LMS/LEH/S30753

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

June 2021

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Approved By:

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U.S. Department of Energy
Office of Legacy Management

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Abbreviations

AEC	U.S. Atomic Energy Commission
ARAR	applicable or relevant and appropriate requirement
CCR	*California Code of 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
Co-60	cobalt-60
COC	constituent of concern
CRWQCB	California Regional Water Quality Control Board
DCM	Design and Construction Management
DOE	U.S. Department of Energy
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
FR	*Federal Register*
HSU	hydrostatic unit
LEHR	Laboratory for Energy-Related Health Research
LM	Office of Legacy Management
LMS	Legacy Management Support
MCL	maximum contaminant level
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
MOA	Memorandum of Agreement
MOC	monitoring-only constituent
NCP	National Contingency Plan
NWC	new well constituents
O&M	operations and maintenance
OSWER	Office of Solid Waste and Emergency Response

PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
pCi/g	picocuries per gram
PFAS	per- and polyfluoroalkyl substances
Ra-226	radium-226
Ra/Sr	radium/strontium
RAO	remedial action objective
RD/RAWP	Remedial Design/Remedial Action Work Plan
Regents	Regents of the University of California
ROD	Record of Decision
RSL	regional screening level
SMP	Soil Management Plan
Sr-90	strontium-90
SWRA	Site-Wide Risk Assessment
SWT	Southwest Trenches
UC Davis	University of California, Davis
USC	*United States Code*
WDPs	Western Dog Pens
WQO	water quality objective

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Executive Summary

This Second 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 (site or project), U.S. Environmental Protection Agency No. CA2890190000, at the University of California, 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 and will continue to be protective of human health and the environment.

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.
- Contingent remediation.

The selected remedies for each specific location within the DOE Areas are presented in Table ES-1. The triggering action for this Five-Year Review was the initiation of site remediation on January 4, 2011.

Table ES-1. Selected Remedies for Each DOE Area

DOE Area	No Action/ No Further Action[a]	Long-Term Groundwater Monitoring/Contingent 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[b]			✓	
Southwest Trenches		✓	✓	
Western Dog Pens	✓			

Note:

[a] Areas checkmarked in this column are suitable for unrestricted use.

[b] Long-term groundwater monitoring/contingent remediation monitoring is not a component of the Eastern Dog Pens remedy, but groundwater downgradient of this area is monitored by DOE for constituents in vadose zone soil that have been identified as having a low potential for future groundwater impacts.

This review indicates that (1) the remedies are being implemented in conformance with all ROD and SMP requirements and (2) the toxicity and exposure assumptions used in the project decision documents remain valid.

- An SMP, soil disturbance permit program, and site worker training program are in place to ensure that soil with potential residual contaminants is properly managed to prevent unacceptable exposure to workers or the public.
- Residential use, use for day care for children, and cultivation of crops for human consumption are not occurring at Domestic Septic System 4 or elsewhere on the site.
- Groundwater monitoring data show no significant impacts from the potential migration of residual constituents of concern (COCs) in vadose zone soil; contingent remedial action to address residual COCs in vadose zone soil is not required at this time.
- The groundwater monitoring/contingent remedial action and land-use control remedies are fully implemented in accordance with the ROD and are functioning as intended.
- An inspection of the site conducted on November 6, 7, and 15, 2019, confirmed that all ROD-required land-use controls and monitoring wells are in place and functioning as intended.
- An evaluation of the vapor-intrusion exposure pathway conducted during the reporting period and reported in an addendum to the First Five-Year Review, determined that vapor intrusion does not pose a threat to human health at the site.
- Non-vapor-intrusion exposure and toxicological assumptions used to support identification of COCs and the selection of the remedies remain valid. Groundwater is not used for any purpose at the site, and there is no evidence that contaminants in soil in the DOE Areas are affecting groundwater.
- Issues identified in the First Five-Year Review have been fully addressed.
- No new issues affecting the protectiveness of the remedies were identified during the review.

Based on these findings, DOE’s Protectiveness Statement for the Second Five-Year Review is:

The remedies at the DOE Areas of the site are protective of human health and the environment. Land-use controls are in place to prevent human exposure to contaminated soil; it has been confirmed that there are no vapor intrusion threats; ecological risks are below the level of concern for ecological receptors; there is no human or ecological exposure to groundwater; and ongoing groundwater monitoring and the implementation of contingent remedial actions, if required, provide protection of groundwater quality.

1.0 Introduction

The purpose of this Second 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 (site or project) 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 (Title 40 *Code of Federal Regulations* Section 300.430(f)(4)(ii) [40 CFR 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.

The DOE Office of Legacy Management (LM) conducted the Five-Year Review of the remedies implemented at the DOE Areas. The U.S. Environmental Protection Agency (EPA) *Comprehensive Five-Year Review Guidance* (EPA 2001) was followed in preparing this Second Five-Year Review. The report format is consistent with the First Five-Year Review (DOE 2016b) and the format used by most Federal Facilities.

This is the Second Five-Year Review for the DOE Areas. The triggering action for this statutory review is the initiation of remediation on January 4, 2011. 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.

The Legacy Management Support (LMS) contractor and its subcontractor Weiss Associates (Weiss) conducted the analysis and provided technical input throughout the Second Five-Year Review period.

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 (DOE)

Author name (Federal or State Project Manager): Kathleen Whysner, LM Site Manager

Author affiliation: LM

Review period: February 10, 2020 to June 11, 2021

Date(s) of DOE Areas inspection: November 6, 7, and 15, 2019

Type of review: Policy

Review number: 2

Triggering action date: 1/4/2011

Due date *(five years after triggering action date)*: 1/4/2021

2.0 DOE Areas Site Cleanup Chronology

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

Table 1. Timeline of LEHR Cleanup-Related Events

Event	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 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 Radium/Strontium 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
Revised Quality Assurance Project Plan	October 2010
Remedial Design/Remedial Action Work Plan and Soil Management Plan	November 2010
Initiation of Remedial Actions; begin monitoring well installation	January 4, 2011
Land survey monuments installed	February 18, 2011
Groundwater background and baseline sampling completed	December 19, 2012
Land-use covenant recorded by Solano County	July 11, 2014

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

Event	Date
First Five-Year Review Report	September 2016
Vapor-intrusion evaluation and Addendum to First Five-Year Review Report	July 2018
EPA First Five-Year Review Concurrence of Protectiveness letter	October 25, 2018
All recommended actions from First Five-Year Review completed	August 14, 2019
Remedial Action Report	December 14, 2020

Abbreviations:
DSS = Domestic Septic System
Regents = Regents of the University of California

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, release history, initial responses, and basis for the remedial actions.

3.1 Physical Characteristics

The site is immediately east of Old Davis Road, about 2500 feet south of U.S. Interstate 80 in Solano County, California, 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) of the UC Davis campus immediately north of the South Fork of Putah Creek. The land surface is generally flat and lies at an elevation of approximately 50 feet based on the National Geodetic Vertical Datum of 1929. The total area of the site is approximately 15 acres.

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

3.2 Land and Resource Use

The LEHR is a former research facility that the U.S. Atomic Energy Commission (AEC) (predecessor to 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 WDPs area
- The EDPs area
- The DOE Disposal Box area
- Areas of contamination originating from the areas listed above, excluding areas assigned to UC Davis as defined in a Memorandum of Agreement (MOA) between the Regents of the University of California (Regents) and DOE (DOE 2009a)

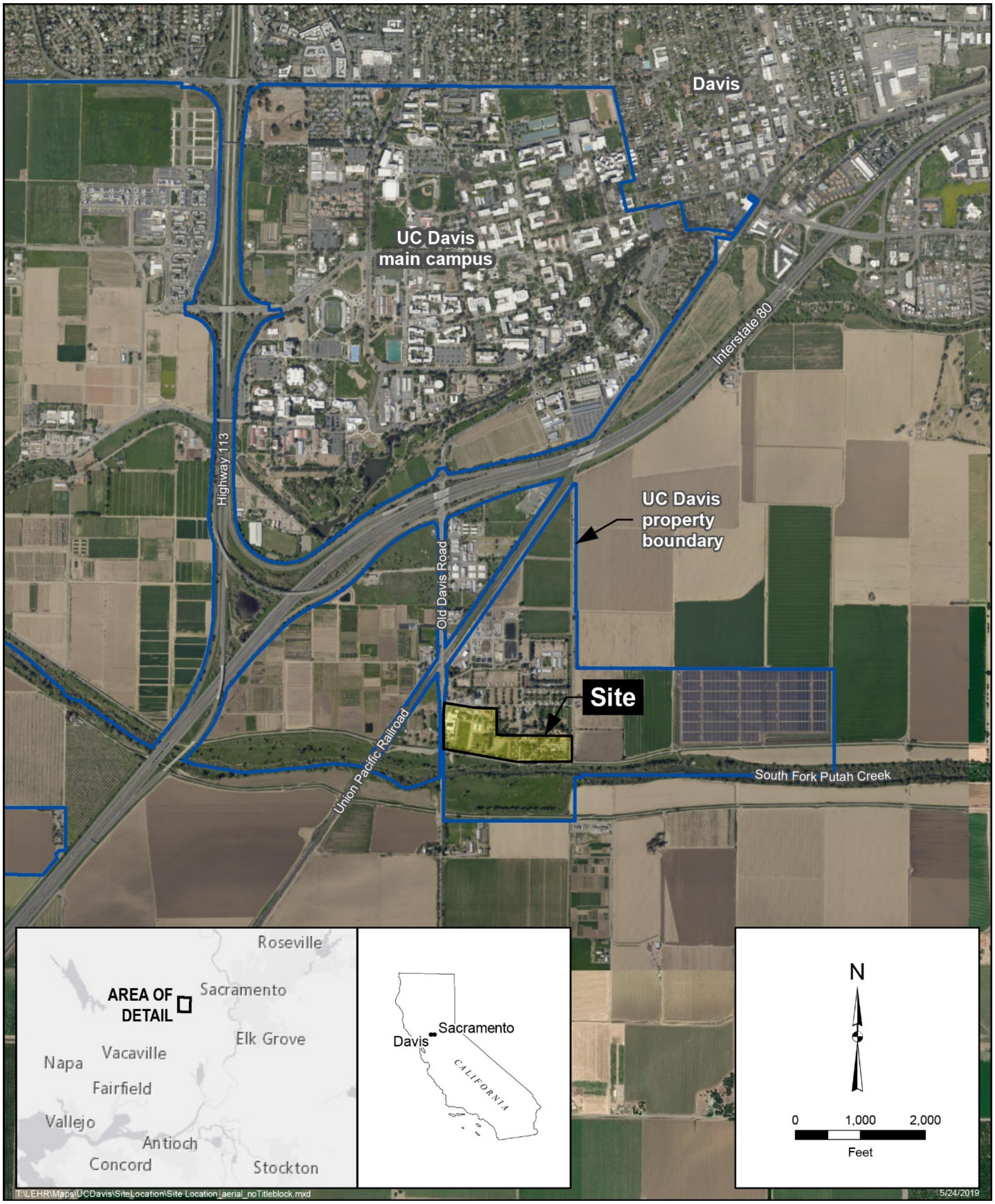

Figure 1. Location of the LEHR Site, UC Davis, Solano County, California

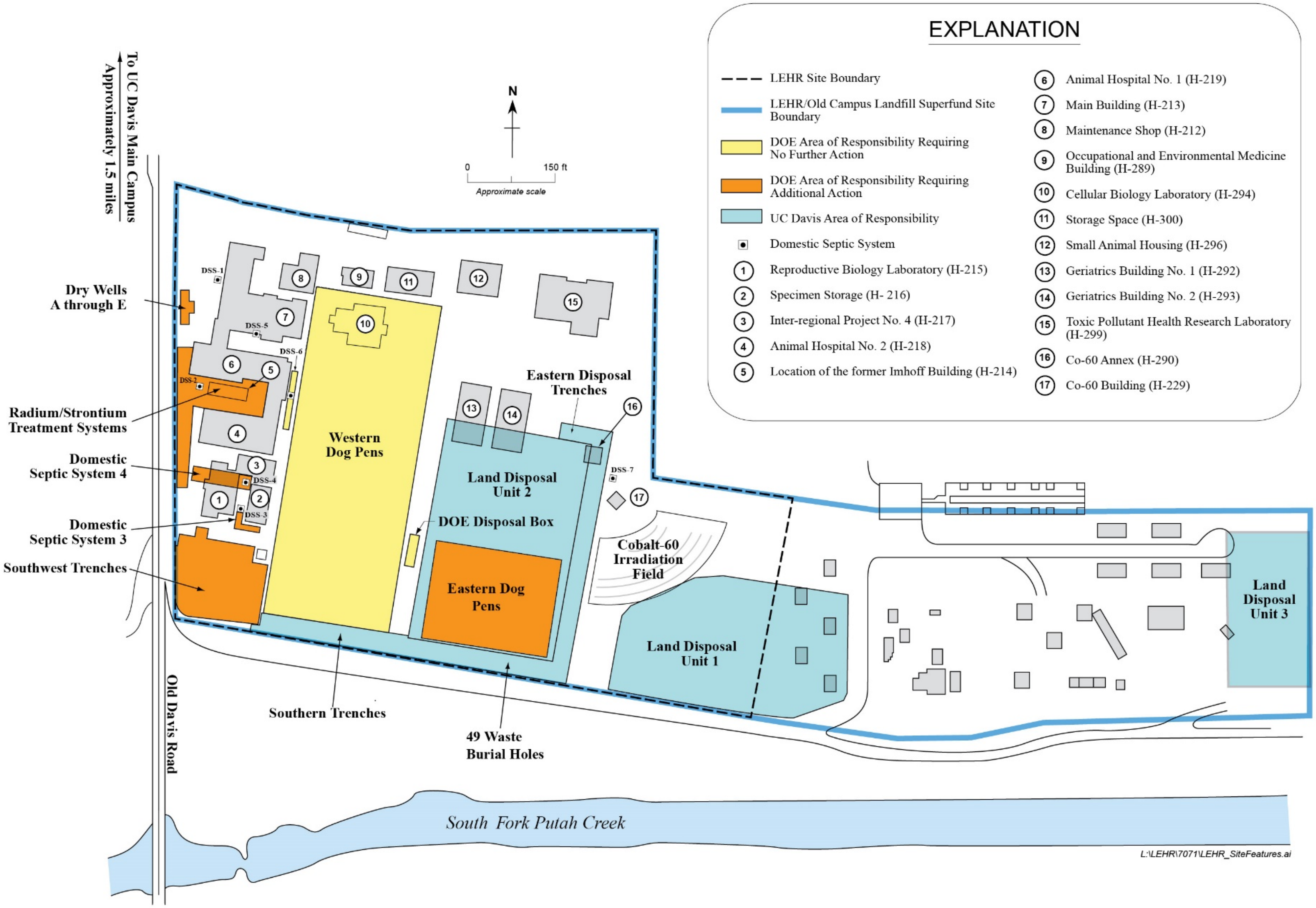

Figure 2. LEHR Site Features

The titles for all buildings comprising a portion of the Federal Facility have been transferred to UC Davis, and the buildings are currently used for research and storage by the Center for Health and the Environment (CHE), a research unit of UC Davis focused on studying the effects of environmental agents on the health of humans, animals, and other organisms. The SWTs, Domestic Septic System (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 Disposal 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 mowed by UC Davis in the spring and summer. Groundwater monitoring wells in the DOE Areas are within portions of open land and paved areas in the SWTs, Ra/Sr Treatment Systems, DSS 3, and WDP areas. All 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 2018), the land and buildings in and near the DOE Areas will continue to be used to support academic and administrative activities with enhancements of the site consistent with the environmental cleanup and reuse objectives.

The groundwater underlying the site is currently not used as a drinking water source. However, groundwater from a production well about 650 feet north of the site is used to supply drinking water for the campus. The dominant groundwater flow direction is to the east. Groundwater is not part of the DOE Operable Unit defined in the FFA. However, under a MOA between DOE and the Regents, DOE is responsible for groundwater monitoring, reporting, and all post-UC Davis ROD actions and any pre-UC Davis ROD interim or removal actions required for DOE-affected groundwater (DOE 2009a).

3.3 Release History

AEC 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 research related to environmental toxicology was conducted at the site concurrently with these long-term studies. In the early 1970s, a Co-60 Irradiation Field was constructed at the site to study the effects of chronic exposure to gamma radiation using beagles as research subjects.

The site features a campus landfill with three waste burial units used from the 1940s until the mid-1960s (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 water and rainwater can potentially mobilize some of the residual contaminants through the vadose zone to groundwater. Hence, a portion of the remedy implemented at the LEHR Federal Facility focuses on the monitoring of groundwater downgradient of areas where residual contaminants are present in vadose zone soil.

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

3.4 Initial Responses

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). On the basis of DOE's compliance with DOE Order 5400.5 Chg 2, *Radiation Protection of the Public and the Environment* (archived), DOE determined that no action or no further action was required at all LEHR buildings and the Co-60 Irradiation Field (62 FR 51844–51845).

In 1997, an MOA divided the responsibility for environmental remediation between DOE and the Regents (DOE 1997). 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 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 areas (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 Remedial Actions

As a result of pre-ROD removal actions conducted in compliance with the NCP and also of 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 DSS 4 area. No removal action was conducted in DSS 4 to remove the contamination that poses a 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. Although available historical survey data from the interior of the building (Layton et al. 1989) and soil sampling results for the DSS 4 leach field (Weiss 2003) suggest the potential for residual radioactivity associated with historical DOE activities at Building H-215 is very low, the absence of residual radioactive contamination of concern should be confirmed by

UC Davis and DOE when the building is scheduled for demolition. A land-use covenant was recorded by Solano County in 2014 prohibiting future residential land use in the DSS 4 area (DTSC 2014).

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 of this report. 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). According to Article IV of the MOA, any removal or response actions required by federal and state regulators for DOE-affected groundwater are the sole responsibility of DOE.

Vadose zone 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).

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%, 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% 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

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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 sensitive and critical habitats of species protected under 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), 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/Contingent 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[b]			✓	
Southwest Trenches		✓	✓	
Western Dog Pens	✓			

Notes:

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

[b] Long-term groundwater monitoring/contingent remediation is not a component of the EDPs remedy but groundwater downgradient of this area is monitored by DOE for constituents in vadose zone soil that have been identified as a having a low potential for future groundwater impacts.

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 as presenting potential human health cancer risks that exceed 1 in 1 million. Table 5 presents ROD groundwater-quality goals developed in conformance with 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*) *at the Laboratory for Energy-Related Health Research, University of California, Davis* (DOE 2005), hereafter referred to 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% 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 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 MCLs 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 CDPH 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% 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 downgradient HSU-1 well at a concentration slightly above groundwater background.

[i] Based on the 4-millirem-per-year federal drinking water maximum contaminant level for beta particles and photon emitters (EPA 2000).

[j] 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.

[k] The sample containing the maximum Ra-226 result in the Radium/Strontium Treatment Systems area was recollected and reanalyzed; the reported maximum value is the average of the initial result (1.81 pCi/g) and recollected sample result (1.63 pCi/g).

[l] The Radium/Strontium Treatment Systems area is inclusive of DSS 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 DSS 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 *Final Remedial Action Report for DOE Areas at the Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis* (DOE 2020c). Remedy implementation and ongoing monitoring are performed in accordance with the *Quality Assurance Project Plan for the U.S. Department of Energy Laboratory for Energy-Related Health Research Federal Facility*, *Davis, California* (DOE 2010b). The remedy as specified in the ROD was successfully implemented in 2014 with the recording of the land-use covenant (DTSC 2014), hereafter called the Covenant. As documented in the *Addendum to Laboratory for Energy-Related Health Research Federal Facility, University of California at Davis, Five-Year Review Report Dated September 15, 2016* (DOE 2018b) and discussed in Section 5.1, all concerns regarding the protectiveness of the remedies with regard to vapor intrusion were addressed by 2018 and at which time DOE and EPA concurred that the remedy was protective. Thus, DOE deferred submitting the Remedial Action Report until the vapor intrusion concerns were resolved. The current status of the implementation of the remedies is discussed below.

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 Site-Wide Risk Assessment

(UC Davis 2004) (SWRA). 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 Risk Characterization Report (DOE 2005). As documented in their approval 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 postremoval 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 area (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[1] for release of property for unrestricted use (62 FR 51844–51845), 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)

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 and continues. Results for the monitoring program are reported in annual water monitoring reports prepared jointly by DOE and UC Davis. The monitoring wells included in the program are shown in Figure 3. Groundwater samples are collected for three categories of analytes:

- **COCs** are constituents that were identified in the Risk Characterization Report (DOE 2005) and identified as COCs in the ROD 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 or their potential to impact groundwater at concentrations above background levels, or both.
- **Monitoring-only constituents (MOCs)** were identified in the Risk Characterization Report (DOE 2005) and the ROD as constituents that should be included in a monitoring plan for

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

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 not identified in the ROD 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 added to the monitoring program after these new monitoring wells were installed in 2011 [Weiss 2014]).

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 and compared to these values, and the sampling program has been updated, as appropriate, in coordination with the regulatory stakeholders. Annual water monitoring reports recording these monitoring changes were prepared for 2011–2020 (Weiss 2013; Weiss 2014; Weiss 2016a; Weiss 2016b; Weiss 2016c; Weiss 2017; Weiss 2018; Weiss 2020a; Weiss 2020b; Weiss 2021). 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 revisions to make it more practicable. In response, DOE developed a revised decision tree for evaluating all well-specific constituents (COCs, MOCs, and NWCs) as part of the First Five-Year Review; this process is summarized in Figure 4 and discussed below.

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 5-year period, the sampling frequency may be further reduced to triennial or once every 5 years. 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 5 years of monitoring, DOE modified the ROD monitoring frequency decision tree in the First Five-Year Review on practical considerations. Specifically, since most well-specific constituent concentrations have been stable and often at baseline concentrations well below maximum contaminant levels (MCLs) or other water-quality criterion for constituents without an MCL or those at or below background concentrations, biennial sampling was programmed. For well-specific concentrations exhibiting recent exceedances of water-quality criterion, annual sampling was retained (see Figure C-1 in Appendix C). In either case, sampling frequency is increased to quarterly if increasing trends are observed (Figure 4).

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 approved by the regulatory agencies before implementation.

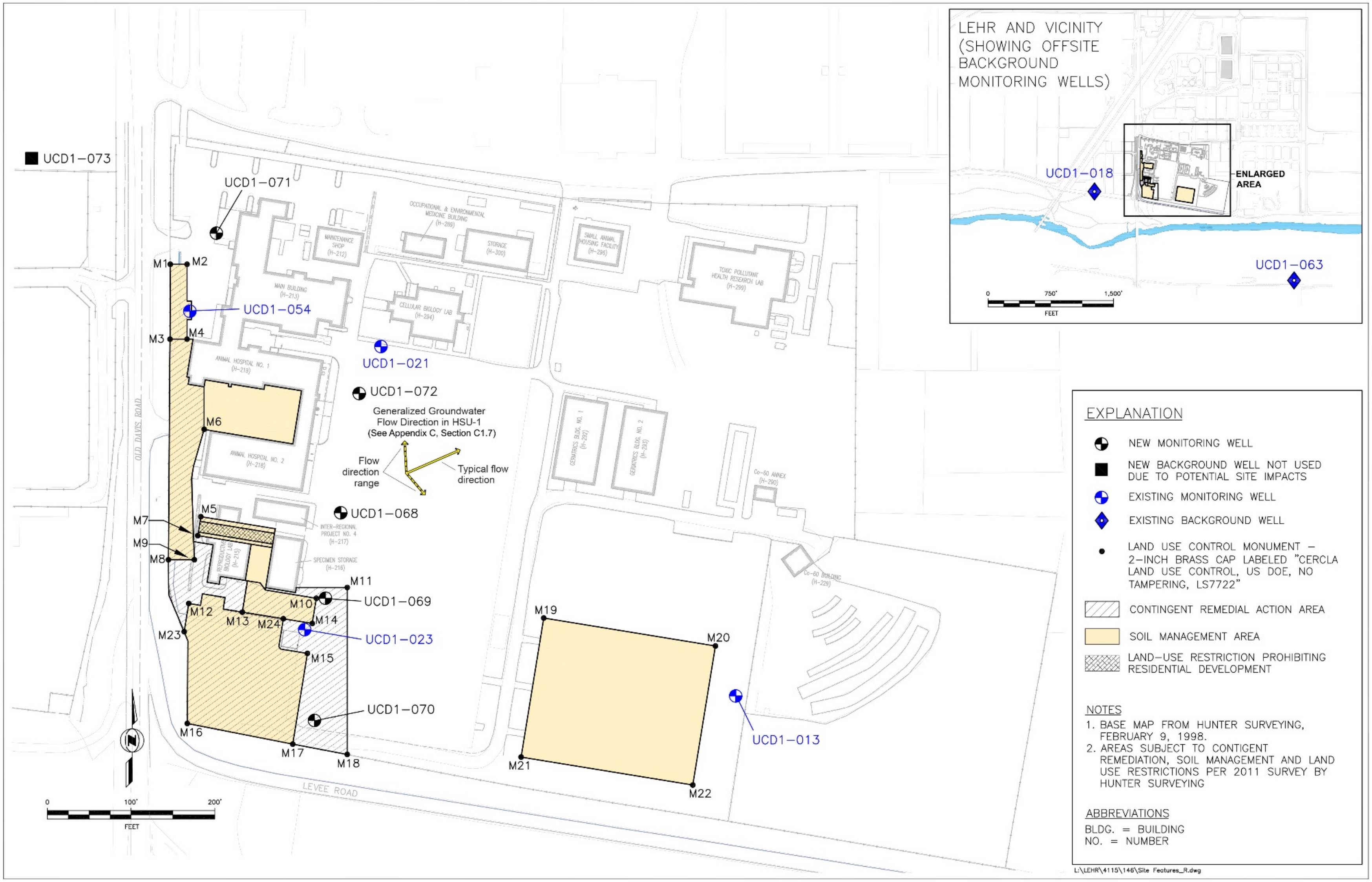
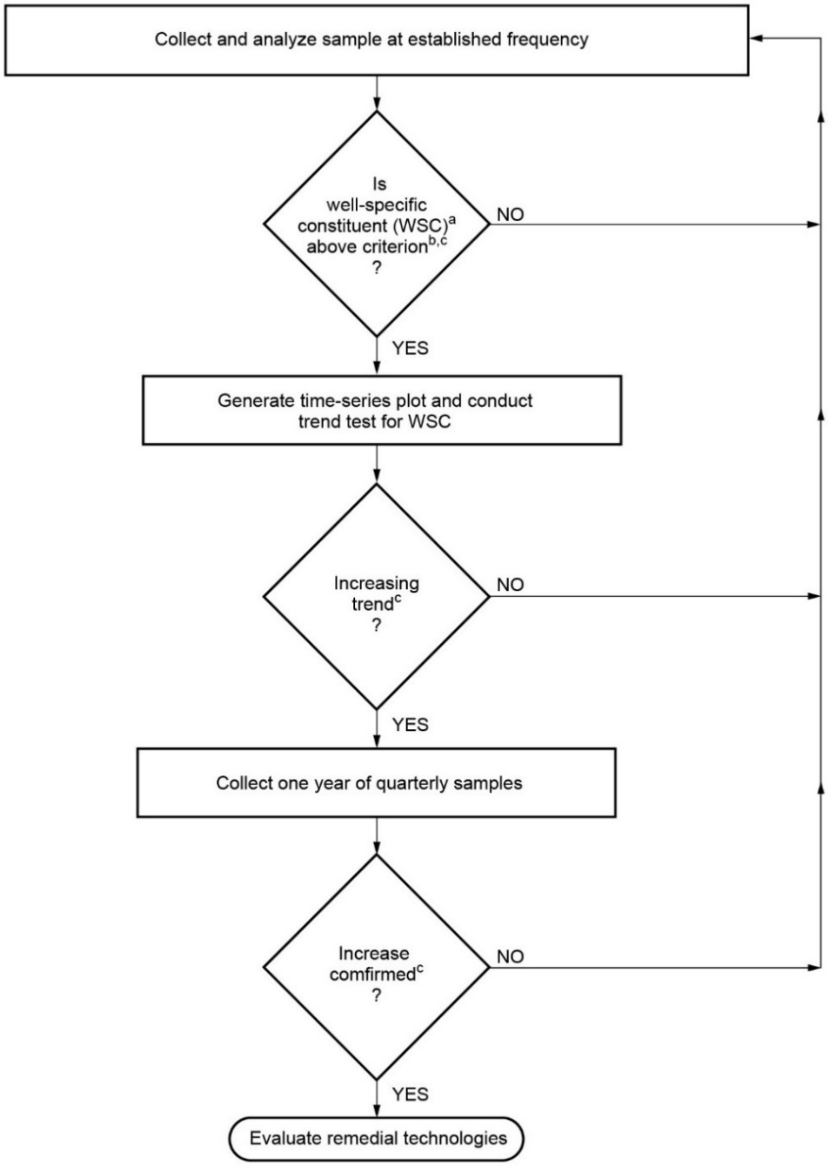


Figure 3. Locations of Groundwater Monitoring and Land-Use Controls for the LEHR Federal Facility



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 (Weiss 2014a).

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

4.2.2.2 Contingent Remediation

As required by the ROD, contingent remediation will be evaluated if there is evidence that residual contaminants in the vadose zone are impacting groundwater quality using the decision process defined in the ROD and RD/RAWP. During the first 10 years of groundwater monitoring, contingent remediation was not required since groundwater concentrations and trends in those concentrations did not indicated that residual contaminants in vadose zone soil in the DOE Areas are being mobilized to groundwater. Well-specific concentration trend plots are included in Appendix C, and a comparison of the data to applicable numerical water-quality objectives (WQOs) is shown in Table D-1 in Appendix D. As shown in Table D-1, nearly all well-specific COC and MOC concentrations are below WQOs, with the only exceedances of WQOs and background being for nitrate as nitrogen in wells UCD1-021 and UCD1-072 (attributable to minor exceedances of baseline likely from regional impacts not related to residual contamination in the DOE Areas) and a single detection of dieldrin in 1 of 18 samples collected in well UCD1-13 since 2011.

All sampling data have been discussed with EPA and state regulatory agencies annually during the reporting period, and all parties have concurred that the evaluation of technologies for contingent remedial action of residual contaminants in vadose zone soil is not required.

4.2.3 Implementation of Land-Use Restrictions

In accordance with 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 human health and the environment from residual contaminants. DTSC is the administrator of this Covenant (DTSC 2014). DOE Areas subject to land-use controls are shown in Figure 3. The Covenant (DTSC 2014) was recorded with the County of Solano on July 11, 2014, as Document No. 201400051822 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 written approval from DTSC and EPA
- 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, ensures enduring notice to parties of the restrictions on land use and land disturbance activities at the DOE Areas.

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 (DOE 1997), 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 was left in place in the DOE Areas at the site, 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 2019b). The Environmental Health and 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 and vegetation management in the DOE Areas
- Areas and contaminants subject to soil and vegetation management requirements
- Soil and vegetation management during excavation or construction
- Permits for soil- and vegetation-disturbing activities
- Plans and documentation
- Soil and vegetation management during emergency work
- Waste management
- Waste characterization and disposal
- Inspections

SMP training for site and campus emergency response personnel is conducted annually. The soil-management areas are inspected for soil disturbance annually and reported in annual land-use covenant inspection reports submitted to DTSC and EPA. To date, the only soil activity requiring a permit for soil disturbance in the DOE Areas with permit requirements was the DOE vapor-intrusion investigation conducted in 2017 (DOE 2018b).

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 3) 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 (DTSC 2014) 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 the site 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 the 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; DOE 2014; DOE 2015; DOE 2016a; DOE 2017; DOE 2018a; DOE 2019a; DOE 2020a; DOE 2021). Maintenance activities such as well repairs are also documented in the inspection reports.

Table 7 compares the long-term groundwater monitoring costs used as the basis for the ROD cost estimates to the actual costs for this second 5-year period. Overall, 5-year groundwater monitoring costs were higher than expected, mostly due to additional background sampling, evaluation, and comment resolution and MOC and NWC analyses whose costs were not evaluated in the ROD.

Table 7. Five-Year Groundwater Monitoring Costs

Year	Cost Estimated for ROD[a] ($)	ROD Cost Estimate Basis	Actual Cost[b] ($)	Actual Work Performed
2016	33,000	Annual monitoring and reporting	53,000	Monitoring of annual and biennial well-specific constituents and annual reporting, including one-quarter of background sample collection.
2017	33,000	Annual monitoring and reporting	76,000	Monitoring of annual well-specific constituents, three-quarters of background sample collection, and annual reporting, including background evaluation
2018	33,000	Annual monitoring and reporting	61,000	Monitoring of annual and biennial well-specific constituents, annual reporting, and comment resolution on the background evaluation.
2019	33,000	Annual monitoring and reporting	51,000	Annual monitoring and reporting
2020	33,000	Annual monitoring and reporting	55,000	Monitoring of annual and biennial well-specific constituents, annual reporting
Total	**165,000**		**296,000**	

Notes:

[a] Expressed in 2009 dollars; sampling costs for NWC and MOCs not included.

[b] Expressed in actual dollars; includes monitoring costs for NWCs and MOCs, and as-needed quarterly sampling.

5.0 Progress Since the Last Five-Year Review

This section provides a summary of the findings from the last Five-Year Review and discusses progress since the last Five-Year Review was completed.

5.1 Previous Five-Year Review and Five-Year Review Addendum Protectiveness Statements and Recommendations

The Protectiveness Statement in the First Five-Year Review report was as follows:

> 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.

In its letter dated September 30, 2016, EPA concurred with DOE's finding that additional data were needed to fully evaluate the vapor-intrusion pathway (EPA 2016).

In response, DOE undertook the following actions:

- Development of a work plan for collecting and evaluating soil-gas data to inform the protectiveness determination for the vapor-intrusion pathway
- Implementation of the vapor-intrusion work plan and preparation of the *Vapor Intrusion Evaluation Report for the Former Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis* (VI Evaluation Report), which is included as an attachment to *Addendum to Laboratory for Energy-Related Health Research Federal Facility, University of California at Davis, Five-Year Review Report Dated September 15, 2016* (DOE 2018b)

As presented in the VI Evaluation Report (DOE 2018b), the data collected for this evaluation were adequate to conclude that vapor-forming chemicals in the DOE Areas of the site do not present an unacceptable risk under current or potential future land-use scenarios. Therefore, the remedy for the DOE Areas is protective in terms of the vapor-intrusion exposure pathway. EPA and state agencies (DTSC and CVRWQCB) concurred with this protectiveness determination.

Based on the vapor-intrusion investigation results, the Protectiveness Statement presented in the approved Five-Year Review Addendum is:

> The remedy at the DOE Areas of LEHR is protective of human health and the environment.

EPA provided its concurrence on the Addendum in a letter dated October 25, 2018 (EPA 2018). EPA's Protectiveness Statement is:

> The remedy at the DOE Areas of LEHR is protective of human health and the environment. Land-use restrictions are in place to prevent exposure to contaminated soil. There is no exposure to groundwater.

The First Five-Year Report also included three additional recommendations to improve on the protective measures already in place in the DOE Areas at the site. The status of these recommendations is outlined in Table 8.

Table 8. Implementation Status of Recommendations for Enhancement of Existing Protective Measures from the First Five-Year Review

Issue	Recommendations	Current Status	Implementation Description	Completion Date
Some monuments not clearly visible, leading to accidental damage	Install new high-visibility markers for monuments	Complete	15 high-visibility markers for selected monuments installed	March 2, 2017
Some monitoring well vaults not clearly visible, leading to accidental damage	Install new high-visibility markers for monitoring wells	Complete	3 high-visibility markers for selected monitoring well installed	March 2, 2017
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	Complete	Procedures added to SMP including vegetation inventory and annual inspection; revisions approved by EPA and state agencies and revised SMP issued	August 14, 2019

5.2 Work Completed During This Five-Year Review Period

Work completed in the DOE Areas at the site during this reporting period included implementing the recommendations shown in Table 8 and monitoring groundwater and maintaining land-use controls. In addition, a Remedial Action Report, documenting that proper implementation of the ROD remedies, was completed in 2020 (DOE 2020c). As discussed in subsequent sections, no significant issues regarding compliance with ROD requirements or protectiveness of the remedies were identified during the reporting period.

6.0 Five-Year Review Process

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

6.1 Community Notification, Involvement, and Interviews

Notices of the Second Five-Year Review were published in *The Sacramento Bee* on February 25, 2020, and in *The Davis Enterprise* on February 26, 2020 (Appendix A, pp. A-1 and A-2). A notice was also published on the LM website (Appendix A, p. A-3) (DOE 2020b). These notices describe DOE's plan to conclude the Second Five-Year Review by early 2021. In addition, several UC Davis employees and faculty who work at CHE or have involvement in the project were notified of the Five-Year Review. This includes CHE staff members at the site, UC Davis Design and Construction Management (DCM), and UC Davis Grounds and Landscape Services. The Davis South Campus Superfund Oversight Committee, 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 then.

Table 9 lists those approached for interviews for this Five-Year Review; each person's title, role on the project, and response to the interview request are also provided. "No response" in the last column of Table 9 indicates that the individual did not respond to the interview request after a minimum of five communication attempts via phone message or email.

Table 9. Individuals Invited to Be Interviewed for the Five-Year Review

Person	Title	Role on DOE Areas Project	Response to Interview Request
Chris Wright	Environmental Manager, UC Davis EH&S Unit	UC Davis project manager	Yes, provided input in writing
Michael Bauer	Supervisor, UC Davis Grounds and Landscape Services	Grounds maintenance	No response
Ardie Dehghani	Campus Engineer, UC Davis DCM	Construction oversight	Yes, provided input in writing
Shari Gallagher	Business Manager, UC Davis CHE	Works at CHE (onsite)	Declined
Shanie McCarty	EHS Specialist I, UC Davis CHE	Works at CHE (onsite)	No response
Kent Pinkerton	Director, UC Davis CHE	Works at CHE (onsite)	Yes, provided input orally
Bret Steadman	Unit Operations Manager, California Raptor Center	Works at neighboring facility	Declined
Tatiana Viau	Animal Resource Manager, UC Davis Center for Equine Health	Works at neighboring facility	No response
Holly Hadlock	Remedial Project Manager	EPA Region 9	Yes, provided input orally
Durin Linderholm	Engineering Geologist	CRWQCB	Declined[a]
John Bystra	Project Manager	DTSC	Yes, provided input in writing

Note:

[a] Indicated he has no additional input beyond that provided through regular meetings and document review.

Potential interviewees were given the option of being interviewed in person, by telephone, or by providing written responses via email. The five individuals listed below who agreed to provide input did so between March 23 and April 21, 2020. These five respondents represent EPA, DTSC, UC Davis EH&S Unit, UC Davis DCM, and UC Davis CHE. As indicated in Table 9, two of the five individuals provided input orally, with their responses recorded and transcribed and transcriptions reviewed by them. The remaining three participants provided input in writing by completing the questionnaire. The questionnaire used for the interview, as well as the filled-in forms or the transcript recording of each interviewee's responses, is provided in Appendix E.

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.
- In terms of impact that the DOE Areas remedy has had on the community, one UC Davis respondent mentioned high costs. A second UC Davis respondent (CHE director Kent Pinkerton) mentioned his understanding that bottled water had been provided to the neighbors and to CHE but did not know who was paying for it.[2]
- All respondents indicated they were not aware of any complaints, violations, incidents, or activities such as vandalism, trespassing, or emergency response involving the DOE Areas and remedy. UC Davis LEHR project manager Chris Wright mentioned that when his office (UC Davis EH&S Unit) was informed of a mowed-down dead elderberry bush, they needed to contact UC Davis staff responsible for vegetation control and perform additional training and outreach, in accordance with the SMP. The management of trees and large shrubs that need to be removed from DOE Areas was identified as an issue in the First Five-Year Review, and as described in Section 5.1 of this report (Table 8), the SMP was revised in 2019 to provide specific procedures for this.
- Four of the five respondents felt they were adequately informed about the DOE remedy and land-use restrictions, trained on their responsibilities regarding the remedy implementation (as appropriate), and knew where to obtain information about the remedy. However, CHE Director Kent Pinkerton indicated he did not feel well-informed and recommended that some sort of report be provided to him. In response to this concern, DOE plans to work with UC Davis to develop additional community outreach measures moving forward (see Table 11 in Section 8.0).

6.2 Document Review

Documents reviewed for this Five-Year Review are listed in Section 11.0, "References." Additional documents are referenced in each of the appendixes, as appropriate. The tables of ARARs presented in the ROD (DOE 2009b) and updated during the First Five-Year Review (DOE 2016b) were reviewed for potential changes. Results of this evaluation are provided in Section 7.2.2 and Appendix B of this report.

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[2] The bottled water program was terminated in the mid-2000s when it was demonstrated in the CERCLA Remedial Investigation that groundwater used by the community was not impacted by site activities.

6.3 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 (Weiss 2013; Weiss 2014; Weiss 2016a; Weiss 2016b; Weiss 2016c; Weiss 2017; Weiss 2018; Weiss 2020a; Weiss 2020b; Weiss 2021). For this Five-Year Review, a comprehensive analysis of data collected throughout the monitoring program and during the 5-year reporting period was conducted for each well-specific constituent identified in the RD/RAWP to determine the correct sample collection frequencies to implement during the next 5 years of the monitoring program (DOE 2010a). Results of this data analysis are presented in Appendixes C and D.

6.4 Inspection of the DOE Areas

An inspection of the DOE Areas was conducted on November 6, 7, and 15, 2019, as part of the annual land-use covenant inspections required under the Covenant (DTSC 2014). Specifically, the inspection focused on:

- Land-use changes and soil disturbances.
- Confirmation that residential use, day care, or the cultivation of crops for human consumption were not occurring at the DSS 4 area.
- Compliance with the SMP, including vegetation management.
- O&M 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. No soil disturbance was observed, and the groundwater monitoring wells were in good condition, with none showing evidence of tampering. Some minor well maintenance issues were noted. The inspection also showed that vegetation in the DOE Areas had not been disturbed or removed from the site, with the exception of a small elderberry shrub (specimen 16222) that was found dead and fallen in the EDPs area during the inspection. DOE collected and sampled the branches from the specimen according to SMP requirements. The samples were analyzed for chromium, hexavalent chromium, pesticides, aroclor-1254, cobalt-60, lead-210, strontium-90, and tritium as specified in the SMP (DOE 2019). The results were either nondetect, below background, or below EPA regional screening levels (RSLs) for direct exposure to soil under a composite worker exposure scenario. The sampling results were discussed during a Project Team meeting on February 27, 2020, and EPA, DTSC, and RWQCB concurred with DOE’s proposal to return the collected elderberry branches to the EDPs based on the sampling results.

Descriptions of the scope and findings of the 2019 inspections of the DOE Areas, including the inspection checklist and photographs, are provided in the 2019 Annual Land-Use Covenant Inspection Report (DOE 2020a).

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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?

This review indicates the remedy is functioning as specified in the ROD, RD/RAWP, and SMP as discussed below.

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.

The land-use restrictions include a recorded deed restriction on residential use at DSS 4; access for contingent remediation; and SMP implementation at the Ra/Sr Treatment Systems, DSS 3, DSS 4, Dry Wells A–E, SWT area, and EDPs area. 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 were completed in 2011, and the Covenant (DTSC 2014) prohibiting residential use was recorded by Solano County in 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 5-year period have been routine and easily manageable.

During the reporting period, the integrity of existing site controls was enhanced by adding high-visibility markers for the land-use control monuments as outlined in Section 5.1. The need to periodically remove or trim trees or shrubs potentially impacted by COCs from these areas was also recognized during the First Five-Year Review, and the SMP was revised to address this during the reporting period (DOE 2019b).

As part of the Second Five-Year Review process, UC Davis identified that a limited number of the shrubs in the inventory of trees and shrubs deemed as potentially impacted by COCs from the DOE Areas are subject to routine pruning by landscape maintenance personnel. As a result, DOE is recommending that the SMP be revised to identify specific trees and shrubs subject to routine landscape management and include sampling and analysis and waste management procedures to assure proper handling and disposal or reuse of cuttings from these trees and shrubs (See Table 11 in Section 8.0).

