ag,a}$	Fruit/Vegetable Ingestion Rate, above ground	0.0103	kg DW/day	Calculated from EPA 2011 Data	CS x CPF x {[$ED_{r,a}$ /BW_a x ($TC_{s\text{-}p,ag}$ x $CR_{ag,a}$
				$CR_{bg,a}$	Fruit/Vegetable Ingestion Rate, below ground	0.028	kg DW/day	Calculated from EPA 2011 Data	+ $TC_{s\text{-}p,bg}$ x $CR_{bg,a}$)] + [$ED_{r,c}$ /BW_c x ($TC_{sp,ag}$ x
				EF_r	Exposure Frequency	350	days/year	UCD 2004	$CR_{ag,c}$ + $TC_{s\text{-}p,bg}$ x $CR_{bg,c}$)]} x EF_r /AT
				$ED_{r,a}$	Exposure Duration	20	years	DTSC 2014 and EPA 2014	
				BW_a	Body Weight	80	kg	DTSC 2014 and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Based on $ED_{r,a}$ + $ED_{r,c}$, DTSC 2014 and EPA 2014	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
				$TC_{s\text{-}p}$	Transfer Coefficient (soil-to-plant)	Note[1]	unitless		
				CPF	Contaminated Plant Fraction	0.40	unitless	UCD 2004	
		Child	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) =
				$CR_{ag,c}$	Fruit/Vegetable Ingestion Rate, above ground	0.0086	kg DW/day	Calculated from EPA 2011 Data	[(CS x $TC_{s\text{-}p}$ x CPF x $CR_{ag,c}$)
				$CR_{bg,c}$	Fruit/Vegetable Ingestion Rate, below ground	0.0108	kg DW/day	Calculated from EPA 2011 Data	+ (CS x $TC_{s\text{-}p}$ x CPF x $CR_{bg,c}$)]
				EF_r	Exposure Frequency	350	days/year	UCD 2004	x EF_r x $ED_{r,c}$ /(BW_c x AT)
				$ED_{r,c}$	Exposure Duration	6	years	UCD 2004	
				BW_c	Body Weight	15	kg	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	Based on $ED_{r,c}$, UCD 2004	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
				$TC_{s\text{-}p}$	Transfer Coefficient (soil-to-plant)	Note[1]	unitless		
				CPF	Contaminated Plant Fraction	0.40	unitless	UCD 2004	

Notes:

[1] Chemical-specific dermal absorption factors for hypothetical future on-site resident shown at the bottom of Table G-2d.

References:

DTSC 2014, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA, 2011, *Exposure Factors Handbook,* 2011 Edition
EPA, 2014, *Human Health Evaluation Manual*
UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Abbreviations:

cm^2 - square centimeters
DSS - Demestic Septic System
DTSC - California Department of Toxic Substances Control
EPA - U.S. Environmental Protection Agency
kg - kilograms
kg DW/day - kilograms dry weight per day
UCD - University of California, Davis

Attachment G-2j. Values Used for Human Health Risk Assessment Daily Intake Calculations, Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Fugitive Dust

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dust Inhalation	Hypothetical Future On-Site Resident	Age-Adjusted Adult	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	EC (ug/m^3) = (CS/PEF) x CF x ET_r x EF_r x ($ED_{r,a}$ + $ED_{r,c}$) / AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	DTSC 2014	
				CF	Conversion Factor	1000	µg/mg	-	
				ET_r	Exposure Time	24	hours/day	EPA 2014	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a}$	Exposure Duration	20	years	DTSC 2014 and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	227,760	hours	Based on $ED_{r,a}$ + $ED_{r,c}$, DTSC 2014 and EPA 2014	
				AT_c	Averaging Time (cancer)	613,200	hours	UCD 2004	
		Child	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table G-11	mg/kg	UCD 2004	EC (ug/m^3) = (CS/PEF) x CF x ET_r x EF_r x $ED_{r,c}$ / AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	DTSC 2014	
				CF	Conversion Factor	1000	µg/mg	-	
				ET_r	Exposure Time	24	hours/day	EPA 2014	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,c}$	Exposure Duration	6	years	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	52,560	hours	Based on $ED_{r,c}$, UCD 2004	
				AT_c	Averaging Time (cancer)	613,200	hours	UCD 2004	

Abbreviations:

DTSC - California Department of Toxic Substances Control

EPA - United States Environmental Protection Agency

m3/kg - cubic meters per kilogram
mg/kg - milligrams per kilogram

UCD - University of California, Davis
µg/mg - micrograms per milligram

References:

DTSC 2014, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*

EPA, 2014, *Human Health Evaluation Manual*

UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment G-2k. Calculation of Chemical Cancer and Non-cancer Risks, Human Health Risk Assessment Reasonable Maximum Exposure, LEHR/SCDS Environmental Restoration

Scenario Timefra Future
Receptor Populat On-Site Resident Adult
Receptor Age: Age-Adjusted Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units		Value	Units	Value	Units	
Surface and Subsurface Soil (0-10 feet)	Surface and Subsurface Soil (0-10 feet)	Eastern Dog Pens	Ingestion	Dieldrin	1.90E-02	mg/kg	2.7E-08	mg/kg-day	1.6E+01	(mg/kg-day)-1	4.4E-07	7.4E-08	mg/kg-day	5.0E-05	mg/kg-day	1.5E-03
			Exp. Route Total								4.4E-07					1.5E-03
			Dermal	Dieldrin	1.90E-02	mg/kg	8.8E-09	mg/kg-day	1.6E+01	(mg/kg-day)-1	1.4E-07	2.4E-08	mg/kg-day	5.0E-05	mg/kg-day	4.7E-04
			Exp. Route Total								1.4E-07					4.7E-04
	Plants		Above Ground Plant Ingestion	Dieldrin	1.90E-02	mg/kg	1.8E-08	mg/kg-day	1.6E+01	(mg/kg-day)-1	2.9E-07	4.9E-08	mg/kg-day	5.0E-05	mg/kg-day	9.9E-04
			Exp. Route Total								2.9E-07					9.9E-04
			Below Ground Plant Ingestion	Dieldrin	1.90E-02	mg/kg	3.5E-08	mg/kg-day	1.6E+01	(mg/kg-day)-1	5.53E-07	9.3E-08	mg/kg-day	5.0E-05	mg/kg-day	1.9E-03
			Exp. Route Total								5.5E-07					1.9E-03
	Fugitive Dust		Dust Inhalation	Dieldrin	1.90E-02	mg/kg	5.0E-09	$\mu g/m^3$	4.6E-03	$(\mu g/m^3)^{-1}$	2.3E-11	1.3E-08	$\mu g/m^3$	NA	$\mu g/m^3$	NA
			Exp. Route Total								2.3E-11					0.0E+00
		Exposure Point List 1 Total									1.4E-06					4.8E-03

	Dermal Absorption Factor			Plant Transfer Factors		
	Cancer	Noncancer	References	Above Ground plant/soil	Below Ground plant/soil	References
Dieldrin	0.1	0.1	UCD 2004	0.03	0.03	UCD 2004

Abbreviations:

CSF - cancer slope factor
EPC- exposure point concentration
Exp - exposure
mg/kg - milligrams per kilogram
NA - not applicable
RfD - reference dose
RfC - reference dose, inhalation
RfD - reference dose, dermal
μ/m^3 - micrograms per cubic meter

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Attachment G-3

RESRAD Onsite Input Parameters, Resident Adult

RESRAD Input Parameters
Resident Adult
LEHR/SCDS Environmental Restoration

Receptor	Resident Adult
Pathways Selected	External
	Inhalation
	Soil Ingestion
	Plant Ingestion
	Radon

Parameter	Value	Source
Transport Parameters	Chemical-specific	Default
Average time since material placement		Calculated based on information from the RI (MWH 2003b)
DOE Disposal Box	32 years	
DSS's and Dry Wells	39 years	
Eastern Dog Pens	32 years	
Eastern Trenches	42 years	
Landfill No.1	53 years	
Landfill No. 2	42 years	
Landfill No. 3	38 years	
Radium/Strontium Treatment System	27 years	
Southern Trenches	42 years	
Southwest Trenches	39 years	
Waste Burial Holes	38 years	
Western Dog Pens	32 years	
Calculation Times	1, 3, 10, 30, 100, 300, 1000 years	Default
Area of Contaminated Zone		Site-specific Information
DOE Disposal Box	121 m^2	
DSS No. 1	16.4 m^2	
DSS No. 3	164 m^2	
DSS No. 4	95 m^2	
DSS No. 5	12.4 m^2	
DSS No. 6	37 m^2	
DSS No. 7	37 m^2	
Eastern Dog Pens	3237 m^2	
Eastern Trenches	2023 m^2	
Landfill No. 1	7689 m^2	
Landfill No. 2	8498 m^2	
Landfill No. 3	4151 m^2	
Non-OU Areas	64750 m^2	
Radium/Strontium Treatment System Area	688 m^2	
Southern Trenches	647 m^2	
Southwest Trenches	2428 m^2	
Waste Burial Holes	809 m^2	
Western Dog Pens	11736 m^2	
Thickness of Contaminated Zone	3 meters	
Length Parallel to Aquifer Flow	28 m	Based on site maps
DOE Disposal Box	13 m	
DSS No. 1	5 m	
DSS No. 3	15 m	
DSS No. 4	12 m	
DSS No. 5	3 m	
DSS No. 6	8 m	
DSS No. 7	9 m	
Eastern Dog Pens	61 m	
Eastern Trenches	27 m	
Landfill No. 1	116 m	
Landfill No. 2	84 m	
Landfill No. 3	68 m	
Non-OU Areas	300 m	
Radium/Strontium Treatment System Area	53 m	
Southern Trenches	8 m	
Southwest Trenches	55 m	
Waste Burial Holes	8 m	
Western Dog Pens	68 m	

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RESRAD Input Parameters
Resident Adult
LEHR/SCDS Environmental Restoration

Receptor	Resident Adult
Pathways Selected	External
	Inhalation
	Soil Ingestion
	Plant Ingestion
	Radon