The only soil-disturbing events that required a permit during this Second Five-Year Review period were associated with the vapor-intrusion evaluation (DOE 2018a). Two permits were applied for and issued: one for installing soil vapor wells and one for destroying these soil vapor wells. For both permits, all requirements were met and documented in a Soil Disturbance Report (DOE 2018a); the permits were closed out by the UC Davis EH&S Unit on October 8, 2018. The permit process successfully communicated soil-management requirements in the SMP to the permittee and documented that all controlled soil generated by the project was properly disposed of at a facility authorized to receive CERCLA waste. During the 2019 annual inspection of land-use restrictions, a small elderberry shrub was found dead and fallen in the EDP area (DOE 2020a).

In accordance with the revised SMP (DOE 2019b), this bush was sampled and returned to the EDPs since no COCs exceeding soil background concentrations were present. The site tree and shrub inventory was updated to reflect its removal.

Based on these findings, DOE concludes that the land-use control components of the remedies are functioning as intended in the decision documents.

7.1.2 Long-Term Groundwater Monitoring/Contingent Remedial Action

As stated in the ROD (DOE 2009b), the purpose of long-term groundwater monitoring is to ensure that if contaminants in vadose zone soil begin to impact groundwater, remedial action will be taken to prevent the degradation of water quality. Groundwater monitoring under the ROD has been conducted by DOE since 2011, and groundwater monitoring data are reported to the LEHR Project Team during routine team meetings and in annual water monitoring reports. These data indicate that COC, MOC, and NWC concentrations are generally well below WQOs and not increasing. As a result, contingent remedial action has not been required. Land-use control inspections of the DOE Areas conducted annually by DOE during the reporting period indicate that the monitoring well network is being maintained and is functioning as intended (DOE 2017; DOE 2018; DOE 2019; DOE 2020a; DOE 2020b). As discussed in Section 5.1, the security of at-grade well vaults susceptible to damage during weed abatement activities was enhanced by adding high-visibility markers.

Consistent with the requirements in the RD/RAWP (DOE 2010a), an analysis of groundwater data was performed as a component of this Five-Year Review (Appendixes C and D). As shown, no COC, MOC, or NWC concentrations are increasing such that contingent remedial actions are warranted, and recommendations are provided in Table 11 in Section 8.0 for reduced sampling frequencies for well-specific constituents that have stable concentrations (no increasing trend) at or below site background or water-quality criteria.

As was the case when the ROD was signed, there continues to be no human or ecological exposure to shallow groundwater potentially impacted by residual contaminants in vadose zone soil in the DOE Areas. Therefore, additional remedial measures such as active remediation or groundwater use restrictions are not required to achieve protectiveness. Information presented in Appendix C indicates that monitoring well locations are optimized to intercept potential groundwater contaminants from the DOE Areas (see Appendix C, Section C1.7) and groundwater monitoring data have been of sufficient quality for the LEHR project team to make informed decisions on the evaluation of contingent groundwater remediation. To date, such evaluations have not been required. Thus, DOE concludes that the groundwater monitoring and contingent remediation component of the remedy is functioning as intended. As discussed in Appendix C, localized and intermittent anomalies in the groundwater gradient have been observed near wells UCD1-071 and UCD1-073, near the northwest corner of the site. While DOE believes these gradient conditions are not affecting the performance or protectiveness of the remedies, DOE is recommending the review of existing data and potentially the collection of additional data to support the development of a conceptual site model for groundwater flow in the northwest corner of the site (See Table 11 in Section 8.0).

Based on these findings, DOE concludes that the groundwater monitoring and contingent remediation component of the remedies is functioning as intended in the ROD.

7.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Selection Still Valid?

The validity of the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection is discussed below.

7.2.1 Evaluation of Exposure Assumptions

There have been no changes in the current and future land or groundwater uses and physical conditions in or near the DOE Areas that would affect exposure assumptions presented in the ROD. However, the ROD relied on exposure assumptions determined in the SWRA (UC Davis 2004), which was completed before formalization of the criteria used to decide if the vapor-intrusion exposure pathway is complete. At the time the SWRA was being conducted (2002–2004), the vapor-intrusion pathway was only assumed complete if volatile organic compounds (classified as such by analytical laboratory methods) were detected in soil, soil gas, or groundwater samples.

Because volatile organic compounds were not identified in soil or groundwater in DOE Areas, the SWRA (UC Davis 2004) did not identify the vapor-intrusion exposure as a complete pathway in these areas. The established and current criteria used to decide if a chemical is sufficiently volatile for exposure via the vapor-intrusion exposure pathway are published in the *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (EPA 2015) and DTSC *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)* (DTSC 2011). These guidance documents indicate that low-volatility compounds, including pesticides, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and other semivolatile compounds with vapor pressure greater than 1 millimeter of mercury (mm Hg) or Henry’s law constant of greater than 10^{-5} atmosphere-cubic meters per mole are sufficiently volatile to potentially create vapor-intrusion impacts. Because pesticides, PAHs, PCBs, and other semivolatile compounds that meet the established volatility criteria are present in DOE Areas soil, a vapor-intrusion risk assessment was necessary. As previously discussed, this issue was identified in the First Five-Year Review and was subsequently addressed in the *Addendum to Laboratory for Energy-Related Health Research Federal Facility, University of California at Davis, Five-Year Review Report Dated September 15, 2016* (DOE 2018b). The evaluation demonstrated that residual compounds in soil in the DOE Areas do not present an unacceptable risk to current and hypothetical receptors. With the vapor-intrusion exposure pathway addressed during this reporting period, the exposure assumptions for the DOE Areas at the site are valid and complete; because vapor-intrusion risks were acceptable, no modifications to the remedies are required.

The exposure pathway evaluation presented in Appendix F indicated that no assumptions involving complete or incomplete exposure pathways have changed since the SWRA (UC Davis 2004) and ROD, other than the vapor-intrusion pathway discussed above. However, exposure parameter value assumptions have changed since the SWRA and ROD, and the primary guidance documents containing current recommended exposure parameter values include DTSC's Note 1 default exposure factors (DTSC 2019) and EPA's 2014 update of standard exposure factors (EPA 2014). The intake calculations and estimated risks resulting from the updated exposure parameter values are presented in detail in Appendix F. The total estimated risks resulting from the exposure parameter value updates were determined to have decreased or remained the same for the hypothetical future onsite residents and construction workers, and were acceptable for onsite researchers and trespassers. Furthermore, the screening component of the non-COC evaluation presented in Appendix G relies on the use of current risk screening values which utilize updated exposure parameters. Thus, the non-COC evaluation captured any non-COCs having increased risk due to exposure parameter changes, and the Appendix G evaluation did not identify any new COCs.

Therefore, DOE concludes that the updated exposure parameters have no significant impacts on the protectiveness of the remedy.

7.2.2 Evaluation of Changes in Standards Used to Establish Cleanup Levels

As discussed in Section 4.1, cleanup goals were established in the ROD for soil (Table 4) and soil concentrations that are protective of groundwater (Table 5). Soil cleanup goals identified in Table 4 of the ROD are risk based, and changes in standards relating to exposures and toxicity that may affect these cleanup goals are discussed in Sections 7.2.1 and 7.2.3, respectively. As discussed in these sections, no significant changes in exposures or toxicity were noted, and no new COCs were identified, so the changes have no bearing on the established cleanup levels. Soil cleanup goals for the protection of groundwater (Designated Levels) identified in Table 5 of the ROD are based on estimated upper-bound soil concentrations that would be protective of specific water-quality standards (e.g., MCLs, secondary MCLs, and EPA RSLs) or groundwater background (Table 5). As shown in Table 10, the only water-quality standard modified after the ROD that remains applicable is the drinking water RSL for molybdenum. As a result, the cleanup goals for molybdenum went from 3.11 to 1.73 milligrams per kilogram (mg/kg) and 3.6 to 2.0 mg/kg at DSS 3 and the Dry Wells A–E areas, respectively. The California MCL for hexavalent chromium of 10 micrograms per liter (µg/L) that was established in 2014 and identified as a changed standard in the First Five-Year Review was invalidated by a court ruling on administrative grounds in 2017; this resulted in a return to the MCL of 50 µg/L for total chromium used in the ROD (Table 10). Accordingly, this change has no effect on the Table 5 cleanup levels established in the ROD.

Groundwater background values were established based on samples collected in 2011 and 2012 (Weiss 2014). As described in Appendix F of the First Five-Year Review, calculated soil to groundwater cleanup targets based on a background endpoint for formaldehyde in DSS 3; selenium in DSS 4; and molybdenum, cesium-137, and strontium-90 in the Dry Wells A–E area changed in response to the 2011/2012 groundwater background levels. As shown in Table 10, revised groundwater background concentrations are generally similar or lower than those used in the ROD to establish cleanup goals to achieve groundwater impacts equal to background concentrations. This indicates that the corresponding ROD cleanup goals should be lower. However, because the evaluation of the need for contingent remedial action relies on the lower and more conservative 2011/2012 background levels and current WQOs, the elevated soil cleanup goals do not impact the protectiveness of the remedy unless contingent remedial action is required.

Table 10. Comparison of ROD and Current Numerical Standards and Background Thresholds for Soil to Groundwater COC in DOE Areas

Soil to Groundwater COC	Units	HSU-1 Groundwater Background Concentrations Used to Establish ROD Cleanup Goals	Current HSU-1 Groundwater Background[a]	Numerical Standard Used to Establish ROD Cleanup Goals	Current Numerical Standard	Current References for Numerical Standard
Carbon-14	pCi/L	3.5	<7	2000	2000	MCL (SWRCB 2018a; EPA 2000)
Cesium-137	pCi/L	1	<5	200	200	MCL (SWRCB 2018a; EPA 2000)
Total chromium	µg/L	25	43.7	50	50	California MCL (SWRCB 2018a)
Hexavalent chromium	µg/L	39.4	40	50	50	California MCL[b] (SWRCB 2018a)
Formaldehyde	µg/L	1140	13	100	100	California Notification Level (SWRCB 2015)
Mercury	µg/L	0.1	0.0479	2	2	MCL (SWRCB 2018a)
Molybdenum	µg/L	14.9	3.13	180	100	RSL (EPA 2020)
Nitrate as N	mg/L	25.1	15	10	10	MCL (SWRCB 2018a)
Radium-226	pCi/L	1.14	1.17	5	5	MCL (SWRCB 2018a)
Selenium	µg/L	5.67	1.74	50	50	MCL (SWRCB 2018a)
Silver	µg/L	5	<1	100	100	Secondary MCLs (SWRCB 2018b)
Strontium-90	pCi/L	1.7	<1	8	8	MCL (SWRCB 2018a)

Notes:

[a] Groundwater background determined from wells UCD1-018 and UCD1-063 monitoring data collected in 2011 and 2012 (Weiss 2014).

[b] There is no current MCL for hexavalent chromium; “total chromium” MCL of 50 µg/L applied.

Abbreviations:

HSU = hydrostratagraphic unit
pCi/L = picocuries per liter
SWRCB = State Water Resources Control Board

Because groundwater at the site is not used for domestic purposes and shallow groundwater immediately downgradient of the DOE Areas is monitored for these constituents, the RSL and background changes do not impact the short-term protectiveness of the remedy. In the event that contingent remediation becomes necessary in the future, soil cleanup goals should be reevaluated at that time.

7.2.3 Evaluation of Changes in Toxicity 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 (Appendix F). The recalculated excess cancer risks and non-cancer hazards for the identified COCs at DSS 4, EDPs, and SWTs are lower, unchanged, or only slightly higher than those presented in the ROD. In all cases the recalculated non-cancer hazards remained below the threshold of 1. The total recalculated risk to hypothetical future residential receptors at DSS 4 was 40% lower than was estimated in the SWRA (decreased from 5×10^{-4} to 3×10^{-4}). Recalculated risks decreased below the 1×10^{-6} risk threshold for construction workers (decreased from 1×10^{-6} to 8×10^{-7}). Risks to onsite outdoor researchers and trespassers increased to levels slightly above the 1×10^{-6} threshold due to a 64% increase in the oral cancer slope factors for COCs benzo[*a*]anthracene and benzo[*b*]fluoranthene (3×10^{-6} and 1×10^{-6} risk, respectively). Because the contamination is spatially limited to a very small area several feet below the ground surface in DSS 4 (DOE 2005), and the updated calculation results fall within EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}, the changes do not affect protectiveness.

7.2.4 Evaluation of Toxicity for Non-COCs

Sample data for constituents not identified in the ROD as soil COCs, which are representative of soil that has not been removed (non-COCs), were screened when their RSLs or preliminary remediation goals changed since the risk assessment was conducted. Toxicity values for non-COCs detected above background in soil were reviewed for changes that may impact the protectiveness of the remedies, including no further action areas, for all receptors (Appendix G). Both chemical and radiological constituents were evaluated. The chemical constituents that were not previously identified as COCs in the Risk Characterization Report (DOE 2005) for the DOE Areas do not present an unacceptable cancer risk or non-cancer hazard to human health. For radiological constituents, the recalculated risks are the same or higher than those calculated in the SWRA (UC Davis 2004). However, as described in detail in Section G2.0 of Appendix G, these changes do not affect the overall protectiveness of the remedies, including those designated in the ROD for no action or no further action, for all receptors. Furthermore, the risk evaluation for non-COCs presented in Appendix G confirms that no additional site COCs have emerged due to changes in toxicity values.

7.2.5 Evaluation of the Groundwater RAO

The RAO for groundwater defined in the ROD is to "mitigate potential future impacts to groundwater," which is achieved by the monitoring and contingent remedial action component of the remedies. As discussed above, there is currently no direct human or ecological exposure to groundwater at the site. Therefore, the groundwater RAO for the current remedies remains appropriate. The vadose zone modeling used to identify COCs and MOCs has proved to be conservative, as the majority of the identified soil to groundwater COCs and MOCs are not being identified above background or increasing above initial baseline concentrations as shown in Appendix C, Tables C-2, C-3, C-4, and C-5.

Therefore, DOE concludes that the groundwater RAO remains valid and the underlying technical methodology for identifying soil to groundwater COCs and MOCs is conservative with respect to achieving the groundwater RAO.

7.2.6 Evaluation of Ecological Risk

Soil screening levels for plant and soil invertebrate evaluation and species-specific toxicity reference values, lowest-observed adverse effect levels, and no-observed adverse effect levels for the bird and mammal evaluation were reviewed. The toxicity data have not changed since the First Five-Year Review (DOE 2016), which concluded that the risk to ecological receptors in the DOE Areas remains similar to risks estimated in the *Final Site-Wide Ecological Risk Assessment* (BBL 2006). Previous changes in available ecological risk information presented in the First Five-Year Review Report had no significant impact on the protectiveness of the remedy.

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

The emerging environmental contaminants 1,4-dioxane and per- and polyfluoroalkyl substances (PFAS) were not evaluated during the Remedial Investigation. Although available information indicates that the likelihood of discovering these contaminants in the DOE Areas is low, they could affect the long-term protectiveness of the remedy if present.

There appears to be a low likelihood of significant PFAS usage during DOE activities at the site since PFAS were primarily used in aqueous foams used in firefighting and training, in industrial processes, and consumer products. In April 2019, DOE searched project records using PFAS-related keywords and found no evidence for their use, storage, or release at the site. Furthermore, site records do not refer to operations that would require the use of aqueous firefighting foam or fume suppressants, which are common sources of PFAS contamination in groundwater. Whereas PFAS are often present in landfill runoff and leachates, the DOE waste disposal areas (the SWT and DOE Disposal Box) are not expected to contain significant PFAS, as the waste in these areas (now removed) was mainly soil, gravel, labware, and minor amounts of animal remains from site activities rather than the industrial or municipal waste typically present in landfills.

Because the likelihood of PFAS releases at the DOE Areas appears low and state and federal policies on PFAS response actions are being developed, DOE will continue to monitor EPA and State of California policy changes on PFAS.

Groundwater was sampled in 2008 and 2009 for 1,4-dioxane in monitoring wells UCD1-021 and UCD1-023, which monitor groundwater immediately downgradient of the Ra/Sr Treatment Systems and DSS 6, and the SWT area, respectively. The sampling results were reported to be below a detection limit of about 1 µg/L, which is above the current EPA RSL of 0.46 µg/L for drinking water. Since the detection limits were elevated and it has been more than 10 years since these wells were sampled, DOE is recommending that all of the DOE site monitoring wells be sampled for 1,4-dioxane during the annual groundwater monitoring event in 2021 (see Table 11 in Section 8.0).

No other information could call into question the protectiveness of the remedy for the DOE Areas at the site.

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8.0 Issues/Recommendations

Issues and Recommendations identified in the Second Five-Year Review are presented in Table 11.

Table 11. Issues and Recommendations Identified in the Second Five-Year Review

<table>
<tr><th colspan="5"><i>ISSUES/RECOMMENDATIONS</i></th></tr>
<tr><td colspan="5">Issues and Recommendations Identified in the Five-Year Review</td></tr>
<tr><td colspan="5">Issue Category: Community Involvement</td></tr>
<tr><td colspan="5">Issue: Campus faculty and staff working at or near the LEHR Federal Facility and neighbors may have limited knowledge of CERCLA activities at the site.</td></tr>
<tr><td colspan="5">Recommendation: Coordinate with UC Davis to develop and implement outreach enhancements for neighbors and interested UC Davis staff that work at or near the LEHR Federal Facility.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>No</td><td>LM and UC Davis</td><td>LM/EPA</td><td>9/30/2021</td></tr>
<tr><td colspan="5">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="5">Issue: The technical evaluation presented in Appendix C of the Second Five-Year Review indicates that reduced groundwater monitoring is recommended by DOE for well-specific constituents that have no upward concentration trends and are below comparison criteria (background or baseline) and baseline WQOs or background, whichever is higher.</td></tr>
<tr><td colspan="5">Recommendation: Reach agreement with EPA and state agencies to modify the sampling monitoring plan prior to the next annual sampling planned in March 2021 based on information presented in Appendix C of the Second Five-Year Review.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>No</td><td>LM</td><td>LM/EPA</td><td>6/30/2021</td></tr>
<tr><td colspan="5">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="5">Issue: UC Davis indicates that certain vegetation controlled under the vegetation management procedures described in the SMP is subject to routine maintenance (e.g., pruning) by grounds staff. The disposal requirements for cuttings generated by grounds staff need to be established and communicated to grounds staff and other UC Davis personnel.</td></tr>
<tr><td colspan="5">Recommendation: Revise the SMP to identify vegetation subject to routine maintenance by grounds staff, and develop and document procedures to characterize the vegetation and manage cuttings. Based on the characterization results, in coordination with UC Davis develop a written cuttings management protocol and train grounds staff to it.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>No</td><td>LM</td><td>LM/EPA</td><td>6/30/2022</td></tr>
<tr><td colspan="5">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="5">Issue: Anomalous groundwater gradients have been observed intermittently near the northwest corner of the site and the offsite area near monitoring well UCD1-073, located west of Old Davis Road. The source of elevated hexavalent chromium in well UCD1-073 is not known, but it could have originated at or near the DSS 1 area (see Appendix C, Section C1.6). The current site conceptual hydrogeologic model does not explain the anomalous groundwater gradients observed in this area, nor the occurrence of elevated hexavalent chromium in groundwater. If contaminants in UCD1-073 originate at the site, additional response actions may be required.</td></tr>
</table>

Table 11. Issues and Recommendations Identified in the Second Five-Year Review (continued)

<table>
<tr><td colspan="5">Recommendation: Further analyze existing groundwater elevation data, and potentially collect additional groundwater elevation data to define the hydraulic conditions driving the anomalous groundwater gradients and determine the frequency of occurrence and net contaminant transport rates that result from the anomalous gradients. Synthesize data to develop a revised conceptual hydrogeologic model for the northwest corner of the site.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>No</td><td>LM</td><td>LM/EPA</td><td>12/29/2023</td></tr>
<tr><td colspan="5">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="5">Issue: 1,4-dioxane was likely used in limited quantities at LEHR in liquid scintillation cocktails. While limited sampling of groundwater has occurred downgradient of the DOE Areas, the sampling occurred more than 10 years ago and only two monitoring wells (UCD1-021 and UCD1-023) downgradient of the DOE Areas were sampled.</td></tr>
<tr><td colspan="5">Recommendation: Conduct a one-time sampling of all DOE site wells for 1,4-dioxane to confirm that it is not present in groundwater. If detected above the EPA RSL, perform confirmatory sampling.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Unknown</td><td>LM</td><td>LM/EPA</td><td>6/30/2022</td></tr>
</table>

9.0 Protectiveness Statement

Table 12 provides the protectiveness statement for the remedies at the DOE Areas of the site.

Table 12. DOE Areas Protectiveness Statement

PROTECTIVENESS STATEMENT
Protectiveness Determination: Protective
Protectiveness Statement: The remedies at the DOE Areas of the site are protective of human health and the environment. Land-use controls are in place to prevent human exposure to contaminated soil; it has been confirmed that there are no vapor intrusion threats; ecological risks are below the level of concern for ecological receptors; there is no human or ecological exposure to groundwater; and ongoing groundwater monitoring and the implementation of contingent remedial actions, if required, provide protection of groundwater quality.

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10.0 Next Review

The next Five-Year Review for the LEHR Federal Facility will be completed on or before January 4, 2026.

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Appendix A

Five-Year Review Public Notices

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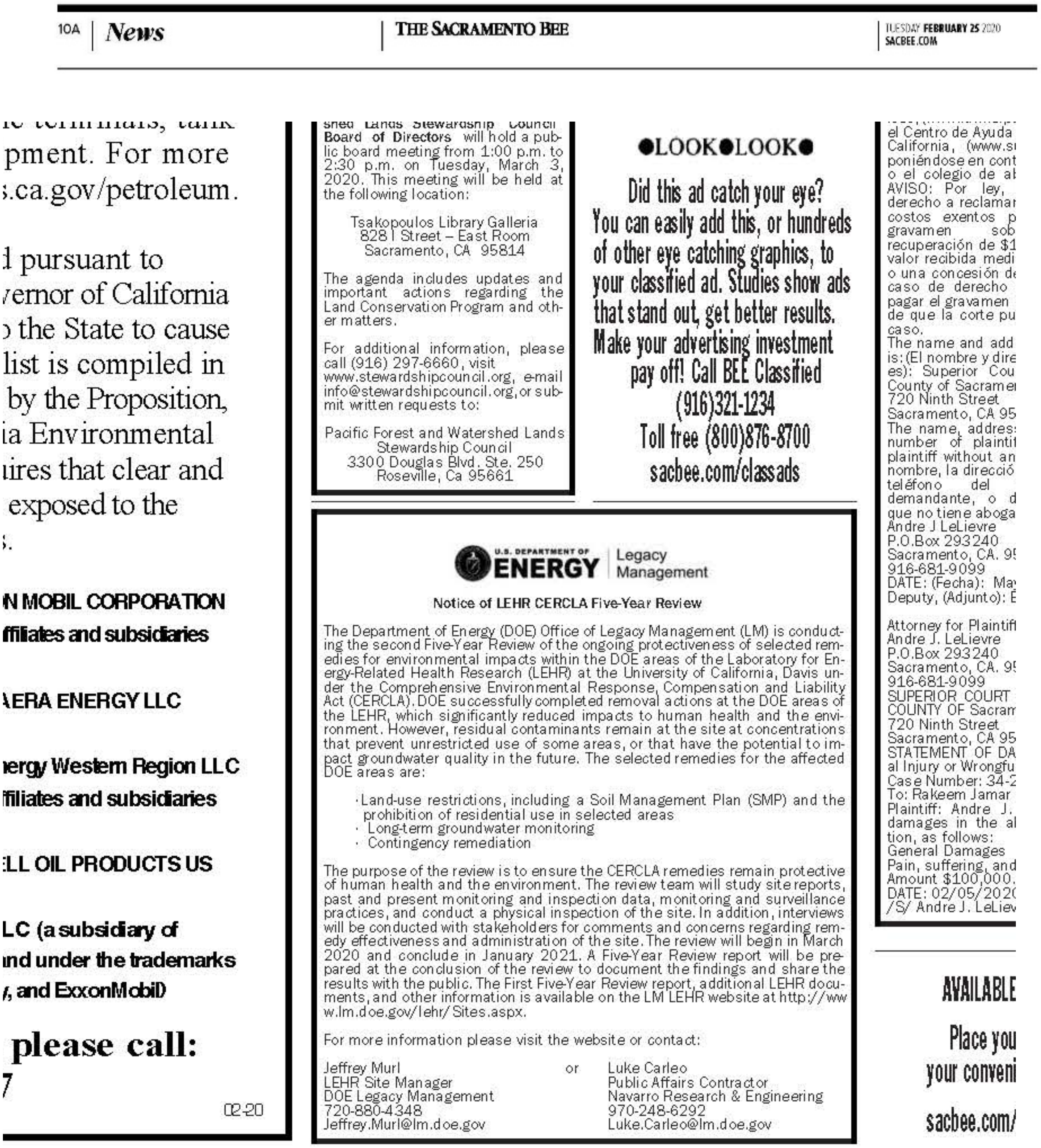

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shed Lands Stewardship Council **Board of Directors** will hold a public board meeting from 1:00 p.m. to 2:30 p.m. on Tuesday, March 3, 2020. This meeting will be held at the following location:

Tsakopoulos Library Galleria
828 I Street – East Room
Sacramento, CA 95814

The agenda includes updates and important actions regarding the Land Conservation Program and other matters.

For additional information, please call (916) 297-6660, visit www.stewardshipcouncil.org, e-mail info@stewardshipcouncil.org, or submit written requests to:

Pacific Forest and Watershed Lands
Stewardship Council
3300 Douglas Blvd. Ste. 250
Roseville, Ca 95661

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U.S. DEPARTMENT OF ENERGY | Legacy Management

Notice of LEHR CERCLA Five-Year Review

The Department of Energy (DOE) Office of Legacy Management (LM) is conducting the second Five-Year Review of the ongoing protectiveness of selected remedies for environmental impacts within the DOE areas of the Laboratory for Energy-Related Health Research (LEHR) at the University of California, Davis under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). DOE successfully completed removal actions at the DOE areas of the LEHR, which significantly reduced impacts to human health and the environment. However, residual contaminants remain at the site at concentrations that prevent unrestricted use of some areas, or that have the potential to impact groundwater quality in the future. The selected remedies for the affected DOE areas are:

- 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 purpose of the review is to ensure the CERCLA 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 stakeholders for comments and concerns regarding remedy effectiveness and administration of the site. The review will begin in March 2020 and conclude in January 2021. A Five-Year Review report will be prepared at the conclusion of the review to document the findings and share the results with the public. The First Five-Year Review report, additional LEHR documents, and other information is available on the LM LEHR website at http://www.lm.doe.gov/lehr/Sites.aspx.

For more information please visit the website or contact:

Jeffrey Murl LEHR Site Manager DOE Legacy Management 720-880-4348 Jeffrey.Murl@lm.doe.gov	or	Luke Carleo Public Affairs Contractor Navarro Research & Engineering 970-248-6292 Luke.Carleo@lm.doe.gov

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Andre J LeLievre
P.O.Box 293240
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Deputy, (Adjunto):

Attorney for Plainti
Andre J. LeLievre
P.O.Box 293240
Sacramento, CA. 9
916-681-9099
SUPERIOR COURT
COUNTY OF Sacran
720 Ninth Street
Sacramento, CA 95
STATEMENT OF DA
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Case Number: 34-2
To: Rakeem Jamar
Plaintiff: Andre J.
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General Damages
Pain, suffering, and
Amount $100,000.
DATE: 02/05/202
/S/ Andre J. LeLiev

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Public Notices

- E-mail your public notice to **legals@davisenterprise.net**
- Be sure to include your name and phone number

FICTITIOUS BUSINESS NAME STATEMENT

Filed: January 14, 2020
FBN Number: F20200053
1. Fictitious Business Name(s)
MANDRO TEAHOUSE
2. Street Address, City, State and Zip of Principal Place of Business in California. Business is located in Yolo County.
1260 LAKE BLVD. SUITE 102A
DAVIS, CA 95616
Mailing Address:
2537 MACK WAY
WOODLAND, CA 95776
3. List Full Name(s) of Registrant(s), Residence Address, State, and Zip
JR MANDRO LLC
3760 39TH AVE. APT D
OAKLAND, CA 94619
4. Business Classification:
LIMITED LIABILITY COMPANY
5. Beginning Date of Business: The Registrant(s) commenced to transact business under the fictitious business

PUBLIC NOTICE

U.S. DEPARTMENT OF ENERGY | Legacy Management

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For more information please visit the website or contact:

Jeffrey Murl
LEHR Site Manager
DOE Legacy Management
720-880-4348
Jeffrey.Murl@lm.doe.gov
or
Luke Carleo
Public Affairs Contractor
Navarro Research & Engineering
970-248-6292
Luke.Carleo@lm.doe.gov

2/26 **715**

Mailing address:
630 RADCLIFFE DRIVE
DAVIS, CA 95616
3. List Full Name(s) of Registrant(s), Residence Address, State, and Zip
CYNTHIA RAUB
630 RADCLIFFE DRIVE
DAVIS, CA 95616
4. Business Classification:
Individual
5. Beginning Date of Business: The Registrant(s) commenced to transact business under the fictitious business name or names listed above on:
FEBRUARY 10, 2020
"I declare that all information in this statement is true and correct." (A registrant who declares as true information which he or she knows to be false is guilty of a crime.)
6. Signature of Registrant(s):
CYNTHIA RAUB
2/12, 2/19, 2/26, 3/4 **718**

FICTITIOUS BUSINESS NAME STATEMENT

Filed: February 10, 2020
FBN Number: 2020-0136
1. Fictitious Business Name(s)
CENARIOS PIZZA IN DAVIS
2. Street Address, City, State and Zip of Principal Place of Business in California. Business is located in Yolo County.
1300 E COVELL BLVD #B
DAVIS, CA 95618
Mailing Address:
1532 HOBSON AVE.
WEST SACRAMENTO, CA 95605
3. List Full Name(s) of Registrant(s), Residence Address, State, and Zip
ONE STOP SHOPS LLC
1532 HOBSON AVE.
WEST SACRAMENTO, CA 95605
4. Business Classification:
Limited Liability Company
5. Beginning Date of Business: The Registrant(s) commenced to transact business under the fictitious business name or names listed above on:
FEBRUARY 10, 2020
"I declare that all information in this statement is true and correct." (A registrant who declares as true information which he or she knows to be false is guilty of a crime.)
6. Signature of Registrant(s):
ONE STOP SHOPS LLC
NADEEM CHAUDHARY, PRESIDENT
2/12, 2/19, 2/26, 3/4 **719**

FICTITIOUS BUSINESS NAME STATEMENT

Filed: FEBRUARY 13, 2020
FBN Number: F20200152
1. Fictitious Business Name(s)
CHASQUI LEARNING
2. Street Address, City, State and Zip of Principal Place of Business in California. Business is located in Yolo County.
3633 CUBRE TERRACE
DAVIS, CA 95618
3. List Full Name(s) of Registrant(s), Residence Address, State, and Zip
GREGORY FRANCIS

(A registrant who declares as true information which he or she knows to be false is guilty of a crime.)
6. Signature of Registrant(s):
Kellie Gale
2/19, 2/26, 3/4, 3/11 **733**

NOTICE OF PETITION TO ADMINISTER ESTATE OF

William J. Sprenger
CASE NO. PB20-34

To all heirs, beneficiaries, creditors, contingent creditors, and persons who may otherwise be interested in the will or estate, or both, of: **William J. Sprenger**
A PETITION FOR PROBATE has been filed by: **Lisa Immel** in the Superior Court of California, County of: **Yolo**
THE PETITION FOR PROBATE requests that: **Lisa Immel** be appointed as personal representative to administer the estate of the decedent.
THE PETITION requests authority to administer the estate under the Independent Administration of Estates Act. (This authority will allow the personal representative to take many actions without obtaining court approval. Before taking certain very important actions, however, the personal representative will be required to give notice to interested persons unless they have waived notice or consented to the proposed action.) The independent administration authority will be granted unless an interested person files an objection to the petition and shows good cause why the court should not grant the authority.
A HEARING on the petition will be held on March 6, 2020 at 9:00 a.m. in Department 10 located at 1000 Main Street, Woodland, CA 95695
IF YOU OBJECT to the granting of the petition, you should appear at the hearing and state your objections or file written objections with the court before the hearing. Your appearance may be in person or by your attorney.
IF YOU ARE A CREDITOR or a contingent creditor of the decedent, you must file your claim with the court and mail a copy to the personal representative appointed by the court within the later of either (1) four months from the date of first issuance of letters to a general personal representative, as defined in section 58(b) of the California Probate Code, or (2) 60 days from the date of mailing or personal delivery to you of a notice under section 9052 of the California Probate Code.
Other California statutes and legal authority may affect your rights as a creditor. You may want to consult with an attorney knowledgeable in California law.
YOU MAY EXAMINE the file kept by the court. If you are a person interested in the estate, you may file with the court a Request for Special Notice (form DE-154) of the filing of an inventory and appraisal of estate assets or of any petition or account as provided in Probate Code section 1250. A Request for Special Notice form is available from the court clerk.
Signed:

described school site. All bids shall be made and presented only on the forms presented by the Owner. Bids shall be received in the Office of the FACILITIES & MAINTENACE DEPARTMENT located at ***1919 5th Street, Davis, California* 95616** and shall be opened and publicly read aloud at the above stated time and place. Any bids received after the time specified above or after any extensions due to material changes shall be returned unopened.

PRE-BID CONFERENCE MTG

There will be a Pre-Bid Conference on March 5, 2020 at 3:30pm. Attendees will be required to sign in. During the Pre-Bid Conference, the District's Labor Compliance Program and the state labor law requirements applicable to this Project will be discussed.

Miscellaneous Information

The bid documents will be emailed to each attendee of the Pre-Bid Conference. Each Project Bid documents are viewable separately at the District Web page using the following link: https://www.djusd.net/departments/facilities/capital improvement under the Facilities Link tab.

Each bidder shall be a licensed contractor pursuant to the California Business and Professions Code, and be
licensed to perform the work called for in the contract documents. The successful bidder must possess a valid and active Class A General Engineering at time of award of contract. The Contractor's California State License number shall be clearly stated on the bidder's proposal.

Subcontractors shall be licensed pursuant to California law for the trades necessary to perform the work called for in the contract documents.

Each bid must strictly conform with and be responsive to the contract documents as defined in the General Conditions.

The DISTRICT reserves the right to reject any or all bids or to waive any irregularities or informalities in any bids or in the bidding.

Each bidder shall submit with his bid, on the form furnished with the contract documents, a list of the designated subcontractors on this project as required by the Subletting and Subcontracting Fair Practices Act, California Public Contract Code sections 4100, et seq.

In accordance with California Public Contract Code section 22300, the DISTRICT will permit the substitution of securities for any moneys withheld by the DISTRICT to ensure performance under the contract.

Each bidder's bid must be accompanied by one of the following forms of bidder's security: (1) cash; (2) a cashier's check made payable to the DISTRICT; (3) a

contract and shall be in the form set forth in the contract documents. All bonds (Bid, Performance, and Payment) must be issued by a California admitted surety as defined in California Code of Civil Procedure section 995.120.

Where applicable, bidders must meet the requirements set forth in Public Contract Code section 10115, et seq., Military and Veterans Code section 999, et seq., and California Code of Regulations, Title 2, section 1896.60, et seq., regarding Disabled Veteran Business Enterprise ("DVBE") Programs. Bidders may contact the District for details regarding the District's DVBE participation goals and requirements.

Any request for substitutions pursuant to Public Contracts Code section 3400 must be made on the form set forth in the contract documents and included with the bid.

No telephone or facsimile machine will be available to bidders on the DISTRICT premises at any time.

It is each bidder's sole responsibility to ensure its bid is timely delivered and received at the location designated as specified above. Any bid received at the designated location after the scheduled closing time for receipt of bids shall be returned to the bidder unopened.

Davis Joint Unified School District
2/26, 3/4 **740**

LIEN SALE

2013 CHRY 200
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CA LIC# 8JWV257
LIEN SALE 03-16-20 8:00 AM
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DAVIS, CA 95616
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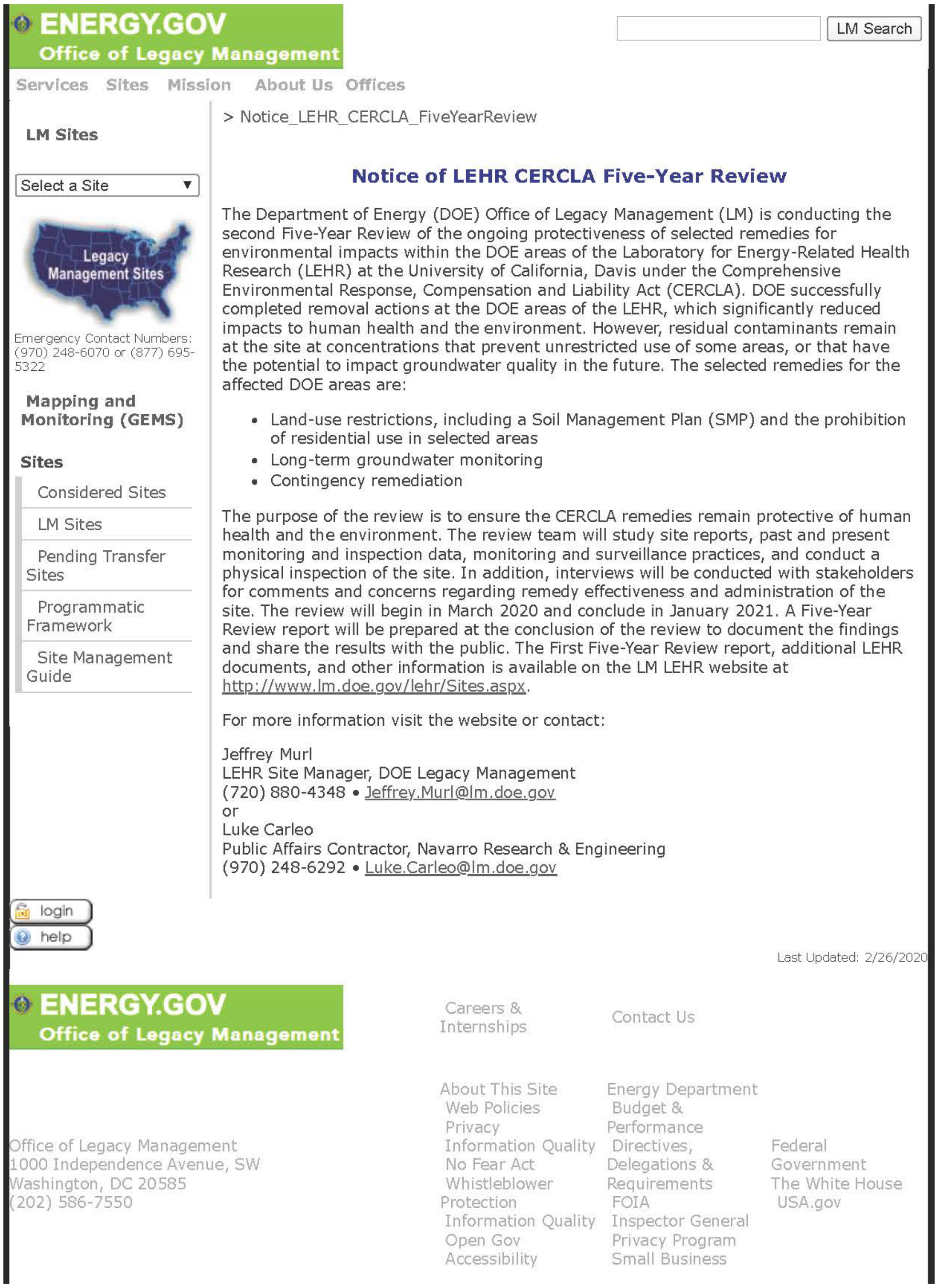

Emergency Contact Numbers: (970) 248-6070 or (877) 695-5322

> Notice_LEHR_CERCLA_FiveYearReview

Notice of LEHR CERCLA Five-Year Review

The Department of Energy (DOE) Office of Legacy Management (LM) is conducting the second Five-Year Review of the ongoing protectiveness of selected remedies for environmental impacts within the DOE areas of the Laboratory for Energy-Related Health Research (LEHR) at the University of California, Davis under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). DOE successfully completed removal actions at the DOE areas of the LEHR, which significantly reduced impacts to human health and the environment. However, residual contaminants remain at the site at concentrations that prevent unrestricted use of some areas, or that have the potential to impact groundwater quality in the future. The selected remedies for the affected DOE areas are:

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For more information visit the website or contact:

Jeffrey Murl
LEHR Site Manager, DOE Legacy Management
(720) 880-4348 • Jeffrey.Murl@lm.doe.gov
or
Luke Carleo
Public Affairs Contractor, Navarro Research & Engineering
(970) 248-6292 • Luke.Carleo@lm.doe.gov

Last Updated: 2/26/2020

Office of Legacy Management
1000 Independence Avenue, SW
Washington, DC 20585
(202) 586-7550

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Appendix B

Applicable or Relevant and Appropriate Requirements Review

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Applicable or Relevant and Appropriate Requirements Review

The tables of applicable or relevant and appropriate requirements (ARARs) in the Record of Decision (ROD) for the U.S. Department of Energy (DOE) areas of the Laboratory for Energy-Related Health Research (LEHR), which were reviewed during the First Five-Year Review (DOE 2016b), were reviewed again for this Second Five-Year Review to determine if any standards identified as ARARs have changed or if there are any newly promulgated standards that might be ARARs. Unmodified tables from the ROD are included 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, no post-ROD ARARs or applicable newly promulgated standards were identified. As identified in the First-Five Year Review, California promulgated a new maximum contaminant level (MCL) for hexavalent chromium in 2014, as was expressed in the Safe Drinking Water and Toxic Enforcement Act (California Health and Safety Code 25249.5–25249.13) Title 22 *California Code of Regulations* Sections 64431–64445 (22 CCR 64431–64445). However, a California court invalidated this MCL in 2017 on administrative grounds, and the affected ARAR is now consistent with the version cited in the ROD.

In 2018, the State of California enacted the “Toxicity Criteria Rule” (California Code of Regulations, Sections 68400.5, 69020-69022) which establishes toxicity criteria for human health risk assessments, risk-based screening levels, and remediation goals approved after September 4, 2018. Although DOE LM has referenced the toxicity criteria in DTSC’s Human and Ecological Risk Office Note 10, which is required under the Toxicity Criteria Rule, in the exposure and toxicity evaluations contained in Appendixes F and G of this report, DOE LM does not consider the Toxicity Criteria Rule to be an ARAR, but DTSC disagrees with this position.

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

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

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

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*
CRWQCB	California Regional Water Quality Control Board
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
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

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 back groundwater 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. Action-Specific Requirements for the Selected Remedy for the DOE Areas for the LEHR Federal Facility (continued)

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
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CEQA	California Environmental Quality Act
CFR	*Code of Federal Regulations*
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

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Appendix C

Groundwater Monitoring Data Analysis

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C1.0 Groundwater Monitoring Data Analysis

Groundwater monitoring data for the U.S. Department of Energy (DOE) Areas of the Laboratory for Energy-Related Health Research (LEHR) were evaluated to determine the appropriate sample collection frequencies for the subsequent 5 years as part of this Five-Year Review. The results of this evaluation and the proposed sample collection plan for the following 5 years are presented below.