Parameter	Value	Source
Cover Depth	0 m	WA 1997 (RBAS)
Density of Contaminated Zone	1.78 g/cm3	MWH 2003b (RI)
Contaminated Zone Erosion Rate	0.001 m/yr	Default
Contaminated Zone Total Porosity	0.47 v/v	MWH 2003b (RI)
Contaminated Zone Field Capacity	0.2	Default
Contaminated Zone Hydraulic Conductivity	0.018 m/yr	WA 1997 (RBAS)
Contaminated Zone b Parameter	7.12	WA 1997 (RBAS)
Humidity in Air	8.4 g/m3	ANL, 2001a. Appendix L. Figure L.1
Evapotranspiration Coefficient	0	WA 1997 (RBAS)
Wind Speed	3.2 m/s	www.wrcc.edu
Precipitation	0.418 m/yr	WA 1997 (RBAS)
Irrigation	0 m/yr	WA 1997 (RBAS)
Runoff Coefficient	0.4	ANL, 2001a. Appendix E. Table E.1
Watershed Area for Nearby Stream or Pond	1e+21 m2	WA 1997 (RBAS)
Accuracy for water/soil computations	0.001	Default
Density of Saturated Zone	1.78 g/cm3	MWH 2003b (RI)
Saturated Zone Total Porosity	0.25 v/v	MWH 2003b (RI)
Saturated Zone Effective Porosity	0.2	Default
Saturated Zone Field Capacity	0.2	Default
Saturated Zone Hydraulic Conductivity	333 m/yr	MWH 2003b (RI)
Saturated Zone Hydraulic Gradient	0.001	MWH 2003b (RI)
Saturated Zone b Parameter	7.75	WA 1997 (RBAS)
Water Table Drop Rate	0.001 m/yr	Default
Well Pump Intake Rate	10 m below the water table	Default
Well Pumping Rate	250 m3/yr	Default
Unsaturated Zone 1 Thickness	9 m	MWH 2003b (RI)
Unsaturated Zone Density	1.78 g/cm3	MWH 2003b (RI)
Unsaturated Zone Total Porosity	0.47 v/v	MWH 2003b (RI)
Unsaturated Zone Effective Porosity	0.08 v/v	WA 1997 (RBAS)
Unsaturated Zone Field Capacity	0.2	Default
Unsaturated Zone Hydraulic Conductivity	0.018 m/yr	WA 1997 (RBAS)
Unsaturated Zone b Parameter	7.12	WA 1997 (RBAS)
Inhalation Rate	7300 m3/yr	USEPA, 2001
Mass Loading for Inhalation	1.43e-6 g/m3	WA 1997 (RBAS)
Exposure Duration	30 yrs	USEPA, 2001
Indoor Dust Infiltration Rate	0.4	Default
External Gamma Shielding Factor	0.21	ANL, 2001b. Attachment C.
Indoor Time Fraction	0.642	WA 1997 (RBAS)
Outdoor Time Fraction	0.317	WA 1997 (RBAS)
Shape of Contaminated Zone	Circular	Default
Fruit, non-leafy vegetable and grain consumption	5.1 kg/yr	USEPA, 1997
Leafy vegetable consumption	5.1 kg/yr	USEPA, 1997
Soil Ingestion	36.5 g/yr	USEPA, 2001
Contaminated Fraction - Household water	0	Default
Contaminated Fraction - Irrigation water	1	Default
Contaminated Fraction - Plant food	-1	Default
Mass Loading of Foliar Deposition	0.0001 g/m3	Default
Depth of Soil Mixing Layer	0.15 m	Default
Depth of Roots	0.9 m	Default
Fractional Usage - Household Water	0	Default
Fractional Usage - Irrigation Water	1	Default
Plant Factors		Default
Radon Cover Total Porosity	0.39	Assumption from Weiss porosity
Radon Cover Volumetric Water Content	0.05	Default
Cover Radon Diffusion Coefficient	0.000002 m2/s	Default
Bldg Foundation Thickness	0.15 m	Default

RESRAD Input Parameters
Resident Adult
LEHR/SCDS Environmental Restoration

Receptor	Resident Adult
Pathways Selected	External
	Inhalation
	Soil Ingestion
	Plant Ingestion
	Radon

Parameter	Value	Source
Bldg Foundation Density	2.4 g/m3	Default
Bldg Foundation Total Porosity	0.1	Default
Bldg Foundation Volumetric Water Content	0.03	Default
Bldg Foundation Radon Diffusion Coefficient	0.0000003 m2/s	Default
Contaminated Radon Diffusion Coefficient	0.000002 m2/s	Default
Radon Vertical Dimension of Mixing	2 m	Default
Building Air Exchange Rate	0..5 1/hr	Default
Building Room Height	2.5 m	Default
Building Indoor Area Factor	Calculated	Default
Foundation Depth bgs	Calculated	Default
Rn-222 Emanation Coefficient	0.25	Default
Rn-220 Emanation Coefficient	0.15	Default
Storage Times Before Use Data	food storage	Default

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Attachment G-4. Fruit and Vegetable ingestion Rate Calculations, Radiation Exposure

Fruits	Moisture Content[1]	State
honeydew melon	89.82%	raw
peach	88.87%	raw
plum	87.23%	raw
apricot	86.35%	raw
cherry	82.25%	raw
nectarine	87.59%	raw
Fruit Average	87.02%	
Average dry content	12.98%	

Resident Age Range	95th Percentile Fruit Ingestion Rate[2] (g WW/kg-day)	Body Weight (US EPA 2014) (kg)	Converted Fruit Ingestion Rate[3] (kg DW/year)
Ages Birth to <6 years	4.4	15	3.13
Ages 6 to 50+ years	0.99	80	3.75
		Fruit Average	3.44

Vegetables	Moisture Content[1]	State
tomato	93.95%	raw
Broccoli	89.25%	cooked
carrots	88.29%	raw
pepper-sweet-green	93.89%	raw
corn	69.57%	cooked
lettuce-cos or romaine	94.61%	raw
spinach	91.40%	raw
green beans	89.22%	cooked
summer squash	93.70%	cooked
Vegetable Average	89.32%	
Average dry content	10.68%	

Resident Age Range	95th Percentile Vegetable Ingestion Rate[2] (g WW/kg-day)	Body Weight (US EPA 2014) (kg)	Converted Vegetable Ingestion Rate[3] (kg DW/year)
Ages Birth to <6 years	6.8	15	3.96
Ages 6 to 50+ years	3.3	80	10.23
		Vegetable Average	7.09

Total Fruit and Vegetable Ingestion Rate[4] (kg DW/year)
10.53

Distribution of Fruit and Vegetable Ingestion Rates for RESRAD Input

	Default RESRAD Distribution[5]	Redistributed Ingestion Rates for RESRAD[6] (kg DW/year)	SWRA Value (kg DW/year)
Fruit, Vegetable, and Grain Consumption (kg DW/year)	92%	9.69	5.1
Leafy Vegetable Consumption (kg DW/year)	8%	0.84	5.1

Notes:

[1] Moisture content values from Table 9-37 of EFH 2011 Edition (US EPA 2011). Table provides values for raw and cooked. Most likely consumed state of garden item selected.
[2] Values from Table 13-1 of EFH 2011 Edition (US EPA 2011), per capita for populations that garden or farm adjusted for preparation and post-cooking losses.
[3] Ingestion rates must be converted from grams wet weight per kilogram body weight per day (g WW/kg-day) to kilograms dry weight per year (kg DW/year) for use in RESRAD.
[4] Sum of average fruit and vegetable ingestion rates.
[5] Default RESRAD proportions of plant ingestion mass for whole diet are 92% fruits/vegetables/grains (160 kg DW/year) and 8% leafy vegetables (14 kg DW/year).
[6] Home grown produce ingestion rates for RESRAD input were determined from the product of the total fruit and vegetable ingestion rate and the distribution percentage.

Abbreviations:

g WW/kg-day - grams wet weight per kilogram body weight per day
kg - kilograms
kg DW/year - kilograms dry weight per year
SWRA - Site Wide Risk Assessment (UC Davis 2004)
RESRAD - RESRAD Version 7.0 (ANL 2014)

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Appendix H

Vapor-Intrusion Evaluation

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H1.0 Vapor-Intrusion Evaluation

Vapor intrusion was evaluated in the *Revised LEHR/SCDS Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment* (UC Davis 2004), but the evaluation did not distinguish between the U.S. Department of Energy (DOE) and the University of California Davis (UC Davis) areas of responsibility, and risks were evaluated using soil-gas data from the UC Davis Areas. This appendix provides an evaluation of vapor intrusion from soil and groundwater contaminants in the DOE Areas. The vapor-intrusion pathway from soil is currently incomplete in 10 of the 12 DOE Areas because there are no buildings that overlie soil contamination. Buildings H-215 and H-294 are the only buildings that currently overlie the DOE Areas. The north end of building H-215 overlies the Domestic Septic System 4 (DSS 4) leach trenches, and building H-294 overlies the north end of the Western Dog Pens as shown on Figure H-1. In addition, vapors could migrate laterally in the vadose zone to buildings that border DOE areas such as those adjacent to the Radium/Strontium Treatment Systems Area (Figure H-1). The currently incomplete vapor-intrusion pathway in 10 of the 12 DOE Areas is expected to remain incomplete for the foreseeable future because UC Davis has no plans to construct new buildings in the DOE Areas (UC Davis 2016). However, because no restrictions on land use are in place for the DOE Areas (other than the restriction on residential use of DSS 4), vapor intrusion is considered a potentially complete future exposure pathway for all DOE Areas.

H1.1 Soil Evaluation Methodology

Physicochemical criteria for defining and screening for volatility as provided in Section 3.1 of the U.S. Environmental Protection Agency (EPA) *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (Technical Guide) (EPA 2015a) were used to evaluate soil data. The soil evaluation does not assess toxicity or health risk. The California Department of Toxic Substances Control (DTSC) Vapor Intrusion Guidance (DTSC 2011) provides an approach for soil data, but cautions that this approach should only be used in a vapor-intrusion evaluation as an additional line of evidence in conjunction with soil-gas and groundwater data. The DTSC approach was not used for DOE Areas soil data due to a lack of applicable soil-gas and groundwater data. No soil-gas data have been collected in DOE Areas, and DOE Areas groundwater data are not directly representative of residual contamination in DOE Areas soil. The water table is below the depth of residual soil contamination in DOE Areas and is a poor representation of potential vapor intrusion from soil.

This soil evaluation is a preliminary step to determine if volatile contaminants are present in soil that could result in vapor intrusion and does not assess toxicity or health risk. Human health risks were not estimated from soil-sample data because the EPA does not recommend using soil data to estimate the potential for vapor intrusion because of the potential for vapor loss due to volatilization during soil sampling, preservation, and chemical analysis and due to uncertainties associated with soil partitioning calculations (EPA 2015a). Soil data are usable for qualitative identification of contaminant presence while soil-gas data are required for quantitative risk estimation (EPA 2015a).

Two physicochemical criteria provided in Section 3.1 of EPA's Technical Guide (EPA 2015a) were used to assess if a chemical present in soil generally is considered to be volatile:

1. Vapor pressure greater than 1 millimeter of mercury, or
2. Henry's law constant greater than 10^{-5} atmosphere-meter cubed per mole.

More than 700 samples representing existing soil in the DOE Areas have been analyzed by state-certified laboratories for organic chemicals. Approximately 90% of these samples were collected from depths of 20 feet or less and are generally representative of vadose-zone soil that lies above the highest seasonal water table. Percentages of soil samples by DOE Area are:

- Western Dog Pens, 39%
- Southwest Trenches, 22%
- Radium/Strontium Treatment Systems including Domestic Septic System 2, 14%
- Domestic Septic System 1, <1%
- Domestic Septic System 3, 8%
- Domestic Septic System 4, 2%
- Domestic Septic System 5, <1%
- Domestic Septic System 6, 2%
- Domestic Septic System 7, <1%
- Dry Wells A–E, 6%
- Eastern Dog Pens, 5%
- DOE Box, 1%

The classes of analyzed chemicals that could pose a vapor-intrusion risk include volatile organic compounds (VOCs); semivolatile organic compounds (SVOCs); pesticides; and polychlorinated biphenyl compounds (PCBs). Mercury was not included; the species/state of mercury contamination in shallow DOE Areas soil was studied and shown to exist in nonvolatile mercuric sulfide form (DOE 2000). Small quantities of mercuric chloride or mercuric bromide solutions may have been disposed in DOE Area trenches or leach systems, but these mercury species are nonvolatile. Elemental mercury from laboratory equipment (such as thermometers) may have been present in buried waste in the Southwest Trenches area, but the waste and associated contaminated soil were removed in 1998 (DOE 2001).

To identify vapor-intrusion constituents of potential concern (COPCs), the DOE Areas soil database was queried for organic chemicals that were detected in soil samples. The detected organic chemicals are shown in Table H-1 and are sorted by analysis class and ascending order. Organic chemicals that were detected by the laboratory but qualified by the data validation chemist as not detected ("UJ" qualified) for reasons such as laboratory contamination were not included or counted as detected. When field or laboratory duplicate results were reported, the highest value between the duplicates was used; the counts of detects and samples presented in Table H-1 do not include duplicates.

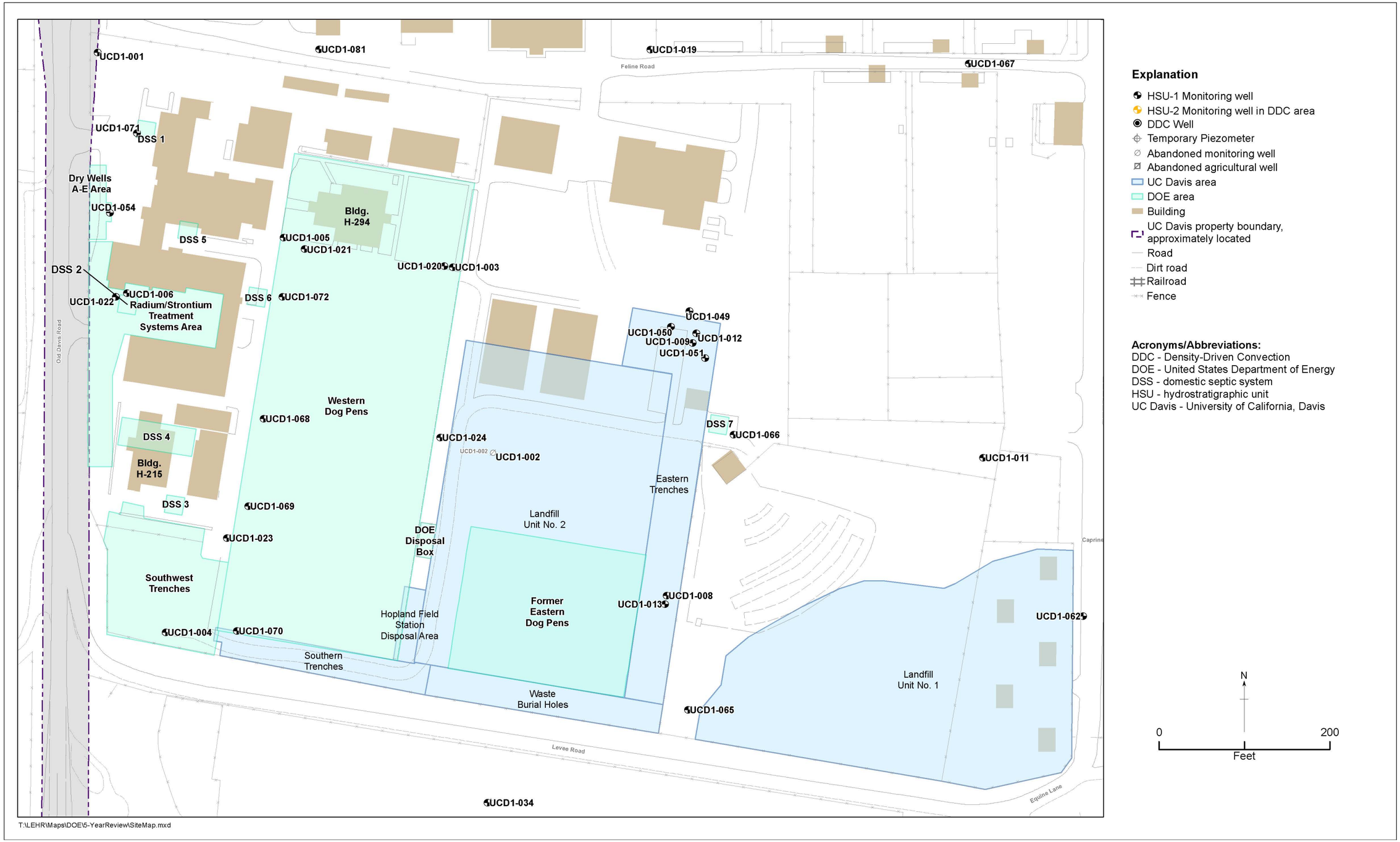

Figure H-1. Site Map of the LEHR Site

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If a constituent was detected in more than 5 percent of samples, it was then screened according to EPA "volatility" screening criteria for potential vapor-intrusion concern (EPA 2015a) stated above. If a constituent had a vapor pressure or Henry's constant above either of the volatility criteria it was retained in this evaluation.

H1.2 Soil Evaluation Results

Of the chemicals with detection frequency above 5 percent, eight VOCs, two SVOCs, and six pesticides (16 total COPCs) met the EPA volatility criteria for potential vapor intrusion (Table H-1).

From this preliminary evaluation, it is recommended that a detailed review of the soil data quality and a spatial analysis of the location of all potential vapor-forming COPCs be conducted. The Technical Guide (EPA 2015a) and chemical lists in EPA's Vapor Intrusion Screening Level Model (VISL) (EPA 2015b) will be consulted to determine the potential vapor-forming COPCs. Based on the results of these analyses, soil-gas sampling may be recommended to estimate human health risk. If soil-gas sampling is deemed necessary, the results of the soil spatial analysis will be used to construct a focused soil-gas sampling plan for regulatory agency review and approval.

Table H-1. Screening of Organic Compounds Detected in DOE Areas Soil Samples

Analyte	Count of Detects	Count of Samples	Maximum Detected Concentration (µg/kg)	Lowest Reporting Limit (µg/kg)	Is Detection Frequency Above 5%	Vapor Pressure[a] (mm Hg)	Henry's Law Constant[a] (atm-m^3/mole)	VI COPC
VOCs								
1,1-Dichloroethene	1	294	0.793	1	No	---	---	No
1,3-Dichlorobenzene	1	33	0.286	1.1	No	---	---	No
1,4-Dichlorobenzene	1	33	0.819	1.1	No	---	---	No
2-Butanone	51	294	548	5.1	Yes	9.1E+01	5.7E-05	Yes
4-Methyl-2-pentanone	1	294	1.27	5.1	No	---	---	No
Acetone	11	294	44.8	5.3	No	---	---	No
Benzene	1	298	1.5	1	No	---	---	No
Bromodichloromethane	1	291	0.234	1	No	---	---	No
Bromomethane	1	294	0.693	1	No	---	---	No
Chlorobenzene	1	294	0.661	1	No	---	---	No
Chloroform	8	294	1.7	1	No	---	---	No
Ethylbenzene	41	298	2.87	1	Yes	9.6E+00	7.9E-03	Yes
Isopropylbenzene	1	33	1.47	1.1	No	---	---	No
Methyl acetate	4	33	4.5	9.6	Yes	2.2E+02	1.2E-04	Yes
Methylene chloride	35	295	457	4.9	Yes	4.4E+02	3.3E-03	Yes
Styrene	8	294	1.76	1	No	---	---	No
Tetrachloroethylene	1	294	0.916	1	No	---	---	No
Toluene	170	298	649	1	Yes	2.8E+01	6.6E-03	Yes
Trichloroethene	3	294	10	1	No	---	---	No

Table H-1 (continued). Screening of Organic Compounds Detected in DOE Areas Soil Samples

Analyte	Count of Detects	Count of Samples	Maximum Detected Concentration (µg/kg)	Lowest Reporting Limit (µg/kg)	Is Detection Frequency Above 5%	Vapor Pressure[a] (mm Hg)	Henry's Law Constant[a] (atm-m^3/mole)	VI COPC
Trichlorofluoromethane	5	33	1.9	1.1	Yes	8.0E+02	9.7E-02	Yes
Xylenes (total)	51	294	16.4	1.1	Yes	8.0E+00	5.2E-03	Yes
Formaldehyde	36	87	2200	23	Yes	3.9E+03	3.4E-07	Yes
SVOCs								
1,2,4-Trichlorobenzene	1	267	24.5	333	No	---	---	No
1,4-Dichlorobenzene	10	267	24	333	No	---	---	No
2,4-Dimethylphenol	1	306	6.3	333	No	---	---	No
2-Chlorophenol	1	306	32.1	333	No	---	---	No
2-Methylnaphthalene	11	306	160	333	No	---	---	No
4-Chloro-3-methylphenol	1	306	24.5	333	No	---	---	No
Acenaphthene	7	306	440	333	No	---	---	No
Anthracene	6	306	1,160	333	No	---	---	No
Benzaldehyde	11	39	53.8	333	Yes	1.3E+00	2.7E-05	Yes
Benzo(*a*)anthracene	6	306	3,760	333	No	---	---	No
Benzo(*a*)pyrene	5	306	2,380	333	No	---	---	No
Benzo(*b*)fluoranthene	5	306	2,700	333	No	---	---	No
Benzo(*g,h,i*)perylene	4	306	1,750	333	No	---	---	No
Benzo(*k*)fluoranthene	6	306	1,530	333	No	---	---	No
bis(2-Ethylhexyl)phthalate	76	306	560	333	Yes	1.4E-07	2.7E-07	No
Butylbenzylphthalate	6	306	13.1	333	No	---	---	No
Carbazole	5	306	486	333	No	---	---	No
Chrysene	7	306	3,010	333	No	---	---	No
Dibenzo(*a,h*)anthracene	2	306	1,080	333	No	---	---	No
Dibenzofuran	6	306	340	333	No	---	---	No
Diethylphthalate	4	306	2.2	333	No	---	---	No
Di-*n*-butylphthalate	21	306	380	333	Yes	2.0E-05	1.8E-06	No
Di-*n*-octylphthalate	6	306	37	333	No	---	---	No
Fluoranthene	15	306	2,900	333	No	---	---	No
Fluorene	6	306	540	333	No	---	---	No
Hexachlorobenzene	1	306	125	333	No	---	---	No
Indeno(1,2,3-*cd*)pyrene	2	306	1,470	333	No	---	---	No
m,p-Cresol	1	172	11.8	333	No	---	---	No
Naphthalene	5	306	120	333	No	---	---	No
N-Nitrosodipropylamine	1	306	22.8	333	No	---	---	No
o-Cresol	1	306	5.6	333	No	---	---	No
Pentachlorophenol	1	306	18.6	344	No	---	---	No
Phenanthrene	11	306	2,880	333	No	---	---	No
Phenol	11	306	35.4	333	No	---	---	No
Pyrene	20	306	5,110	333	Yes	4.5E-06	1.2E-05	Yes