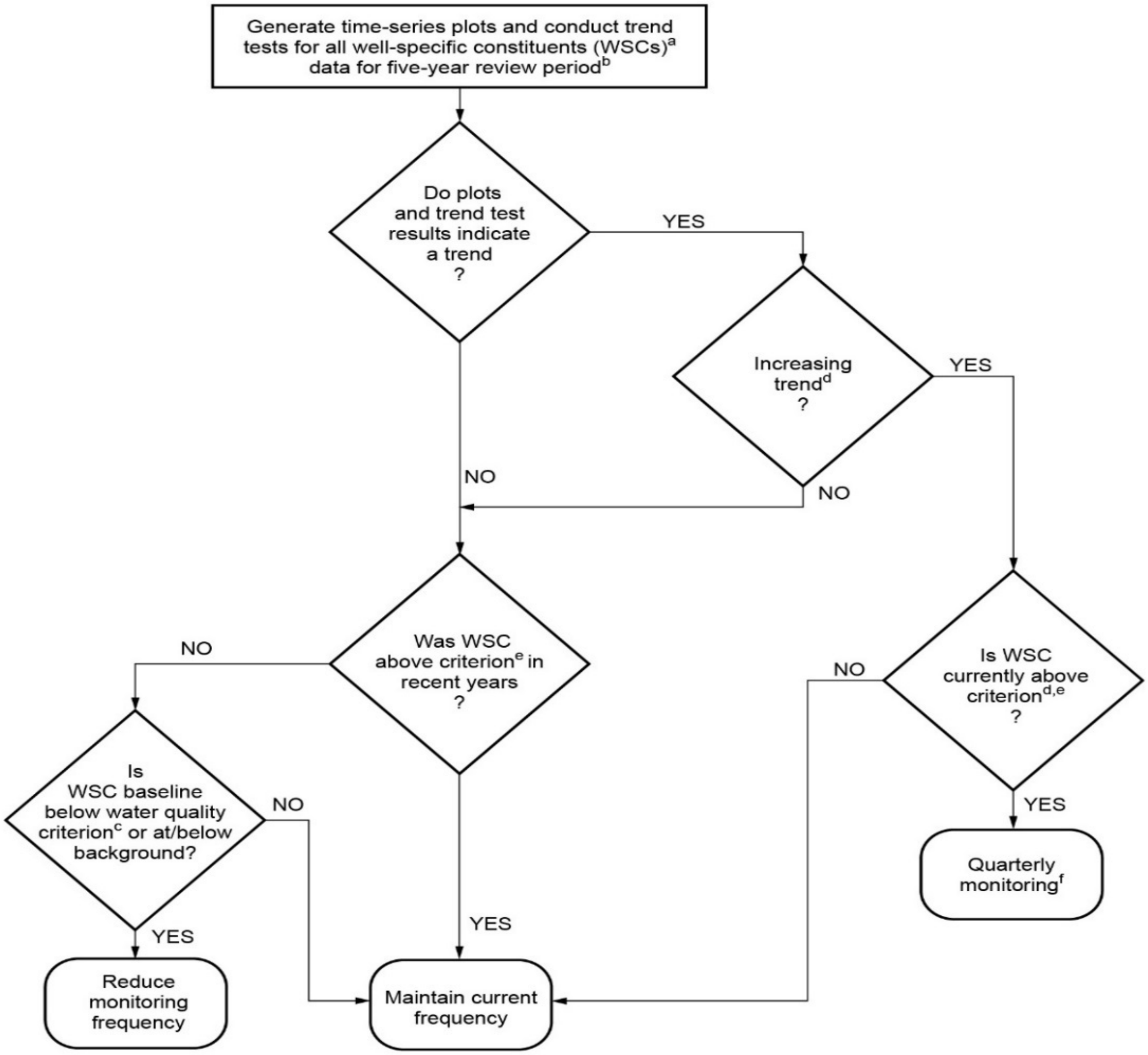
The DOE groundwater monitoring program was initiated in 2011 and followed the sampling protocol outlined in the *Remedial Design/Remedial Action Work Plan for the Former Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis* (DOE 2010) (RD/RAWP). On the basis of these results, the sampling program was refined and the 2012–2013 annual sampling program was developed and approved by the regulatory agencies (Weiss 2013a). Based on recommendations for sampling frequency reductions presented in the First Five-Year Review (DOE 2016), several well-specific constituents sampled in the 2016–2020 (Reporting Period) were placed on biennial frequency and sampled in 2016, 2018, and 2020, while other well-specific constituents were sampled more frequently (e.g., annually or quarterly). Sampling program summaries for this Reporting Period including DOE Areas monitored, analytes sampled, and collection frequencies are included as Attachment C-1.

C1.1 Monitoring Decision Process

This Five-Year Review monitoring frequency evaluation includes the following:

- Performing statistical trend tests of valid monitoring data collected from 2011 through 2020 at the 1% significance level (applicable for $n \geq 5$ [Gilbert 1987, Table A18])
- Performing statistical trend tests of valid monitoring data collected annually from 2016 through 2020 at the 5% significance level (applicable for $n \geq 4$ [Gilbert 1987, Table A18])
- Generating time-series plots for all wells, and conducting a visual trend evaluation
- Comparing the data to the established site background concentration if the well-specific baseline concentration was below background; otherwise, comparing the data to the established well-specific baseline values (Weiss 2014)
- Comparing the data to appropriate numerical enforceable or recommended screening values (see Section C1.1.2)
- Processing the results of the trend tests and data comparisons according to the established monitoring frequency decision tree (Figure C-1)
- Developing recommendations for sampling frequencies for the next reporting period (i.e., 2021–2025)

Statistical trend tests were conducted using the Mann Kendall test in accordance with the U.S. Environmental Protection Agency (EPA) guidance *Data Quality Assessment: Statistical Methods for Practitioners* (EPA 2006).



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. Monitoring Frequency Decision Tree

C1.1.1 Outlier Screening

Review of the time-series plots generated for this evaluation indicated the presence of high-concentration outlier data for zinc in well UCD1-023; uranium-238 in well UCD1-068; aluminum, gross beta radioactivity (gross beta), iron, and manganese in well UCD1-069; gross beta, uranium-238, and zinc in well UCD1-070; gross beta, manganese, molybdenum, and uranium-238 in well UCD1-071; and aluminum and uranium-238 in well UCD1-072 (Attachment C-2). The suspect well-specific constituent data were tested for outliers. If testing confirmed that a suspect sample result was an outlier, it was removed before conducting the monitoring frequency decision process (Figure C-1).

Sample results for the listed well-specific constituents were tested for outliers using Dixon's outlier test according to EPA's guidance (EPA 2006). The outlier test results indicated outliers at the 1%, 5%, and 10% significance levels for zinc in well UCD1-023; uranium-238 in well UCD1-068; aluminum, iron, and manganese in well UCD1-069; uranium-238 and zinc in well UCD1-070; manganese and molybdenum in well UCD1-071; and aluminum in well UCD1-072. With the outliers removed, tests were again conducted for these well-specific constituents and no results indicated an outlier at the 1% significance level. All of the well-specific constituents that tested positive for outliers have their baseline conditions established on these outliers, with the exception of zinc in wells UCD1-023 and UCD1-070, and uranium-238 in wells UCD1-068 and UCD1-070. The outliers are annotated in the time-series plots (Attachment C-2) and were removed before conducting the monitoring frequency decision process.

Baseline conditions were established for well-specific constituents as the maximum concentration from the sampling conducted in 2011 and 2012 (Weiss 2014). The outlier test results indicate that established baseline is incorrect for aluminum, iron, and manganese in well UCD1-069; manganese and molybdenum in well UCD1-071; and aluminum in well UCD1-072. Baseline conditions for these well-specific constituents were updated using the second highest concentration from the sampling conducted in 2011 and 2012 (Table C-1). Since the outliers are all from the same sampling event, the outlier results are likely an artifact of failing to filter the samples prior to acid preservation.

Table C-1. Well-Specific Constituents Baseline Corrections

Monitoring Well	Constituent	Established Baseline (µg/L)	Corrected Baseline (µg/L)
Constituents of Concern			
UCD1-071	Molybdenum	3.29	1.54
Monitoring-Only Constituents			
UCD1-069	Aluminum	1080	4.05
UCD1-072	Aluminum	207	39.9
New Well Constituents			
UCD1-069	Iron	1620	47
UCD1-069	Manganese	34	1
UCD1-071	Manganese	48.7	6.34

Abbreviation:
µg/L = micrograms per liter

C1.1.2 Sampling Frequency Decision Tree

The process used to determine the future sampling frequency as developed in the RD/RAWP and modified in the First Five-Year Review (DOE 2016) is shown in Figure C-1. The water-quality criteria used in the decision tree consists of the primary maximum contaminant level (MCL) or, if none established, either the secondary MCL, maximum contaminant level goal (MCLG), California Notification Level (SWRCB 2020), or EPA Regional Screening Level for tap water (EPA 2020).

C1.1.3 Results

Results of the future sampling frequency analysis are discussed below and presented in two tables each for constituents of concern (COCs) (Tables C-2 and C-3), monitoring-only constituents (MOCs) (Tables C-4 and C-5), and new well constituents (NWCs) (Tables C-6 and C-7). The first of each pair of tables contains results for annually monitored constituents because they received trend tests for both the 2011–2020 and the Reporting Period data, while biennially monitored constituents (second table) were tested for trends using the 2011–2020 dataset. Plots of time-series data for each well-specific constituent are provided in Attachment C-2 with subsection headings indicating which table contains their visual trend summary. Well-specific constituent plots appear in Attachment C-2 in the order that they appear in the tables. Mann Kendall trend test results are provided in Attachment C-3 with the same headings and order as the plots. Comparisons of baseline concentrations with background and water-quality criteria are presented in Attachment C-4. Based on this evaluation, a proposed monitoring plan for 2021 through 2025 (the next Five-Year Review period) was developed (Table C-8).

C1.2 DOE Constituents of Concern (COCs) Analysis

The Five-Year Review COCs data and trend analyses are summarized in Tables C-2 and C-3. 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, 9 well-specific COCs were monitored annually and 22 well-specific COCs were monitored biennially during the Reporting Period. Annually and biennially monitored COCs were evaluated separately as discussed below.

C1.2.1 Well-Specific COCs Monitored Annually During Recent 5 Years

Trend analyses and comparisons of data to applicable criteria were performed for each well-specific COC to determine if a significant increase in concentration has occurred (Table C-2).

C1.2.1.1 Baseline Above Background

Monitoring data for well-specific COCs having baseline concentrations above background were compared to baseline. As shown in Table C-2, chromium and hexavalent chromium in well UCD1-071 had increasing trends above baseline during the Reporting Period and their proposed sample collection frequency was increased to quarterly for 1 year (Figure C-1). Based on visual evaluation of the graphed data, a slight increasing trend above baseline was identified for nitrate in well UCD1-072 during the Reporting Period, but the trend test did not indicate an increasing trend. The proposed monitoring frequency was maintained at annual for nitrate in well UCD1-072 but will be increased to quarterly if the increasing trend continues.

Table C-2. Trend Test Results, Data Comparisons, and Proposed Monitoring Frequencies for COCs Currently Monitored Annually

Monitoring Well	**Constituent**	**Trend Analysis**				**5-Year Comparison of Results to Criteria**[a]	**Baseline Below WQC or Background?**[b]	**Proposed Monitoring Frequency**
		Mann Kendall Test Result		**Visual Test Result**				
		2011–2020	**2016–2020**	**2011–2020**	**2016–2020**			
Criterion is baseline (baseline above background)								
UCD1-021	Nitrate as N	Increasing trend	No trend[c]	No trend[d]	No trend[d]	All at or above baseline	No	Annual
UCD1-023	Carbon-14	No trend[c]	No trend[c]	Increasing trend[d]	No trend[d]	11 of 12 above baseline	Yes	Annual
UCD1-068	Selenium	Increasing trend	No trend[c]	Increasing trend	No trend[d]	11 of 14 above baseline	Yes	Annual
UCD1-070	Carbon-14	No trend[c]	Decreasing trend	No trend[d]	Decreasing trend	10 of 15 above baseline	Yes	Annual
UCD1-071	Chromium	No trend[c]	Increasing trend	No trend[d]	Increasing trend	3 of 5 above baseline	No	Quarterly[e]
UCD1-071	Chromium (hexavalent)	Increasing trend	Increasing trend	Increasing trend	Increasing trend	6 of 8 above baseline	No	Quarterly[e]
UCD1-072	Nitrate as N	No trend[c]	No trend [c]	No trend[d]	No trend[d]	1 of 5 above baseline	No	Annual
Criterion is background (baseline at or below background or not detected)								
UCD1-021	Radium-226	NA[f]	NA[f]	No trend[d]	No trend[d]	None above background	Yes	Biennial
UCD1-069	Nitrate as N	No trend[c]	Decreasing trend	No trend[d]	Decreasing trend[d]	None above background	Yes	Biennial

Notes:

[a] Monitoring results from 2016 through 2020 compared to baseline when baseline is above background, otherwise monitoring results compared to 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 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 when testing 2011–2020 data (DOE 2010); 5% significance level when testing 2016–2020 data (DOE 2016).

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

[e] Analyte will be monitored quarterly for 1 year. If quarterly monitoring confirms increasing trend significantly above baseline, remedial technologies will be evaluated; if not, annual monitoring will be resumed.

[f] Analyte not detected with sufficient frequently to provide reliable trend test result; detected in fewer than half of samples.

Abbreviations:

NA = not applicable; reason noted
WQC = water-quality criteria

The proposed monitoring frequency was unchanged for four well-specific COCs that had no increasing trends but had sample results above baseline.

C1.2.1.2 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. As shown in Table C-2, the proposed monitoring frequency was reduced to biennial for both well-specific COCs based on no increasing trends and no results above background during the Reporting Period.

C1.2.2 Well-Specific COCs Monitored Biennially During Recent 5 Years

C1.2.2.1 Baseline Above Background

Comparisons of data to baseline were performed for each biennially monitored well-specific COC with baseline above background. As shown in Table C-3, the proposed monitoring frequency was unchanged for mercury in UCD1-071, which had no increasing trend but had sample results above baseline. The proposed monitoring frequency was reduced to quinquennial (once every 5 years) for mercury in UCD1-054 based on no increasing trend for the 2011–2020 sample results, no results above baseline during the Reporting Period, and baseline below the MCL.

C1.2.2.2 Baseline at or Below Background or Not Detected

Monitoring data for biennially monitored well-specific COCs having baseline concentrations at or below background (or not detected) were compared to background. As shown in Table C-3, the proposed monitoring frequency was unchanged for radium-226 in well UCD1-068 because some sample results were above background during the Reporting Period, but there was no increasing trend for the 2011–2020 sample results. Although formaldehyde in well UCD1-069 was not detected during the Reporting Period, the proposed monitoring frequency was unchanged because formaldehyde background is zero and detection limits are, by definition, greater than zero, making the comparison indeterminate. The proposed monitoring frequency was reduced to quinquennial for 18 well-specific COCs based on no increasing trend for the 2011–2020 sample results and no results above background during the Reporting Period.

Table C-3. Decision Process Results for DOE COCs Monitored Biennially

Monitoring Well	Constituent	2011–2020 Trend Analysis		5-Year Comparison of Results to Criteria[a]	Baseline Below WQC or Background?[b]	Proposed Monitoring Frequency
		Mann Kendall Test Result (1% Significance Level)	Visual Test Result			
Criterion is baseline (baseline above background)						
UCD1-054	Mercury	NA[e]	No trend[d]	None above baseline	Yes	Quinquennial[g]
UCD1-071	Mercury	NA[e]	No trend[d]	2 of 5 above baseline	Yes	Biennial
Criterion is background (baseline at or below background or not detected)						
UCD1-021	Carbon-14	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-023	Nitrate as N	No trend[c]	No trend[d]	None above background	Yes	Quinquennial
UCD1-054	Cesium-137	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-054	Chromium	No trend[c]	No trend[d]	None above background	Yes	Quinquennial
UCD1-054	Chromium (hexavalent)	No trend[c]	No trend[d]	None above background	Yes	Quinquennial
UCD1-054	Molybdenum	No trend[c]	No trend[d]	None above background	Yes	Quinquennial
UCD1-054	Silver	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-054	Strontium-90	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-068	Carbon-14	NA[e]	No trend[d]	None above background	Yes	Quinquennial
UCD1-068	Nitrate as N	Increasing trend	No trend[d]	None above background	Yes	Quinquennial
UCD1-068	Radium-226	NA[e]	No trend[d]	2 of 6 above background	Yes	Biennial
UCD1-069	Formaldehyde	NA[e]	NA[e]	Indeterminate[h]	No	Biennial
UCD1-069	Molybdenum	Decreasing trend	Decreasing trend[d]	None above background	Yes	Quinquennial
UCD1-070	Nitrate as N	Decreasing trend	No trend[d]	None above background	Yes	Quinquennial
UCD1-071	Cesium-137	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-071	Molybdenum	Decreasing trend	Decreasing trend	None above background	Yes	Quinquennial
UCD1-071	Silver	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-071	Strontium-90	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-072	Carbon-14	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-072	Radium-226	No trend[c]	No trend[d]	None above background	Yes	Quinquennial

Table C-3. Decision Process Results for DOE COCs Monitored Biennially (continued)

Notes:

[a] Monitoring results from 2016 through 2020 compared to baseline when baseline is above background, otherwise monitoring results compared to background.
[b] WQC is primary 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 when testing 2011–2020 data (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; detected in fewer than half of samples.
[f] Analyte not detected in samples collected from well; trend test is not applicable.
[g] Once every 5 years.
[h] Comparison indeterminant due to detection limits above criteria.

Abbreviations:

NA = not applicable; reason noted
WQC = water-quality criteria

C1.3 DOE Monitoring-Only Constituents (MOCs) Analysis

Three well-specific MOCs have baseline concentrations above background, and 14 well-specific MOCs have baseline concentrations below or the same as background.

C1.3.1 MOCs Currently Monitored Annually

All four annually monitored well-specific MOCs have baseline concentrations at or below background (or not detected) and were compared to background (Table C-4). None of these four MOCs had detectable increasing concentration trends. Although chlordane in well UCD1-013 was not detected during the Reporting Period, the proposed monitoring frequency was unchanged because the detection limit was above background (zero), making the comparison indeterminant. The proposed monitoring frequency will remain annual for dieldrin in well UCD1-013 because dieldrin was detected in one sample during the Reporting Period. The proposed monitoring frequency will remain annual for chromium in well UCD1-068 and aluminum in well UCD1-069 because most of their sample results were slightly above background during the Reporting Period.

C1.3.2 MOCs Currently Monitored Biennially

Trend analyses performed on the 2011–2020 data showed no increasing concentration trends for all three biennially monitored well-specific MOCs having baseline above-background (Table C-5). These three MOCs had concentrations consistently at or below their comparison criteria (baseline) during the Reporting Period, and their baseline is below water-quality criteria or background, resulting in a proposed monitoring frequency reduction to quinquennial.

The 10 biennially monitored well-specific MOCs that have baseline concentrations at or below background (or not detected) were compared to background (Table C-5). None of these 10 MOCs had detectable increasing concentration trends for the 2011–2020 sample results. The proposed monitoring frequency will remain biennial for aluminum in wells UCD1-021 and UCD1-068, and mercury in well UCD1-023 because some of their sample results were above background during the Reporting Period. The proposed monitoring frequency was reduced to quinquennial for seven MOCs that had concentrations consistently at or below background throughout the Reporting Period and baseline below background or water-quality criteria.

Table C-4. Trend Test Results, Data Comparisons, and Proposed Monitoring Frequencies for MOCs Currently Monitored Annually

Monitoring Well	Constituent	Trend Analysis				5-Year Comparison of Results to Criteria[a]	Baseline Below WQC or Background?[b]	Proposed Monitoring Frequency
		Mann Kendall Test Result		Visual Test Result				
		2011–2020	2016–2020	2011–2020	2016–2020			
Criterion is background (baseline at or below background or not detected)								
UCD1-013	Chlordane	NA[f]	NA[f]	NA[f]	NA[f]	Indeterminate[g]	No	Annual
UCD1-013	Dieldrin	NA[e]	NA[e]	NA[e]	NA[e]	1 of 6 above background	No	Annual
UCD1-068	Chromium	No trend[c]	No trend[c]	No trend[d]	No trend[d]	5 of 7 above background	Yes	Annual
UCD1-069	Aluminum	No trend[c]	No trend[c]	No trend[d]	No trend[c]	4 of 5 above background	Yes	Annual

Notes:

[a] Monitoring results from 2016 through 2020 compared to background.

[b] WQC is primary 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 when testing 2011–2020 data (DOE 2010); 5% significance level when testing 2016–2020 data (DOE 2016).

[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; less frequent than annual during recent 5 years or analyte detected in fewer than half of all-years samples.

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

[g] Comparison indeterminant due to detection limits above criteria. Maintain current monitoring frequency and obtain detection limits below criteria when feasible.

Abbreviations:

NA = not applicable; reason noted
WQC = water-quality criteria

Table C-5. Trend Test Results, Data Comparisons, and Proposed Monitoring Frequencies for MOCs Currently Monitored Biennially

Monitoring Well	Constituent	2011–2020 Trend Analysis		5-Year Comparison of Results to Criteria[a]	Baseline Below WQC or Background?[b]	Proposed Monitoring Frequency
		Mann Kendall Test Result (1% Significance Level)	Visual Test Result			
Criterion is baseline (baseline above background)						
UCD1-070	Zinc	No trend[c]	No trend[d]	None above baseline	Yes	Quinquennial
UCD1-071	Aluminum	No trend[c]	No trend[d]	None above baseline	Yes	Quinquennial[g]
UCD1-072	Aluminum	No trend[c]	No trend[d]	None above baseline	Yes	Quinquennial
Criterion is background (baseline at or below background or not detected)						
UCD1-021	Aluminum	NA[e]	No trend[d]	2 of 4 above background	Yes	Biennial
UCD1-021	Americium-241	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-023	Mercury	NA[e]	NA[e]	2 of 4 above background	Yes	Biennial
UCD1-023	Zinc	No trend[c]	No trend[d]	None above background	Yes	Quinquennial
UCD1-068	Aluminum	No trend[c]	No trend[d]	3 of 5 above background	Yes	Biennial
UCD1-068	Americium-241	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-068	Nickel	No trend[c]	No trend[d]	None above background	Yes	Quinquennial
UCD1-069	Silver	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-070	Mercury	NA[f]	NA[f]	None above background	Yes	Quinquennial
UCD1-072	Americium-241	NA[f]	NA[f]	None above background	Yes	Quinquennial

Notes:

[a] Monitoring results from 2016 through 2020 compared to baseline when baseline is above background, otherwise monitoring results compared to 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 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; analyte detected in fewer than half of samples.

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

[g] Once every 5 years.

[h] Comparison indeterminant due to detection limits above criteria. Maintain current monitoring frequency and obtain detection limits below criteria when feasible.

Abbreviations:

NA = not applicable; reason noted
WQC = water-quality criteria

C1.4 DOE New Well Constituents (NWCs) Analysis

As shown in Tables C-6 and C-7, the baseline concentrations for 21 well-specific NWCs were above background and three well-specific NWCs have baseline concentrations below or the same as background (or not detected).

C1.4.1 NWCs Currently Monitored Annually

Trend analyses showed no increasing concentration trends for nine of the 11 annually monitored well-specific NWCs having baseline above background (Table C-6). Chloroform in well UCD1-072 had an increasing trend above baseline for the 2011–2020 dataset but no trend during the Reporting Period; its proposed sample collection frequency was maintained at annual. Hexavalent chromium in well UCD1-072 tested positive for an increasing trend above baseline for the 2011–2020 dataset but not for the Reporting Period. While the visual trend evaluation of hexavalent chromium in well UCD1-072 did not indicate an increasing trend for either period, its proposed sample collection frequency was maintained at annual because the sample results were only slightly above baseline during the Reporting Period. Of the nine NWCs that did not show increasing trends, no reductions in monitoring frequency are proposed for six because they had sample results slightly above baseline during the Reporting Period. Gross beta sample results in wells UCD1-068, UCD1-069, and UCD1-070 were consistently at or below background throughout the Reporting Period. Baseline could not be directly compared to the water-quality criterion for gross beta (MCL of 4 millirem per year [mrem/yr]) because the isotopic composition of the beta emitters in the samples was not determined. However, comparison of the maximum gross beta activity concentrations in wells UCD1-068, UCD1-069, UCD1-070, UCD1-071, and UCD1-072 to the 8 picocuries per liter (pCi/L) MCL for Strontium-90 (a beta emitter) provides a conservative indicator of being below the 4 mrem/yr MCL for individual beta emitters. Because the gross beta activity concentration has been consistently below 8 pCi/L in wells UCD1-068, UCD1-069, and UCD1-070 and concentration trends are stable, the proposed monitoring frequency for these NWCs was reduced to biennial.

The proposed monitoring frequency was changed to biennial for iron in well UCD1-069 because all sample results were below the comparison criterion (background) throughout the Reporting Period and trend tests did not indicate an increasing trend (Table C-6).

C1.4.2 NWCs Currently Monitored Biennially

Trend analyses for the 2011–2020 dataset showed no increasing concentration trends for all 10 biennially monitored well-specific NWCs having baseline above background (Table C-7). Of these 10 NWCs, no reductions in monitoring frequency are proposed for five because they had sample results slightly above baseline during the Reporting Period. Although formaldehyde in wells UCD1-068 and UCD1-072 was not detected during the Reporting Period, no reduction in monitoring frequency is proposed because the detection limits are by definition greater than the background value of zero, making comparisons to background indeterminant. Sample results were consistently at or below baseline throughout the Reporting Period for 1,1-dichloroethane and chloroform in well UCD1-069, and benzene in UCD1-071, and their baseline was below water-quality criteria, resulting in a proposed monitoring frequency reduction to quinquennial.

The proposed monitoring frequency was changed to quinquennial for manganese in wells UCD1-069 and UCD1-071 because the sample results were consistently at or below comparison criteria (background) and trend analyses showed no increasing concentration trends.

Table C-6. Trend Test Results, Data Comparisons, and Proposed Monitoring Frequencies for NWCs Currently Monitored Annually

Monitoring Well	**Constituent**	**Trend Analysis**				**5-Year Comparison of Results to Criteria[a]**	**Baseline Below WQC or Background?[b]**	**Proposed Monitoring Frequency**
		Mann Kendall Test Result		**Visual Test Result**				
		2011–2020	**2016–2020**	**2011–2020**	**2016–2020**			
Criterion is baseline (baseline above background)								
UCD1-068	Gross beta	NA[e]	NA[e]	No trend[d]	No trend[d]	None above baseline	Indeterminant[f]	Biennial
UCD1-068	Chromium (hexavalent)	No trend[c]	No trend[c]	No trend[d]	No trend[d]	6 of 8 above baseline	Yes	Annual
UCD1-069	Gross beta	No trend[c]	No trend[c]	No trend[d]	No trend[d]	None above baseline	Indeterminant[f]	Biennial
UCD1-069	Uranium-238	No trend[c]	No trend[c]	No trend[d]	Decreasing trend[d]	5 of 8 above baseline	Yes	Annual
UCD1-070	Gross beta	No trend[c]	No trend[c]	No trend[d]	No trend[d]	None above baseline	Indeterminant[f]	Biennial
UCD1-071	Gross beta	No trend[c]	No trend[c]	No trend[d]	No trend[d]	1 of 5 above baseline	Indeterminant[f]	Annual
UCD1-072	Gross beta	NA[e]	NA[e]	No trend[d]	No trend[d]	1 of 8 above baseline	Indeterminant[f]	Annual
UCD1-072	Chloroform	Increasing trend	No trend [c]	Increasing trend [d]	No trend[d]	All above baseline	Yes	Annual
UCD1-072	Chromium	No trend [c]	No trend [c]	No trend[d]	No trend[d]	3 of 8 above baseline	No	Annual
UCD1-072	Chromium (hexavalent)	Increasing trend	No trend [c]	No trend[d]	No trend[d]	All above baseline	No	Annual
UCD1-072	Uranium-238	No trend [c]	No trend [c]	No trend[d]	No trend[d]	6 of 10 above baseline	Yes	Annual
Criterion is background (baseline historically at or below background or not detected)								
UCD1-069	Iron	No trend [c]	No trend [c]	No trend[d]	No trend[d]	None above background	Yes	Biennial

Notes:

[a] Monitoring results from 2016 through 2020 compared to baseline when baseline is above background, otherwise monitoring results compared to 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 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 when testing 2011–2020 data (DOE 2010); 5% significance level when testing 2016–2020 data (DOE 2016).

[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; less frequent than annual during recent 5 years or analyte detected in fewer than half of all-years samples.

[f] WQC not available since the isotopic composition of the beta emitters in the sample was not determined.

Abbreviations:

NA = not applicable; reason noted	WQC = water-quality criteria

Table C-7. Trend Test Results, Data Comparisons, and Proposed Monitoring Frequencies for NWCs Currently Monitored Biennially

Monitoring Well	**Constituent**	**2011–2020 Trend Analysis**		**5-Year Comparison of Results to Criteria[a]**	**Baseline Below WQC or Background?[b]**	**Proposed Monitoring Frequency**
		Mann Kendall Test Result (1% Significance Level)	**Visual Test Result**			
Criterion is baseline (baseline above background)						
UCD1-068	Chloroform	No trend[c]	No trend[d]	1 of 4 above baseline	Yes	Biennial
UCD1-068	Formaldehyde	NA[e]	NA[e]	Indeterminant [g]	No	Biennial
UCD1-068	Uranium-238	No trend[c]	No trend[d]	5 of 7 above baseline	Yes	Biennial
UCD1-069	1,1-Dichloroethane	NA[e]	NA[e]	None above baseline	Yes	Quinquennial[f]
UCD1-069	Carbon-14	No trend[b]	No trend[d]	1 of 3 above baseline	Yes	Biennial
UCD1-069	Chloroform	NA[e]	NA[e]	None above baseline	Yes	Quinquennial
UCD1-070	Uranium-238	No trend[c]	No trend[d]	4 of 6 above baseline	Yes	Biennial
UCD1-071	Benzene	NA[e]	NA[e]	None above baseline	Yes	Quinquennial
UCD1-071	Uranium-238	No trend [c]	No trend [d]	4 of 6 above baseline	Yes	Biennial
UCD1-072	Formaldehyde	NA[e]	NA[e]	Indeterminant [g]	No	Biennial
Criterion is background (baseline historically at or below background or not detected)						
UCD1-069	Manganese	NA[e]	No trend[d]	None above background	Yes	Quinquennial
UCD1-071	Manganese	No trend[c]	No trend[d]	None above background	Yes	Quinquennial

Notes:

[a] Monitoring results from 2016 through 2020 compared to baseline when baseline is above background, otherwise monitoring results compared to 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 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; analyte detected in fewer than half of samples.

[f] Once every 5 years.

[g] Comparison indeterminant due to detection limits above criteria. Maintain current monitoring frequency and obtain detection limits below criteria when feasible.

Abbreviations:

NA = not applicable; reason noted
WQC = water-quality criteria

C1.5 Summary of Proposed Monitoring Changes

On the basis of this analysis, no well-specific constituent is recommended for removal from the monitoring program, but monitoring for most DOE areas groundwater well-specific constituents can be reduced (Table C-8) and still provide adequate data to evaluate potential groundwater impacts. Of the 72 well-specific constituents monitored:

- Chromium and hexavalent chromium in well UCD1-071 showed increasing trends above comparison criteria during the Reporting Period by both the Mann Kendall and visual tests. Following existing procedures in the RD/RAWP, 1 year of quarterly sample collection was conducted for these well-specific constituents starting in 2020 and spanning into the second quarter of 2021. Contingent remediation will be evaluated if the four quarters of monitoring data support a significant increasing trend above baseline and water-quality criteria; otherwise, these well-specific constituents will be returned to annual frequency.
- The sample collection frequency remains unchanged for 21 well-specific constituents because some or all of their sample results during the Reporting Period were slightly above criteria (background or baseline, as applicable) but they did not have increasing trends.
- The sample collection frequency remains unchanged for five well-specific constituents that had sample results above criteria, did not have increasing trends for the Reporting Period data, but the 2011–2020 sample results did display increasing trends.
- The sample collection frequency remains unchanged for four well-specific constituents that were not detected during the Reporting Period but are organic chemicals having detection limits above their background comparison criteria (organic chemical background = zero). Their evaluation is indeterminant.
- The sample collection frequency was reduced (annual to biennial or biennial to quinquennial) for 40 well-specific constituents that did not have increasing trends and did not exceed applicable criteria during the Reporting Period.

If approved, biennial sample collection during the following 5 years will be performed in 2022 and 2024, and quinquennial sampling performed in 2025.

Trend analysis for the next Five-Year Review in 2025 will include the following:

- Testing of all monitoring data collected from 2011 through 2025 at the 1% significance level (applicable for $n \geq 5$ [Gilbert 1987, Table A18])
- Testing of the Five-Year Review period annually monitored data only (i.e., 2021–2025 data) at the 5% significance level (applicable for $n \geq 4$ [Gilbert 1987, Table A18])
- Visual trend evaluation for both datasets

Table C-8. Proposed 2021–2025 DOE Sampling Plan

	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	🟩 Qq			🟦 Qq													🟦 A	🟦 B					
UCD1-023						🟦 A										🟩 B			🟦 Qq						🟩 Qq
UCD1-054							🟦 Qq			🟦 Qq	🟦 Qq					🟦 Qq	🟦 Qq					🟦 Qq	🟦 Qq		
UCD1-068		🟩 B	🟩 Qq		🟪 B	🟦 Qq			🟪 B	🟪 A	🟩 A		🟪 B					🟩 Qq	🟦 Qq	🟦 B	🟦 A			🟪 B	
UCD1-069	🟪 Qq	🟩 A			🟪 B	🟪 B			🟪 Qq				🟦 B	🟪 B	🟪 Qq		🟦 Qq		🟦 B			🟩 Qq		🟪 A	
UCD1-070					🟪 B	🟦 A										🟩 Qq			🟦 Qq					🟪 B	🟩 Qq
UCD1-071		🟩 Qq		🟪 Qq	🟪 A		🟦 Qq			🟦 Q[a]	🟦 Q[a]				🟪 Qq	🟦 B	🟦 Qq					🟦 Qq	🟦 Qq	🟪 B	
UCD1-072		🟩 Qq	🟩 Qq		🟪 A	🟦 Qq			🟪 A	🟪 A	🟪 A		🟪 B						🟦 A	🟦 Qq				🟪 A	

Notes:

🟩	monitoring-only constituent
🟪	new well constituent
🟦	constituent of concern

Note:

[a] Evaluate contingent remediation if four quarters of monitoring data indicate a significant increasing trend above baseline and water-quality criteria; otherwise return to annual frequency.

Abbreviations:
A = annual
B = biennial (once every 2 years; to be sampled in 2022 and 2024)
Q = quarterly
Qq = Quinquennial (once every 5 years; to be sampled in 2025)

C1.6 Groundwater Gradient and Monitoring Well Location Evaluation

Quarterly groundwater elevation data were examined from 2011 through 2019 to determine whether the existing monitoring well locations are adequate to ensure that the groundwater monitoring/contingent remedial action component of the DOE remedies is functioning as intended. These data included point water elevation measurements at individual wells and the resulting quarterly interpreted groundwater elevation contours, taken from the Annual Water Monitoring Reports for each year (Weiss 2013a; Weiss 2014; Weiss 2016a; Weiss 2016b; Weiss 2016c; Weiss 2017; Weiss 2018; Weiss 2019; Weiss 2020; Weiss 2021). Figures presenting interpreted groundwater elevation contours in hydrostratigraphic unit (HSU-1) wells for each quarter, taken from each of these reports, are presented in Attachment C-5. The evaluation included both a general case for the western portion of the LEHR site and well-specific/local area gradients as discussed below.

An evaluation of the groundwater gradient in the northern half of the former Western Dog Pens was conducted to estimate the generalized horizontal groundwater gradient and flow direction for the DOE Areas. Derived estimates for horizontal groundwater gradient and flow direction are tabulated in Table C-9, along with the primary data used to derive the estimate (specific wells or contours). In cases where wells were predominantly dry or where the gradient in this area was otherwise indeterminable (e.g., no gradient), a value of "NA" was assigned. These estimates of magnitude and azimuth for horizontal groundwater gradients were broken into their north/south and east/west vector components and vector-averaged, to yield an estimate of the overall average horizontal gradient and flow direction to the northeast, with a range between northwest and southwest. This analysis provides the basis for the generalized groundwater flow direction arrows shown in Figure 3 of the main report.

Because the groundwater gradient direction varies spatially and temporally within the DOE Areas, local area groundwater gradient directions were determined by inspection for each of the eight wells monitored by DOE—wells UCD1-021, UCD1-023, UCD1-054, UCD1-068, UCD1069, UCD1-070, UCD1-071, and UCD1-072 for each quarter between 2011 and 2019 (Table C-10). As noted above, in cases where either wells were predominantly dry or where the gradient in this area was otherwise indeterminable (e.g., no gradient), a value of "NA" was assigned. As shown in Table C-10, the results show that while the gradient varies spatially and temporally, there is a distinct dominant gradient direction to the northeast. Well UCD1-070, which is the closest well to the South Fork of Putah Creek, exhibits higher frequencies of gradients directed to the north than other site wells, while groundwater gradients in the area near wells UCD1-054 and UC1-071 exhibit higher frequencies of gradients directed to the northwest, particularly in early winter months following relatively dry years.

As shown in Table C-10, during the majority of time between 2011 and 2019, the groundwater gradient was to the northeast in all monitoring wells in the DOE Areas (i.e., all wells exhibit a northeast direction for more than 50% of the quarters with valid gradient determinations). As this was the assumed dominant groundwater gradient used for siting wells in the RD/RAWP and the existing monitoring wells are located northeast of the potential sources of residual contaminants in soil in the DOE Areas, this gradient analysis confirms that the gradient direction assumptions applied in the RD/RAWP remain reasonable, and demonstrates that existing well locations are adequate to generate data to confirm remedy protectiveness and achievement of the remedial action objectives.

As discussed above in Section C1.2.1.1, concentrations of total and hexavalent chromium have been increasing recently in well UCD1-071. Coupled with the observed higher frequency of groundwater gradients to the northwest near wells UCD1-054 and UCD1-071, as discussed above, there is a need to develop a specific hydrogeologic conceptual model for the northwest corner of the site to help determine whether chromium is migrating to the northwest from the DSS 1 area or if releases of chromium from a different source closer to well UCD1-073 are impacting groundwater quality near well UCD1-071. These uncertainties have prevented the use of well UCD1-073 as a background well as originally intended.

To address these flow and transport uncertainties, DOE plans to use existing well logs, groundwater contaminant concentration data, and existing and new groundwater elevation data to evaluate the durations, magnitudes, and direction of gradients in the vicinity of wells UCD1-054, UCD1-071, and UCD1-073. A recommendation for this evaluation has been included Table 11 in Section 8.0 of the main report.

Table C-9. Estimated Groundwater Flow Direction and Horizontal Groundwater Gradients in the Northern Half of the Former Western Dog Pens, 2011–2019

Year	Quarter	Direction (cardinal)	Estimated Groundwater Flow Direction (azimuth)	Estimated Horizontal Gradient Range	Average Horizontal Gradient Estimate	Basis for Estimate
2011	1	ENE	60°	0.0031	0.0031	UCD1-023, UCD1-069
	2	NE	47°	0.0019–0.005	0.0120	UCD1-020, UCD1-023, UCD1-024
	3	ENE	58°	0.009	0.0090	3 ft and 4 ft contours
	4	NE	53°	0.0005	0.0005	6 ft contour, UCD1-020, UCD1-068
2012	1	ENE	55°	0.0013–0.0014	0.0014	UCD1-068, UCD1-023, 10-ft contour
	2	ENE	54°	0.0048–0.0066	0.0057	3 ft and 4 ft contours, UCD1-070
	3	ENE	71°	0.0028	0.0028	15 ft and 16 ft contours, UCD1-023
	4	ESE	111°	0.0115–0.0006	0.0061	0 ft and 1 ft contours, UCD1-024
2013	1	NE	42°	0.0033	0.0330	7 ft and 8 ft contours, UCD1-069
	2	NE	52°	0.0085	0.0850	0 ft and 1 ft contours
	3	ESE	115°	0.0164	0.0164	18 ft and 19 ft contours
	4	ESE	112°	0.0002–0.0018	0.0010	6 ft and 6.5 ft contours
2014	1	E	95°	0.0008	0.0008	UCD1-068, UCD1-024
	2	NNE	33°	0.0625	0.0625	10 ft and 11 ft contours
	3	NA	NA	NA	NA	NA
	4	NNE	15°	0.000–0.002	0.0010	UCD1-021, UCD1-068, UCD1-072
2015	1	NNE	27°	0.0078–0.0091	0.0085	2 ft and 2.5 ft contours, UCD1-069
	2	ENE	74°	0.0052	0.0052	3 ft and 3.5 ft contours
	3	NE	48°	0.0019	0.0019	23 ft contour, UCD1-020
	4	NA	NA	NA	NA	NA
2016	1	NA	NA	NA	NA	NA
	2	NA	NA	NA	NA	NA
	3	NA	NA	NA	NA	NA
	4	ENE	70°	0.0024	0.0024	9 ft, 8 ft, and 7 ft contours, UCD1-068
2017	1	NNE	14°	0.0127–0.0171	0.0149	18 ft and 20 ft contours, UCD1-023
	2	NE	40°	0.0035–0.0052	0.0044	10 ft contour, UCD1-069, UCD1-023
	3	ENE	60°	0.0027	0.0027	0 ft and 1 ft contours
	4	ENE	72°	0.0009–0.0012	0.0051	8 ft contour, UCD1-068, UCD1-020

Table C-9. Estimated Groundwater Flow Direction and Horizontal Groundwater Gradients in the Northern Half of the Former Western Dog Pens, 2011–2019 (continued)

Year	Quarter	Direction (cardinal)	Estimated Groundwater Flow Direction (azimuth)	Estimated Horizontal Gradient Range	Average Horizontal Gradient Estimate	Basis for Estimate
2018	1	NNE	30°	0.0004	0.0004	UCD1-68, UCD1-020, UCD1-021
	2	NNE	35°	0.0025–0.0040	0.0033	8 ft contour, UCD1-024, UCD1-068
	3	ESE	100°	0.0032	0.0032	10 ft contour, UCD1-068
	4	NA	NA	NA	NA	NA
2019	1	NNE	22°	0.0106–0.012	0.0113	22 ft and 21 ft contours, UCD1-068
	2	NNE	16°	0.0034	0.0034	11 ft contour, UCD1-202
	3	NE	47°	0.0010–0.0017	0.0014	2 ft contour, UCD1-068, UCD1-020
	4	ENE	77°	0.001	0.0010	8 ft and 9 ft contours, UCD1-069

Abbreviations:
E = east
ENE = east-northeast
ESE = east-southeast
ft = feet
NA = not applicable; gradient unable to be determined with confidence from either nearby well data or contouring of broader site data
NE = northeast
NNE = north-northeast

Table C-10. Well-Specific Groundwater Gradient Direction and Monitoring Well Location Adequacy Evaluation

Year	**Quarter**	**Well ID**							
		UCD1-021	**UCD1-023**	**UCD1-054**	**UCD1-068**	**UCD1-069**	**UCD1-070**	**UCD1-071**	**UCD1-072**
		Well-Specific Groundwater Gradient Direction							
2011	1	NE	NE	NE	NE	NE	NE	NA[a]	NE
	2	NE	NE	NE	NE (e)	NE (e)	NE	NE (e)	NE (e)
	3	NE	NE	NE	NE	NE	NE	NE	NE
	4	NE	NE	NE	NE	NE	N	NE	NE
2012	1	NE	NE	NE	NE	NE	NE	NE	NE
	2	NE	NE	NE	NE	NE	NE	NE	NE
	3	E	NE	NE	NE (e)	NE (e)	NA (Dry)	NA (Dry)	NE (e)
	4	E	SE	SE	SE	SE	N	SE	E
2013	1	NE	NE	NW	NE	NE	NE	NW	NW
	2	NW	NE	N	NE	NE	NE	NW	N
	3	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]
	4	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]
2014	1	E	NE	E	E	NE	N	E	E
	2	E	N	N	N	NE	N	NE	E
	3	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]
	4	NE	NA[d]	NW	NA[d]	NA[d]	NA[4] (Dry) (e)	NW	NE
2015	1	E	S	NW	S	S	E	NW	E
	2	N	NE	N	E	NE	NE	NW	N
	3	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]
	4	E	E	NW	E	E	N	E	NA[d]
2016	1	NE	SW	NW	N	N	N	NW	NE
	2	E	E	NE	E	E	N	NE	E
	3	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]
	4	E	SW	SW	SW	SW	SW	SW	E
2017	1	NE	NE	NE	NE	NE	N	NE	NE
	2	NE	NE	NE	NE	NE	NE	NE	NE
	3	NE	NE	NE	NE	NE	NE	NE	NE
	4	NE	NE	NE	NE	NE	NE	NE	NE

Table C-10. Well-Specific Groundwater Gradient Direction and Monitoring Well Location Adequacy Evaluation (continued)

Year	**Quarter**	**Well ID**							
		UCD1-021	**UCD1-023**	**UCD1-054**	**UCD1-068**	**UCD1-069**	**UCD1-070**	**UCD1-071**	**UCD1-072**
		Well-Specific Groundwater Gradient Direction							
2018	1	NE	NE	NE	NE	NE	NE	NE	NE
	2	NE	NE	NE	NE	NE	NE	E	NE
	3	E	NE	NE	NE	E	NE (e)	NE	NE
	4	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]
2019	1	NE	NE	NE	NE	NE	NE	NE	NE
	2	N	NE	N	NE	NE	NE	NE	N
	3	NE	NE	NE	NE	NE	NE	NE	NE
	4	NE	NE	NE	NE	NE	NE	NE	NE
Dominant Gradient Direction		NE	NE	NE	NE	NE	NE	NE	NE
Persistence of Dominant Gradient[f]		0.60	0.76	0.60	0.69	0.76	0.64	0.61	0.66
Well Location with Respect to Center of Potential Source		NE	NE	NE	NE	NE	NE	NE	NE
Is monitoring location adequate to generate data to confirm remedy protectiveness and achievement of RAOs?		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:

[a] Water level in well UCD1-071 was anomalous and not used in gradient analysis.