Table H-1 (continued). Screening of Organic Compounds Detected in DOE Areas Soil Samples

Analyte	Count of Detects	Count of Samples	Maximum Detected Concentration (µg/kg)	Lowest Reporting Limit (µg/kg)	Is Detection Frequency Above 5%	Vapor Pressure[a] (mm Hg)	Henry's Law Constant[a] (atm-m^3/mole)	VI COPC
Pesticides								
4,4'-DDD	57	527	140	0.73	Yes	1.4E-06	6.6E-06	No
4,4'-DDE	118	528	26.8	0.73	Yes	6.0E-06	4.2E-05	Yes
4,4'-DDT	95	528	276	0.73	Yes	1.6E-07	8.3E-06	No
alpha-BHC	4	528	11	0.36	No	---	---	No
alpha-Chlordane	336	619	1,700	0.36	Yes	1.0E-05	7.0E-05	Yes
Chlordane[b]	83	109	15,000	6.6	Yes	1.0E-05	7.0E-05	Yes
delta-BHC	5	529	2	0.36	No	---	---	No
Dieldrin	42	529	223	0.73	Yes	5.9E-06	1.0E-05	No
Endosulfan I	5	529	2	0.36	No	---	---	No
Endosulfan II	3	529	2.5	0.73	No	---	---	No
Endosulfan sulfate	4	529	11	0.73	No	---	---	No
Endrin	7	529	6.2	0.73	No	---	---	No
Endrin aldehyde	2	529	0.39	0.73	No	---	---	No
Endrin ketone	2	529	2.7	0.73	No	---	---	No
gamma-BHC (Lindane)	4	529	1.8	0.36	No	---	---	No
gamma-Chlordane	340	619	1,900	0.36	Yes	1.0E-05	7.0E-05	Yes
Heptachlor	36	528	96	0.36	Yes	4.0E-04	2.9E-04	Yes
Heptachlor epoxide	29	554	13.4	0.36	Yes	2.0E-05	2.1E-05	Yes
Methoxychlor	8	529	14.8	3.6	No	---	---	No
PCBs								
Aroclor-1254	8	529	225	6.9	No	---	---	No
Aroclor-1260	3	529	15.4	6.9	No	---	---	No

Notes:
Highest concentration between field duplicates used; count of detects and count of samples do not include duplicates.
[a] Volatility screening criteria for vapor-intrusion concern (vapor pressure >1 mm Hg or Henry's Law Constant >1.0×10^{-5} atm m^3/mol) (EPA 2015a).
[b] Maximum chlordane concentration is more than 3 times the next highest concentration (4340 µg/kg); maximum is potential outlier.

Abbreviations:
--- = Eliminated from evaluation. Detected in less than 5 percent of samples
atm-m^3/mole = atmospheres-cubic meters per mole
mm Hg = millimeters mercury
VI = vapor intrusion
µg/kg = micrograms per kilogram

H2.0 References

DOE (U.S. Department of Energy), 2000. *Addendum to Former Dog Pens Technical Memoranda for the Laboratory for Energy-Related Health Research, University of California, Davis*, February.

DOE (U.S. Department of Energy), 2001. *Final Southwest Trenches Area 1998 Removal Action Confirmation Report for the Laboratory for Energy-Related Health Research, University of California, Davis*, June 13.

DTSC (California Department of Toxic Substances Control), 2011. *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance),* October.

EPA (U.S. Environmental Protection Agency), 2015a. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, Office of Solid Waste and Emergency Response Publication 9200.2-154, June.

EPA (U.S. Environmental Protection Agency), 2015b. *Vapor Intrusion Screening Level (VISL) Calculator*, Version 3.4, June.

UC Davis (University of California, Davis), 2004. *Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment*, University of California, Davis, March.

UC Davis (University of California, Davis), 2016. *2017–2027 Long Range Development Plan Preliminary Planning Scenario,* University of California, Davis, May, available at http://campustomorrow.ucdavis.edu/.

Appendix I

Non-COC Toxicity Value Review

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I1.0 Introduction

Following U.S. Environmental Protection (EPA) guidance (EPA 2009), up-to-date toxicity information for chemicals identified at the U.S. Department of Energy (DOE) Areas, but not previously identified as chemical constituents of concern (COCs), was reviewed to determine if any of these detected chemicals could pose a risk to human health above the target risk range. The nonradionuclide constituents and radionuclides were evaluated separately as described in this appendix.

I1.1 Nonradionuclide Constituent Evaluation

The following steps were followed to evaluate whether nonradionuclide constituents (both organic and inorganic) that were detected in one or more DOE Areas but not previously identified as COCs might present a human health risk based on the latest available toxicity information.

1. Integrated Risk Information System (IRIS) (EPA 2015a) was used to identify constituents with toxicity values that have been revised since the *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment (Part B-Risk Characterization for DOE Areas) at the Laboratory for Energy-Related Health Research, University of California, Davis* (Risk Characterization Report) (DOE 2005) was conducted.
2. Chemicals detected in DOE Area soil samples that were on this list from IRIS were then identified.
3. The 2002 preliminary remediation goals (PRGs) used in the *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration* (SWRA) (UC Davis 2004) and 2015 regional screening levels (RSLs) (EPA 2015b) for the constituents identified in Step 2 were compiled and compared to assess which have a 2015 RSL lower than the 2002 PRG and, therefore, warranted further evaluation.

As shown in Table I-1, the changes in toxicity value resulted in a lower RSL for three constituents: 2-methylnaphthalene, pentachlorophenol, and phenol. Detections for each of these constituents in any DOE Area were below the 2015 RSL (EPA 2015b).

In addition to this comparison using updated EPA toxicity factors and RSLs, the 2002 PRGs were also compared with the screening levels in Department of Toxic Substances Control (DTSC) Human Health Risk Assessment (HHRA) Note 3 (DTSC 2015). All constituents with DTSC HHRA Note 3 screening levels lower than the 2002 PRGs were carried forward and compared with the DOE Areas soil sample data. For these constituents, only arsenic and chlordane were detected above the DTSC HHRA Note 3 screening levels in any DOE Area soil sample. Although DOE Area soil arsenic concentrations exceed the 0.067 milligram per kilogram (mg/kg) screening level, they are considered representative of background, as discussed in detail in the Risk Characterization Report (DOE 2005). Although chlordane was detected above the DTSC HHRA Note 3 screening level (430 micrograms per kilogram [µg/kg]) in several samples from the Western Dog Pens, the exposure point concentration calculated in *Former Western Dog Pens Backfill Risk Assessment* (DOE 2007) was 47.4 µg/kg for alpha-chlordane and 49.8 µg/kg for gamma chlordane, below the DTSC HHRA Note 3 screening level.

Table I-1. Risk Evaluation for Nonchemicals of Concern in DOE Areas

Substance Name	2002 PRG[b]	2015 RSL[c]	Screening Concentrations											
			micrograms per kilogram (µg/kg)[a]											
			DOE Disposal Box	DSS 1	DSS 3	DSS 4	DSS 5	DSS 6	DSS 7	Dry Wells	EDP	Ra/Sr Treatment System	SWT	WDP
2-Methylnaphthalene	NE	240	0.0011 J	ND	0.0007 J	0.0567 J	ND	ND	ND	NA	NA	0.0263 J	ND	ND
Pentachlorophenol	3	1.0	ND	ND	ND	ND	ND	ND	ND	NA	NA	0.0186 J	ND	ND
Phenol	37,000	19,000	ND	ND	ND	0.0036 J	0.0034 J	ND	ND	NA	NA	0.0354 J	ND	ND

Notes:
[a] From the Risk Characterization Report (DOE 2005); maximum concentration detected in the area.
[b] EPA Region 9 PRG used in the *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis California* (UC Davis 2004).
[c] EPA Region 9 June 2015 RSL (EPA 2015b).

Abbreviations:
DSS = Domestic Septic System
EDP = Eastern Dog Pens
J = detected below the laboratory reporting limit; value is estimated
NA = not analyzed
ND = not detected
NE = not established
Ra/Sr = Radium/Strontium
SWT = Southwest Trenches
UC Davis = University of California, Davis
WDP = Western Dog Pens

On the basis of this evaluation, none of the nonradionuclides not previously identified as COCs for the DOE Areas present a risk to human health.

I1.2 Radionuclide Evaluation

The following steps were followed to determine whether any radionuclide constituents that were detected in one or more DOE Area but were not previously identified as COCs present a human health risk based on the latest available toxicity information.

1. The PRGs used in the SWRA for screening radionuclides (UC Davis 2004) were compared with the most recent EPA Superfund radionuclide PRGs (EPA 2014).
2. For radionuclides with a change in PRG, the SWRA (UC Davis 2004) was used to identify those radionuclides for each DOE Area that were detected above either the SWRA PRG or the 2014 PRG and were also identified as above background in the Risk Characterization Report (DOE 2005). The results of this screening are shown in Table I-2.
3. Because this evaluation indicated that risks associated with some radionuclides not previously identified as COCs may exceed 1×10^{-6} based on newer toxicity values, a risk evaluation was conducted using Argonne National Laboratory's (ANL) Residual Radiation computer program RESRAD Onsite.