[b] Water levels affected by water pipe leak near Ra/Sr Treatment Area; gradient determination not possible.

[c] Majority of HSU-1 wells dry; gradient determination not possible.

[d] Well at or near groundwater gradient divide; gradient direction not definable.

[e] Gradient generally flat with anomalies; gradient direction not definable.

[f] Ratio of the total count of dominate gradient observations divided by the total number of quarters with valid gradient determinations.

Gradient direction determined by inspection of quarterly groundwater gradient maps from annual water monitoring reports for the LEHR site (see Attachment C-5).

Dry = well dry; water elevation below well bottom elevation
(e) = water level not measured or well dry; gradient direction extrapolated from nearby well elevations

Abbreviations:
E = east, NA = not applicable, NA (Dry) = not applicable; well dry, N= north, NE = northeast, NW = northwest, Ra/Sr = Radium/Strontium, RAO = remedial action objective, S = south, SW = southwest

C2.0 References

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Attachment C-1

2016–2020 Sampling Program Summaries

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Table 24. 2016 DOE Areas Constituents, Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

		Radiological Analytes							Chemical Analytes																	
Monitoring Wells	**Area Monitored**	**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**	**Electrical Conductivity**
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.

Table 24. 2017 DOE Areas Constituents, Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

		Radiological Analytes							Chemical Analytes																	
Monitoring Wells	**Area Monitored**	**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**	**Electrical Conductivity**
UCD1-013	Eastern Dog Pens	---		---	---	---	---	---	---	MOC (Y)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	MOC (Y)
UCD1-021	DSS 5 and Ra/Sr System	MOC (N)	---	COC (N)	---	COC (Y)	---	---	---	---	MOC (N)	---	---	---	---	---	---	---	---	---	---	COC (Y)	---	---	---	MOC (Y)
UCD1-023	Southwest Trenches	---	---	COC (N)	---	---	---	---	---	---	---	---	---	---	---	---	MOC (N)	---	---	---	---	COC (N)	---	---	MOC (N)	MOC (N)
UCD1-054	Dry Wells A-E Area	---	---	---	COC (N)	---	COC (N)	---	---	---	---	---	---	COC (N)	COC (N)	---	COC (N)	---	---	COC (N)	---	---	---	COC (N)	---	MOC (N)
UCD1-068	DSS 4 and Ra/Sr System	MOC (N)	NWC (Y)	COC (N)	---	COC (N)	---	NWC (N)	---	---	MOC (N)	---	NWC (N)	NWC (Y)	MOC (Y)	NWC (N)	---	---	---	---	MOC (Y)	COC (N)	COC (Y)	---	---	MOC (Y)
UCD1-069	DSS 3	---	NWC (Y)	NWC (N)	---	---	---	NWC (Y)	NWC (N)	---	MOC (Y)	---	NWC (N)	---	---	COC (N)	---	NWC (Y)	NWC (N)	COC (N)	---	COC (Y)	---	MOC (N)	---	MOC (Y)
UCD1-070	Southwest Trenches	---	NWC (Y)	COC (Y)	---	---	---	NWC (N)	---	---	---	---	---	---	---	---	MOC (N)	---	---	---	---	COC (N)	---	---	MOC (N)	MOC (Y)
UCD1-071	Dry Wells A-E Area and DSS 1	---	NWC (Y)	---	COC (N)	---	COC (N)	NWC (N)	---	---	MOC (N)	NWC (N)	---	COC (Y)	COC (Y)	---	COC (N)	---	NWC (N)	COC (N)	---	---	---	COC (N)	---	MOC (Y)
UCD1-072	DSS 6 and Ra/Sr System	MOC (N)	NWC (Y)	COC (N)	---	COC (N)	---	NWC (Y)	---	---	MOC (N)	---	NWC (Y)	NWC (Y)	NWC (Y)	NWC (N)	---	---	---	---	---	COC (Y)	---	---	---	MOC (Y)

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.

Sampled in 2017	Not sampled in 2017	
COC (Y)	COC (N)	constituent of concern
MOC (Y)	MOC (N)	monitoring-only constituent
NWC (Y)	NWC (N)	new well constituent

Acronyms/Abbreviations:

--- - constituent not monitored in this well
DOE - U.S. 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.

Table 24. 2018 DOE Areas Constituents, Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

Monitoring Wells	Area Monitored	Radiological Analytes							Chemical Analytes																	
		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**	**Electrical Conductivity**
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 - U.S. Department of Energy
DSS - domestic septic system
Ra/Sr - radium/strontium

References:

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,* November.

Table 29. DOE Areas Water Monitoring Program in 2019 and 2020, Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

			Radiological Analytes							Chemical Analytes																		
Monitoring Wells	**Area Monitored**	**Program Year**	**Americium-241**	**Gross Beta**	**Carbon-14**	**Cesium-137**	**Radium-226**	**Strontium-90**	**Uranium-238**	**Aluminum**	**Benzene**	**Chlordane**	**Chloroform**	**Chromium (Hexavalent)**	**Chromium, Total**	**1,1-Dichloroethane**	**Dieldrin**	**Formaldehyde**	**Iron**	**Manganese**	**Mercury**	**Molybdenum**	**Nickel**	**Nitrates (as Nitrogen)**	**Selenium**	**Silver**	**Zinc**
UCD1-013	Eastern Dog Pens	2019										A					A										
		2020										🟩 A					🟩 A										
UCD1-021	DSS 5 and Ra/Sr System	2019					A																	A			
		2020	🟩 B		🟩 B		🟩 A			🟩 B														🟩 A			
UCD1-023	Southwest Trenches	2019			A[a]																						
		2020			🟧 A																🟩 B			🟩 B			🟩 B
UCD1-054	Dry Wells A-E Area	2019																									
		2020				🟩 B		🟩 B						🟩 B	🟩 B						🟩 B	🟩 B				🟩 B	
UCD1-068	DSS 4 and Ra/Sr System	2019		A										A	A										A		
		2020	🟩 B	🟩 A	🟩 B		🟩 B		🟩 B	🟩 B			🟩 B	🟩 A	🟩 A			🟩 B					🟩 B	🟩 B	🟩 A		
UCD1-069	DSS 3	2019		A					A	A									A					A			
		2020		🟩 A	🟩 B				🟩 A	🟩 A			🟩 B			🟩 B		🟩 B	🟩 A	🟩 B		🟩 B		🟩 A		🟩 B	
UCD1-070	Southwest Trenches	2019		A	A																						
		2020		🟩 A	🟩 A				🟩 B												🟩 B			🟩 B			🟩 B
UCD1-071	Dry Wells A-E Area and DSS 1	2019		A										A	A						A[a]						
		2020		🟩 A		🟩 B		🟩 B	🟩 B	🟩 B	🟩 B			🟩 A	🟩 A					🟩 B	🟩 B	🟩 B				🟩 B	
UCD1-072	DSS 6 and Ra/Sr System	2019		A					A				A	A	A									A			
		2020	🟩 B	🟩 A	🟩 B		🟩 B		🟩 A	🟩 B			🟩 A	🟩 A	🟩 A			🟩 B						🟩 A			

Notes:

[a] Annual sample in the first quarter of 2019; if 2019 result is below comparison criteria, resume biennial frequency.

🟩	no change in sampling frequency	A - annual
🟧	increase in sampling frequency	B - biennial (once every 2 years)

Abbreviations:
DOE - U.S. Department of Energy
DSS - domestic septic system
Ra/Sr - radium/strontium
UCD - University of California, Davis

Attachment C-2

Data Analysis Graphs

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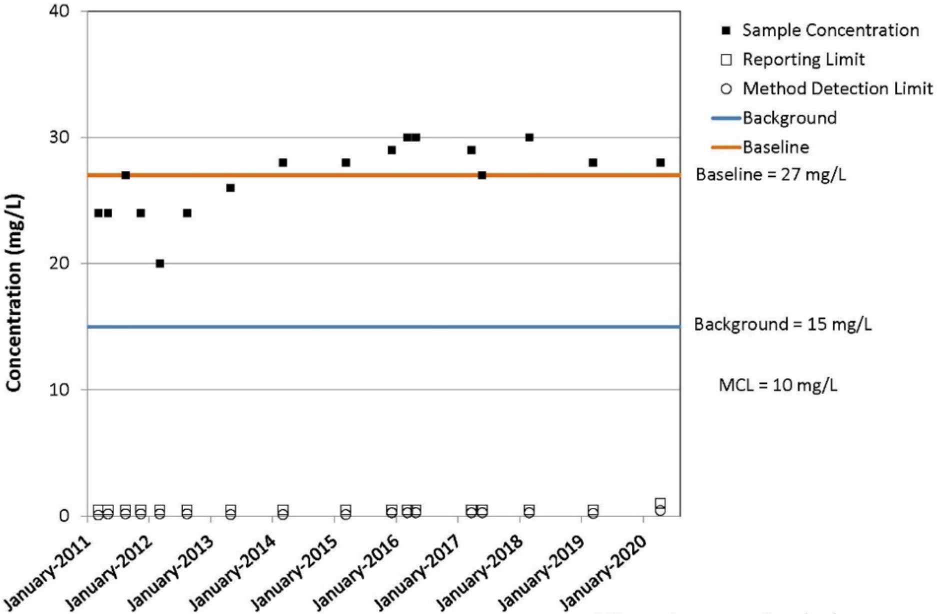
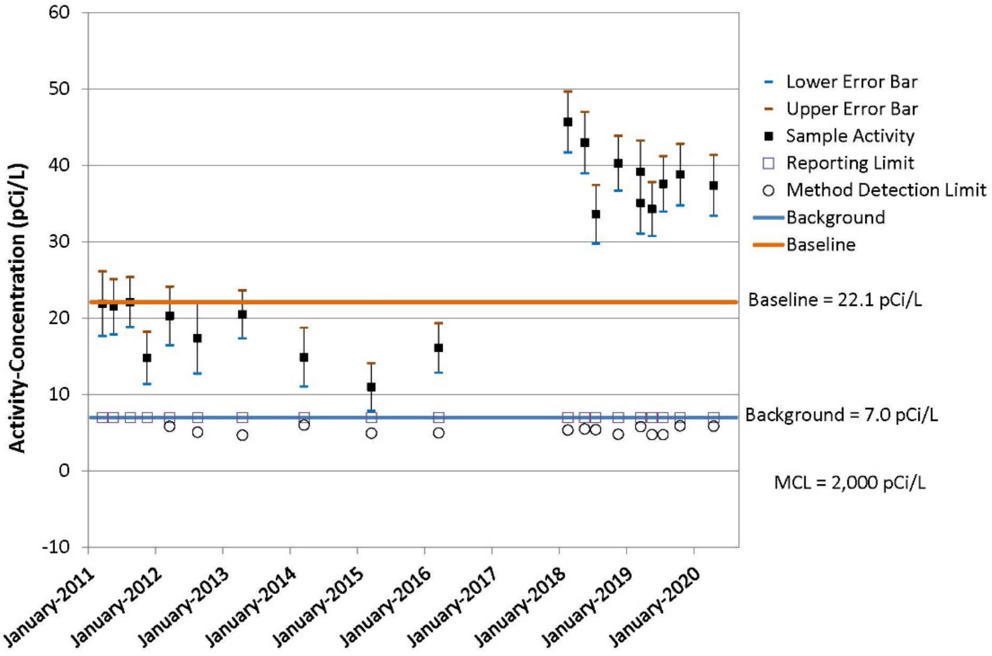
C2.1 Constituents of Concern (COCs)

C2.1.1 COCs Monitored Currently Monitored Annually, Baseline Above Background (Trends Summarized in Table C-2)



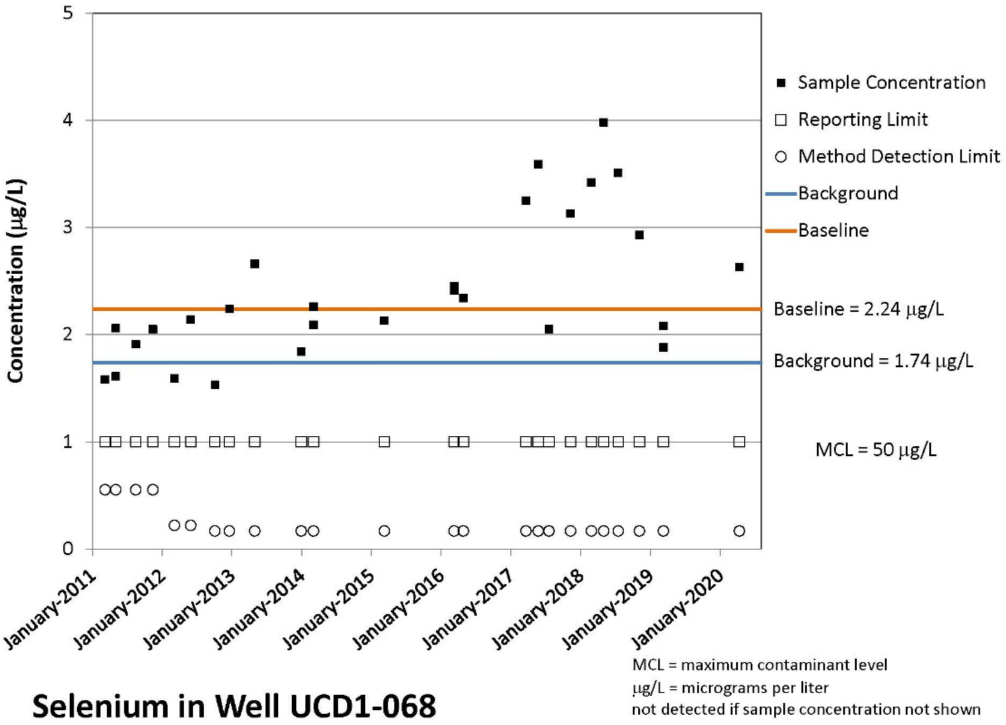
MCL = maximum contaminant level
mg/L = milligrams per liter
not detected if sample concentration not shown

Nitrate in Well UCD1-021



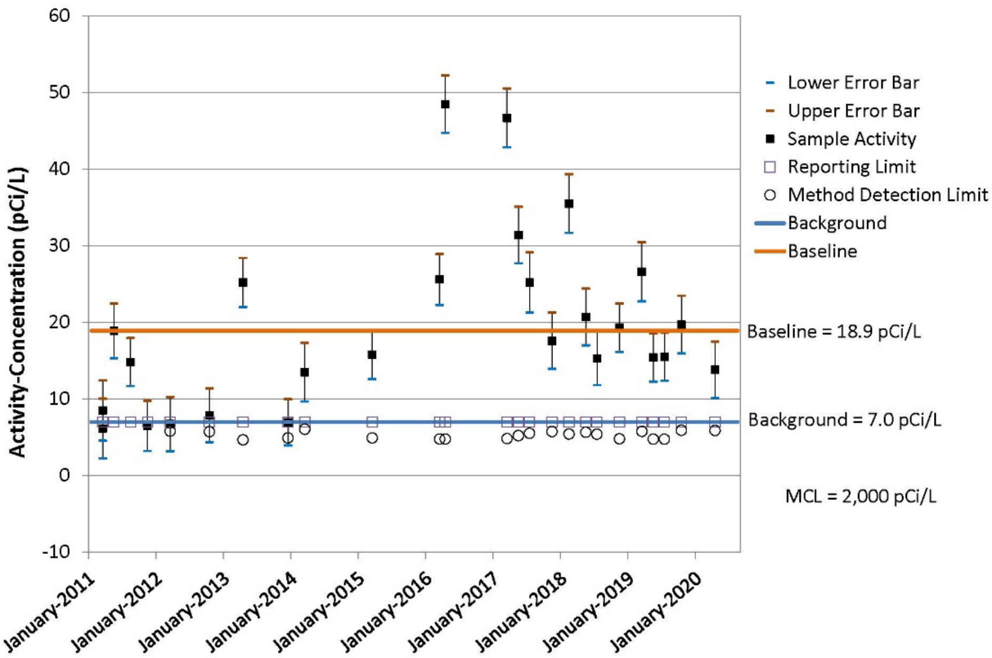
Carbon-14 in Well UCD1-023

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



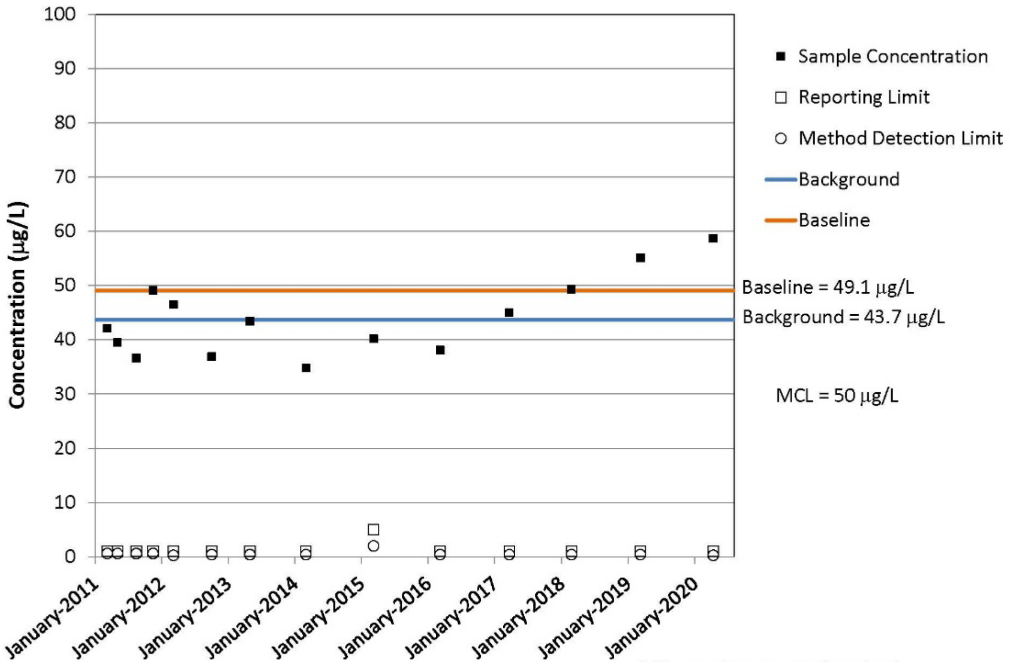
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

Selenium in Well UCD1-068



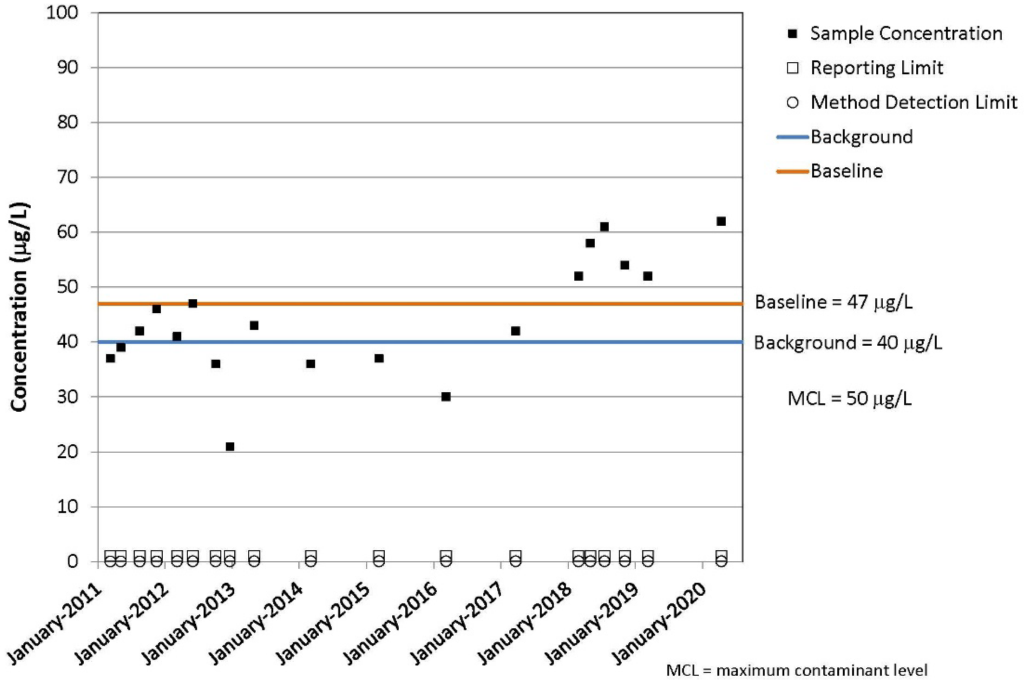
Carbon-14 in Well UCD1-070

MCL = maximun contaminant level



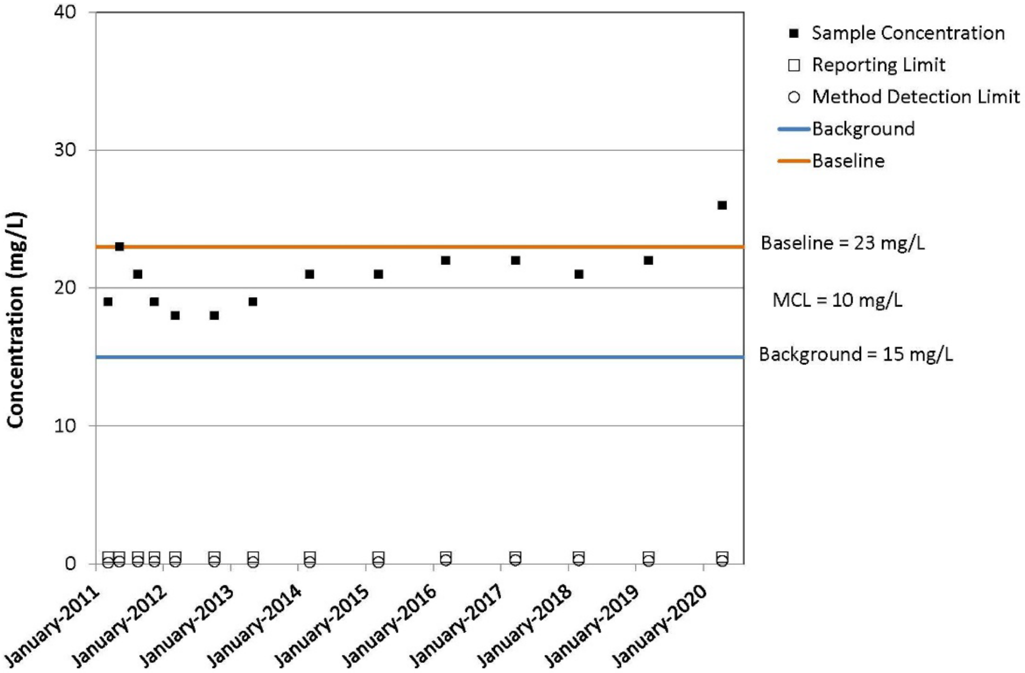
Chromium in Well UCD1-071

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



Hexavalent Chromium in Well UCD1-071

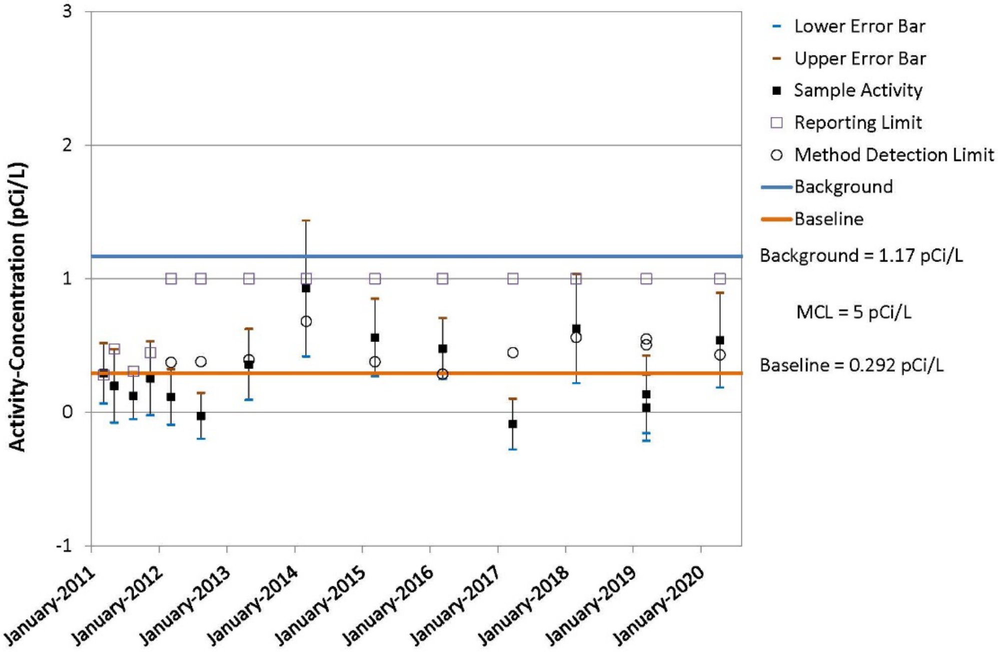
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



Nitrate in Well UCD1-072

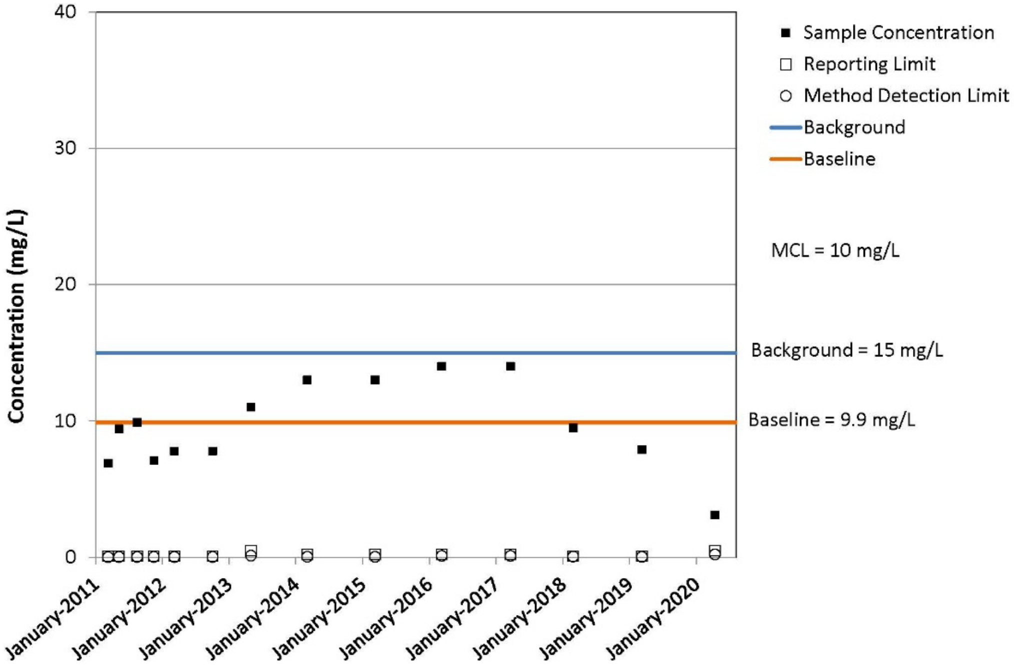
MCL = maximum contaminant level
mg/L = milligrams per liter
not detected if sample concentration not shown

C2.1.2 COCs Currently Monitored Annually, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-2)



Radium-226 in Well UCD1-021

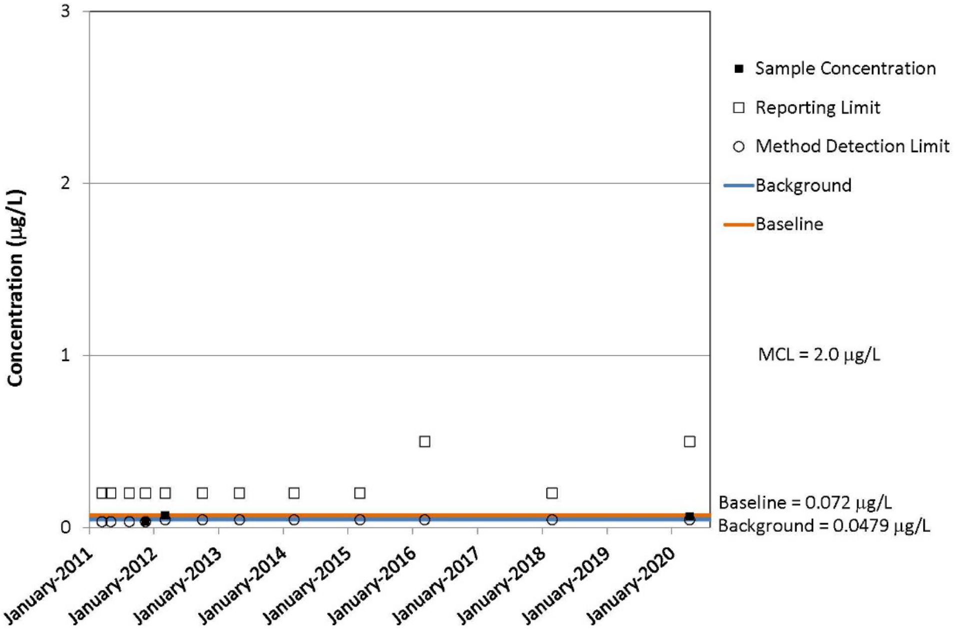
MCL = maximum contaminant level
pCi/L = picocuries per liter



Nitrate in Well UCD1-069

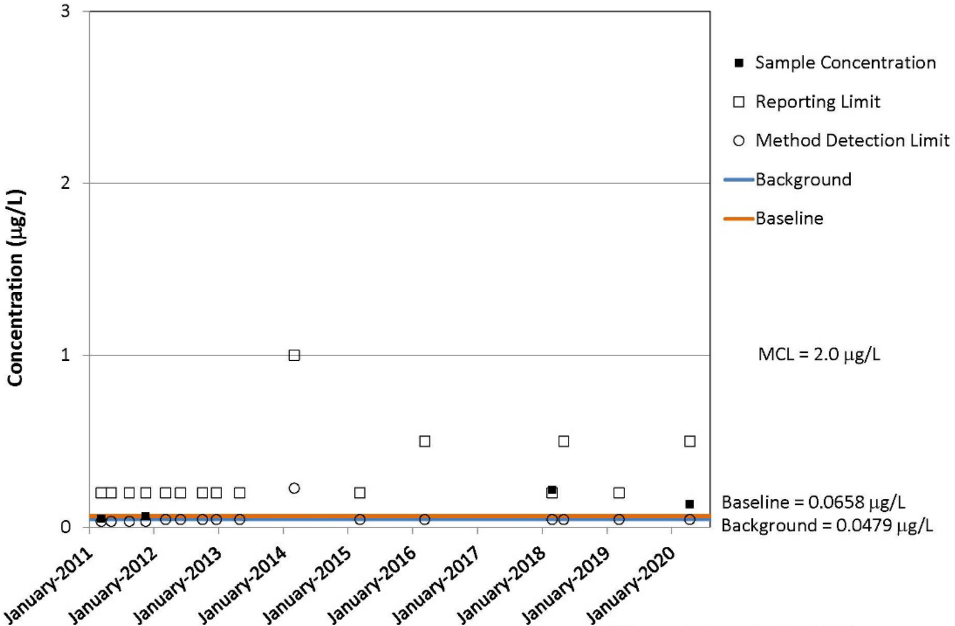
MCL = maximum contaminant level
mg/L = milligrams per liter
not detected if sample concentration not shown

C2.1.3 COCs Currently Monitored Biennially, Baseline Above Background (Trends Summarized in Table C-3)



Mercury in Well UCD1-054

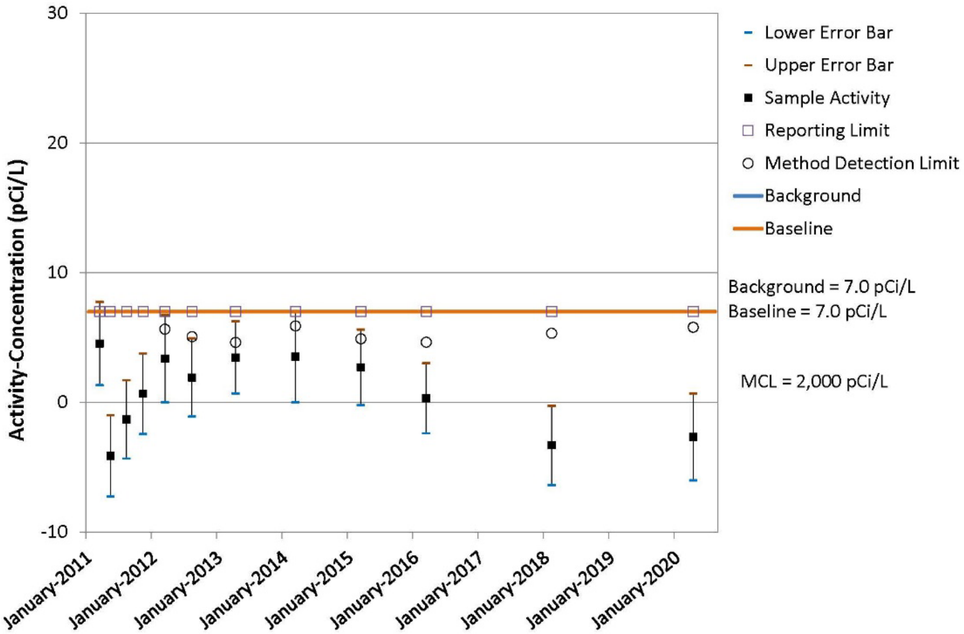
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



Mercury in Well UCD1-071

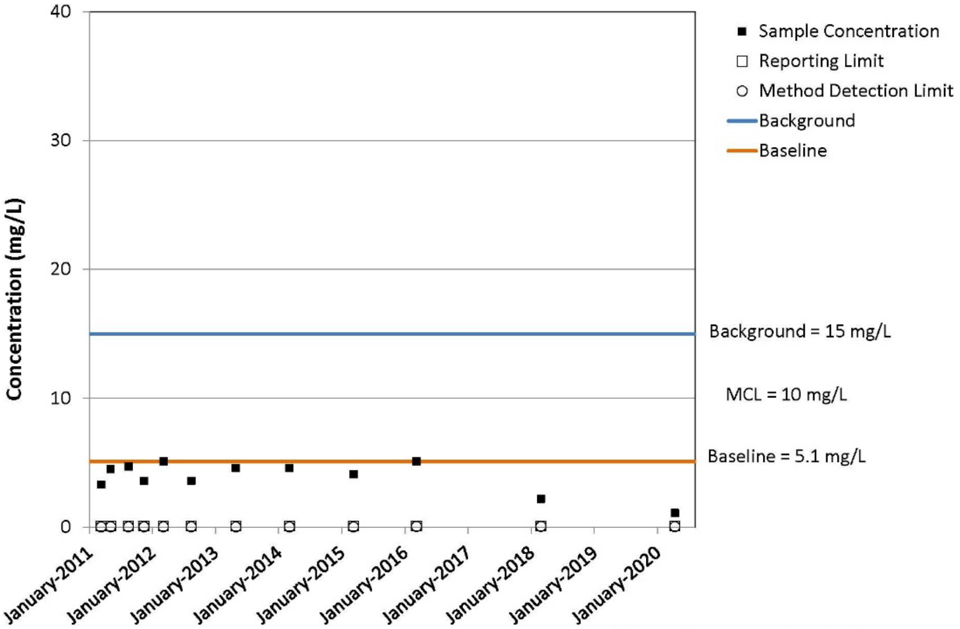
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

C2.1.4 COCs Currently Monitored Biennially, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-3)