As shown in Table I-2, radionuclides requiring risk reevaluation include americium-241, carbon-14, lead-210, strontium-90, thorium-232, uranium-235, and uranium-238. As indicated in Table I-2, at least one of these radionuclides was reevaluated for each DOE Area except for the Eastern Dog Pens (EDPs). The risk calculations and results, risk characterization, and conclusions of these evaluations are discussed below.

I1.2.1 RESRAD Calculations

Radiological risks were calculated in the SWRA using RESRAD Onsite version 6.21 (ANL 2002). Risk factors (slope factors) selected in RESRAD Onsite version 6.21 for the SWRA (UC Davis 2004) were referenced to the 2001 version of the Health Effects Assessment Summary Tables (HEAST 2001) (EPA 2001). Most values in HEAST 2001 were taken from Federal Guidance Report No. 13 (EPA 1999). RESRAD Onsite version 7.0 is the most recent update to ANL's Residual Radiation computer program (ANL 2014). DOE currently uses Dose Coefficient File Package version 3.02 (EPA 2015c) in RESRAD Onsite version 7.0 as the source of risk coefficients for radiation risk assessment at DOE sites.

Parameter values used in RESRAD Onsite version 6.21 for the SWRA (UC Davis 2004) were reviewed; a copy is included in Attachment I-1. Each *"area of contaminated zone"* for Domestic Septic System (DSS) 3, DSS 4, the Radium/Strontium (Ra/Sr) Treatment Systems, and Southwest Trenches areas was inaccurate compared to the respective areas measured by the land surveyor for the California Department of Toxic Substance Control's Covenant to Restrict Use of Property; Environmental Restriction, as recorded with the County of Solano on July 11, 2014 (DTSC 2014). Likewise, the length parallel to aquifer flow was inaccurate for some DOE Areas based on review of the land surveyor maps. Comparisons of the areas and lengths used in the SWRA to those determined in the land survey are shown in Table I-3.

Table I-2. Evaluation of Nonconstituent of Concern Radionuclides Identified as Potentially Above Background to Determine Need for Risk Calculation

			DSS 1	DSS 3	DSS 4	DSS 5	DSS 6	DSS 7	DOE Disposal Box	Dry Wells A–E	Eastern Dog Pens	Ra/Sr Treatment System	Southwest Trenches	Western Dog Pens
	2002 PRG	**2014 PRG**	**Screening Concentration[1]**											
Americium-241	1.87E+00	4.90E-02										**8.47E-02**	***3.22E+00***	
Carbon-14	4.56E-01	1.50E-01	***2.10E+00***						**2.70E-01**			***2.38E+00***	***5.84E+00***	***1.13E+01***
Cesium-137	5.97E-02	2.10E-01		*1.26E-01*									*1.18E+00*	*1.15E-01*
Lead-210	1.50E-01	7.70E-03	***1.80E+00***	***4.40E+00***	***4.70E+00***			***4.10E+00***	***2.40E+00***		***2.00E+00***		***1.61E+00***	***4.96E+00***
Strontium-90	2.31E-01	9.20E-02	***4.00E-01***	***5.91E-01***		***1.31E+00***		***2.70E-01***	***2.80E-01***	**1.53E-01**		***2.18E+00***		***5.66E+00***
Thorium-228	1.54E-01	4.10E-01							***7.68E-01***	***7.71E-01***		***1.12E+00***	***8.94E-01***	***1.02E+00***
Thorium-232	3.10E+00	4.80E-02							**8.20E-01**	**8.76E-01**				
Uranium-235	1.95E-01	5.10E-02			**1.60E-01**	**6.31E-02**	**1.60E-01**	**1.00E-01**						***3.17E-01***
Uranium-238	7.42E-01	7.30E-02								**5.99E-01**				***1.67E+00***

Notes:

[1] From Site-Wide Risk Assessment (UC Davis 2004); the lower of the maximum concentration or the 95 percent UCL of the mean concentration

All values are in picocuries per gram (pCi/g).

Bold font indicates that concentration is above the 2014 PRG.

Italic font indicates that concentration is above the 2002 PRG.

	2014 PRG is higher than 2002 PRG, so risk is reduced
	Not above background per the Risk Characterization Report (DOE 2005)
RECALCULATE	Potentially above-background, and 2014 PRG is lower than 2002 PRG
	Only one sample w/ elevated concentration and short half-life per the Risk Characterization Report (DOE 2005)
	Screening concentration used in SWRA (UC Davis 2004) was maximum; 95 percent UCL calculated for the Risk Characterization Report (DOE 2005) is 0.12 pCi/g, below 2014 PRG

Abbreviations:

pCi/g = picocurie per gram
Ra/Sr = Radium/Strontium
UC = University of California
UCL = upper confidence limit

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Table I-3. Comparison of Sitewide Risk Assessment Areas and Surveyed Areas/Lengths

DOE Area	SWRA Area (square meters)	Land Surveyed Area (square meters)	SWRA Length Parallel to Aquifer Flow (meters)	Length Parallel to Aquifer Flow from Survey Maps (meters)
DSS-3	164	359	15	26
DSS-4	95	191	12	27
Dry Wells A–E	NR	178	NR	8
Eastern Dog Pens	3,237	3,249	61	61
Ra/Sr Treatment System	688	1,399	53	53
Southwest Trenches	2,428	1,785	55	55

Abbreviations:
NR = not reported
Ra/Sr = Radium/Strontium

Areas and lengths obtained from the land survey for the areas listed above were entered in RESRAD. The areas and lengths used in the SWRA (UC Davis 2004) for DSS 1, DSS 5, DSS 6, DSS 7, DOE Disposal Box, and Western Dog Pens (WDPs) were entered in RESRAD for this evaluation because land survey data were not available. The areas range from 0.003 acre for DSS 5 to approximately 3 acres for the Western Dog Pens and are small with respect to a realistic exposure scenario. Receptors at this site do not spend significant time at any one of the DOE Areas while the model assumptions are based on receptors remaining in the center of one area on a continuous basis. In addition, the model assumes no soil cover and a 3-meter thick contaminated zone distributed evenly across each area. These model assumptions are consistent with the approved SWRA (UC Davis 2004) and represent conservative overestimates of risk with respect to contaminated area, thickness, and overburden. In reality the residual soil contamination in most DOE Areas is localized in small pockets under clean fill or overburden.

Home garden plant ingestion rates were calculated using data from the EPA's Exposure Factors Handbook 2011 (EPA 2011). The resulting fruit, vegetable, and grain consumption rate is 9.69 kilograms dry weight/year (kg DW/year); up from 5.1 kg DW/year used in the SWRA (UC Davis 2004). The resulting leafy vegetable consumption rate is 0.84 kg DW/year, which is down from 5.1 kg DW/year used in the SWRA. The sum of these two plant ingestion rates (10.53 kg DW/year) is slightly higher than the sum of plant ingestion values used in the SWRA (10.2 kg DW/year). Derivation of these plant ingestion rates is described in detail in Appendix G.

The soil ingestion rate used in the RESRAD calculations for the SWRA was 36.5 grams per year. This soil ingestion rate was the default in RESRAD Onsite version 6.21 and remains the default in RESRAD Onsite version 7.0. No change to the soil ingestion rate was made in this evaluation.

Respirable dust inhalation parameters, such as wind speed, were not modified in this evaluation because dust inhalation risk is several orders of magnitude below the other exposure pathway risks and any changes to these parameters would not contribute to the risk.

I1.2.2 Upper Confidence Levels

The 95 percent upper confidence levels of the mean (95% UCLs) determined in the SWRA (UC Davis 2004) were used as the exposure point concentrations (EPCs) when available; otherwise, maximum detected activity concentrations were used. The 95 percent UCLs determined in the SWRA are no longer representative of the WDPs because fill material was imported in the WDPs since the SWRA. The 95 percent UCL EPCs determined in the Former WDPs Backfill Risk Assessment (DOE 2007) were used. The 95 percent UCLs calculated for thorium-232 in the DOE Disposal Box and Dry Wells A–E areas were used as EPCs for RESRAD calculations. The EPC inputs for RESRAD are shown in Table I-4.

Table I-4. Revised Risk Estimate for Onsite Resident for Nonconstituent of Concern Radionuclides

Constituent	EPC (pCi/g)[a]	Basis	Soil Ingestion	Plant Ingestion	External Radiation	Dust Inhalation	Total Cancer Risk[b]
Domestic Septic System 1							
Carbon-14	1.8	95% UCL	9E-13	1E-10	2E-12	1E-11	1E-10
Lead-210	1.6	95% UCL	6E-08	9E-08	4E-08	4E-10	2E-07
Strontium-90	0.36	95% UCL	4E-10	2E-08	4E-08	1E-12	6E-08
Domestic Septic System 3							
Strontium-90	0.21	95% UCL	5E-09	2E-07	3E-08	1E-12	3E-07
Domestic Septic System 4							
Uranium-235/236	0.16	max	3E-09	1E-09	1E-06	6E-11	1E-06
Domestic Septic System 5							
Strontium-90	1.3	95% UCL	1E-09	5E-08	1E-07	5E-12	2E-07
Uranium-235	0.0631	max	8E-11	3E-11	3E-07	2E-11	3E-07
Domestic Septic System 6							
Uranium-235	0.16	max	6E-10	2E-10	9E-07	5E-11	9E-07
Domestic Septic System 7							
Lead-210	4.1	95% UCL	4E-07	5E-07	1E-07	1E-09	1E-06
Strontium-90	0.27	95% UCL	7E-10	3E-08	3E-08	1E-12	7E-08
Uranium-235	0.1	max	4E-10	1E-10	5E-07	3E-11	5E-07
DOE Disposal Box							
Carbon-14	0.27	max	1E-12	2E-10	3E-13	5E-12	2E-10
Lead-210	0.95	95% UCL	3E-07	4E-07	3E-08	3E-10	7E-07
Strontium-90	0.11	95% UCL	9E-10	4E-08	2E-08	5E-13	6E-08
Thorium-232	0.66	95% UCL	1E-07	5E-07	5E-05	2E-09	6E-05
Dry Wells A–E							
Strontium-90	0.153	max	2E-09	9E-08	2E-08	7E-13	1E-07
Thorium-232	0.63	95% UCL	2E-07	7E-07	5E-05	2E-09	5E-05
Uranium-238	0.599	max	1E-08	5E-09	8E-07	2E-10	8E-07
Radium/Strontium Treatment Systems							
Americium-241	0.0847	max	1E-08	2E-09	3E-08	6E-11	4E-08
Strontium-90	0.25	95% UCL	2E-08	8E-07	4E-08	2E-12	8E-07

Table I-4 (continued). Revised Risk Estimate for Onsite Resident for Nonconstituent of Concern Radionuclides

Constituent	EPC (pCi/g)[a]	Basis	Soil Ingestion	Plant Ingestion	External Radiation	Dust Inhalation	Total Cancer Risk[b]
Southwest Trenches							
Americium-241 (0–0.5 feet)	3.2	95% UCL	2E-07	6E-09	6E-07	1E-09	8E-07
Americium-241	0.16	95% UCL	2E-08	3E-09	5E-08	1E-10	8E-08
Carbon-14	0.55	95% UCL	2E-11	1E-08	8E-13	4E-11	1E-08
Lead-210	1.3	95% UCL	3E-06	5E-06	5E-08	5E-10	8E-06
Western Dog Pens							
Carbon-14	0.61	95% UCL	2E-11	4E-08	8E-13	1E-10	4E-08
Lead-210	1.1	95% UCL	3E-06	4E-06	4E-08	6E-10	7E-06
Strontium-90	0.26	95% UCL	3E-08	1E-06	7E-08	3E-12	1E-06
Uranium-235	0.065	95% UCL	1E-08	4E-09	8E-07	6E-11	8E-07
Uranium-238	0.74	95% UCL	9E-08	3E-08	1E-06	4E-10	1E-06

Notes:
[a] EPC is for depths of 0–10 feet below ground surface except where noted.
[b] Total cancer risk is sum of risk contributions using all digits to be consistent with RESRAD output.
All radionuclides are at maximum dose/risk at time = 0 years, except for thorium-232, which peaks at 100 years.

Abbreviations:
max = maximum concentration
pCi/g = picocuries per gram

I2.0 Results and Conclusions

As shown on Table I-4, this risk reevaluation indicates that radionuclides not previously designated as COCs may present risks greater than 1×10^{-6} (1 in 1 million) in the DOE Disposal Box, Dry Wells A–E, Southwest Trenches, and WDP areas. Risks potentially above 1×10^{-6} are attributable to lead-210 in the Southwest Trenches and WDPs and to thorium-232 in the other two areas. The calculated risks associated with lead-210 are in the 1×10^{-6} to 1×10^{-5} range, while those calculated for thorium-232 are approximately 5×10^{-5} for both areas.

Table I-5 compares the carcinogenic risk recalculated for each radionuclide/DOE Area combination in this evaluation with the risk presented in the Risk Characterization Report (DOE 2005). Calculated cumulative risks from this updated evaluation and from the Risk Characterization Report are also compared. In addition, Table I-5 assesses the updated potential risks based on comparison with background levels, data quality, and other factors, and summarizes the risk characterization assessment for other constituents as presented in the Risk Characterization Report (DOE 2005). As shown, the recalculated risks for this Five-Year Review are only slightly higher than those calculated in the Risk Characterization Report (DOE 2005). As indicated in Table I-5, lead-210 in the Southwest Trenches and the WDPs was eliminated from further consideration in the Risk Characterization Report due to lack of evidence for a release, data quality issues, and/or relatively low risks (expected to be further reduced by decay, with a half-life of approximately 20 years). No further action is needed for thorium-232 in the DOE Disposal Box and Dry Wells A–E areas. Although thorium-232 was identified in the Risk Characterization Report as above-background in these areas, detailed data review indicates that

these results are consistent with background levels given the high degree of analytical uncertainty; additionally, the thorium-232 results and those for daughter product thorium-228 appear to be in secular equilibrium, suggesting that they are naturally occurring (DOE 2005). Changes in toxicity values for constituents detected in the DOE Areas resulted in changes in calculated cancer risks. However, these changes are small and do not affect the overall protectiveness of the remedy.

Table I-5. Risk Summary, Risk Characterization and Recommendations for Onsite Resident for Nonconstituent of Concern Radionuclides

Constituent	Total Cancer Risk SWRA-Part B	Total Cancer Risk Five-Year Review	Risk Characterization Summary and Recommendations
DOE Disposal Box			
Thorium-232	Not calculated	6×10^{-5}	No further action; consistent with background and in approximately secular equilibrium with thorium-228 daughter, given large analytical uncertainty (see Risk Characterization Report, DOE 2005, Appendix E)
Total	6×10^{-6}	7×10^{-5}	Remaining risk due to thorium-228 and lead-210; no further action for thorium-228 based on decay to background in 6.9 years and for lead-210 based on risk below 10^{-6} (DOE 2005)
Dry Wells A–E			
Thorium-232	Not calculated	5×10^{-5}	No further action; consistent with background and in approximately secular equilibrium with thorium-228 daughter, given large analytical uncertainty (see Risk Characterization Report, DOE 2005, Appendix E)
Total	2×10^{-4}	2×10^{-4}	Remaining risk due to arsenic, radium-226, and thorium-228; no further action for arsenic based on only one sample above background, for radium-226 based on concentrations consistent with background, and for thorium-228 based on decay to background in less than 5 years (DOE 2005)
Southwest Trenches			
Lead-210	6×10^{-6}	8×10^{-6}	No further action; no correlation with site activities and analytical issues lead to likely over-estimate (per Risk Characterization Report, DOE 2005)
Total	2×10^{-5}	2×10^{-5}	Remaining risk due to cesium-137, strontium-90, and thorium-228; no further action for cesium-137 based on decay-corrected risk below 10^{-6} and for thorium-228 based on decay to background in less than 2 years; strontium-90 retained (DOE 2005)
Western Dog Pens			
Lead-210	6×10^{-6}	7×10^{-6}	No further action; risk values may be due to analytical errors (per Risk Characterization Report, DOE 2005)
Total	2×10^{-5}	2×10^{-5}	Remaining risk due to thorium-228 and uranium-238; no further action for thorium-228 based on risk being derived from concentrations found in clean fill and for uranium-238 based on indications it is not related to site activities (DOE 2005)

I3.0 References

ANL (Argonne National Laboratory), 2002. *RESRAD Onsite*, Version 6.21, Environmental Assessment Division, United States Department of Energy, Argonne, Illinois, September 5.

ANL (Argonne National Laboratory), 2014. *RESRAD Onsite*, Version 7.0, Environmental Assessment Division, United States Department of Energy, Argonne, Illinois, February 25.

DOE (United States Department of Energy), 2005. *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment (Part B-Risk Characterization for DOE Areas) at the Laboratory for Energy-Related Health Research, University of California, Davis*, prepared for the U.S. DOE by Weiss Associates, September 30.

DOE (United States Department of Energy), 2007. *Former Western Dog Pens Backfill Risk Assessment for the Laboratory for Energy-Related Health Research, University of California at Davis, California*, Rev. 0, April 26.

DTSC (California Department of Toxic Substances Control), 2014. *Covenant to Restrict Use of Property, Environmental Restriction (Re: Portions of County of Solano Assessor's Parcel No. 110-05-04 UC Davis, Laboratory for Energy-related Health Research/Old Campus Landfill (LEHR/OCL) Superfund Site*, Site Code 100424), Solano County Recorder's Office Document Number 201400051822, July 11.

DTSC (California Department of Toxic Substances Control), 2015. *Human Health Risk Assessment Note 3, DTSC-modified Screening Levels (DTSC-SLs)*, Human and Ecological Risk Office, October.

EPA (United States Environmental Protection Agency), 1999. *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, Federal Guidance Report No. 13, EPA 402-R-99-001, September.

EPA (United States Environmental Protection Agency), 2001. *Radionuclide Carcinogenicity Slope Factors: Health Effects Assessment Summary Tables (HEAST)*, http://www.epa.gov/rpdweb00/heast/index.html#download, April 16, accessed June 29, 2015.

EPA (United States Environmental Protection Agency), 2009. *Five-Year Reviews, Frequently Asked Questions (FAQs) and Answers*, OSWER 9355.7–21.

EPA (United States Environmental Protection Agency), 2011. *Exposure Factors Handbook* 2011 Edition (Final). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/052F.

EPA (United States Environmental Protection Agency), 2014. *Radionuclide Preliminary Remediation Goals (PRG) Summary Table (TR=1E-6)*, November 2014, http://epa-prgs.ornl.gov/radionuclides/download.html , accessed July 1, 2015.

EPA (United States Environmental Protection Agency), 2015a. *Integrated Risk Information System (IRIS),* http://www2.epa.gov/iris, accessed July 1, 2015.

EPA (United States Environmental Protection Agency), 2015b. *Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1)*, June.

EPA (United States Environmental Protection Agency), 2015c. Radiation Protection, Technical Reports, online: http://www.epa.gov/radiation/ federal/techdocs.html , last updated on Monday, June 29, 2015, accessed June 30, 2015.

UC Davis (University of California, Davis), 2004. *Revised LEHR/SCDS Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment,* University of California, Davis, March.

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Attachment I-1

RESRAD Input Parameters

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ATTACHMENT I-1
RESRAD Input Parameters
Resident Adult
LEHR/SCDS Environmental Restoration

Receptor	Resident Adult
Pathways Selected	External
	Inhalation
	Soil Ingestion
	Plant Ingestion
	Radon

Parameter	Value	Source
Transport Parameters	Chemical-specific	Default
Average time since material placement		Calculated based on information from the RI (MWH 2003b)
DOE Disposal Box	32 years	
DSS's and Dry Wells	39 years	
Eastern Dog Pens	32 years	
Eastern Trenches	42 years	
Landfill No.1	53 years	
Landfill No. 2	42 years	
Landfill No. 3	38 years	
Radium/Strontium Treatment System	27 years	
Southern Trenches	42 years	
Southwest Trenches	39 years	
Waste Burial Holes	38 years	
Western Dog Pens	32 years	
Calculation Times	1, 3, 10, 30, 100, 300, 1000 years	Default
Area of Contaminated Zone		Site-specific Information
DOE Disposal Box	121 m^2	
DSS No. 1	16.4 m^2	
DSS No. 3	164 m^2	
DSS No. 4	95 m^2	
DSS No. 5	12.4 m^2	
DSS No. 6	37 m^2	
DSS No. 7	37 m^2	
Eastern Dog Pens	3237 m^2	
Eastern Trenches	2023 m^2	
Landfill No. 1	7689 m^2	
Landfill No. 2	8498 m^2	
Landfill No. 3	4451 m^2	
Non-OU Areas	64750 m^2	
Radium/Strontium Treatment System Area	688 m^2	
Southern Trenches	647 m^2	
Southwest Trenches	2428 m^2	
Waste Burial Holes	809 m^2	
Western Dog Pens	11736 m^2	
Thickness of Contaminated Zone	3 meters	
Length Parallel to Aquifer Flow	28 m	Based on site maps
DOE Disposal Box	13 m	
DSS No. 1	5 m	
DSS No. 3	15 m	
DSS No. 4	12 m	
DSS No. 5	3 m	
DSS No. 6	8 m	
DSS No. 7	9 m	
Eastern Dog Pens	61 m	
Eastern Trenches	27 m	
Landfill No. 1	116 m	
Landfill No. 2	84 m	
Landfill No. 3	68 m	
Non-OU Areas	300 m	
Radium/Strontium Treatment System Area	53 m	
Southern Trenches	8 m	
Southwest Trenches	55 m	
Waste Burial Holes	8 m	
Western Dog Pens	68 m	