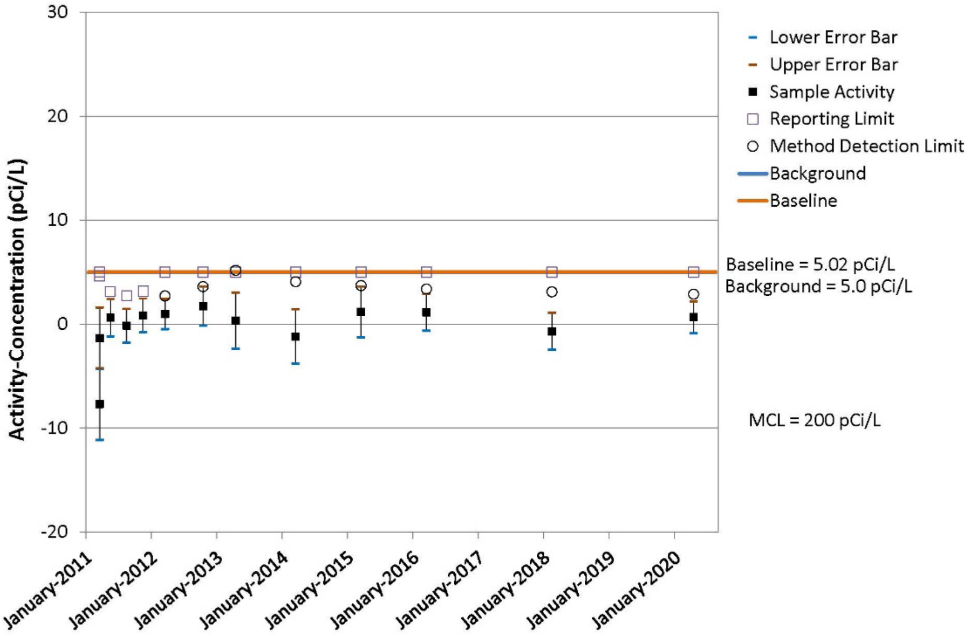
Carbon-14 in Well UCD1-021

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



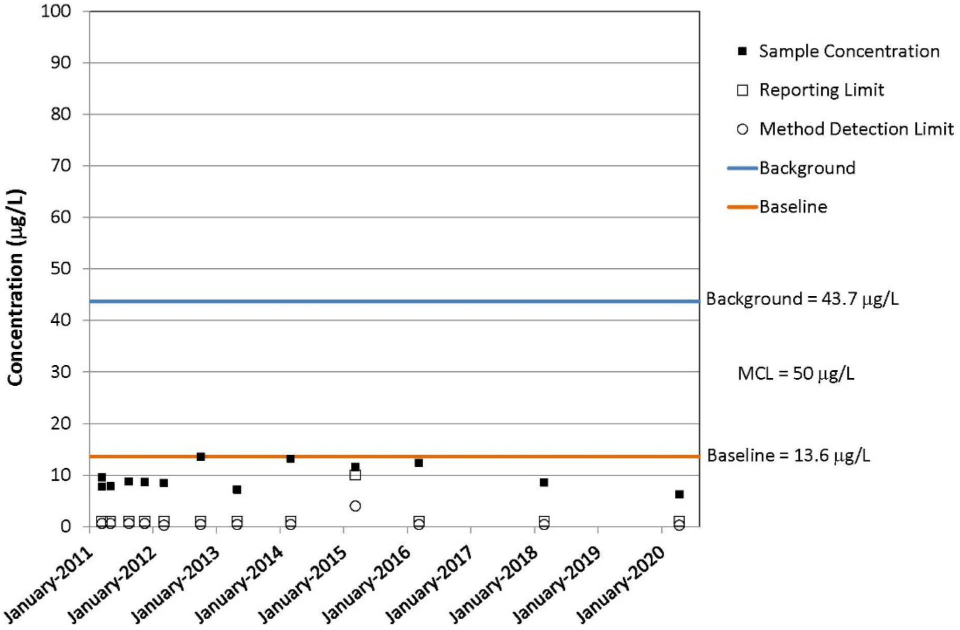
Nitrate in Well UCD1-023

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



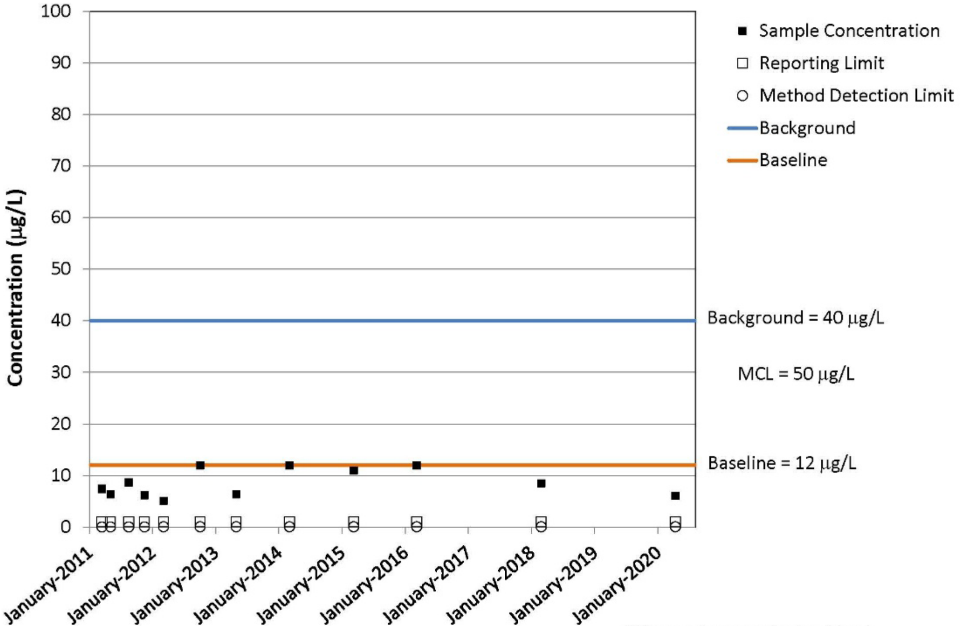
Cesium-137 in Well UCD1-054

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



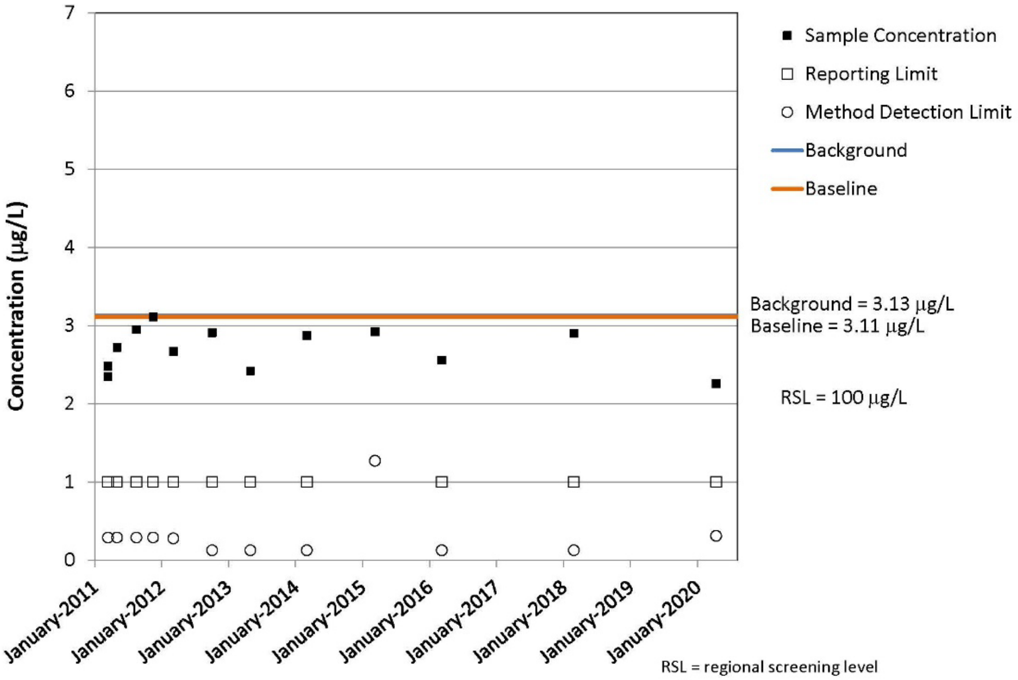
Chromium in Well UCD1-054

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



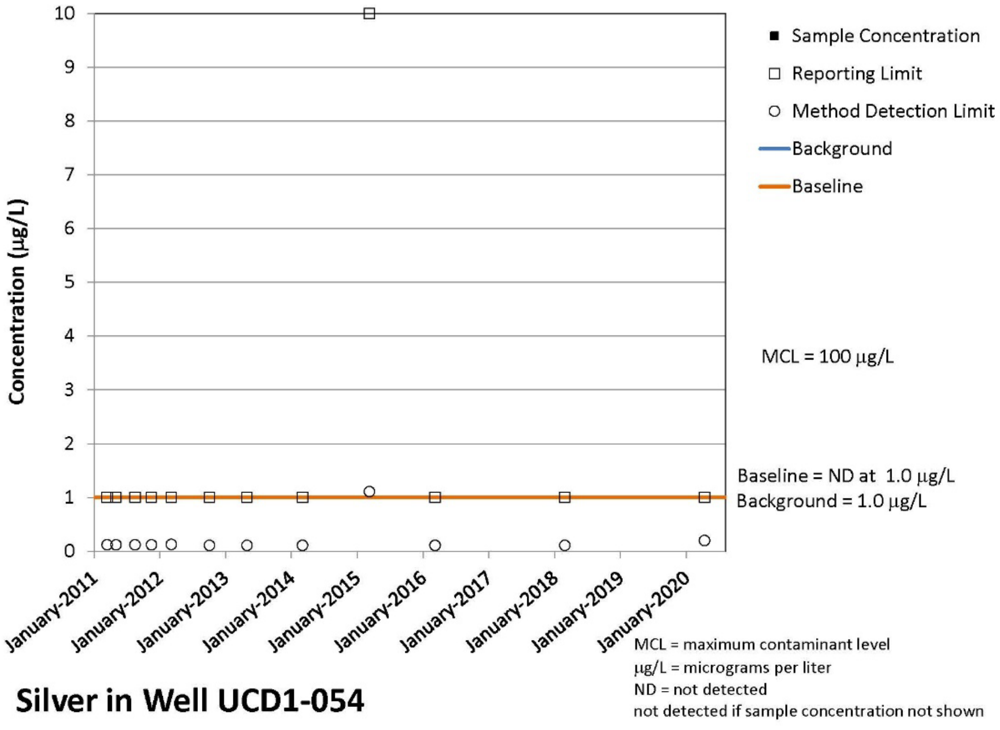
Hexavalent Chromium in Well UCD1-054

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



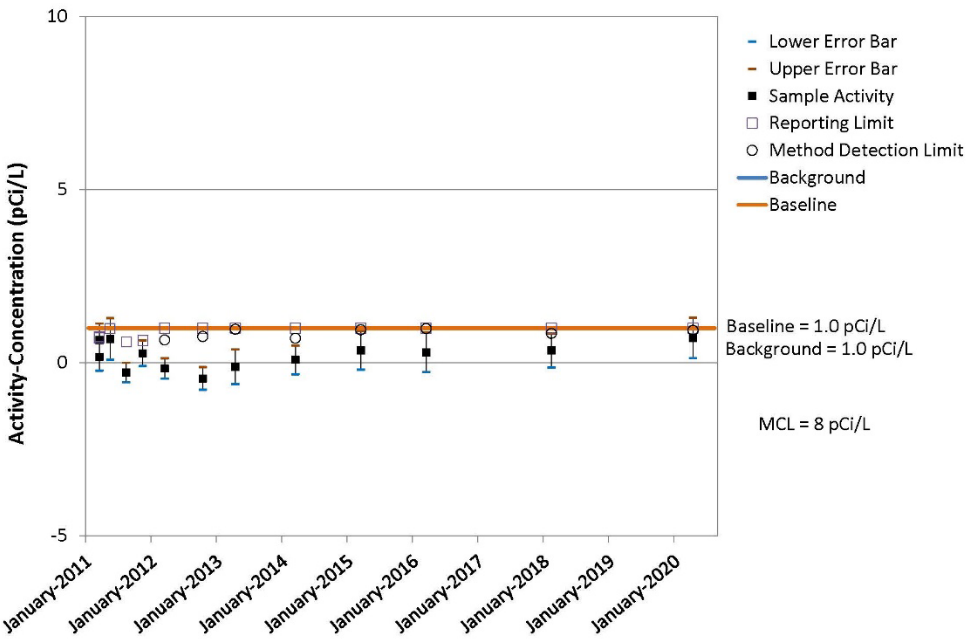
Molybdenum in Well UCD1-054

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



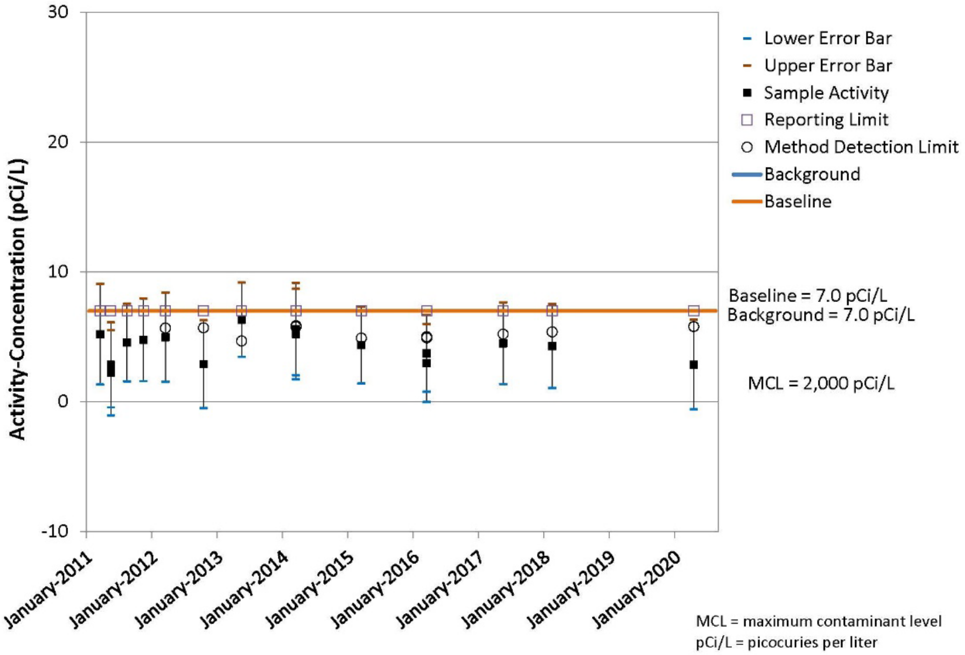
MCL = maximum contaminant level
µg/L = micrograms per liter
ND = not detected
not detected if sample concentration not shown

Silver in Well UCD1-054

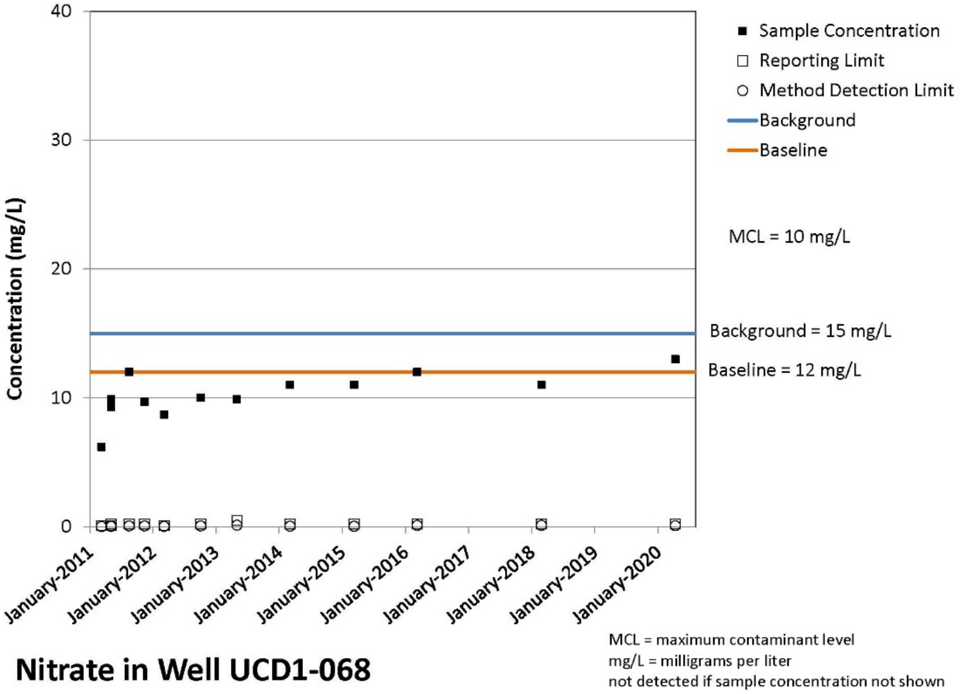


Strontium-90 in Well UCD1-054

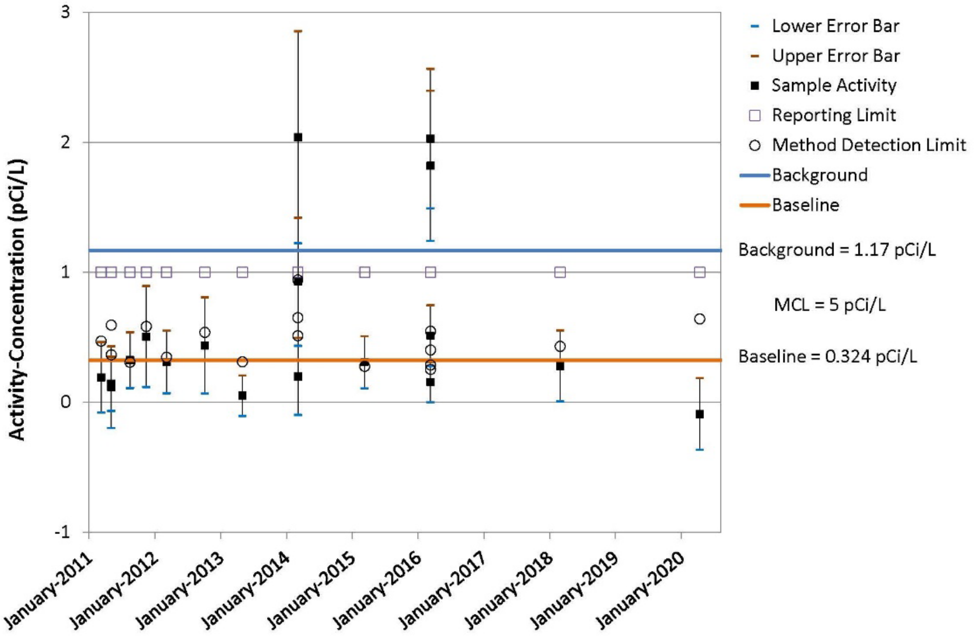
MCL = maximum contaminant level



Carbon-14 in Well UCD1-068

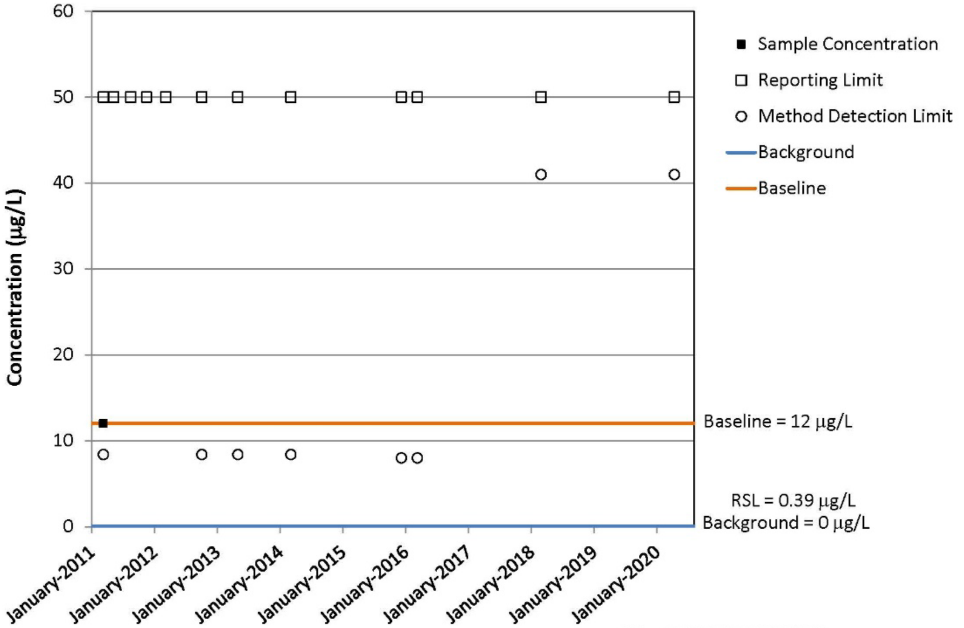


Nitrate in Well UCD1-068



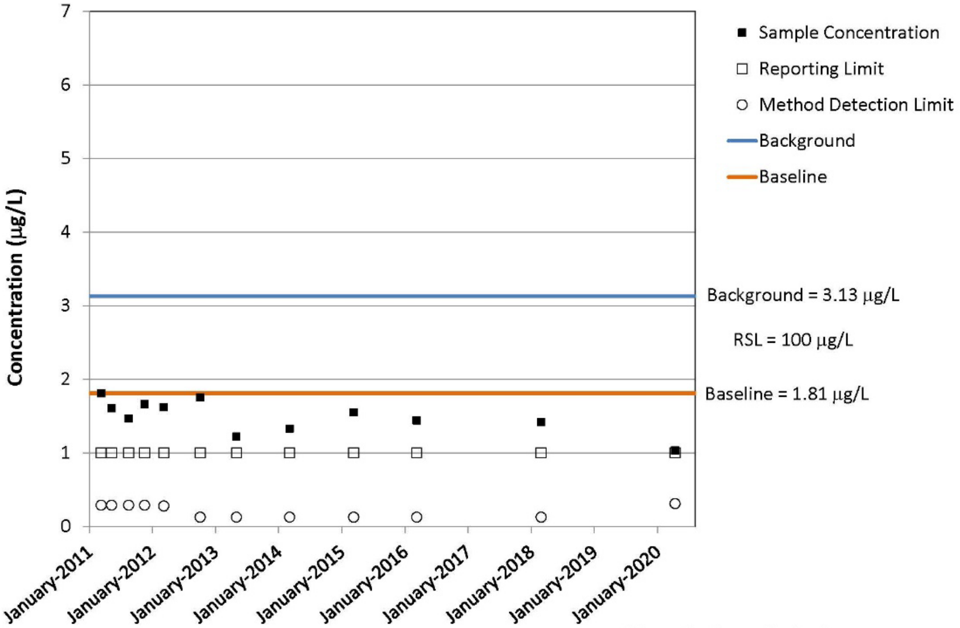
Radium-226 in Well UCD1-068

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



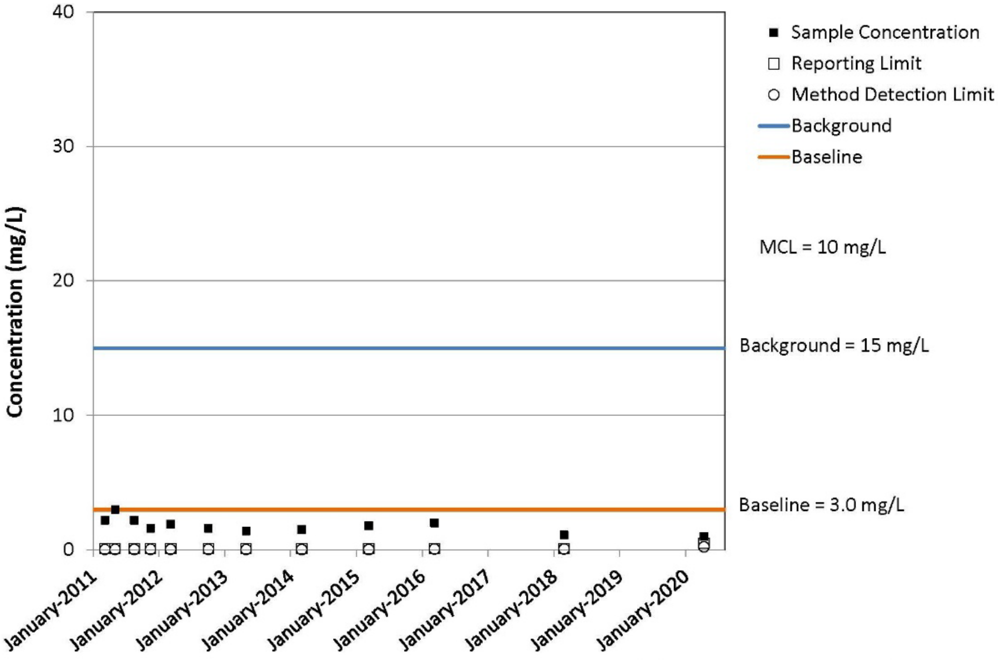
Formaldehyde in Well UCD1-069

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



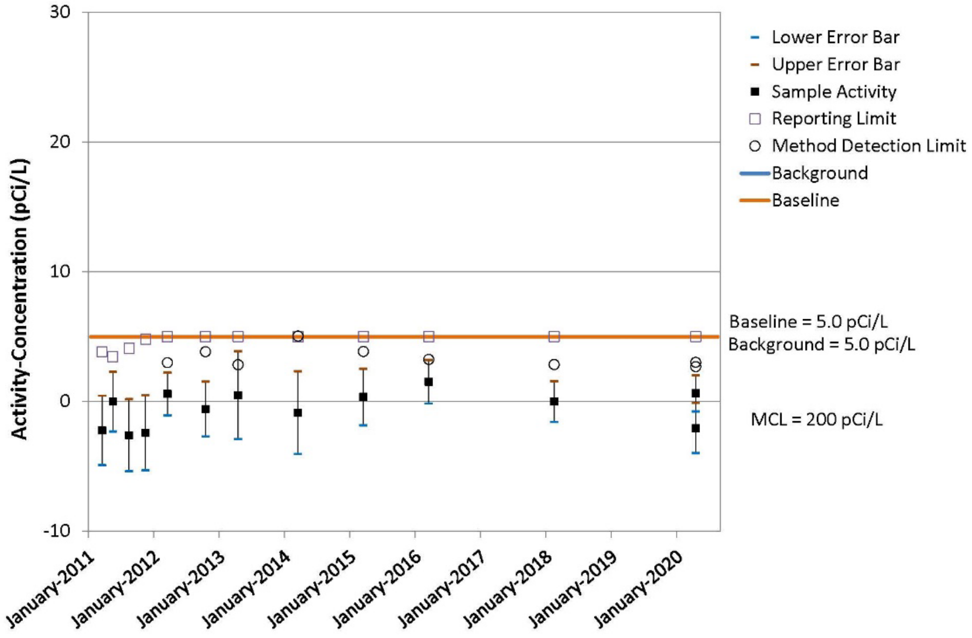
Molybdenum in Well UCD1-069

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



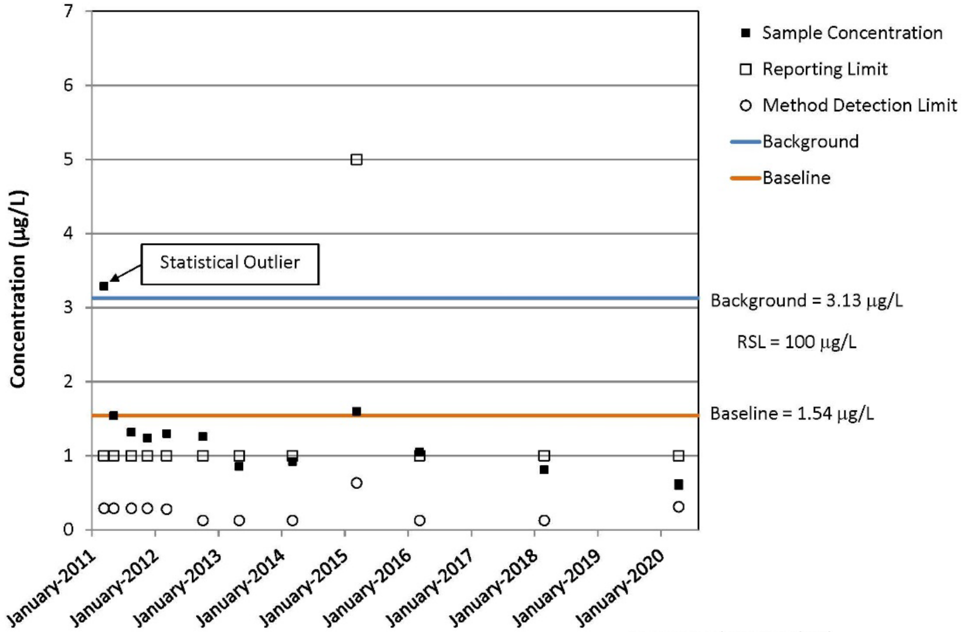
Nitrate in Well UCD1-070

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



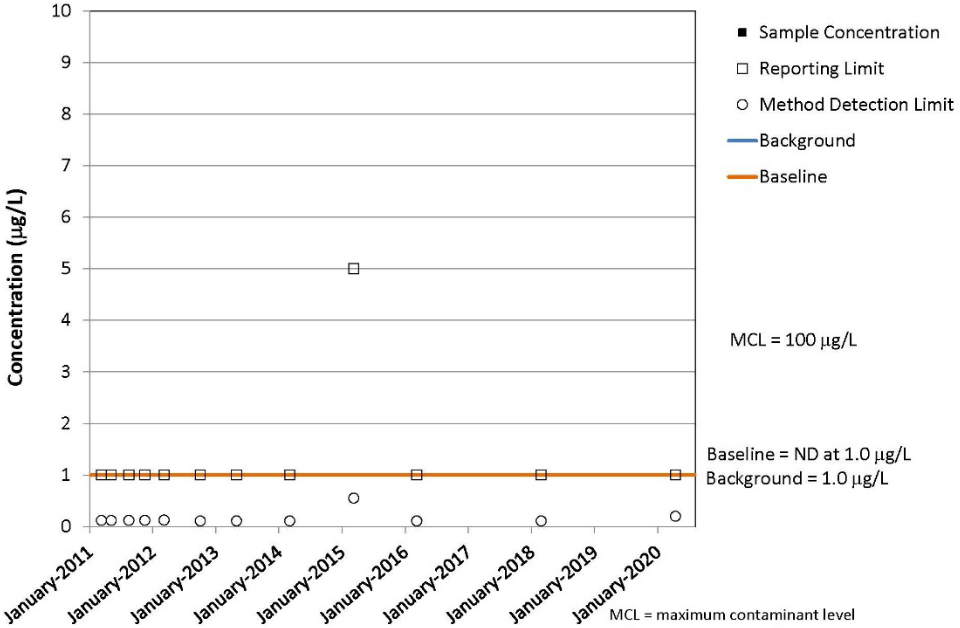
Cesium-137 in Well UCD1-071

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



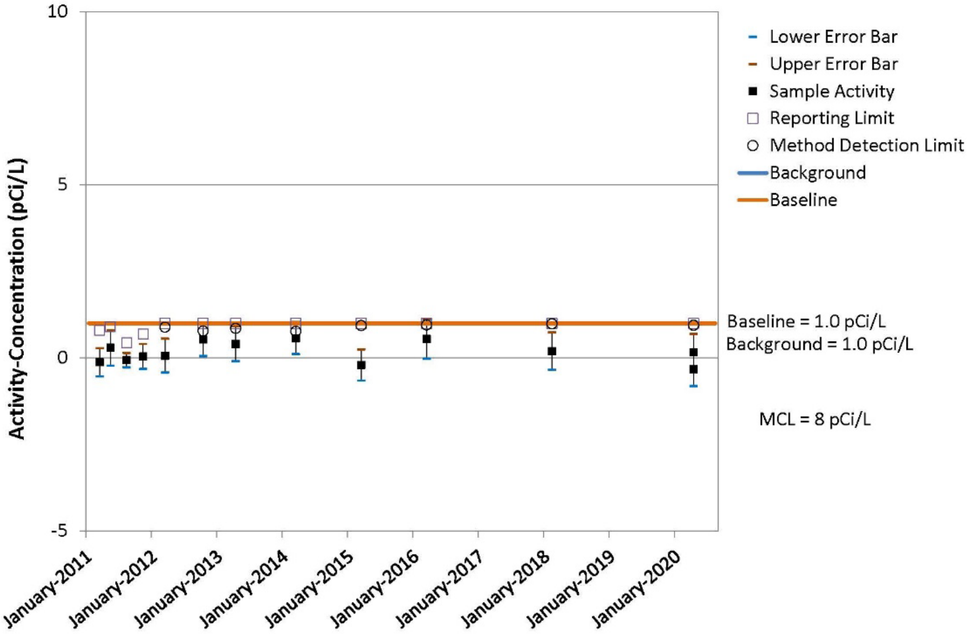
Molybdenum in Well UCD1-071

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



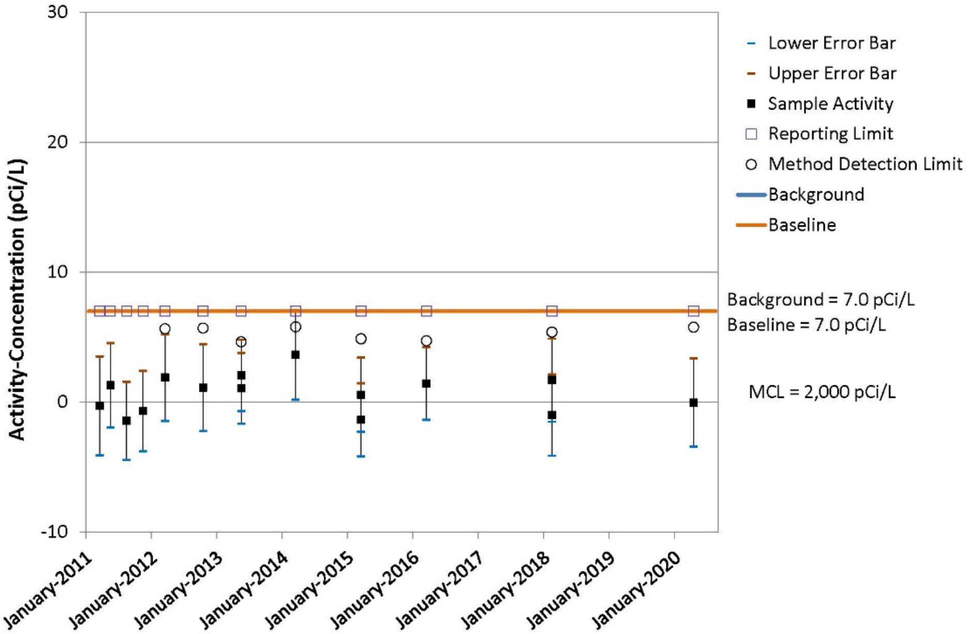
Silver in Well UCD1-071

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



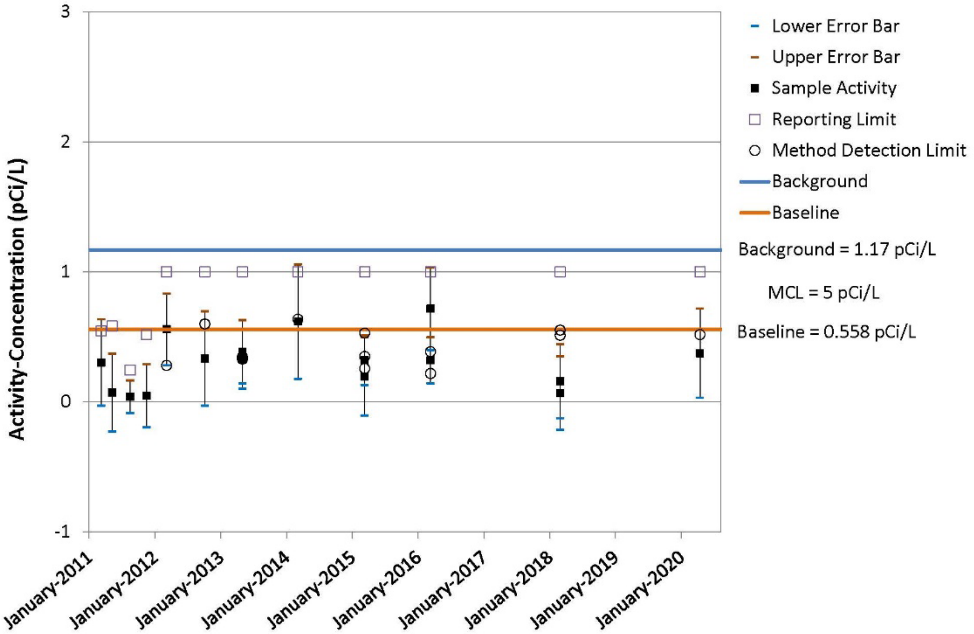
Strontium-90 in Well UCD1-071

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



Carbon-14 in Well UCD1-072

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

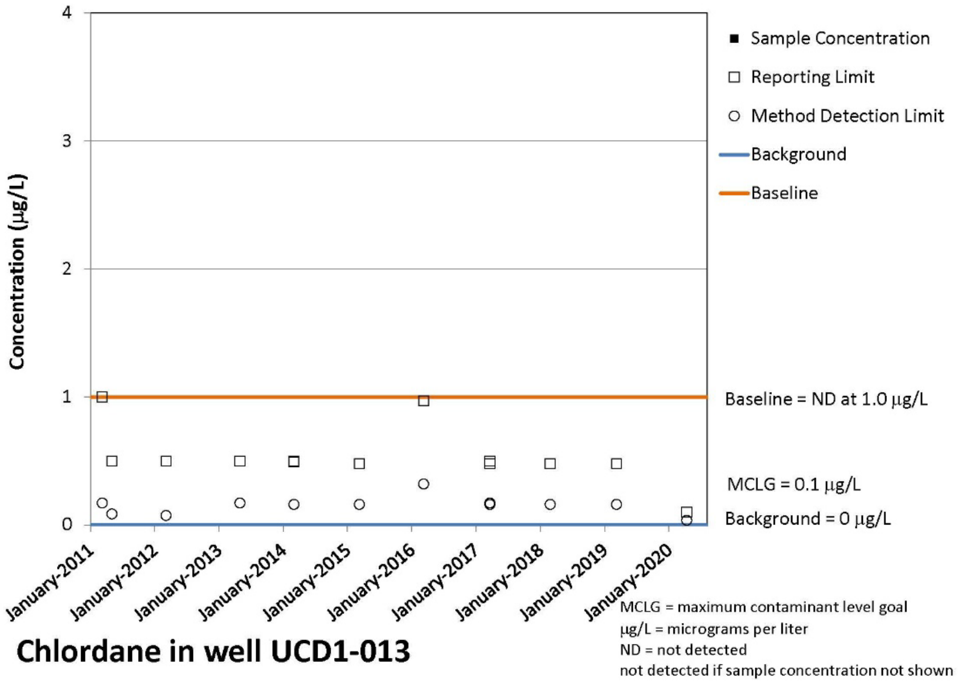


Radium-226 in Well UCD1-072

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

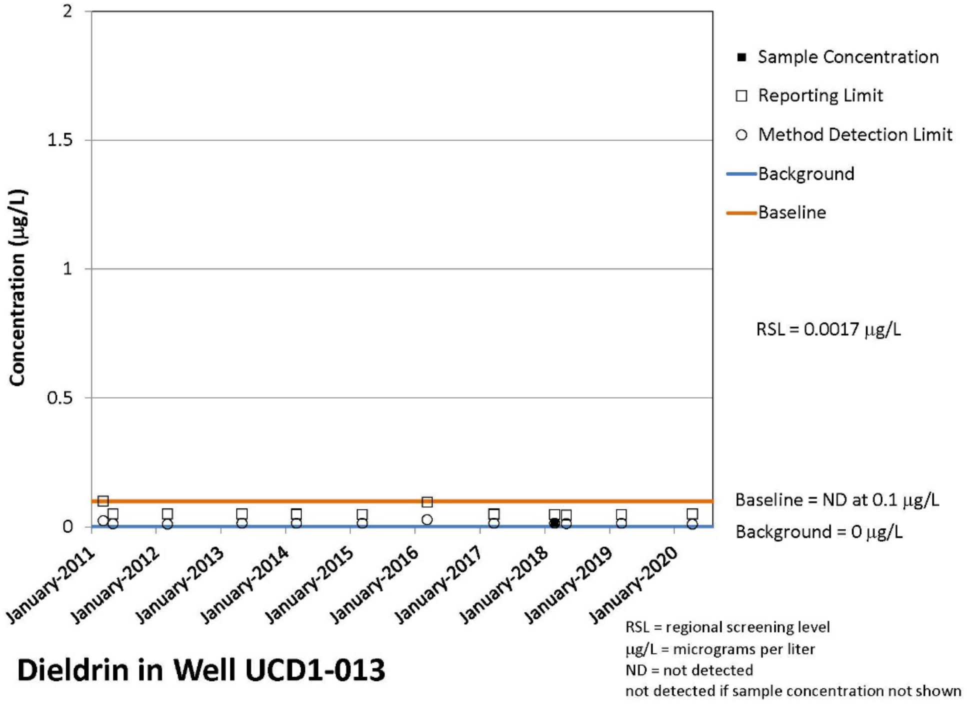
C2.2 Monitoring-Only Constituents (MOCs)

C.2.2.1 MOCs Currently Monitored Annually, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-4)



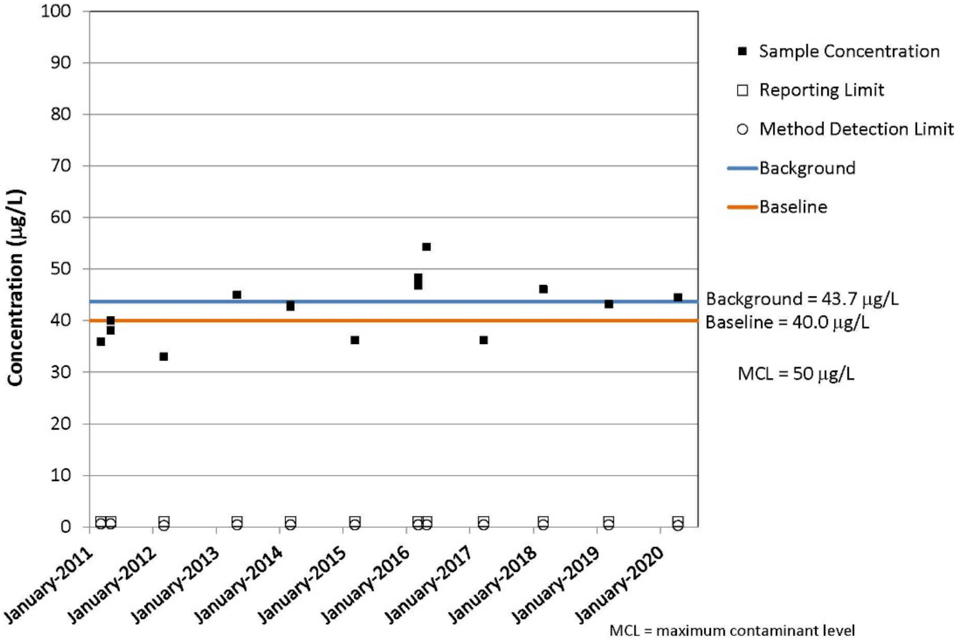
Chlordane in well UCD1-013

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



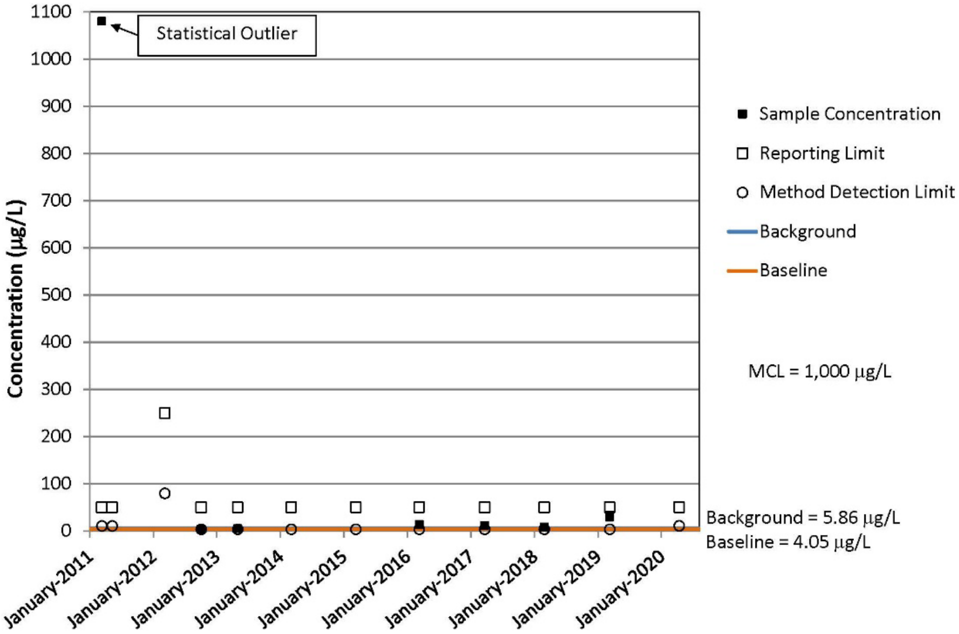
Dieldrin in Well UCD1-013

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



Chromium in Well UCD1-068

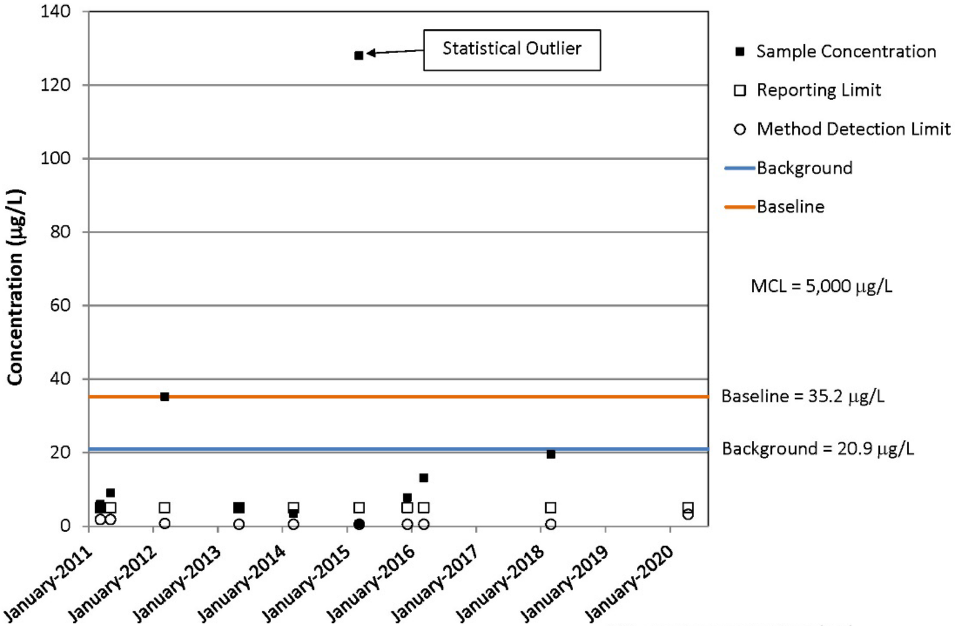
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



Aluminum in Well UCD1-069

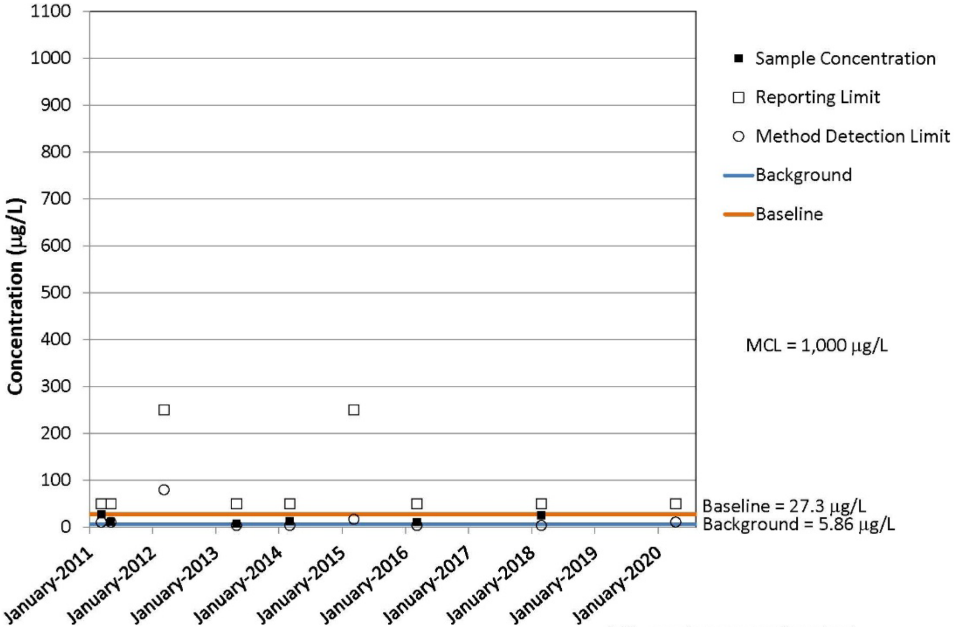
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

C.2.2.2 MOCs Currently Monitored Biennially, Baseline Above Background (Trends Summarized in Table C-5)



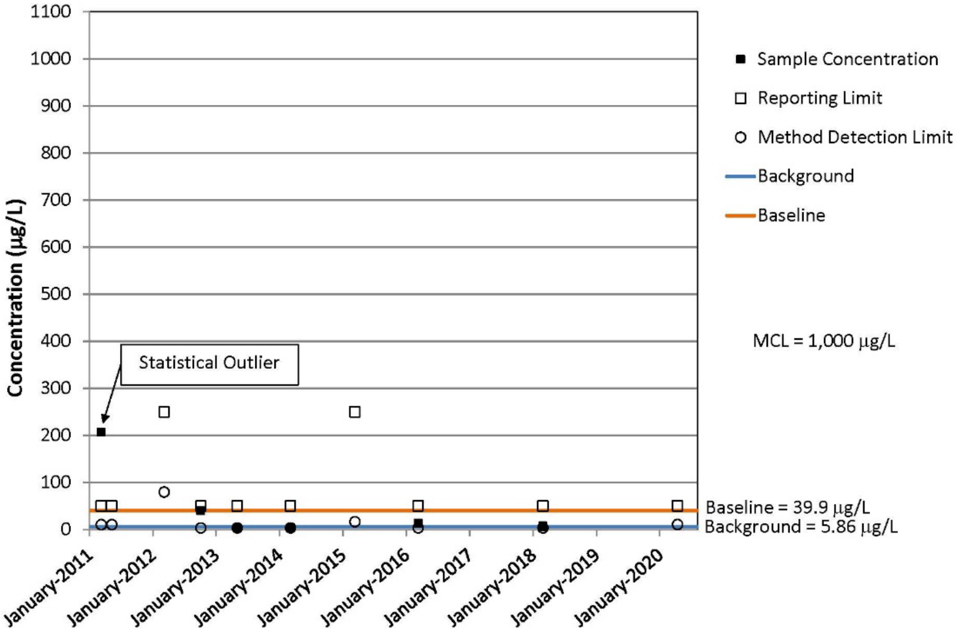
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