ATTACHMENT I-1
RESRAD Input Parameters
Resident Adult
LEHR/SCDS Environmental Restoration

Receptor	Resident Adult
Pathways Selected	External
	Inhalation
	Soil Ingestion
	Plant Ingestion
	Radon

Parameter	Value	Source
Cover Depth	0 m	WA 1997 (RBAS)
Density of Contaminated Zone	1.78 g/cm3	MWH 2003b (RI)
Contaminated Zone Erosion Rate	0.001 m/yr	Default
Contaminated Zone Total Porosity	0.47 v/v	MWH 2003b (RI)
Contaminated Zone Field Capacity	0.2	Default
Contaminated Zone Hydraulic Conductivity	0.018 m/yr	WA 1997 (RBAS)
Contaminated Zone b Parameter	7.12	WA 1997 (RBAS)
Humidity in Air	8.4 g/m3	ANL, 2001a. Appendix L. Figure L.1
Evapotranspiration Coefficient	0	WA 1997 (RBAS)
Wind Speed	3.2 m/s	www.wrcc.edu
Precipitation	0.418 m/yr	WA 1997 (RBAS)
Irrigation	0 m/yr	WA 1997 (RBAS)
Runoff Coefficient	0.4	ANL, 2001a. Appendix E. Table E.1
Watershed Area for Nearby Stream or Pond	1e+21 m2	WA 1997 (RBAS)
Accuracy for water/soil computations	0.001	Default
Density of Saturated Zone	1.78 g/cm3	MWH 2003b (RI)
Saturated Zone Total Porosity	0.25 v/v	MWH 2003b (RI)
Saturated Zone Effective Porosity	0.2	Default
Saturated Zone Field Capacity	0.2	Default
Saturated Zone Hydraulic Conductivity	333 m/yr	MWH 2003b (RI)
Saturated Zone Hydraulic Gradient	0.001	MWH 2003b (RI)
Saturated Zone b Parameter	7.75	WA 1997 (RBAS)
Water Table Drop Rate	0.001 m/yr	Default
Well Pump Intake Rate	10 m below the water table	Default
Well Pumping Rate	250 m3/yr	Default
Unsaturated Zone 1 Thickness	9 m	MWH 2003b (RI)
Unsaturated Zone Density	1.78 g/cm3	MWH 2003b (RI)
Unsaturated Zone Total Porosity	0.47 v/v	MWH 2003b (RI)
Unsaturated Zone Effective Porosity	0.08 v/v	WA 1997 (RBAS)
Unsaturated Zone Field Capacity	0.2	Default
Unsaturated Zone Hydraulic Conductivity	0.018 m/yr	WA 1997 (RBAS)
Unsaturated Zone b Parameter	7.12	WA 1997 (RBAS)
Inhalation Rate	7300 m3/yr	USEPA, 2001
Mass Loading for Inhalation	1.43e-6 g/m3	WA 1997 (RBAS)
Exposure Duration	30 yrs	USEPA, 2001
Indoor Dust Infiltration Rate	0.4	Default
External Gamma Shielding Factor	0.21	ANL, 2001b. Attachment C.
Indoor Time Fraction	0.642	WA 1997 (RBAS)
Outdoor Time Fraction	0.317	WA 1997 (RBAS)
Shape of Contaminated Zone	Circular	Default
Fruit, non-leafy vegetable and grain consumption	5.1 kg/yr	USEPA, 1997
Leafy vegetable consumption	5.1 kg/yr	USEPA, 1997
Soil Ingestion	36.5 g/yr	USEPA, 2001
Contaminated Fraction - Household water	0	Default
Contaminated Fraction - Irrigation water	1	Default
Contaminated Fraction - Plant food	-1	Default
Mass Loading of Foliar Deposition	0.0001 g/m3	Default
Depth of Soil Mixing Layer	0.15 m	Default
Depth of Roots	0.9 m	Default
Fractional Usage - Household Water	0	Default
Fractional Usage - Irrigation Water	1	Default
Plant Factors		Default
Radon Cover Total Porosity	0.39	Assumption from Weiss porosity
Radon Cover Volumetric Water Content	0.05	Default
Cover Radon Diffusion Coefficient	0.000002 m2/s	Default
Bldg Foundation Thickness	0.15 m	Default

ATTACHMENT I-1
RESRAD Input Parameters
Resident Adult
LEHR/SCDS Environmental Restoration

Receptor	Resident Adult
Pathways Selected	External
	Inhalation
	Soil Ingestion
	Plant Ingestion
	Radon

Parameter	Value	Source
Bldg Foundation Density	2.4 g/m3	Default
Bldg Foundation Total Porosity	0.1	Default
Bldg Foundation Volumetric Water Content	0.03	Default
Bldg Foundation Radon Diffusion Coefficient	0.0000003 m2/s	Default
Contaminated Radon Diffusion Coefficient	0.000002 m2/s	Default
Radon Vertical Dimension of Mixing	2 m	Default
Building Air Exchange Rate	0..5 1/hr	Default
Building Room Height	2.5 m	Default
Building Indoor Area Factor	Calculated	Default
Foundation Depth bgs	Calculated	Default
Rn-222 Emanation Coefficient	0.25	Default
Rn-220 Emanation Coefficient	0.15	Default
Storage Times Before Use Data	food storage	Default

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Appendix J

Ecological Risk Review

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J1.0 Introduction

Identified ecological risk drivers at the U.S. Department of Energy (DOE) Areas listed in Table ES-1 of the *Final Site-Wide Ecological Risk Assessment LEHR/SCDS, University of California, Davis* (SWERA) (BBL 2006) are as follows:

- Antimony
- Cadmium
- Chromium
- Manganese
- Selenium
- Thallium
- Vanadium
- Zinc

Table J-1 shows the DOE Areas where these metals were identified as constituents of potential ecological concern (COPEC).

Where available, the U.S. Environmental Protection Agency (EPA) 2005 Soil Screening Levels (SSLs) were used in the SWERA for plant and soil invertebrate evaluation and species-specific toxicity reference values, and lowest-observed adverse effect levels (LOAEL) and no-observed adverse effect levels (NOAEL) were used for the bird and mammal evaluation. The SWERA did not add ecological hazard quotients to evaluate cumulative exposures and potential associated risks, based on the lack of support for the assumption of additive effects (BBL Sciences 2006).

J1.1 Soil Screening Levels

Of the eight COPECs identified, four have updated SSL documents: chromium (EPA 2008), manganese (EPA 2007b), selenium (EPA 2007d), and zinc (EPA 2007e). In addition, SSLs for copper (EPA 2007a), nickel (EPA 2007c), and silver (EPA 2006) were developed after completion of the SWERA. Table J-2 shows the SSLs for plants and soil invertebrates used in the SWERA and the updated SSLs.

The SSL value used in the SWERA for cadmium remained the same; therefore, there is no change in estimated risk for this constituent. For antimony, the soil invertebrate SSL remained the same and the plant SSL was still not available; therefore, there is also no change in the estimated risk for this constituent. There were no updates to the plant or soil invertebrate SSLs for chromium (III or VI), thallium, or vanadium; risk estimates for these constituents also remain unchanged.

The SSLs for nickel and silver increased from those used in the SWERA. Therefore, risks are expected to be lower using the new SSL values. No further evaluation of these constituents was conducted.

Table J- 1. Summary of List 2 COPEC Risk Results

Receptor	DOE Disposal Box	Dry Wells A–E	DSS 1	DSS 3	DSS 4	DSS 5	DSS 6	DSS 7	EDPs	Ra/Sr Treatment System	SWT	WDPs
Plants	Se, V, Zn	V, Zn	Mn, Se	Tl	Se	Se		Mn, Zn		Se, V, Zn	V, Zn	Se, V, Zn
Soil Invertebrates					Cr				Cr			
Botta's Pocket Gopher	Se, V	V			Se					Se, V	V	Se, V
Ornate Shrew									Cr	Cd, Se, C, Zn	Sb, Se, V, Zn	Se, V, Zn
American Robin									Cr	Cd, V, Zn	V, Zn	Se, V, Zn
Horned Lark									Cr		V, Zn	Se, V, Zn

Abbreviations:

DSS = Domestic Septic System
EDPs = Eastern Dog Pens
Ra/Sr = Radium/Strontium
SWT = Southwest Trenches
WDPs = Western Dog Pens

Cd = cadmium
Cr = chromium
Mn = manganese
Sb = antimony
Se = selenium
Tl = thallium
V = vanadium
Zn = zinc

Table J-2. Changes to Soil Screening Levels

Constituent	Plants		Soil Invertebrates	
	SWERA Screening	Updated SSL	SWERA Screening	Updated SSL
Antimony	5.0	NA	78	78
Cadmium	32	32	140	140
Chromium III	NA	NA	0.4	NA
Chromium VI	1.0	NA	0.4	NA
Copper	92.5	70	60	80
Manganese	500	220	NA	450
Nickel	30	38	200	280
Selenium	1.0	0.52	70	4.1
Silver	2.0	560	NA	NA
Thallium	1.0	NA	NA	NA
Vanadium	2.0	NA	NA	NA
Zinc	50	160	200	120

Notes:
All units in milligrams per kilogram dry weight.

Abbreviations:
NA = not available
SSL = soil screening level (http://www.epa.gov/ecotox/ecossl/)
SWERA = Site-Wide Ecological Risk Assessment (BBL 2006)

As seen in Table J-2, the SSL for copper decreased for plants (92.5 to 70 milligrams per kilogram [mg/kg]) and increased for soil invertebrates (60 to 80 mg/kg). Copper was identified as a metal above background only at the Ra/Sr Treatment Storage Area, with an exposure point concentration of 48 mg/kg. With the use of the updated SSLs, the hazard quotient (HQ) for plants is 6.9×10^{-1} and 6×10^{-1} for soil invertebrates. These HQs are below 1 and do not indicate a potential ecological risk.