Zinc in Well UCD1-070



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

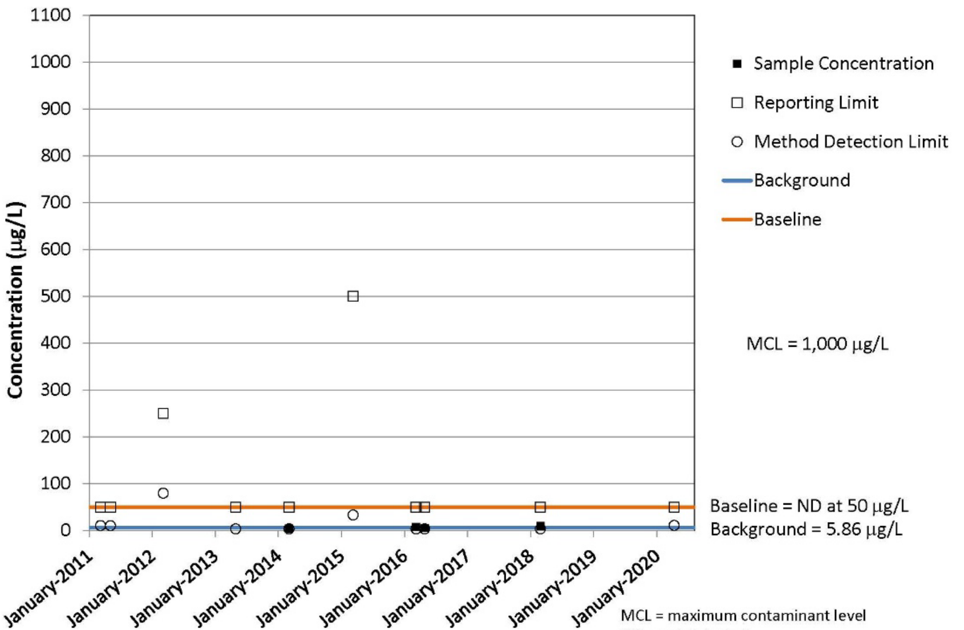
Aluminum in Well UCD1-071



Aluminum in Well UCD1-072

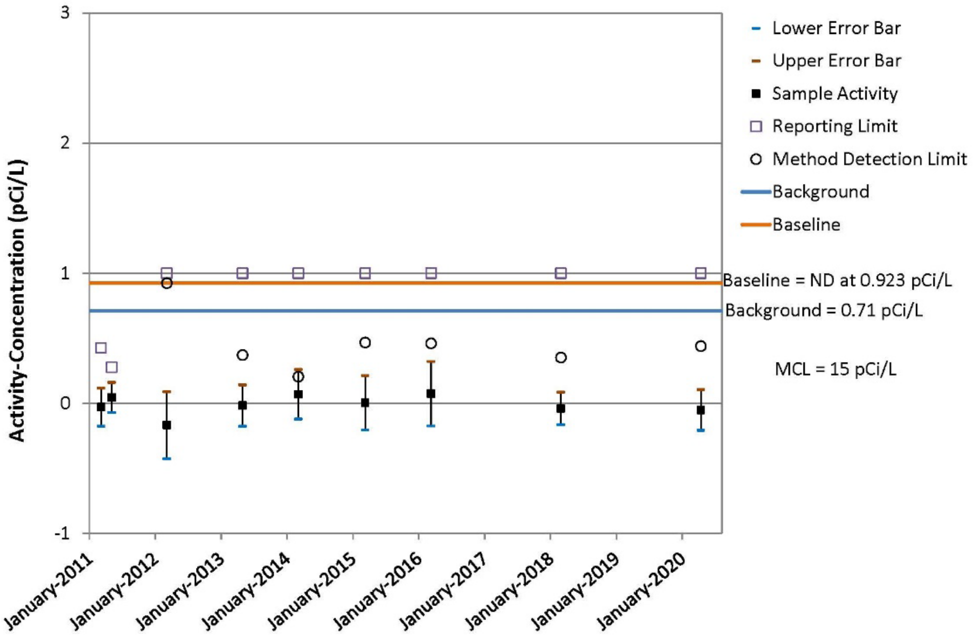
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown

C.2.2.3 MOCs Currently Monitored Biennially, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-5)



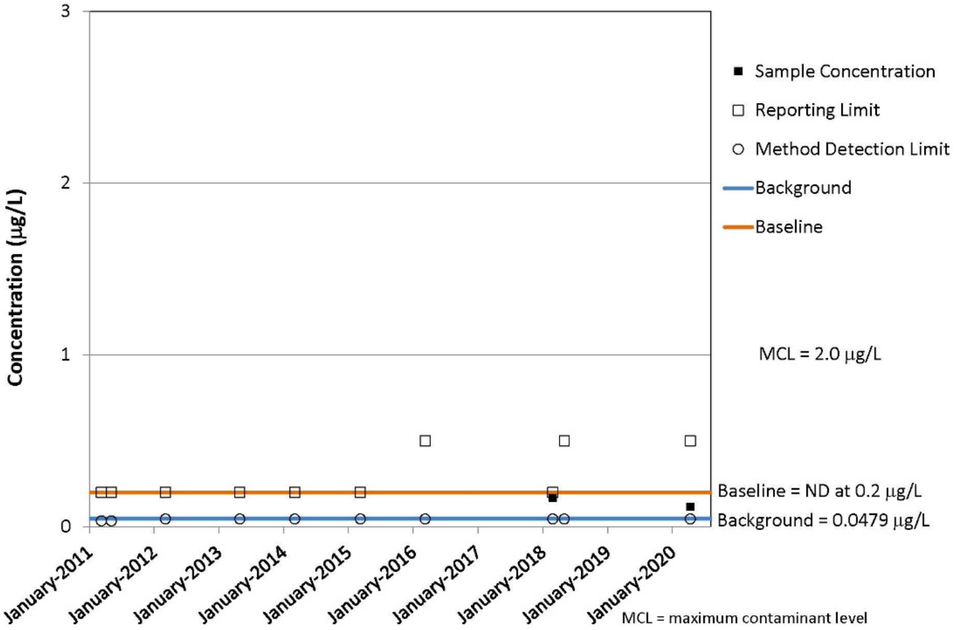
MCL = maximum contaminant level
ND = not detected
µg/L = micrograms per liter
not detected if sample concentration not shown

Aluminum in Well UCD1-021



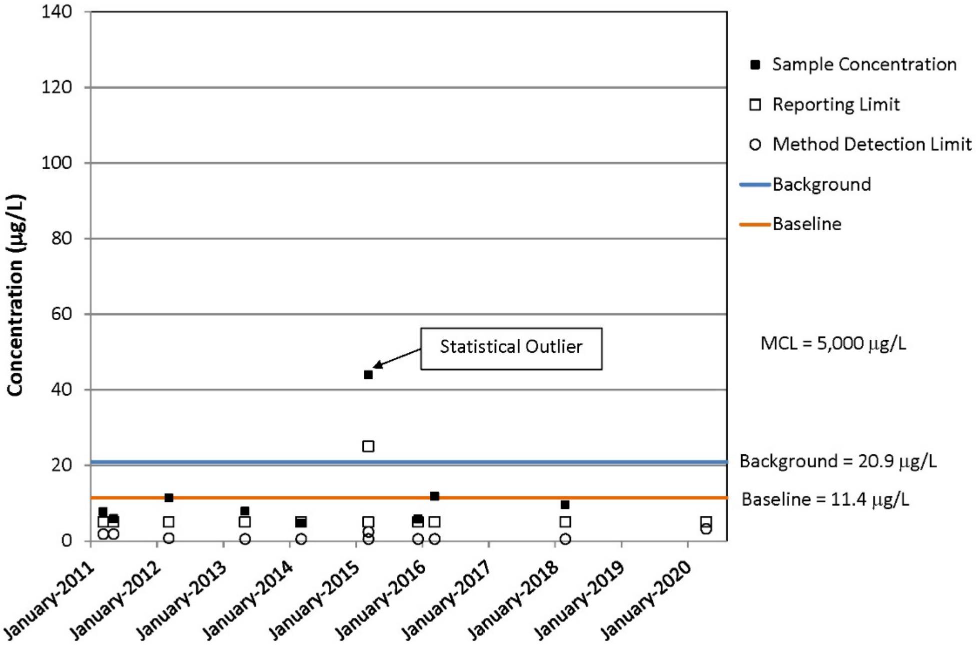
Americium-241 in Well UCD1-021

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



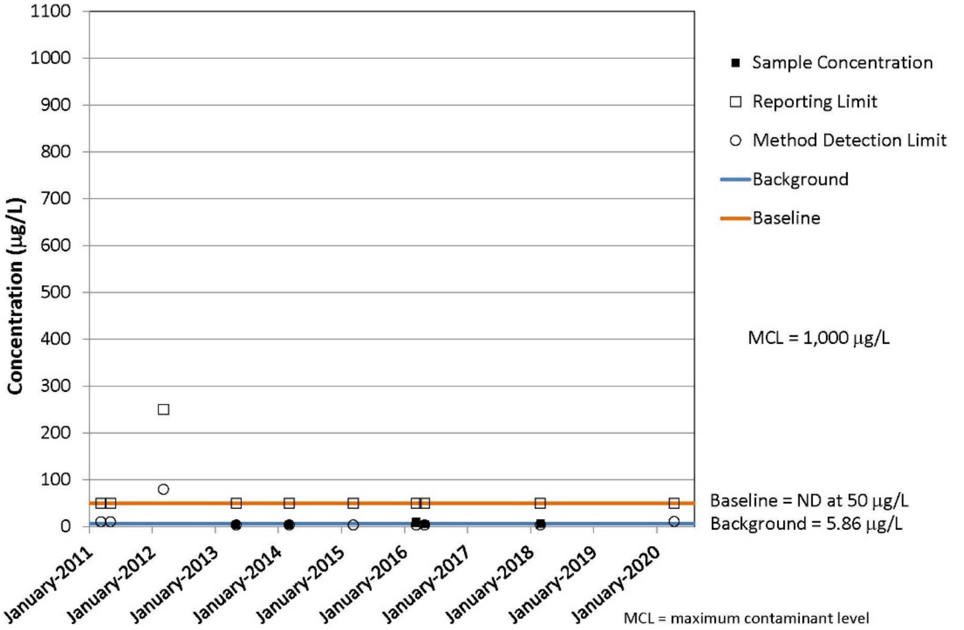
Mercury in Well UCD1-023

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



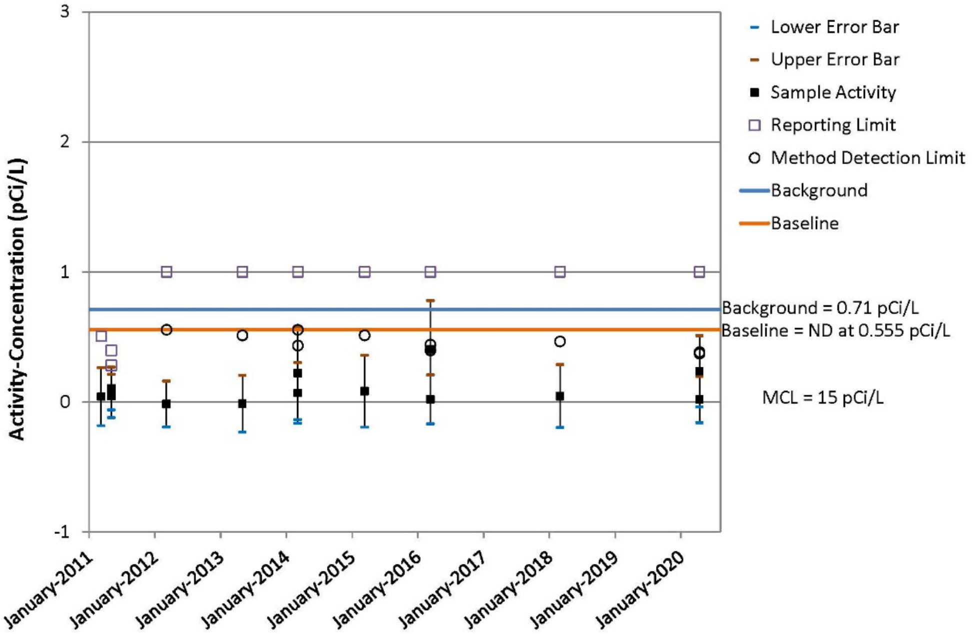
Zinc in Well UCD1-023

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



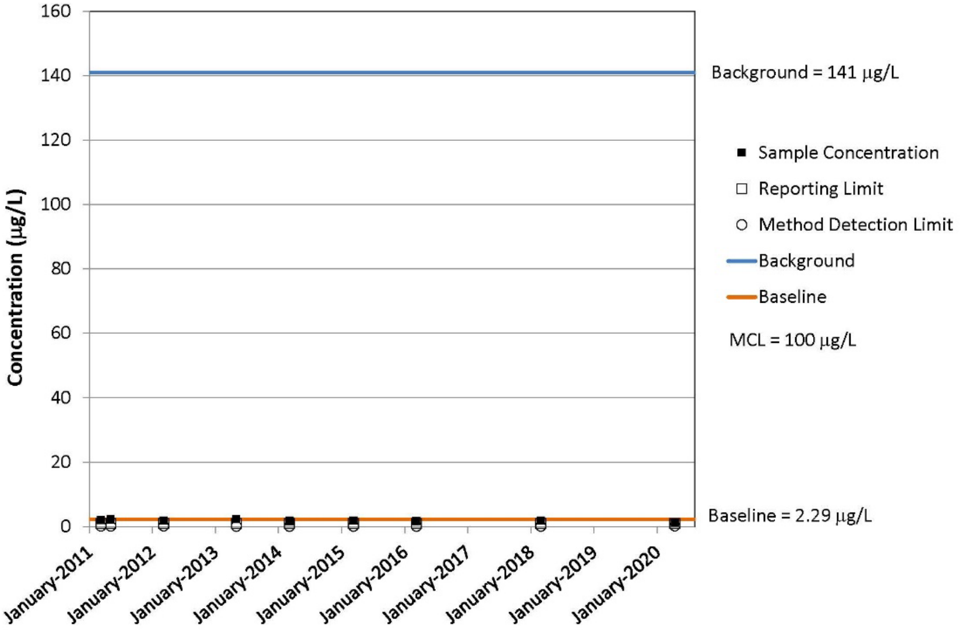
MCL = maximum contaminant level
ND = not detected
µg/L = micrograms per liter
not detected if sample concentration not shown

Aluminum in Well UCD1-068



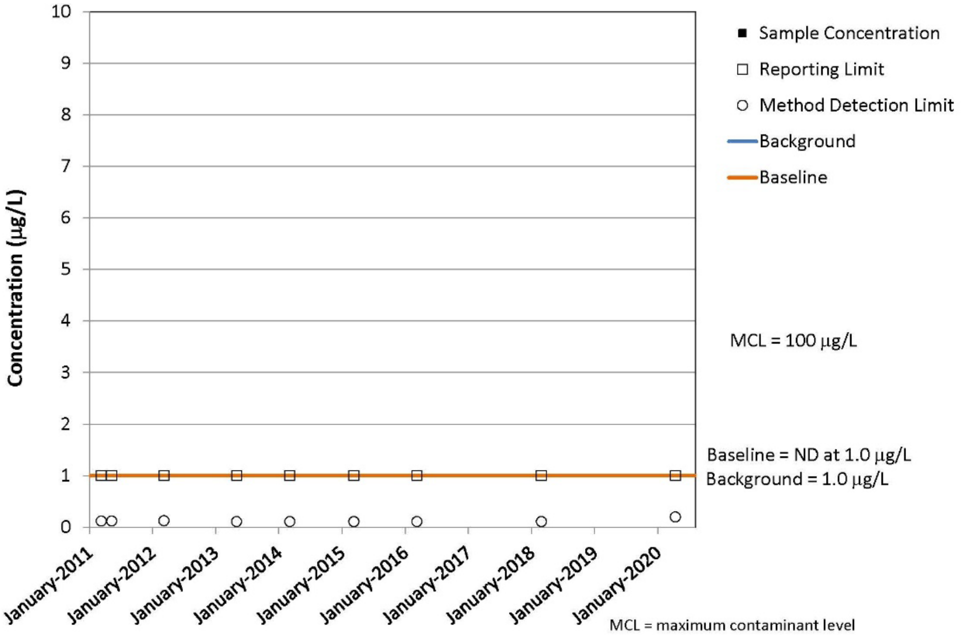
Americium-241 in Well UCD1-068

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



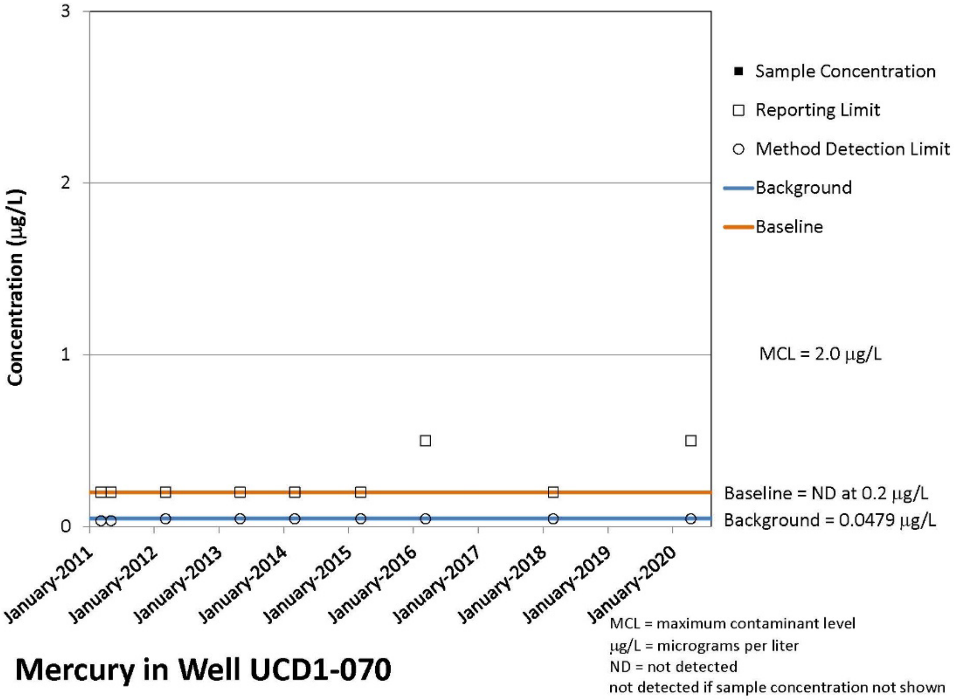
Nickel in Well UCD1-068

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

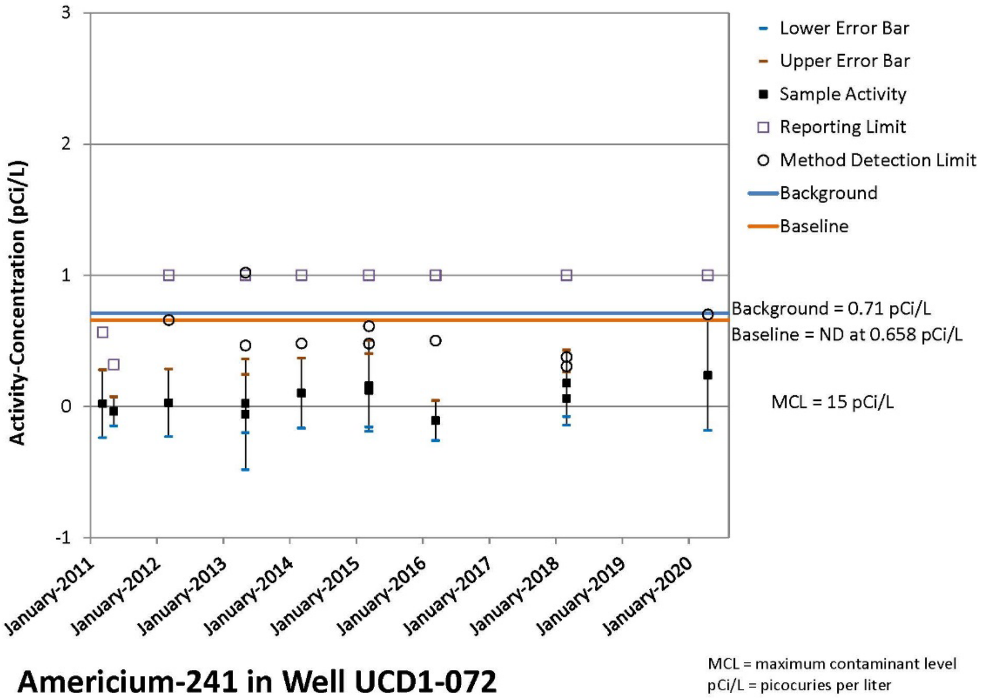


Silver in Well UCD1-069

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



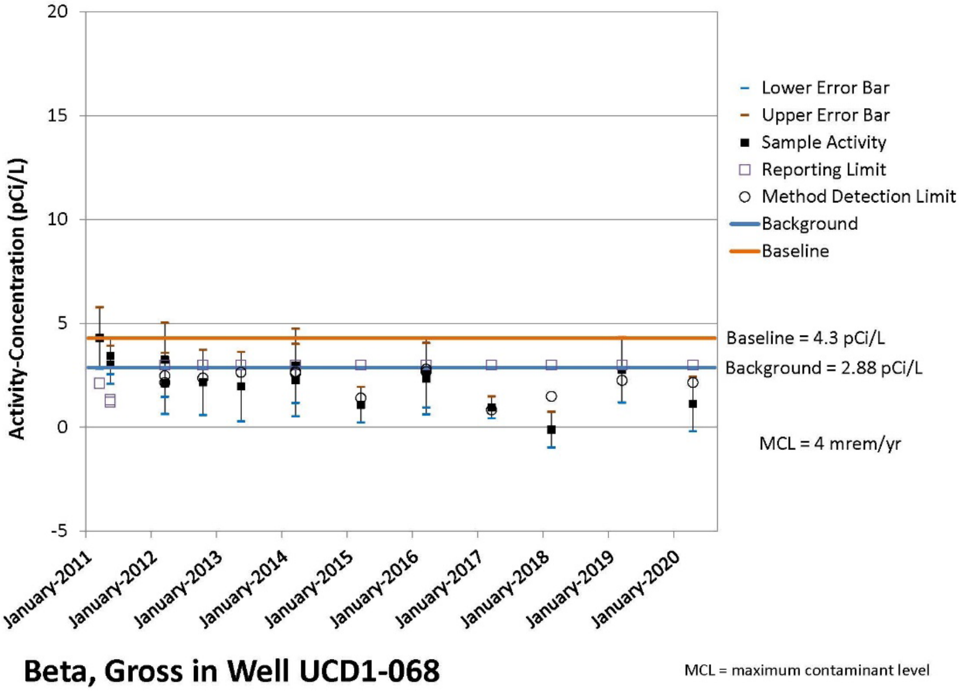
Mercury in Well UCD1-070

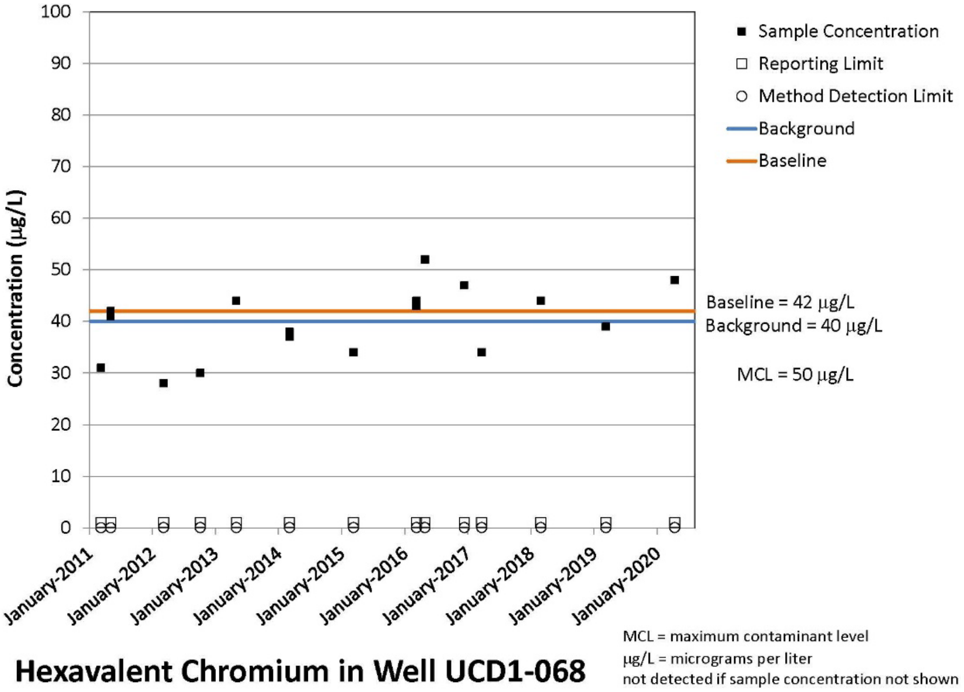


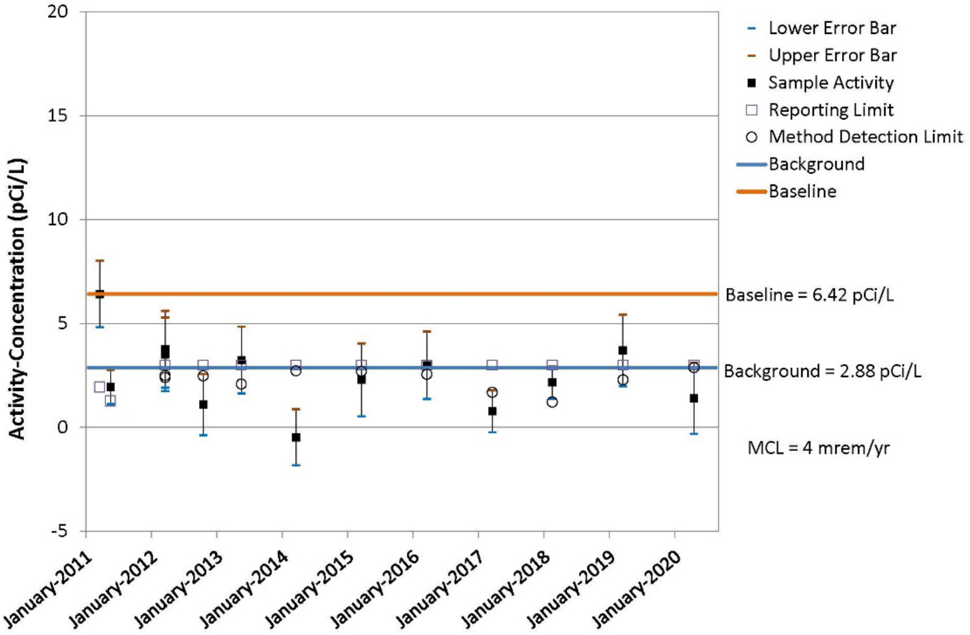
Americium-241 in Well UCD1-072

C.2.3 New Well Constituents (NWCs)

C.2.3.1 NWCs Currently Monitored Annually, Baseline Above Background (Trends Summarized in Table C-6)

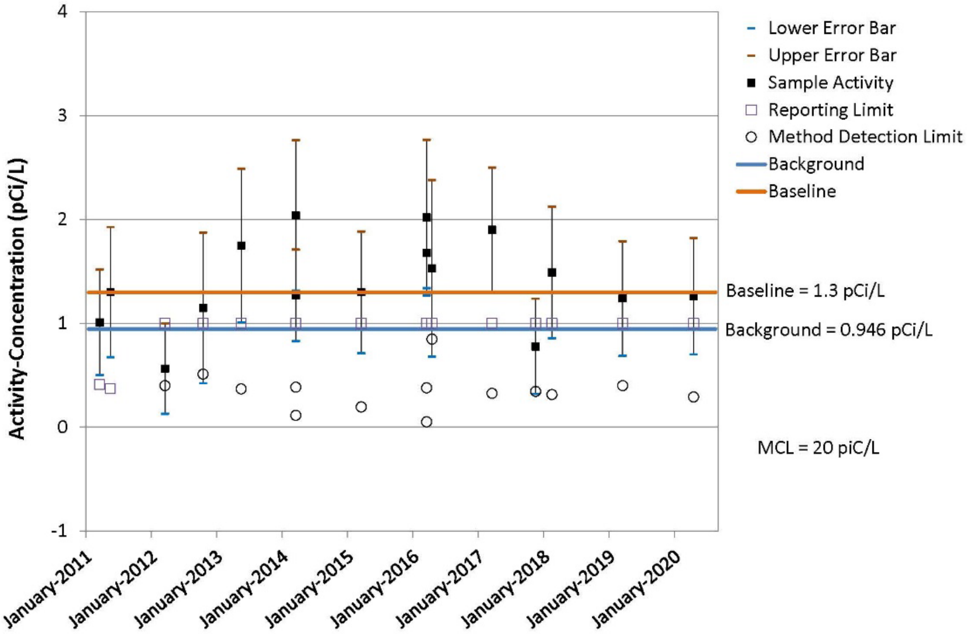






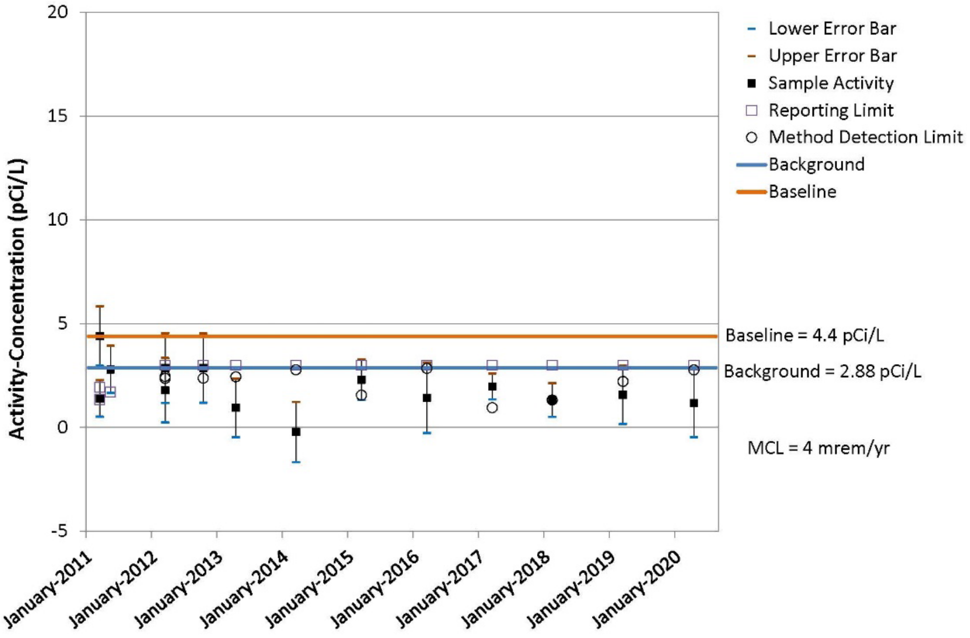
MCL = maximum contaminant level
pCi/L = picocuries per liter

Beta, Gross in Well UCD1-069



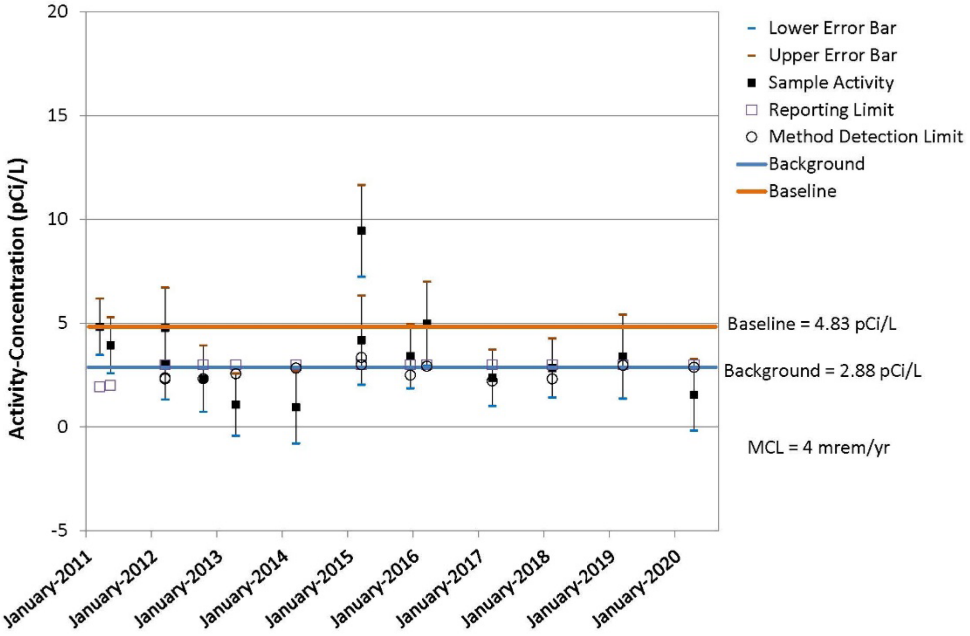
MCL = maximum contaminant level
pCi/L = picocuries per liter

Uranium-238 in Well UCD1-069



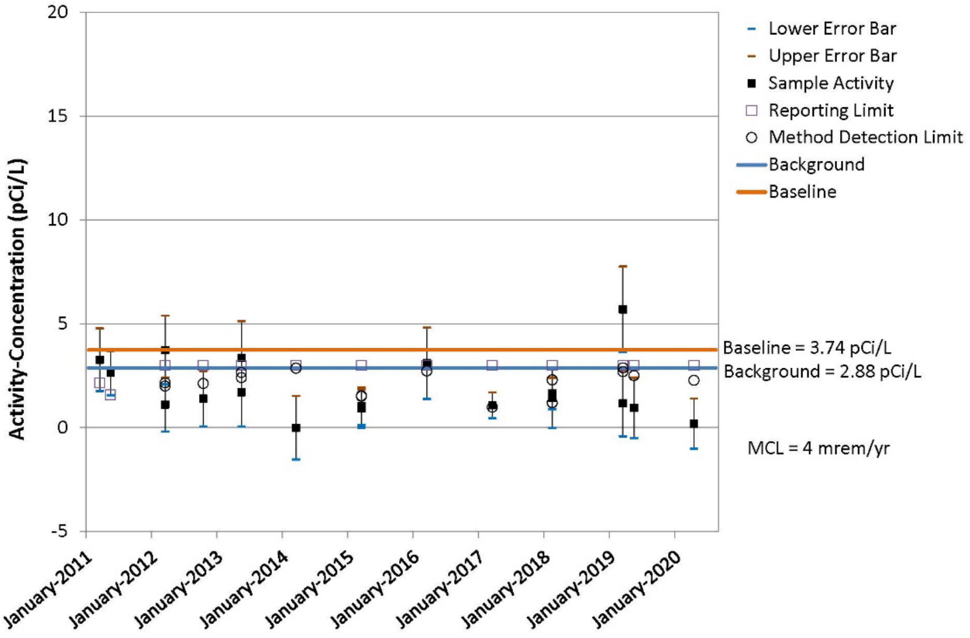
Beta, Gross in Well UCD1-070

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



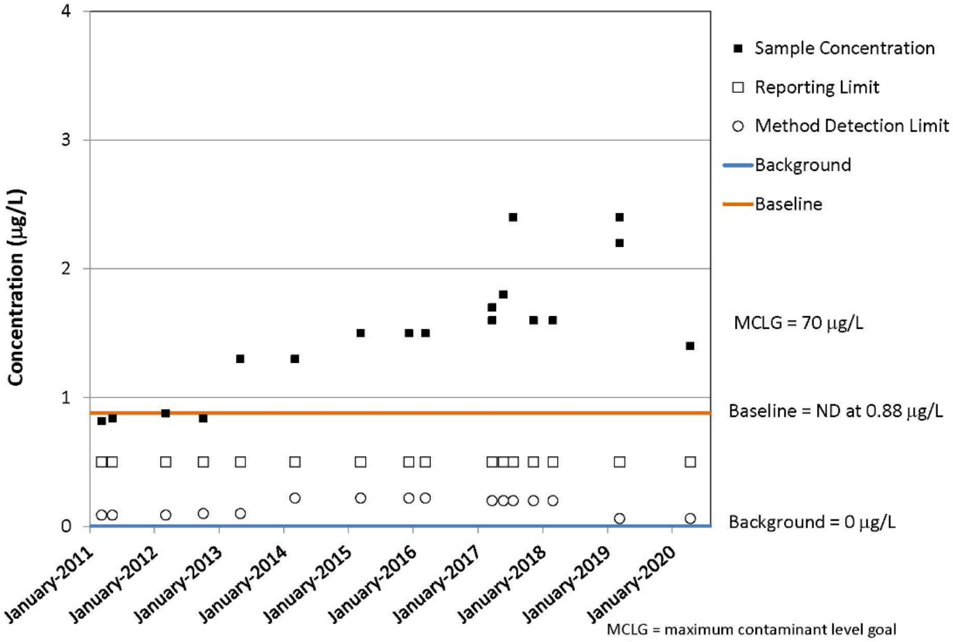
Beta, Gross in Well UCD1-071

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



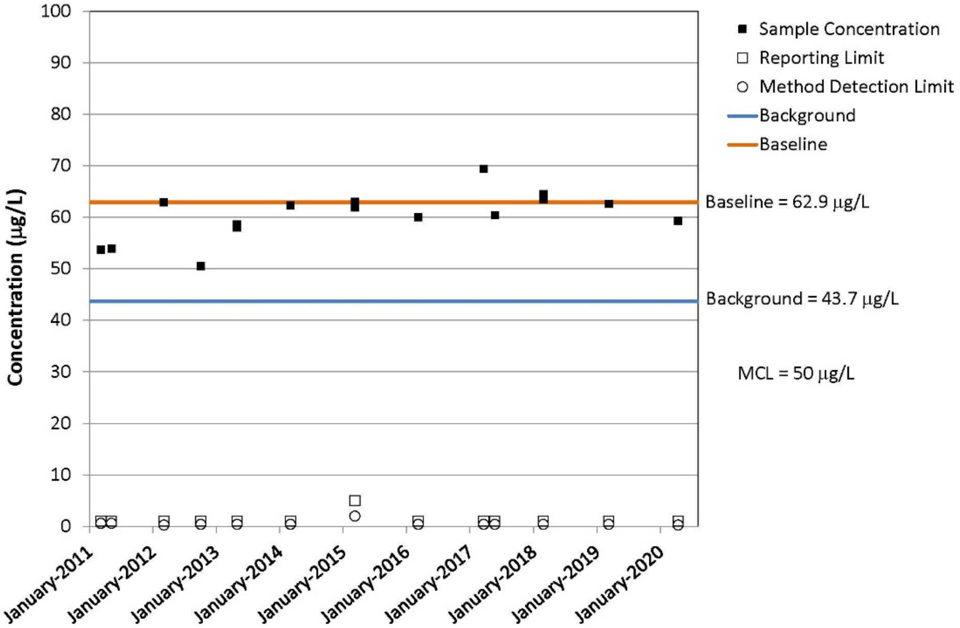
Beta, Gross in Well UCD1-072

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



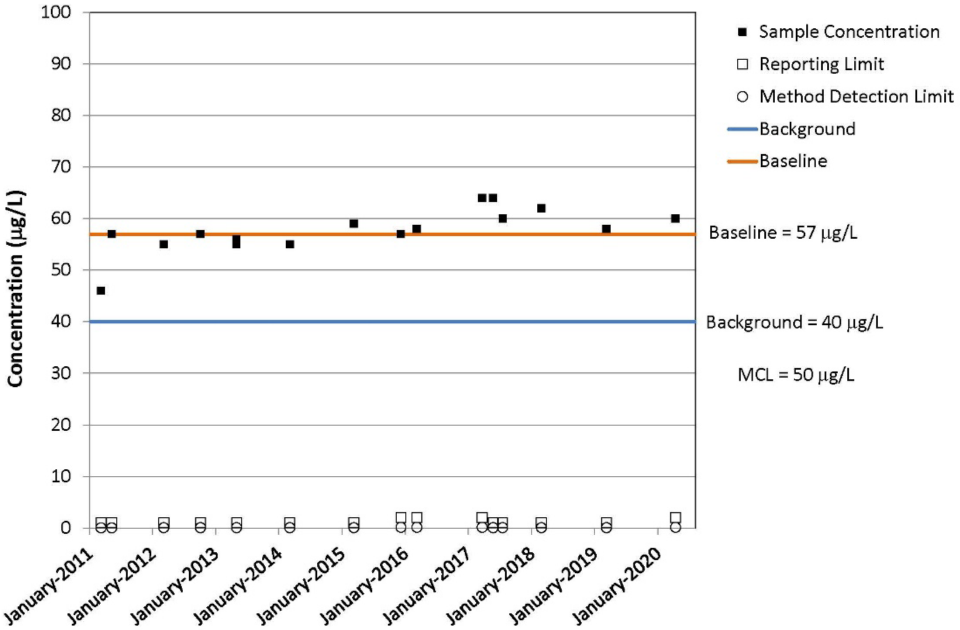
Chloroform in Well UCD1-072

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



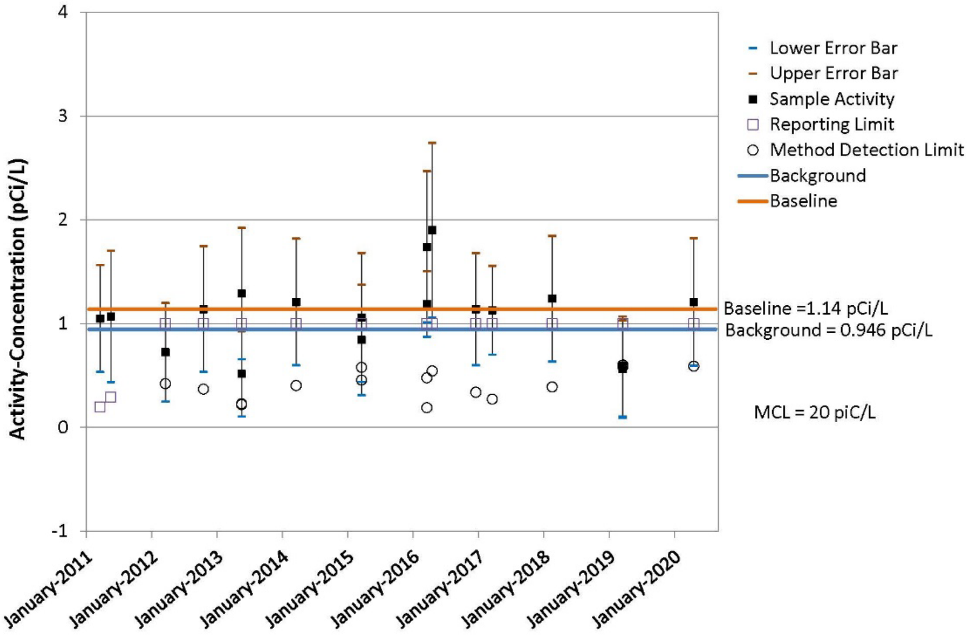
Chromium in Well UCD1-072

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



Hexavalent Chromium in Well UCD1-072

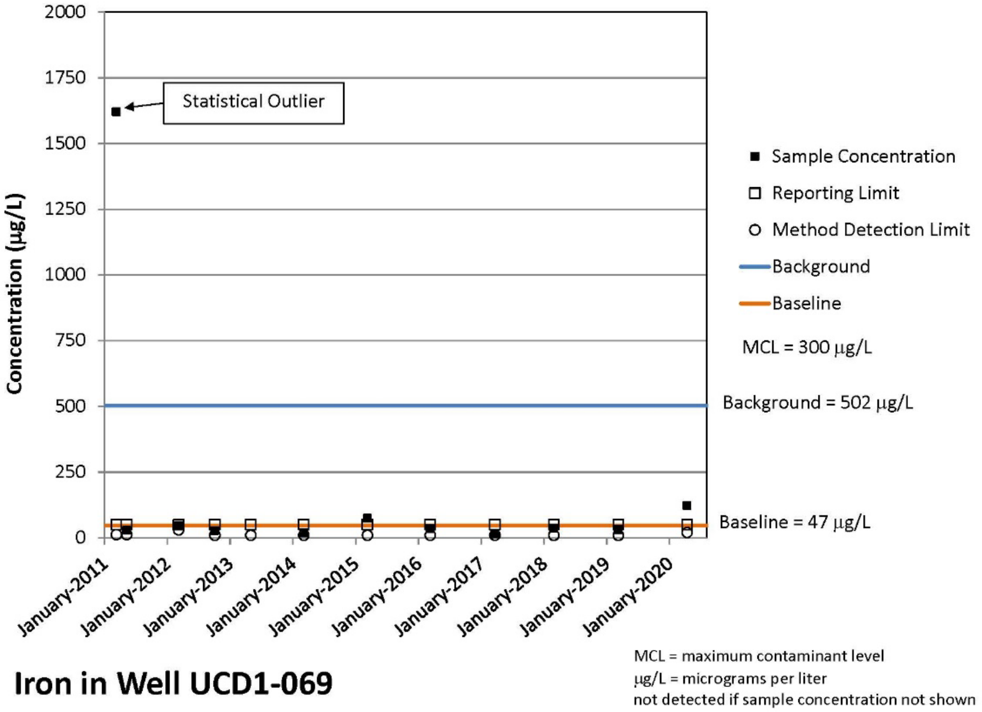
MCL = maximum contaminant level
µg/L = micrograms per liter
not detected if sample concentration not shown



Uranium-238 in Well UCD1-072

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

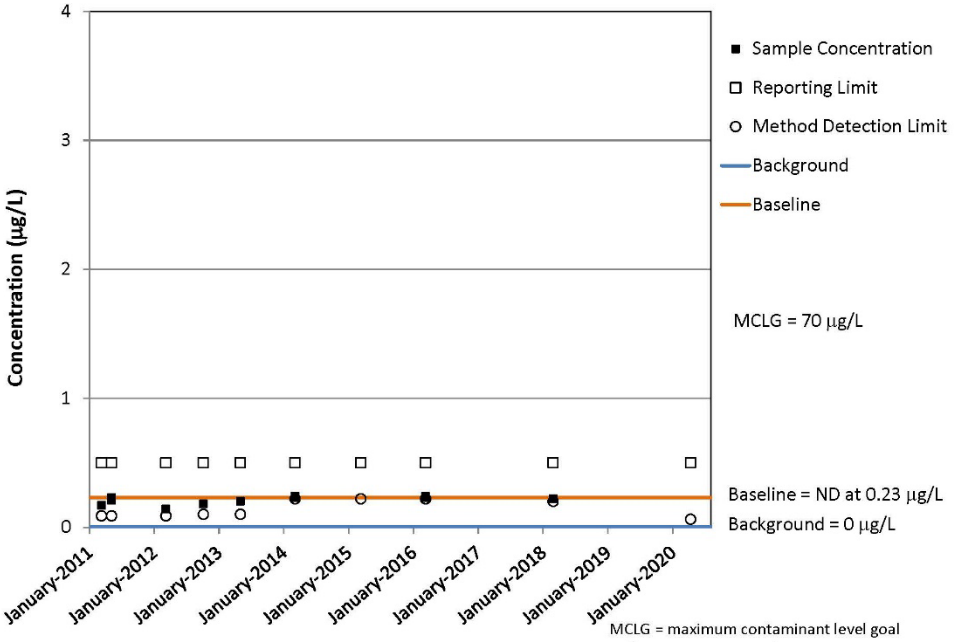
C.2.3.2 NWCs Currently Monitored Annually, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-6)



Iron in Well UCD1-069

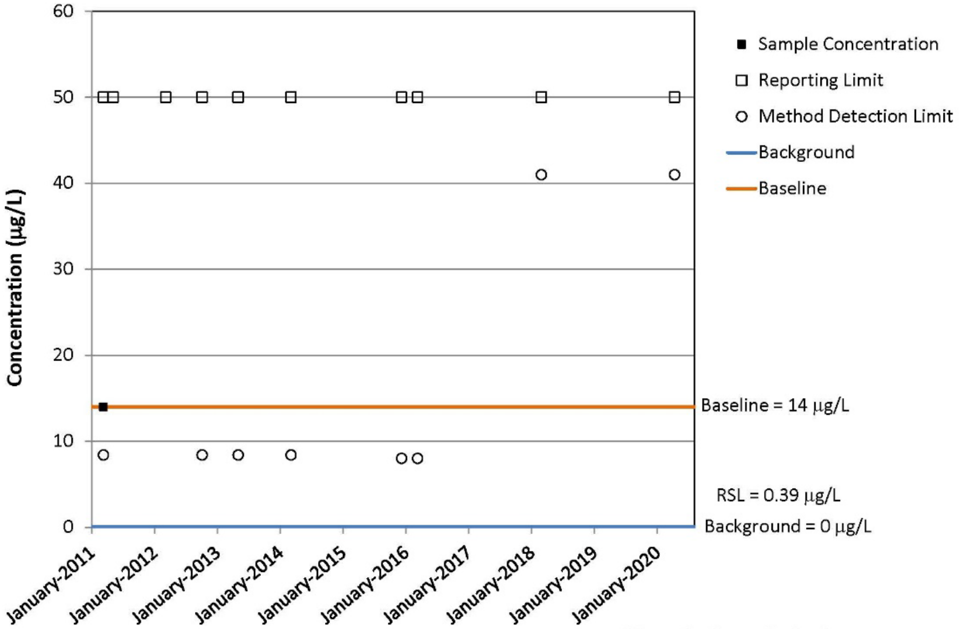
MCL = maximum contaminant level
μg/L = micrograms per liter
not detected if sample concentration not shown

C.2.3.3 NWCs Currently Monitored Biennially, Baseline Above Background (Trends Summarized in Table C-7)



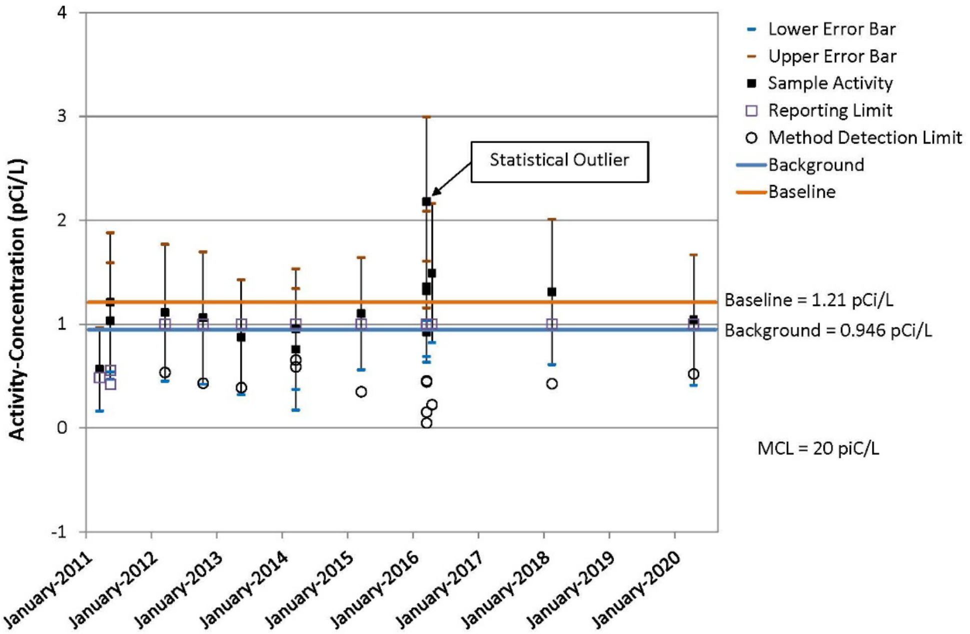
Chloroform in Well UCD1-068

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



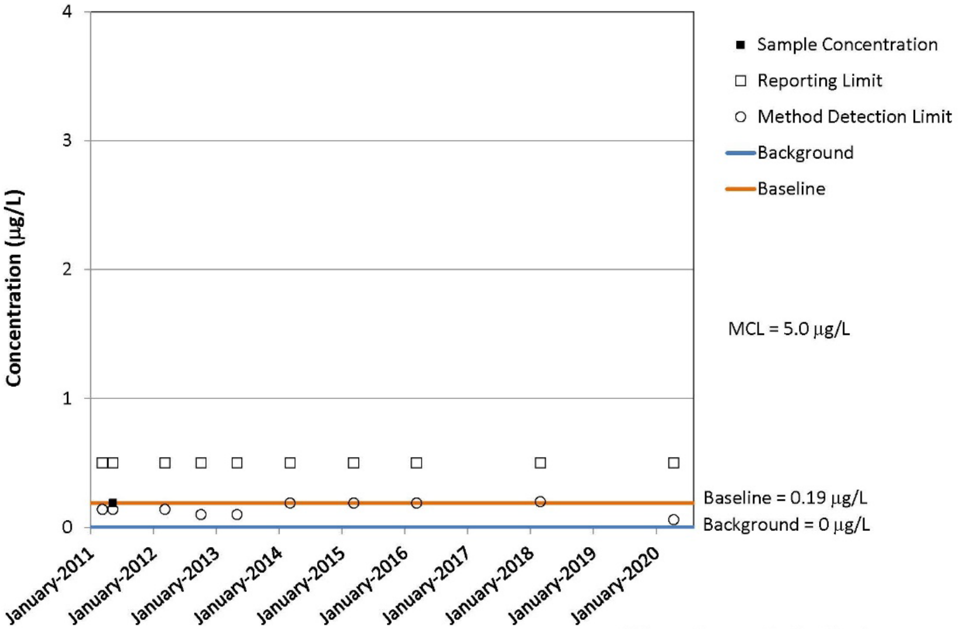
Formaldehyde in Well UCD1-068

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



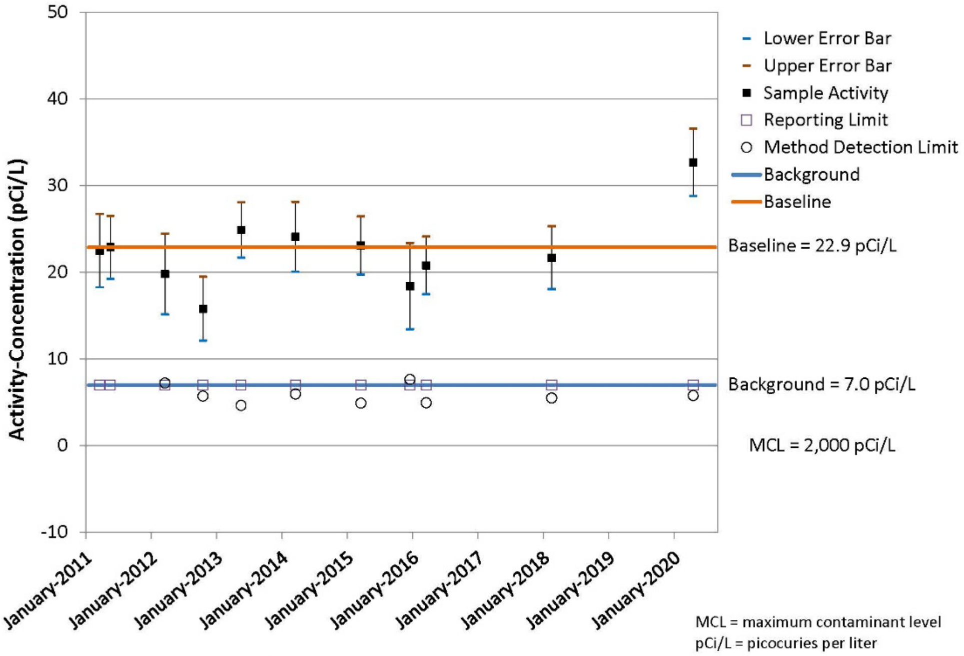
Uranium-238 in Well UCD1-068

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

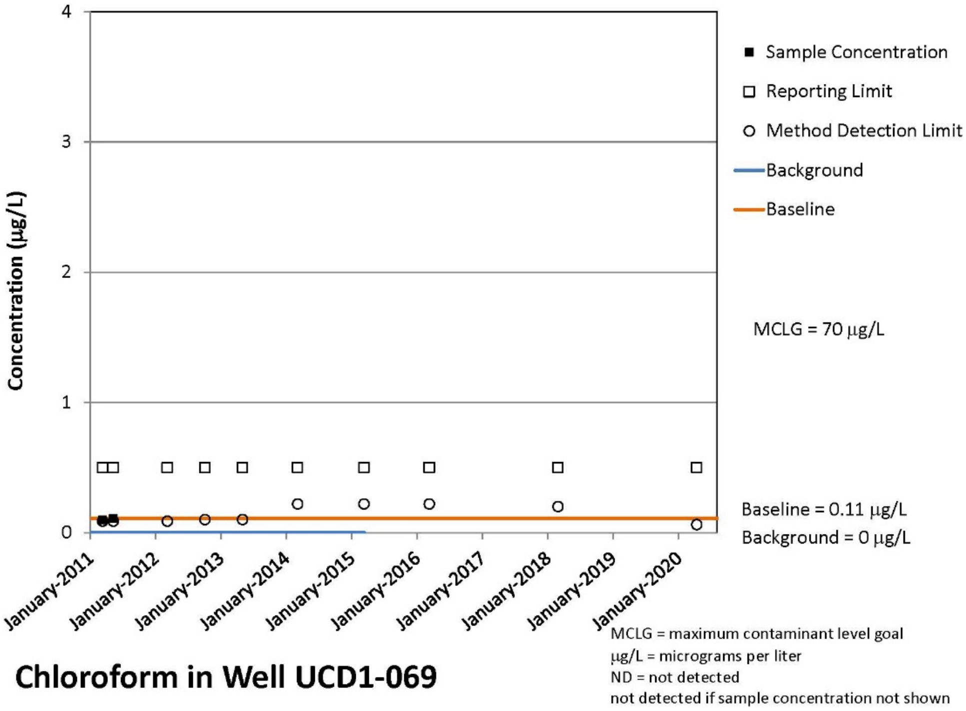


MCL = maximum contaminant level
μg/L = micrograms per liter
not detected if sample concentration not shown

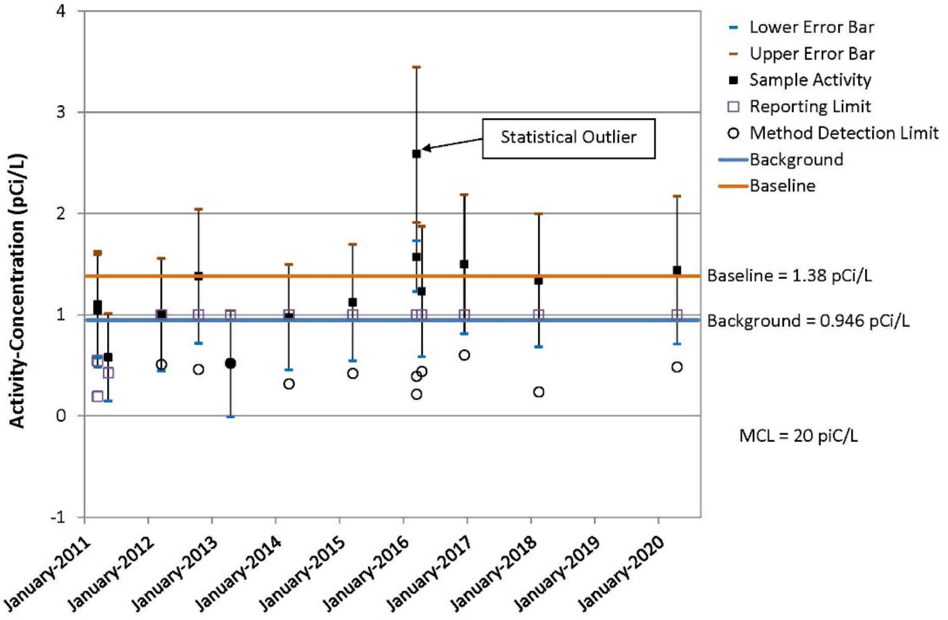
1,1-Dichloroethane in Well UCD1-069



Carbon-14 in Well UCD1-069

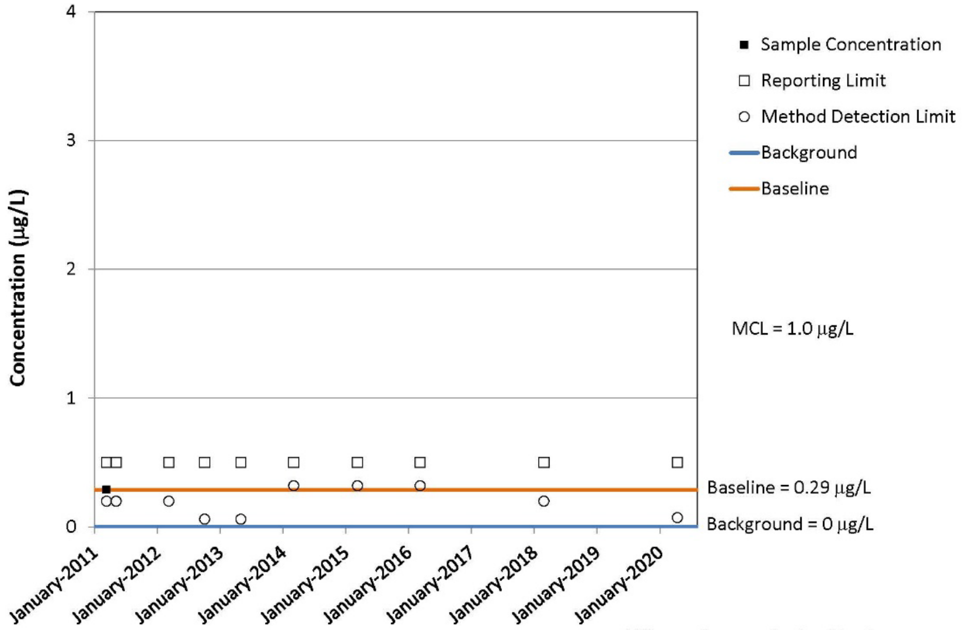


Chloroform in Well UCD1-069



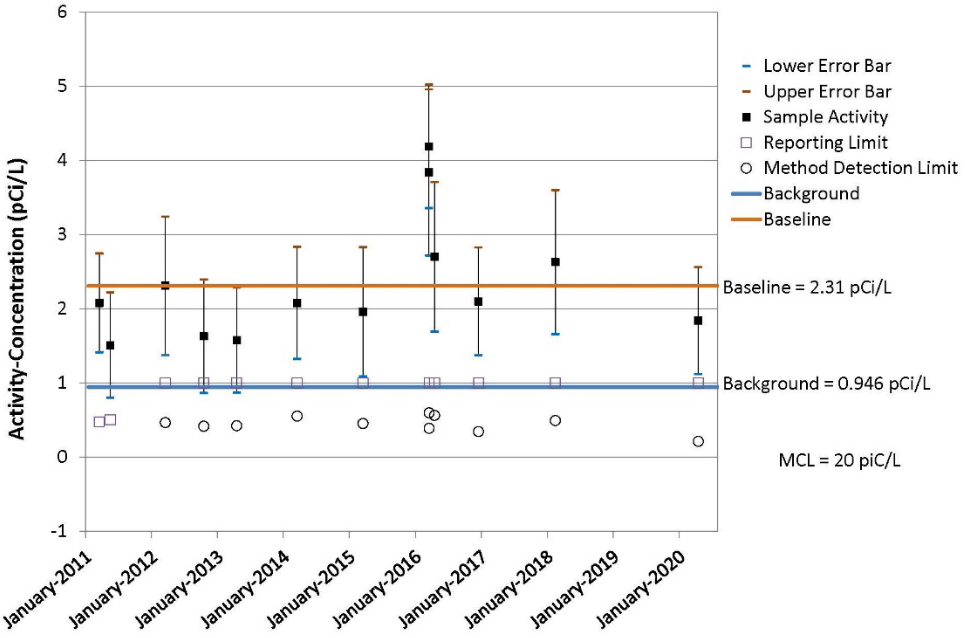
Uranium-238 in Well UCD1-070

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



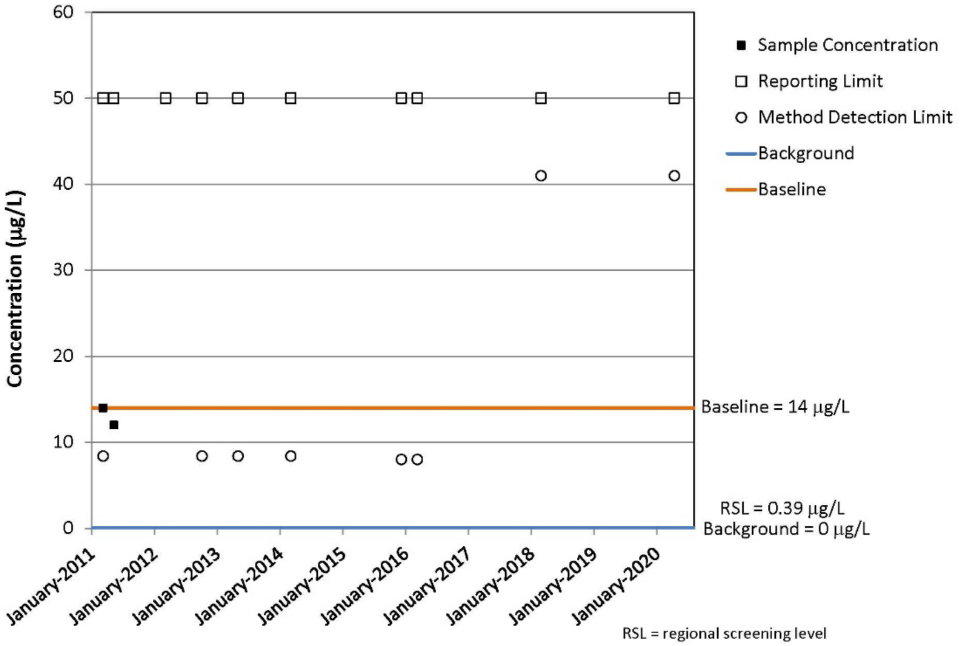
Benzene in Well UCD1-071

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



Uranium-238 in Well UCD1-071

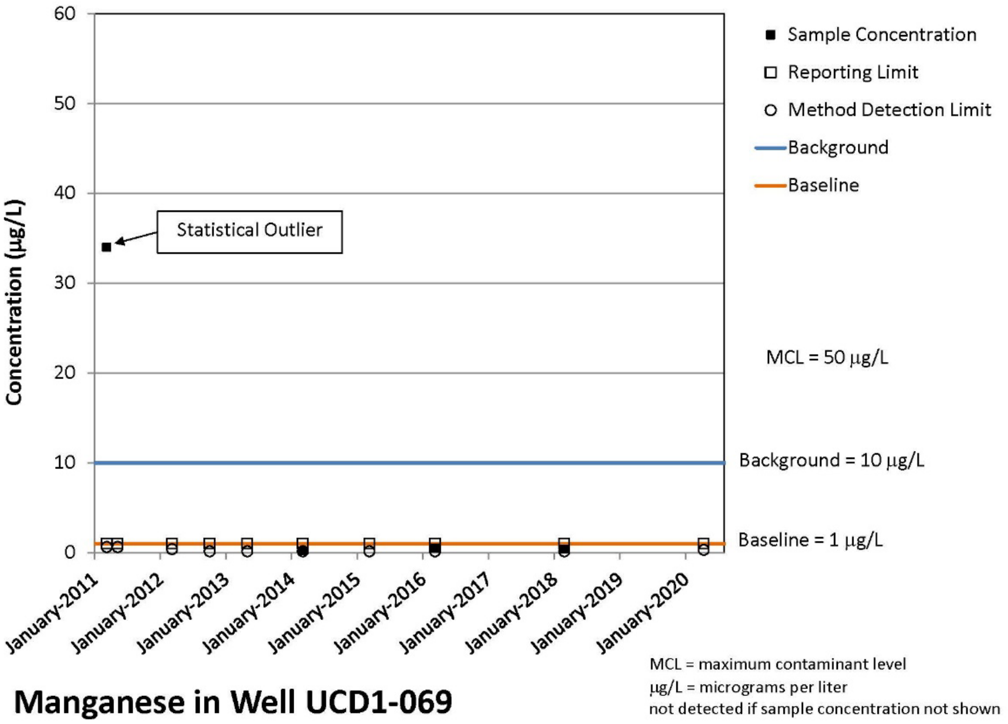
MCL = maximum contaminant level
pCi/L = picocuries per liter

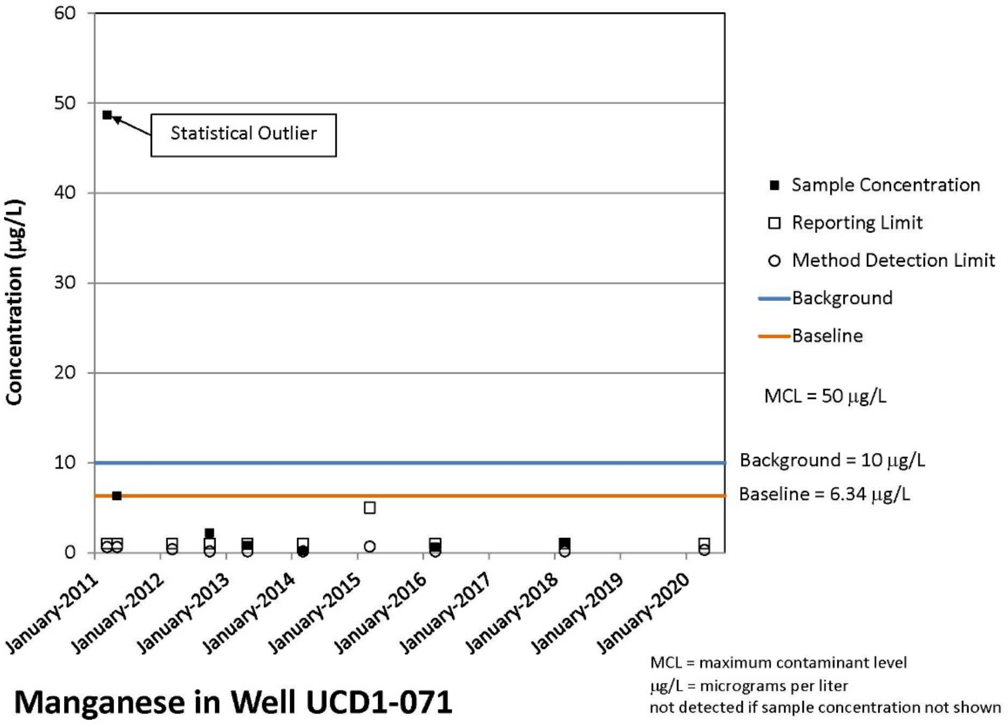


Formaldehyde in Well UCD1-072

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

C.2.3.4 NWCs Currently Monitored Biennially, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-7)





Attachment C-3

Mann Kendall Trend Test Results

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C3.1 Constituents of Concern (COCs)

C3.1.1 COCs Currently Monitored Annually Baseline Above Background (Trends Summarized in Table C-2)

```
                                Mann-Kendall Trend Test Analysis
           User Selected Options
      Date/Time of Computation  ProUCL 5.15/28/2020 3:22:56 PM
                     From File  Database_Download_Chemicals.xls
                Full Precision  ON
        Confidence Coefficient  0.9900000
         Level of Significance  0.0100000

           UCD1-021 Nitrate as N

             General Statistics
 Number or Reported Events Not Used    0
       Number of Generated Events     17
        Number Values Reported (n)    17
                            Minimum 20.000000
                            Maximum 30.000000
                               Mean 26.823529
                     Geometric Mean 26.677141
                             Median 28.000000
                 Standard Deviation 2.7891597
           Coefficient of Variation 0.1039818

            Mann-Kendall Test
                 M-K Test Value (S) 69.000000
                 Tabulated p-value 0.0020000
              Standard Deviation of S 23.797759
             Standardized Value of S 2.8574119
                 Approximate p-value 0.0021356

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

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.15/28/2020 2:17:55 PM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-021 Nitrate as N: Years 2016 - 2020

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	27
Maximum	30
Mean	28.86
Geometric Mean	28.84
Median	29
Standard Deviation	1.215
Coefficient of Variation	0.0421

Mann-Kendall Test

M-K Test Value (S)	-9
Tabulated p-value	0.119
Standard Deviation of S	6.298
Standardized Value of S	-1.27
Approximate p-value	0.102

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	ProUCL 5.15/20/2020 1:37:24 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-023 Carbon-14

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	19
Number Values Reported (n)	19
Minimum	11
Maximum	45.7
Mean	27.81
Geometric Mean	25.54
Median	22.1
Standard Deviation	11.2
Coefficient of Variation	0.403

Mann-Kendall Test

M-K Test Value (S)	57
Tabulated p-value	0.025
Standard Deviation of S	28.58
Standardized Value of S	1.959
Approximate p-value	0.025

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	ProUCL 5.15/22/2020 12:02:16 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-023 Carbon-14; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	10
Number Values Reported (n)	10
Minimum	16.1
Maximum	45.7
Mean	36.4
Geometric Mean	35.27
Median	37.5
Standard Deviation	8.016
Coefficient of Variation	0.22

Mann-Kendall Test

M-K Test Value (S)	-1
Tabulated p-value	0.5
Standard Deviation of S	11.18
Standardized Value of S	0
Approximate p-value	0.5

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   ProUCL 5.15/19/2020 5:41:47 PM
                       From File   Database_Download_Chemicals.xls
                  Full Precision   ON
          Confidence Coefficient   0.9900000
           Level of Significance   0.0100000

                    UCD1-068 Selenium

                   General Statistics
     Number or Reported Events Not Used     0
           Number of Generated Events     24
          Number Values Reported (n)     24
                             Minimum  1.5300000
                             Maximum  3.9800000
                                Mean  2.4550000
                      Geometric Mean  2.3643703
                              Median  2.2075000
                  Standard Deviation  0.7031034
            Coefficient of Variation  0.2863965

                  Mann-Kendall Test
                 M-K Test Value (S)  141.00000
                Critical Value (0.01)  2.3263479
              Standard Deviation of S  40.303019
             Standardized Value of S  3.4736852
                  Approximate p-value  2.5668E-4

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

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.15/22/2020 11:50:33 AM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-068 Selenium; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	1.98
Maximum	3.98
Mean	2.937
Geometric Mean	2.868
Median	3.03
Standard Deviation	0.648
Coefficient of Variation	0.221

Mann-Kendall Test

M-K Test Value (S)	0
Tabulated p-value	0.527
Standard Deviation of S	14.58
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	ProUCL 5.15/20/2020 1:43:23 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-070 Carbon-14

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	25
Number Values Reported (n)	25
Minimum	6.47
Maximum	48.5
Mean	20.01
Geometric Mean	17.21
Median	17.6
Standard Deviation	11.29
Coefficient of Variation	0.564

Mann-Kendall Test

M-K Test Value (S)	63
Critical Value (0.01)	2.326
Standard Deviation of S	42.81
Standardized Value of S	1.448
Approximate p-value	0.0738

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	ProUCL 5.15/22/2020 12:07:08 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-070 Carbon-14; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	15
Number Values Reported (n)	15
Minimum	13.8
Maximum	48.5
Mean	25.12
Geometric Mean	23.19
Median	20.7
Standard Deviation	11.06
Coefficient of Variation	0.44

Mann-Kendall Test

M-K Test Value (S)	-57
Tabulated p-value	0.002
Standard Deviation of S	20.21
Standardized Value of S	-2.771
Approximate p-value	0.00279

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	ProUCL 5.15/28/2020 3:41:27 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-071 Chromium

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	14
Number Values Reported (n)	14
Minimum	34.800000
Maximum	58.700000
Mean	43.950000
Geometric Mean	43.436662
Median	42.750000
Standard Deviation	7.1462470
Coefficient of Variation	0.1625995

Mann-Kendall Test

M-K Test Value (S)	33.000000
Tabulated p-value	0.0400000
Standard Deviation of S	18.266545
Standardized Value of S	1.7518365
Approximate p-value	0.0399010

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	ProUCL 5.15/28/2020 2:25:27 PM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-071 Chromium: Years 2016 - 2020

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	5
Number Values Reported (n)	5
Minimum	38.1
Maximum	58.7
Mean	49.24
Geometric Mean	48.68
Median	49.3
Standard Deviation	8.153
Coefficient of Variation	0.166

Mann-Kendall Test

M-K Test Value (S)	10
Tabulated p-value	0.008
Standard Deviation of S	4.082
Standardized Value of S	2.205
Approximate p-value	0.0137

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

```
                                  Mann-Kendall Trend Test Analysis
          User Selected Options
     Date/Time of Computation     ProUCL 5.15/19/2020 5:51:37 PM
                    From File     Database_Download_Chemicals.xls
               Full Precision     ON
       Confidence Coefficient     0.9900000
        Level of Significance     0.0100000

             UCD1-071 Chromium Hexavalent

                     General Statistics
         Number or Reported Events Not Used     0
               Number of Generated Events    19
               Number Values Reported (n)    19
                                  Minimum 21.000000
                                  Maximum 62.000000
                                     Mean 44.000000
                           Geometric Mean 42.671241
                                   Median 42.000000
                       Standard Deviation 10.656245
                 Coefficient of Variation 0.2421874

                    Mann-Kendall Test
                        M-K Test Value (S) 71.000000
                        Tabulated p-value 0.0060000
                   Standard Deviation of S 28.513155
                  Standardized Value of S 2.4550072
                       Approximate p-value 0.0070441

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

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.15/22/2020 11:55:43 AM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-071 Chromium Hexavalent; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	8
Number Values Reported (n)	8
Minimum	30
Maximum	62
Mean	51.38
Geometric Mean	50.2
Median	53
Standard Deviation	10.7
Coefficient of Variation	0.208

Mann-Kendall Test

M-K Test Value (S)	17
Tabulated p-value	0.031
Standard Deviation of S	8.021
Standardized Value of S	1.995
Approximate p-value	0.023

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

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.15/28/2020 3:44:55 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-072 Nitrate as N

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	14
Number Values Reported (n)	14
Minimum	18.000000
Maximum	26.000000
Mean	20.857143
Geometric Mean	20.754774
Median	21.000000
Standard Deviation	2.1788191
Coefficient of Variation	0.1044639

Mann-Kendall Test

M-K Test Value (S)	36.000000
Tabulated p-value	0.0240000
Standard Deviation of S	17.795130
Standardized Value of S	1.9668302
Approximate p-value	0.0246014

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	ProUCL 5.15/28/2020 2:30:31 PM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-072 Nitrate as N: Years 2016 - 2020

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	5
Number Values Reported (n)	5
Minimum	21
Maximum	26
Mean	22.6
Geometric Mean	22.54
Median	22
Standard Deviation	1.949
Coefficient of Variation	0.0863

Mann-Kendall Test

M-K Test Value (S)	3
Tabulated p-value	0.408
Standard Deviation of S	3.606
Standardized Value of S	0.555
Approximate p-value	0.29

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

C3.1.2 COCs Currently Monitored Annually, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-2)

```
                          Mann-Kendall Trend Test Analysis
      User Selected Options
   Date/Time of Computation  ProUCL 5.15/28/2020 3:39:01 PM
                  From File  Database_Download_Chemicals.xls
             Full Precision  ON
     Confidence Coefficient  0.9900000
      Level of Significance  0.0100000

            UCD1-069 Nitrate as N

             General Statistics
   Number or Reported Events Not Used   0
         Number of Generated Events    14
         Number Values Reported (n)    14
                            Minimum 3.1000000
                            Maximum 14.000000
                               Mean 9.6000000
                     Geometric Mean 9.0176504
                             Median 9.4500000
                 Standard Deviation 3.1513123
           Coefficient of Variation 0.3282617

             Mann-Kendall Test
                 M-K Test Value (S) 22.000000
                  Tabulated p-value 0.1170000
             Standard Deviation of S 18.184242
            Standardized Value of S 1.1548460
                 Approximate p-value 0.1240767

 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	ProUCL 5.15/28/2020 2:22:51 PM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-069 Nitrate as N: Years 2016 - 2020

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	5
Number Values Reported (n)	5
Minimum	3.1
Maximum	14
Mean	9.7
Geometric Mean	8.547
Median	9.5
Standard Deviation	4.578
Coefficient of Variation	0.472

Mann-Kendall Test

M-K Test Value (S)	-9
Tabulated p-value	0.042
Standard Deviation of S	3.958
Standardized Value of S	-2.021
Approximate p-value	0.0216

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

C3.1.3 COCs Currently Monitored Biennially, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-3)

```
                                 Mann-Kendall Trend Test Analysis
          User Selected Options
      Date/Time of Computation   ProUCL 5.15/28/2020 3:23:43 PM
                      From File   Database_Download_Chemicals.xls
                  Full Precision   ON
        Confidence Coefficient   0.9900000
             Level of Significance   0.0100000

                UCD1-023 Nitrate as N

                  General Statistics
   Number or Reported Events Not Used     0
          Number of Generated Events     12
           Number Values Reported (n)     12
                                 Minimum 1.1000000
                                Maximum 5.1000000
                                    Mean 3.8750000
                         Geometric Mean 3.6124933
                                  Median 4.3000000
                     Standard Deviation 1.2121544
                 Coefficient of Variation 0.3128140

                  Mann-Kendall Test
                     M-K Test Value (S) -7.000000
                      Tabulated p-value 0.3690000
                 Standard Deviation of S 14.479871
              Standardized Value of S -0.414368
                  Approximate p-value 0.3393022

  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	ProUCL 5.15/28/2020 3:24:35 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-054 Chromium

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	6.2800000
Maximum	13.600000
Mean	9.6091667
Geometric Mean	9.3386836
Median	8.6700000
Standard Deviation	2.4380486
Coefficient of Variation	0.2537211

Mann-Kendall Test

M-K Test Value (S)	-2.000000
Tabulated p-value	0.4730000
Standard Deviation of S	14.583095
Standardized Value of S	-0.068573
Approximate p-value	0.4726649

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	ProUCL 5.15/19/2020 5:14:18 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-054 Chromium Hexavalent

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	5.1000000
Maximum	12.000000
Mean	8.4875000
Geometric Mean	8.1246915
Median	7.9750000
Standard Deviation	2.6210793
Coefficient of Variation	0.3088164

Mann-Kendall Test

M-K Test Value (S)	6.0000000
Tabulated p-value	0.3690000
Standard Deviation of S	14.422205
Standardized Value of S	0.3466876
Approximate p-value	0.3644130

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	ProUCL 5.15/19/2020 5:15:07 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-054 Molybdenum

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	2.2600000
Maximum	3.1100000
Mean	2.7254167
Geometric Mean	2.7134694
Median	2.7950000
Standard Deviation	0.2625700
Coefficient of Variation	0.0963412

Mann-Kendall Test

M-K Test Value (S)	-8.000000
Tabulated p-value	0.3190000
Standard Deviation of S	14.583095
Standardized Value of S	-0.480008
Approximate p-value	0.3156109

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	ProUCL 5.15/28/2020 3:27:33 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-068 Nitrate as N

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	6.2000000
Maximum	13.000000
Mean	10.341667
Geometric Mean	10.180195
Median	10.500000
Standard Deviation	1.7834891
Coefficient of Variation	0.1724566

Mann-Kendall Test

M-K Test Value (S)	40.000000
Tabulated p-value	0.0030000
Standard Deviation of S	14.422205
Standardized Value of S	2.7041635
Approximate p-value	0.0034238

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

```
                                  Mann-Kendall Trend Test Analysis
          User Selected Options
     Date/Time of Computation     ProUCL 5.15/19/2020 5:44:37 PM
                    From File     Database_Download_Chemicals.xls
               Full Precision     ON
       Confidence Coefficient     0.9900000
        Level of Significance     0.0100000

                   UCD1-069 Molybdenum

                     General Statistics
       Number or Reported Events Not Used    0
            Number of Generated Events      12
            Number Values Reported (n)      12
                                Minimum 1.0300000
                                Maximum 1.8100000
                                   Mean 1.4925000
                         Geometric Mean 1.4758521
                                 Median 1.5100000
                     Standard Deviation 0.2239369
               Coefficient of Variation 0.1500415

                     Mann-Kendall Test
                     M-K Test Value (S) -34.00000
                      Tabulated p-value 0.0100000
                  Standard Deviation of S 14.583095
                 Standardized Value of S -2.262894
                     Approximate p-value 0.0118211

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  ProUCL 5.15/28/2020 3:39:52 PM
               From File  Database_Download_Chemicals.xls
          Full Precision  ON
  Confidence Coefficient  0.9900000
   Level of Significance  0.0100000
```

UCD1-070 Nitrate as N

General Statistics

```
Number or Reported Events Not Used   0
      Number of Generated Events    12
     Number Values Reported (n)     12
                          Minimum 0.9900000
                          Maximum 3.0000000
                             Mean 1.7741667
                   Geometric Mean 1.6997139
                           Median 1.7000000
               Standard Deviation 0.5459014
         Coefficient of Variation 0.3076945
```

Mann-Kendall Test

```
       M-K Test Value (S) -38.00000
       Tabulated p-value 0.0040000
   Standard Deviation of S 14.514361
  Standardized Value of S -2.549199
      Approximate p-value 0.0053985
```

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	ProUCL 5.17/1/2020 8:17:29 AM
From File	ProUCL Load File_Chemicals wo Outliers.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-071 Molybdenum

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	11
Number Values Reported (n)	11
Minimum	0.6110000
Maximum	1.6000000
Mean	1.1375455
Geometric Mean	1.0953288
Median	1.2400000
Standard Deviation	0.3124709
Coefficient of Variation	0.2746887

Mann-Kendall Test

M-K Test Value (S)	-31.00000
Tabulated p-value	0.0080000
Standard Deviation of S	12.845233
Standardized Value of S	-2.335497
Approximate p-value	0.0097587

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	ProUCL 5.16/1/2020 9:05:36 AM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-072 Radium-226

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	15
Number Values Missing	3
Number Values Used	12
Minimum	0.0399
Maximum	1.561
Mean	0.408
Geometric Mean	0.249
Median	0.344
Standard Deviation	0.415
Coefficient of Variation	1.017

Mann-Kendall Test

M-K Test Value (S)	24
Tabulated p-value	0.058
Standard Deviation of S	14.58
Standardized Value of S	1.577
Approximate p-value	0.0574

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

C3.2 Monitoring-Only Constituents (MOCs)

C3.2.1 MOCs Currently Monitored Annually, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-4)

```
                          Mann-Kendall Trend Test Analysis
     User Selected Options
   Date/Time of Computation  ProUCL 5.15/28/2020 3:26:22 PM
                  From File  Database_Download_Chemicals.xls
             Full Precision  ON
     Confidence Coefficient  0.9900000
      Level of Significance  0.0100000

              UCD1-068 Chromium

              General Statistics
   Number or Reported Events Not Used    0
          Number of Generated Events    12
           Number Values Reported (n)    12
                              Minimum 33.000000
                              Maximum 54.300000
                                 Mean 41.987500
                       Geometric Mean 41.585514
                               Median 43.025000
                   Standard Deviation 6.1089028
             Coefficient of Variation 0.1454934

              Mann-Kendall Test
                   M-K Test Value (S) 23.000000
                    Tabulated p-value 0.0760000
                Standard Deviation of S 14.548769
               Standardized Value of S 1.5121555
                   Approximate p-value 0.0652472

   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	ProUCL 5.15/28/2020 2:19:39 PM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-068 Chromium: Years 2016 - 2020

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	6
Number Values Reported (n)	6
Minimum	36.2
Maximum	54.3
Mean	45.31
Geometric Mean	44.98
Median	45.3
Standard Deviation	5.909
Coefficient of Variation	0.13

Mann-Kendall Test

M-K Test Value (S)	-5
Tabulated p-value	0.235
Standard Deviation of S	5.323
Standardized Value of S	-0.751
Approximate p-value	0.226

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	ProUCL 5.17/1/2020 8:59:36 AM
From File	ProUCL Load File_Chemicals wo Outliers.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-069 Aluminum

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	11
Number Values Reported (n)	11
Minimum	3.3100000
Maximum	79.500000
Mean	16.447273
Geometric Mean	9.7298861
Median	10.500000
Standard Deviation	22.374734
Coefficient of Variation	1.3603918

Mann-Kendall Test

M-K Test Value (S)	6.0000000
Tabulated p-value	0.3240000
Standard Deviation of S	12.806248
Standardized Value of S	0.3904344
Approximate p-value	0.3481077

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	ProUCL 5.15/22/2020 11:51:23 AM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-069 Aluminum; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	5
Number Values Reported (n)	5
Minimum	8.27
Maximum	31.4
Mean	15.15
Geometric Mean	13.48
Median	11.8
Standard Deviation	9.285
Coefficient of Variation	0.613

Mann-Kendall Test

M-K Test Value (S)	-2
Tabulated p-value	0.408
Standard Deviation of S	4.082
Standardized Value of S	-0.245
Approximate p-value	0.403

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

C3.2.2 MOCs Currently Monitored Biennially, Baseline Above Background (Trends Summarized in Table C-5)

```
                         Mann-Kendall Trend Test Analysis
    User Selected Options
  Date/Time of Computation  ProUCL 5.15/19/2020 5:49:03 PM
                 From File  Database_Download_Chemicals.xls
            Full Precision  ON
    Confidence Coefficient  0.9900000
     Level of Significance  0.0100000

                UCD1-070 Zinc

             General Statistics
  Number or Reported Events Not Used   0
         Number of Generated Events   10
        Number Values Reported (n)   10
                            Minimum 0.5990000
                            Maximum 35.200000
                               Mean 10.210900
                     Geometric Mean 6.3644594
                             Median 6.5700000
                 Standard Deviation 10.357458
           Coefficient of Variation 1.0143531

             Mann-Kendall Test
                 M-K Test Value (S) -3.000000
                 Tabulated p-value 0.4310000
             Standard Deviation of S 11.180340
            Standardized Value of S -0.178885
                Approximate p-value 0.4290138

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  ProUCL 5.15/19/2020 5:50:05 PM
                From File  Database_Download_Chemicals.xls
           Full Precision  ON
   Confidence Coefficient  0.9900000
    Level of Significance  0.0100000

               UCD1-071 Aluminum


               General Statistics
   Number or Reported Events Not Used    0
         Number of Generated Events      9
         Number Values Reported (n)      9
                            Minimum  7.1500000
                            Maximum  79.500000
                               Mean  22.438889
                     Geometric Mean  16.952476
                             Median  13.400000
                 Standard Deviation  22.429581
           Coefficient of Variation  0.9995852

               Mann-Kendall Test
                  M-K Test Value (S)  -8.000000
                  Tabulated p-value  0.2380000
              Standard Deviation of S  9.5916630
              Standardized Value of S  -0.729800
                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	ProUCL 5.17/1/2020 9:00:40 AM
From File	ProUCL Load File_Chemicals wo Outliers.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-072 Aluminum

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	3.5350000
Maximum	79.500000
Mean	20.621667
Geometric Mean	12.663917
Median	10.700000
Standard Deviation	24.624797
Coefficient of Variation	1.1941225

Mann-Kendall Test

M-K 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.