In the SWERA (BBL 2006), for the COPECs identified for plants and soil invertebrates, an HQ was calculated by dividing the exposure point soil concentration (EPC) by the SSL. If the result of this ratio was above 1 (indicating a potential for an adverse ecological effect from that constituent), a statistical background analysis was performed to refine the risk result. If the result of the ratio was below 1, the constituent was eliminated from concern. Table J-3 shows the updated HQs for manganese, selenium, and zinc (COPECs listed for the majority of DOE Areas in Table J-1) for plants and soil invertebrates for each of the DOE Areas. The notes in Table J-3 summarize the results of the background evaluation in Appendix J of the SWERA (BBL 2006). HQs and notes in Table J-3 are highlighted in yellow if the constituent is above background and the HQ is above 1.

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Table J- 3. Updated Hazard Quotients for Plants and Soil Invertebrates by Area

DOE Areas	Manganese					Selenium					Zinc				
	EPC (mg/kg)	Plants		Soil Invertebrates		EPC (mg/kg)	Plants		Soil Invertebrates		EPC (mg/kg)	Plants		Soil Invertebrates	
		Updated SSL (mg/kg)	HQ	Updated SSL (mg/kg)	HQ		Updated SSL (mg/kg)	HQ	Updated SSL (mg/kg)	HQ		Updated SSL (mg/kg)	HQ	Updated SSL (mg/kg)	HQ
DOE Disposal Box	701	220	3.2E+00	450	1.6E+00	1.2	0.52	2.3E+00	4.1	2.9E-01	79	160	4.9E-01	120	6.6E-01
Dry Wells A–E	724	220	3.3E+00	450	1.6E+00	0.92	0.52	1.8E+00	4.1	2.2E-01	94	160	5.9E-01	120	7.8E-01
Domestic Septic System 1	890	220	4.0E+00	450	2.0E+00	1.4	0.52	2.7E+00	4.1	3.4E-01	84	160	5.3E-01	120	7.0E-01
Domestic Septic System 3	790	220	3.6E+00	450	1.8E+00	1.7	0.52	3.3E+00	4.1	4.1E-01	258	160	1.6E+00	120	2.2E+00
Domestic Septic System 4	655	220	3.0E+00	450	1.5E+00	2.0	0.52	3.8E+00	4.1	4.9E-01	144	160	9.0E-01	120	1.2E+00
Domestic Septic System 5	719	220	3.3E+00	450	1.6E+00	1.3	0.52	2.5E+00	4.1	3.2E-01	82	160	5.1E-01	120	6.8E-01
Domestic Septic System 6	670	220	3.0E+00	450	1.5E+00	NA	0.52	--	4.1	--	80.6	160	5.0E-01	120	6.7E-01
Domestic Septic System 7	790	220	3.6E+00	450	1.8E+00	NA	0.52	--	4.1	--	92	160	5.8E-01	120	7.7E-01
Eastern Dog Pens	161	220	7.3E-01	450	3.6E-01	0.42	0.52	8.1E-01	4.1	1.0E-01	NA	160	--	120	--
Ra/Sr Treatment	663	220	3.0E+00	450	1.5E+00	1.1	0.52	2.1E+00	4.1	2.7E-01	78	160	4.9E-01	120	6.5E-02
Southwest Trenches	658	220	3.0E+00	450	1.5E+00	0.53	0.52	1.0E+00	4.1	1.3E-01	72	160	4.5E-01	120	6.0E-01
Western Dog Pens	685	220	3.1E+00	450	1.5E+00	1.8	0.52	3.5E+00	4.1	4.4E-01	76	160	4.8E-01	120	6.3E-01
Potential for ecological concern: HQ > 1 and above background															

Notes:
EPCs and background evaluation summarized below are from the Final Site-Wide Ecological Risk Assessment (BBL 2006).
Yellow highlight indicates a value above background and an HQ above 1.

	Manganese	Selenium	Zinc
DOE Disposal Box	not greater than background	EPC = to UTL (1.2)	HQ below 1
Dry Wells A–E	not greater than background	EPC just slightly above background EPC (0.9)	HQ below 1
Domestic Septic System 1	4 detects of 4 samples in data set; maximum used	2 detects of 4 samples in data set; maximum used	not greater than background
Domestic Septic System 3	not greater than background	not greater than background	not greater than background
Domestic Septic System 4	not greater than background	2 detects of 6 samples in data set; maximum used	not greater than background
Domestic Septic System 5	not greater than background	1 detect in 1 sample in data set; maximum used	not greater than background
Domestic Septic System 6	not greater than background	not greater than background	not greater than background
Domestic Septic System 7	2 detects of 2 samples in data set; maximum used	No selenium background evaluation	HQ below 1
Eastern Dog Pens	not greater than background	not greater than background	not greater than background
Ra/Sr Treatment	not greater than background	HQ from soil EPC between HQ EPC background and UTL background	HQ below 1
Southwest Trenches	not greater than background	HQ = 1	HQ below 1
Western Dog Pens	not greater than background	12 detects of 34 samples in data set; maximum used	HQ below 1

Abbreviations:
NA = not available
Ra/Sr = radium/strontium
SSL = soil screening level (http://www.epa.gov/ecotex/ecossl/)

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The calculated HQs for zinc were below 1, or zinc did not exceed background in each DOE Area. The areas where the HQ was above 1 and the listed constituent was above background included:

- Domestic Septic System (DSS) 1, manganese and selenium
- DSS 4 and DSS 5, selenium
- DSS 5, selenium
- DSS 7, manganese
- Western Dog Pens (WDPs), selenium

The updated manganese and selenium HQs are compared to the HQs determined in the SWERA (BBL 2006) in Table J-4. Plants impacts from manganese and selenium were evaluated in the SWERA according to multiple lines of evidence including COPEC spatial distribution, data quality, and contribution of background to overall risk. Based on weight of evidence, the SWERA concluded that manganese and selenium HQs were unlikely to represent concentrations that would result in adverse effects to plants. The slightly increased manganese and selenium HQs determined in this evaluation do not represent a significant change in the weight of evidence for risk to plants. As shown in the SWERA, most of the risk to plants from manganese and selenium is from the background contribution and the spatial distribution of elevated concentrations is minimal.

Soil invertebrate SSLs were not available for manganese when the SWERA was issued, and HQs were not calculated at that time. Soil invertebrate HQs estimated in this evaluation for manganese at DSS 1 and DSS 7 are 2.0 and 1.8, respectively. These HQs are just slightly above 1 and are unlikely to represent concentrations that would result in adverse effects. In addition, most of the risk to invertebrates from manganese is from the background contribution, and the spatial distribution of elevated concentrations is minimal.

Table J-4. Summary of COPEC Hazard Quotients

DOE Area	Manganese				Selenium	
	Plants		Soil Invertebrates		Plants	
	SWERA HQ	Updated HQ	SWERA HQ	Updated HQ	SWERA HQ	Updated HQ
DSS 1	1.8	4.0	NA	2.0	1.4	2.7
DSS 4					2.0	3.8
DSS 5					1.3	2.5
DSS 7	1.6	3.6	NA	1.8		
WDPs					1.8	3.5

J1.2 LOAELs and NOAELs

In the SWERA (BBL 2006), food web toxicity reference values (TRVs) were used to evaluate health risks to wildlife (birds and mammals). The hierarchy of sources for these TRVs was:

- EPA Region 9 Biological Technical Assessment Group (BTAG; TRVs) (U.S. Navy 1998)
- EPA's Eco-SSLs (EPA 2005) when no BTAG TRV was available
- Oak Ridge National Laboratory toxicity benchmarks (Sample *et al*. 1996) when no BTAG TRV or Eco-SSL was available
- Chronic NOAELs derived from specific studies in the scientific literature

The TRVs used in the SWERA are listed in Table 2-8 of that document. TRVs for mammals and birds from the SWERA and the updated SSL documents were compared where the SSL was the reference listed in Table 2-8. TRVs remained the same for each constituent except for those in mammals for hexavalent chromium. In this case, the TRV increased from 5.66 milligrams per kilogram per day (mg/kg-d) to 9.24 mg/kg-d. Therefore, risks are lower using the new values. No further evaluation of hexavalent chromium was conducted.

J2.0 Conclusions

After this Five-Year Review evaluation and accounting for the updated SSL values, the calculated ecological HQs changed by 2.5 times or less and TRVs remained the same or indicated lower ecological risk than calculated in the SWERA. Based on this, the conclusion is that the risks to ecological receptors remain similar to the risks estimated in the SWERA (BBL 2006) and, therefore, remain acceptable.

J3.0 References

BBL (Blasland, Bouck, and Lee), 2006. *Final Site-Wide Ecological Risk Assessment*, *Laboratory for Energy-Related Health Research/South Campus Disposal Sites, University of California, Davis*, August.

EPA (U.S. Environmental Protection Agency), 2005. *Guidance for Developing Ecological Soil Screening Levels*, OSWER Directive 9285.7-55, U.S. EPA Office of Solid Waste and Emergency Response, Washington, DC, November 2003, revised February 2005.

EPA (U.S. Environmental Protection Agency), 2006. *Ecological Soil Screening Levels for Silver. Interim Final*, OSWER Directive 9285.7-77, September.

EPA (U.S. Environmental Protection Agency), 2007a. *Ecological Soil Screening Levels for Copper, Interim Final*, OSWER Directive 9285.7-68, Issued July 2006, Revised February 2007.

EPA (U.S. Environmental Protection Agency), 2007b. *Ecological Soil Screening Levels for Manganese, Interim Final*, OSWER Directive 9285.7-71, April.

EPA (U.S. Environmental Protection Agency), 2007c. *Ecological Soil Screening Levels for Nickel, Interim Final*, OSWER Directive 9285.7-76, March.

EPA (U.S. Environmental Protection Agency), 2007d. *Ecological Soil Screening Levels for Selenium, Interim Final,* OSWER Directive 9285.7-72, July.

EPA (U.S. Environmental Protection Agency), 2007e. *Ecological Soil Screening Levels for Zinc. Interim Final,* OSWER Directive 9285.7-73, June.

EPA (U.S. Environmental Protection Agency), 2008. *Ecological Soil Screening Levels for Chromium, Interim Final*, OSWER Directive 9285.7-66, March 2005, Revised April 2008.

Sample, B.E., D.M. Opresko, and G.W Suter II, 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision,* ES/ER/TM-86/R3, Prepared by the Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, June.

United States Navy, 1998. *Development of Toxicity Residue Values for Conducting Ecological Risk Assessments at Naval Facilities in California*, *Interim Final*, EFA West, Naval Facilities Engineering Command, U.S. Navy, San Bruno, California.

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