C3.2.3 MOCs Currently Monitored Biennially, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-5)

```
                                Mann-Kendall Trend Test Analysis
           User Selected Options
       Date/Time of Computation ProUCL 5.15/19/2020 5:12:51 PM
                      From File Database_Download_Chemicals.xls
                 Full Precision ON
         Confidence Coefficient 0.9900000
          Level of Significance 0.0100000

                    UCD1-023 Zinc

                  General Statistics
    Number or Reported Events Not Used   0
           Number of Generated Events   10
          Number Values Reported (n)   10
                             Minimum 0.4790000
                             Maximum 11.800000
                                Mean 6.8469000
                      Geometric Mean 5.3530481
                              Median 6.8000000
                  Standard Deviation 3.5769035
            Coefficient of Variation 0.5224121

                  Mann-Kendall Test
                  M-K Test Value (S) -5.000000
                  Tabulated p-value 0.3640000
             Standard Deviation of S 11.180340
            Standardized Value of S -0.357771
                Approximate p-value 0.3602574

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	ProUCL 5.15/19/2020 5:35:05 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-068 Aluminum

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	10
Number Values Reported (n)	10
Minimum	3.3100000
Maximum	79.500000
Mean	14.363500
Geometric Mean	8.3678268
Median	7.6450000
Standard Deviation	23.067114
Coefficient of Variation	1.6059536

Mann-Kendall Test

M-K Test Value (S)	-2.000000
Tabulated p-value	0.4310000
Standard Deviation of S	11.135529
Standardized Value of S	-0.089803
Approximate p-value	0.4642220

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	ProUCL 5.15/19/2020 5:38:41 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-068 Nickel

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	9
Number Values Reported (n)	9
Minimum	1.2300000
Maximum	2.3400000
Mean	1.8911111
Geometric Mean	1.8640732
Median	1.8400000
Standard Deviation	0.3218383
Coefficient of Variation	0.1701847

Mann-Kendall Test

M-K Test Value (S)	-19.00000
Tabulated p-value	0.0380000
Standard Deviation of S	9.5393920
Standardized Value of S	-1.886913
Approximate p-value	0.0295860

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

C3.3 New Well Constituents (NWCs)

C3.3.1 NWCs Currently Monitored Annually, Baseline Above Background (Trends Summarized in Table C-6)

```
                                Mann-Kendall Trend Test Analysis
        User Selected Options
   Date/Time of Computation     ProUCL 5.15/19/2020 5:37:45 PM
                  From File     Database_Download_Chemicals.xls
             Full Precision     ON
     Confidence Coefficient     0.9900000
      Level of Significance     0.0100000

         UCD1-068 Chromium Hexavalent

               General Statistics
 Number or Reported Events Not Used     0
        Number of Generated Events     14
        Number Values Reported (n)     14
                            Minimum 28.000000
                            Maximum 52.000000
                               Mean 39.535714
                     Geometric Mean 38.881997
                             Median 40.250000
                 Standard Deviation 7.3627552
           Coefficient of Variation 0.1862305

               Mann-Kendall Test
                 M-K Test Value (S) 37.000000
                 Tabulated p-value 0.0240000
           Standard Deviation of S 18.211718
          Standardized Value of S 1.9767493
              Approximate p-value 0.0240350

 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	ProUCL 5.15/22/2020 11:49:51 AM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-068 Chromium Hexavalent; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	34
Maximum	52
Mean	43.93
Geometric Mean	43.56
Median	44
Standard Deviation	5.975
Coefficient of Variation	0.136

Mann-Kendall Test

M-K Test Value (S)	-1
Tabulated p-value	0.5
Standard Deviation of S	6.658
Standardized Value of S	0
Approximate p-value	0.5

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	ProUCL 5.15/20/2020 1:39:20 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-069 Beta, Gross

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	-0.481
Maximum	6.42
Mean	2.433
Geometric Mean	N/A
Median	2.225
Standard Deviation	1.767
Coefficient of Variation	0.727

Mann-Kendall Test

M-K Test Value (S)	-12
Tabulated p-value	0.23
Standard Deviation of S	14.58
Standardized Value of S	-0.754
Approximate p-value	0.225

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	ProUCL 5.15/22/2020 12:03:44 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-069 Beta, Gross; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	5
Number Values Reported (n)	5
Minimum	0.773
Maximum	3.71
Mean	2.207
Geometric Mean	1.918
Median	2.16
Standard Deviation	1.181
Coefficient of Variation	0.535

Mann-Kendall Test

M-K Test Value (S)	0
Tabulated p-value	0.592
Standard Deviation of S	4.082
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	ProUCL 5.15/20/2020 1:41:17 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-069 Uranium-238

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	14
Number Values Reported (n)	14
Minimum	0.565
Maximum	1.9
Mean	1.341
Geometric Mean	1.279
Median	1.3
Standard Deviation	0.39
Coefficient of Variation	0.291

Mann-Kendall Test

M-K Test Value (S)	12
Tabulated p-value	0.259
Standard Deviation of S	18.24
Standardized Value of S	0.603
Approximate p-value	0.273

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	ProUCL 5.15/22/2020 12:04:58 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-069 Uranium-238; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.778
Maximum	1.9
Mean	1.435
Geometric Mean	1.384
Median	1.49
Standard Deviation	0.387
Coefficient of Variation	0.27

Mann-Kendall Test

M-K Test Value (S)	-9
Tabulated p-value	0.119
Standard Deviation of S	6.658
Standardized Value of S	-1.202
Approximate p-value	0.115

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	ProUCL 5.15/20/2020 1:42:07 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-070 Beta, Gross

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	-0.222
Maximum	2.9
Mean	1.781
Geometric Mean	N/A
Median	1.775
Standard Deviation	0.931
Coefficient of Variation	0.522

Mann-Kendall Test

M-K Test Value (S)	-32
Tabulated p-value	0.016
Standard Deviation of S	14.58
Standardized Value of S	-2.126
Approximate p-value	0.0168

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	ProUCL 5.15/22/2020 12:05:58 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-070 Beta, Gross; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	5
Number Values Reported (n)	5
Minimum	1.17
Maximum	1.98
Mean	1.494
Geometric Mean	1.47
Median	1.43
Standard Deviation	0.309
Coefficient of Variation	0.207

Mann-Kendall Test

M-K Test Value (S)	-4
Tabulated p-value	0.242
Standard Deviation of S	4.082
Standardized Value of S	-0.735
Approximate p-value	0.231

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	ProUCL 5.15/20/2020 1:44:58 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-071 Beta, Gross

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	13
Number Values Reported (n)	13
Minimum	0.946
Maximum	6.82
Mean	3.261
Geometric Mean	2.824
Median	3.39
Standard Deviation	1.68
Coefficient of Variation	0.515

Mann-Kendall Test

M-K Test Value (S)	-18
Tabulated p-value	0.153
Standard Deviation of S	16.39
Standardized Value of S	-1.037
Approximate p-value	0.15

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	ProUCL 5.15/22/2020 12:07:57 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-071 Beta, Gross; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	5
Number Values Reported (n)	5
Minimum	1.55
Maximum	4.98
Mean	3.026
Geometric Mean	2.813
Median	2.84
Standard Deviation	1.284
Coefficient of Variation	0.424

Mann-Kendall Test

M-K Test Value (S)	-4
Tabulated p-value	0.242
Standard Deviation of S	4.082
Standardized Value of S	-0.735
Approximate p-value	0.231

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	ProUCL 5.15/28/2020 3:42:24 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-072 Chloroform

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	16
Number Values Reported (n)	16
Minimum	0.8200000
Maximum	2.4000000
Mean	1.4518750
Geometric Mean	1.3788116
Median	1.5000000
Standard Deviation	0.4728244
Coefficient of Variation	0.3256647

Mann-Kendall Test

M-K Test Value (S)	80.000000
Tabulated p-value	0
Standard Deviation of S	22.060523
Standardized Value of S	3.5810575
Approximate p-value	1.7110E-4

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

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.15/28/2020 2:27:14 PM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-072 Chloroform: Years 2016 - 2020

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	8
Number Values Reported (n)	8
Minimum	1.4
Maximum	2.4
Mean	1.781
Geometric Mean	1.75
Median	1.625
Standard Deviation	0.37
Coefficient of Variation	0.208

Mann-Kendall Test

M-K Test Value (S)	-1
Tabulated p-value	0.548
Standard Deviation of S	8.021
Standardized Value of S	0
Approximate p-value	0.5

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	ProUCL 5.15/28/2020 3:43:52 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-072 Chromium

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	13
Number Values Reported (n)	13
Minimum	50.500000
Maximum	69.400000
Mean	59.980769
Geometric Mean	59.783430
Median	60.400000
Standard Deviation	5.0125484
Coefficient of Variation	0.0835693

Mann-Kendall Test

M-K Test Value (S)	28.000000
Tabulated p-value	0.0500000
Standard Deviation of S	16.391054
Standardized Value of S	1.6472400
Approximate p-value	0.0497544

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	ProUCL 5.15/28/2020 2:28:43 PM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-072 Chromium: Years 2016 - 2020

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	6
Number Values Reported (n)	6
Minimum	59.3
Maximum	69.4
Mean	62.62
Geometric Mean	62.53
Median	61.5
Standard Deviation	3.76
Coefficient of Variation	0.06

Mann-Kendall Test

M-K Test Value (S)	-3
Tabulated p-value	0.36
Standard Deviation of S	5.323
Standardized Value of S	-0.376
Approximate p-value	0.354

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	ProUCL 5.15/19/2020 5:56:41 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-072 Chromium Hexavalent

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	15
Number Values Reported (n)	15
Minimum	46.000000
Maximum	64.000000
Mean	57.833333
Geometric Mean	57.669235
Median	58.000000
Standard Deviation	4.3738944
Coefficient of Variation	0.0756293

Mann-Kendall Test

M-K Test Value (S)	58.000000
Tabulated p-value	0.0010000
Standard Deviation of S	20.016660
Standardized Value of S	2.8476280
Approximate p-value	0.0022023

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

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.15/22/2020 11:57:50 AM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-072 Chromium Hexavalent; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	58
Maximum	64
Mean	60.86
Geometric Mean	60.81
Median	60
Standard Deviation	2.545
Coefficient of Variation	0.0418

Mann-Kendall Test

M-K Test Value (S)	-4
Tabulated p-value	0.281
Standard Deviation of S	6.429
Standardized Value of S	-0.467
Approximate p-value	0.32

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	ProUCL 5.15/20/2020 1:46:54 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-072 Uranium-238

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	14
Number Values Reported (n)	14
Minimum	0.574
Maximum	1.9
Mean	1.122
Geometric Mean	1.081
Median	1.135
Standard Deviation	0.316
Coefficient of Variation	0.281

Mann-Kendall Test

M-K Test Value (S)	21
Tabulated p-value	0.14
Standard Deviation of S	18.21
Standardized Value of S	1.098
Approximate p-value	0.136

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	ProUCL 5.15/22/2020 12:08:51 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-072 Uranium-238; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	7
Number Values Reported (n)	7
Minimum	0.574
Maximum	1.9
Mean	1.237
Geometric Mean	1.175
Median	1.21
Standard Deviation	0.398
Coefficient of Variation	0.322

Mann-Kendall Test

M-K Test Value (S)	-9
Tabulated p-value	0.119
Standard Deviation of S	6.658
Standardized Value of S	-1.202
Approximate p-value	0.115

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

C3.3.2 NWCs Currently Monitored Annually, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-6)

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.17/1/2020 8:46:49 AM
From File	ProUCL Load File_Chemicals wo Outliers.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-069 Iron

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	11
Number Values Reported (n)	11
Minimum	9.2600000
Maximum	122.00000
Mean	40.714545
Geometric Mean	32.247472
Median	32.000000
Standard Deviation	32.080915
Coefficient of Variation	0.7879473

Mann-Kendall Test

M-K Test Value (S)	11.000000
Tabulated p-value	0.2230000
Standard Deviation of S	12.845233
Standardized Value of S	0.7784989
Approximate p-value	0.2181375

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	ProUCL 5.15/22/2020 11:52:42 AM
From File	Database_Download_Chemicals.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

UCD1-069 Iron; 2016 - 2020 Data Only

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	5
Number Values Reported (n)	5
Minimum	15.9
Maximum	122
Mean	48.46
Geometric Mean	38.19
Median	35.2
Standard Deviation	41.96
Coefficient of Variation	0.866

Mann-Kendall Test

M-K Test Value (S)	4
Tabulated p-value	0.242
Standard Deviation of S	4.082
Standardized Value of S	0.735
Approximate p-value	0.231

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

C3.3.3 NWCs Currently Monitored Biennially, Baseline Above Background (Trends Summarized in Table C-7)

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.15/28/2020 3:25:28 PM
From File	Database_Download_Chemicals.xls
Full Precision	ON
Confidence Coefficient	0.9900000
Level of Significance	0.0100000

UCD1-068 Chloroform

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	10
Number Values Reported (n)	10
Minimum	0.0620000
Maximum	0.2350000
Mean	0.1882000
Geometric Mean	0.1776100
Median	0.2100000
Standard Deviation	0.0539564
Coefficient of Variation	0.2866969

Mann-Kendall Test

M-K Test Value (S)	9.0000000
Tabulated p-value	0.2420000
Standard Deviation of S	10.969655
Standardized Value of S	0.7292846
Approximate p-value	0.2329138

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	ProUCL 5.17/8/2020 7:44:12 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-068 Uranium-238

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	11
Number Values Reported (n)	11
Minimum	0.565
Maximum	1.49
Mean	1.068
Geometric Mean	1.039
Median	1.1
Standard Deviation	0.246
Coefficient of Variation	0.23

Mann-Kendall Test

M-K Test Value (S)	15
Tabulated p-value	0.141
Standard Deviation of S	12.85
Standardized Value of S	1.09
Approximate p-value	0.138

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	ProUCL 5.15/20/2020 1:40:27 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-069 Carbon-14

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	11
Number Values Reported (n)	11
Minimum	15.8
Maximum	32.7
Mean	22.43
Geometric Mean	22.08
Median	22.5
Standard Deviation	4.305
Coefficient of Variation	0.192

Mann-Kendall Test

M-K Test Value (S)	7
Tabulated p-value	0.324
Standard Deviation of S	12.85
Standardized Value of S	0.467
Approximate p-value	0.32

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	ProUCL 5.17/8/2020 7:45:00 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-070 Uranium-238

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	0.517
Maximum	2.08
Mean	1.186
Geometric Mean	1.112
Median	1.175
Standard Deviation	0.42
Coefficient of Variation	0.354

Mann-Kendall Test

M-K Test Value (S)	30
Tabulated p-value	0.022
Standard Deviation of S	14.58
Standardized Value of S	1.989
Approximate p-value	0.0234

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	ProUCL 5.15/20/2020 1:45:47 PM
From File	Database_Download_Radiological.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

UCD1-071 Uranium-238

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	12
Number Values Reported (n)	12
Minimum	1.51
Maximum	4.015
Mean	2.203
Geometric Mean	2.123
Median	2.08
Standard Deviation	0.684
Coefficient of Variation	0.311

Mann-Kendall Test

M-K Test Value (S)	17
Tabulated p-value	0.155
Standard Deviation of S	14.55
Standardized Value of S	1.1
Approximate p-value	0.136

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

C3.3.4 NWCs Currently Monitored Biennially, Baseline at or Below Background or Not Detected (Trends Summarized in Table C-7)

```
                                  Mann-Kendall Trend Test Analysis
          User Selected Options
     Date/Time of Computation     ProUCL 5.17/1/2020 8:32:24 AM
                    From File     ProUCL Load File_Chemicals wo Outliers.xls
               Full Precision     ON
       Confidence Coefficient     0.9900000
        Level of Significance     0.0100000

                UCD1-071 Manganese

                  General Statistics
     Number or Reported Events Not Used     0
           Number of Generated Events     9
          Number Values Reported (n)     9
                              Minimum 0.1810000
                              Maximum 6.3400000
                                 Mean 1.4072222
                       Geometric Mean 0.7851783
                               Median 0.6940000
                   Standard Deviation 1.9468587
             Coefficient of Variation 1.3834764

                  Mann-Kendall Test
                   M-K 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.
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Attachment C-4

Baseline Comparison with Background and Water-Quality Criteria

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Attachment C-4. Baseline Comparison with Background and Water Quality Criteria, DOE Areas Groundwater Monitoring Program, LEHR

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 (EPA 2000)	Yes
UCD1-021	Nitrate as N	mg/L	27	15	10	MCL (SWRCB 2018a)	**No**
UCD1-021	Radium-226	pCi/L	0.292 J	1.17	5	MCL (SWRCB 2018a)	Yes
UCD1-023	Carbon-14	pCi/L	22.1	<7	2,000	MCL (EPA 2000)	Yes
UCD1-023	Nitrate as N	mg/L	5.1	15	10	MCL (SWRCB 2018a)	Yes
UCD1-054	Cesium-137	pCi/L	<5.02	<5	200	MCL (EPA 2000)	Yes
UCD1-054	Chromium	µg/L	13.6	43.7	50	MCL (SWRCB 2018a)	Yes
UCD1-054	Chromium (Hexavalent)	µg/L	12	40	50	MCL (SWRCB 2018a)	Yes
UCD1-054	Mercury	µg/L	0.072 J	0.0479 J	2	MCL (SWRCB 2018a)	Yes
UCD1-054	Molybdenum	µg/L	3.11	3.13	100	RSL (EPA 2020)	Yes
UCD1-054	Silver	µg/L	<1	<1	100	Secondary MCL (SWRCB 2018b)	Yes
UCD1-054	Strontium-90	pCi/L	<1	<1	8	MCL (SWRCB 2018a)	Yes
UCD1-068	Carbon-14	pCi/L	<7	<7	2,000	MCL (EPA 2000)	Yes
UCD1-068	Nitrate as N	mg/L	12	15	10	MCL (SWRCB 2018a)	Yes
UCD1-068	Radium-226	pCi/L	0.324	1.17	5	MCL (SWRCB 2018a)	Yes
UCD1-068	Selenium	µg/L	2.24	1.74	50	MCL (SWRCB 2018a)	Yes
UCD1-069	Formaldehyde	µg/L	12 J	13 J	100	California Notification Level (SWRCB 2020)	Yes
UCD1-069	Molybdenum	µg/L	1.81	3.13	100	RSL (EPA 2020)	Yes
UCD1-069	Nitrate as N	mg/L	9.9	15	10	MCL (SWRCB 2018a)	Yes
UCD1-070	Carbon-14	pCi/L	18.9	<7	2,000	MCL (EPA 2000)	Yes
UCD1-070	Nitrate as N	mg/L	3	15	10	MCL (SWRCB 2018a)	Yes
UCD1-071	Cesium-137	pCi/L	<5	<5	200	MCL (EPA 2000)	Yes
UCD1-071	Chromium	µg/L	49.1	43.7	50	MCL (SWRCB 2018a)	Yes
UCD1-071	Chromium (Hexavalent)	µg/L	47	40	50	MCL (SWRCB 2018a)	Yes
UCD1-071	Mercury	µg/L	0.0658 J	0.0479 J	2	MCL (SWRCB 2018a)	Yes
UCD1-071	Molybdenum	µg/L	1.54	3.13	100	RSL (EPA 2020)	Yes
UCD1-071	Silver	µg/L	<1	<1	100	Secondary MCL (SWRCB 2018b)	Yes
UCD1-071	Strontium-90	pCi/L	<1	<1	8	MCL (SWRCB 2018a)	Yes
UCD1-072	Carbon-14	pCi/L	<7	<7	2,000	MCL (EPA 2000)	Yes
UCD1-072	Nitrate as N	mg/L	23	15	10	MCL (SWRCB 2018a)	**No**
UCD1-072	Radium-226	pCi/L	0.558 J	1.17	5	MCL (SWRCB 2018a)	Yes

Attachment C-4. Baseline Comparison with Background and Water Quality Criteria, DOE Areas Groundwater Monitoring Program, LEHR

Monitoring Well	**Constituent**	**Units**	**Baseline Concentration**	**Background Concentration[a]**	**Water Quality Criterion (WQC)[b]**	**WQC Reference**	**Baseline Below WQC or at/below Background?[c]**
Monitoring-only Constituents							
UCD1-013	Chlordane	µg/L	<1	0	0.1	MCL (SWRCB 2018a)	**No**
UCD1-013	Dieldrin	µg/L	<0.1	0	0.0018	RSL (EPA 2020)	**No**
UCD1-021	Aluminum	µg/L	<50	5.86 J	1,000	MCL (SWRCB 2018a)	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 2018a)	Yes
UCD1-023	Zinc	µg/L	11.4	20.9	5,000	Secondary MCL (SWRCB 2018b)	Yes
UCD1-068	Aluminum	µg/L	<50	5.86 J	1,000	MCL (SWRCB 2018a)	Yes
UCD1-068	Americium-241	pCi/L	<0.555	<0.71	15	MCL (EPA 2000)	Yes
UCD1-068	Chromium	µg/L	40	43.7	50	MCL (SWRCB 2018a)	Yes
UCD1-068	Nickel	µg/L	2.29	141	100	MCL (SWRCB 2018a)	Yes
UCD1-069	Aluminum	µg/L	4.05	5.86 J	1,000	MCL (SWRCB 2018a)	Yes
UCD1-069	Silver	µg/L	<1	<1	100	Secondary MCL (SWRCB 2018b)	Yes
UCD1-070	Mercury	µg/L	<0.2	0.0479 J	2	MCL (SWRCB 2018a)	Yes
UCD1-070	Zinc	µg/L	35.2	20.9	5,000	Secondary MCL (SWRCB 2018b)	Yes
UCD1-071	Aluminum	µg/L	27.3 J	5.86 J	1,000	MCL (SWRCB 2018a)	Yes
UCD1-072	Aluminum	µg/L	39.9	5.86 J	1,000	MCL (SWRCB 2018a)	Yes
UCD1-072	Americium-241	pCi/L	<0.658	<0.71	15	MCL (EPA 2000)	Yes
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	50	MCL (SWRCB 2018a)	Yes
UCD1-068	Formaldehyde	µg/L	14 J	13 J	100	California Notification Level (SWRCB 2020)	Yes
UCD1-068	Gross Beta	pCi/L	4.3	2.88 J	NA (4 mrem/yr)	MCL (SWRCB 2018a)	**No**
UCD1-068	Uranium-238	pCi/L	1.21	0.946 J	20	MCL (SWRCB 2018a)	Yes
UCD1-069	1,1-Dichloroethane	µg/L	0.19 J	0	5	MCL (SWRCB 2018a)	Yes
UCD1-069	Carbon-14	pCi/L	22.9	<7	2000	MCL (EPA 2000)	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 2018a)	**No**
UCD1-069	Iron	µg/L	47	502	300	Secondary MCL (SWRCB 2018b)	Yes
UCD1-069	Manganese	µg/L	1	10	50	Secondary MCL (SWRCB 2018b)	Yes
UCD1-069	Uranium-238	pCi/L	1.3	0.946 J	20	MCL (SWRCB 2018a)	Yes
UCD1-070	Gross Beta	pCi/L	4.4 J	2.88 J	NA (4 mrem/yr)	MCL (SWRCB 2018a)	**No**
UCD1-070	Uranium-238	pCi/L	1.38	0.946 J	20	MCL (SWRCB 2018a)	Yes
UCD1-071	Benzene	µg/L	0.29 J	0	1	MCL (SWRCB 2018a)	Yes
UCD1-071	Gross Beta	pCi/L	4.83	2.88 J	NA (4 mrem/yr)	MCL (SWRCB 2018a)	**No**

Attachment C-4. Baseline Comparison with Background and Water Quality Criteria, DOE Areas Groundwater Monitoring Program, LEHR

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	Manganese	µg/L	6.34	10	50	Secondary MCL (SWRCB 2018b)	Yes
UCD1-071	Uranium-238	pCi/L	2.31	0.946 J	20	MCL (SWRCB 2018a)	Yes
UCD1-072	Chloroform	µg/L	0.88	0	70	MCL (EPA 2006)	Yes
UCD1-072	Chromium	µg/L	62.9	43.7	50	MCL (SWRCB 2018a)	**No**
UCD1-072	Chromium (Hexavalent)	µg/L	57	40	50	MCL (SWRCB 2018a)	**No**
UCD1-072	Formaldehyde	µg/L	14 J	13 J	100	California Notification Level (SWRCB 2020)	Yes
UCD1-072	Gross Beta	pCi/L	3.74	2.88 J	NA (4 mrem/yr)	MCL (SWRCB 2018a)	**No**
UCD1-072	Uranium-238	pCi/L	1.14	0.946 J	20	MCL (SWRCB 2018a)	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, USEPA Primary MCL, Secondary MCL, California Notification Level, USEPA RSL.

[c] "No" indicates that baseline level is either below the WQC, or, if above the WQC, is at or below the background level.

J = estimated value

Abbreviations:

MCL = Maximum Contaminant Level
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 Resources Control Board
µg/L = micrograms per liter
USEPA = U.S. Environmental Protection Agency
WQC = water quality criterion

References:

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

USEPA (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.

USEPA (U.S. Environmental Protection Agency), 2020. *Regional Screening Level (RSL) - Generic Tables,* Summary Table (TR=1E-6, HQ=1), https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables, last updated on May 1, 2020, accessed June 26, 2020.

SWRCB (State Water Resource Control Board), 2018a. *Maximum Contaminant Levels and Regulatory Dates For Drinking Water, U.S. EPA vs California,* https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ccr/mcls_epa_vs_dwp.pdf, last updated October 2018, accessed June 26, 2020.

SWRCB (State Water Resource Control Board), 2018b. *Secondary Drinking Water Standards,* https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ddw_secondary_standards.pdf, last updated October 1, 2018, accessed June 29, 2020.

SWRCB (State Water Resource Control Board), 2020. *Division of Drinking Water (DDW), Drinking Water Notification Levels and Response Levels: An Overview.* https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notification_levels_response_levels_overview.pdf, Last updated February 6, 2020, Accessed July 6, 2020.

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.

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Attachment C-5

Hydrostratigraphic Unit-1 Quarterly Groundwater Elevation Contour Maps – 2011 through 2019

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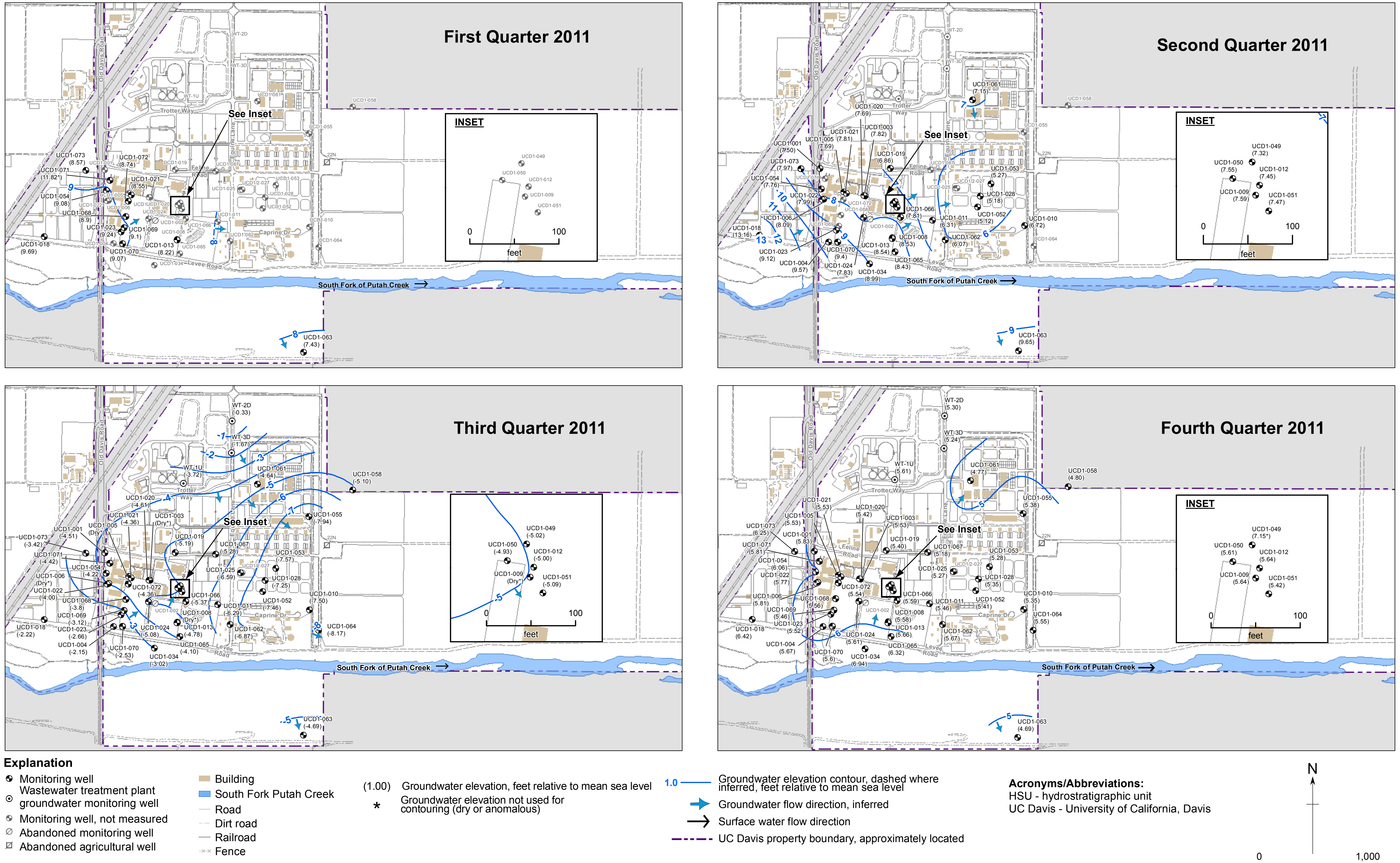


Figure 4-1. Groundwater Elevations in HSU-1 – Four Quarters 2011 - Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

Weiss Associates

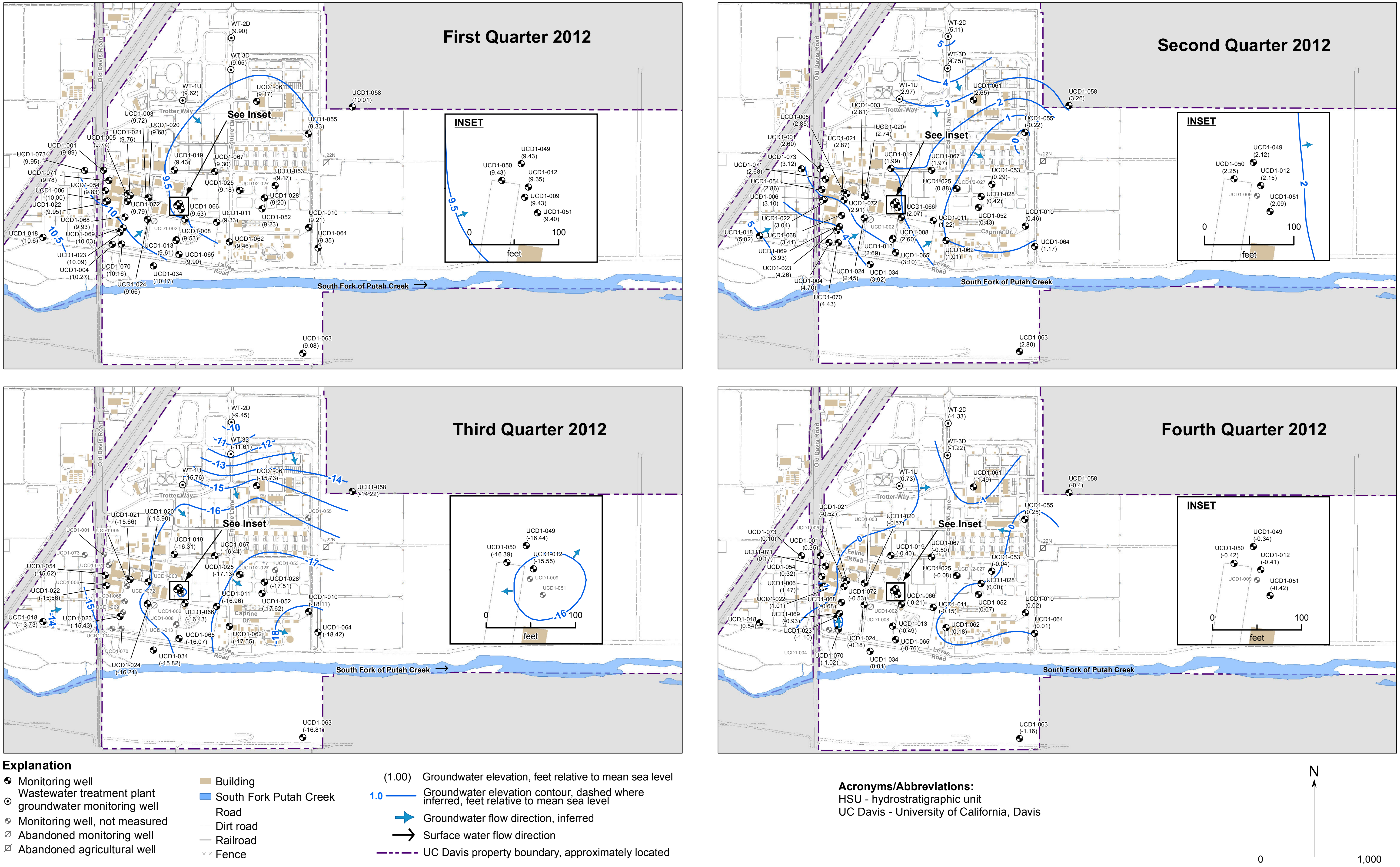
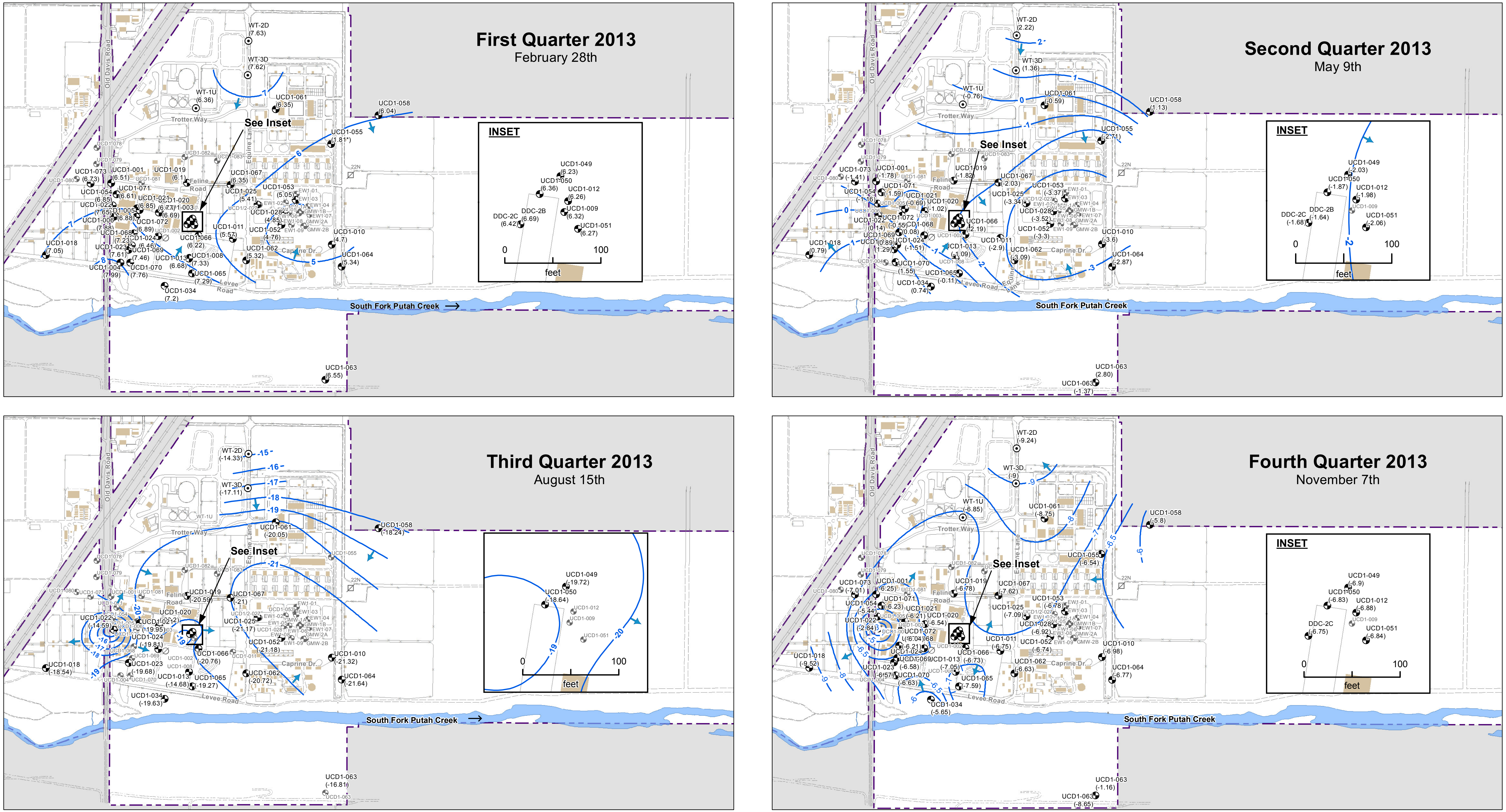


Figure 4-2. Groundwater Elevations in HSU-1 – Four Quarters 2012 - Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis



Explanation

- ● Monitoring well
- ⊙ Wastewater treatment plant groundwater monitoring well
- ● Monitoring well, not measured
- ⌀ Abandoned monitoring well
- ⌀ Abandoned agricultural well
- ▨ Building
- ▨ South Fork Putah Creek
- — Road
- --- Dirt road
- — Railroad
- -x- Fence
- (1.00) Groundwater elevation, feet relative to mean sea level
- 1.0 — Groundwater elevation contour, dashed where inferred, feet relative to mean sea level
- ➡ Groundwater flow direction, inferred
- → Surface water flow direction
- --- UC Davis property boundary, approximately located
- * Anomalous groundwater elevation not used for contouring

Acronyms/Abbreviations:

HSU - hydrostratigraphic unit

UC Davis - University of California, Davis

N

0 1,000

feet

Figure 4-2. Groundwater Elevations in HSU-1 – Four Quarters 2013 - Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

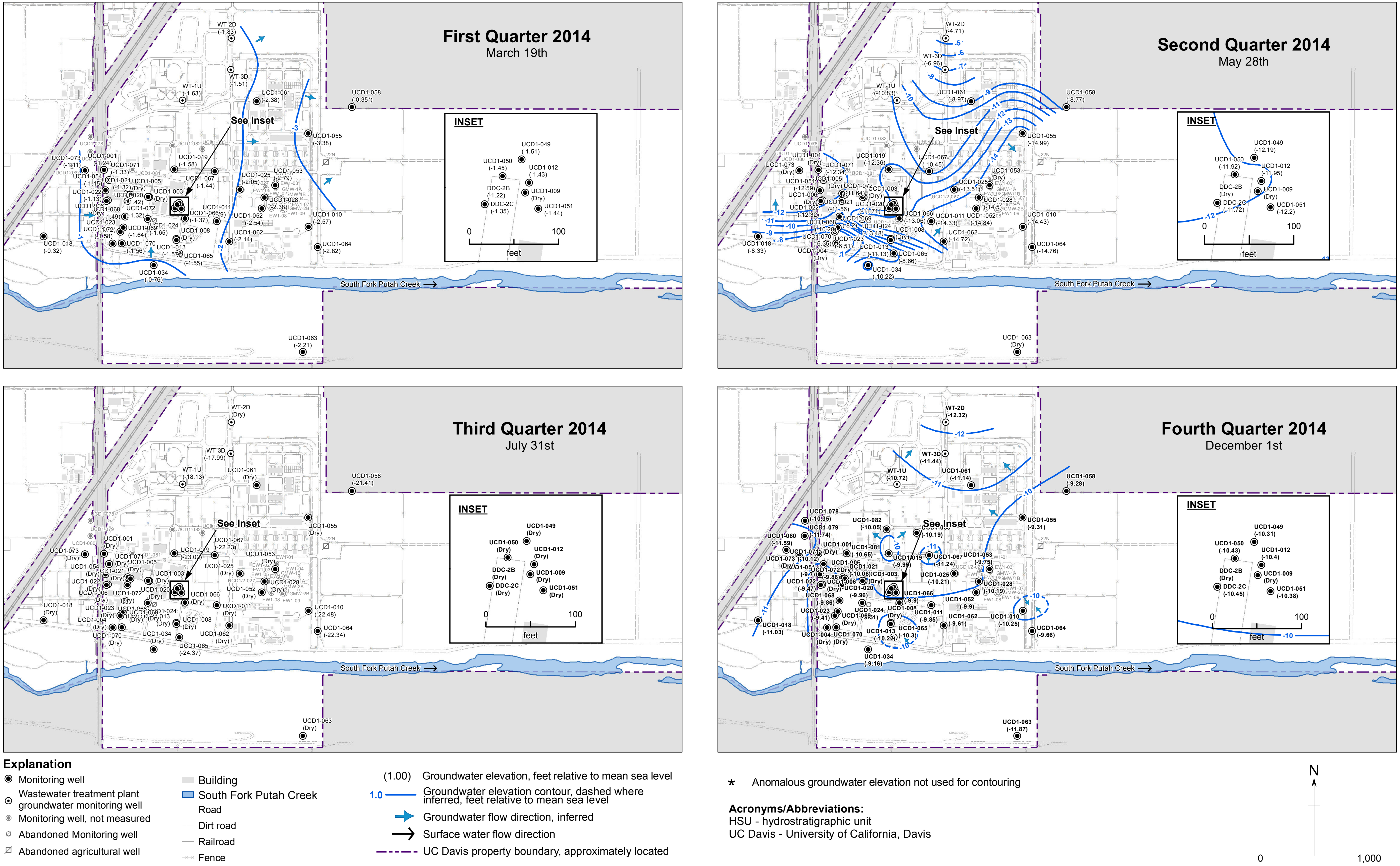
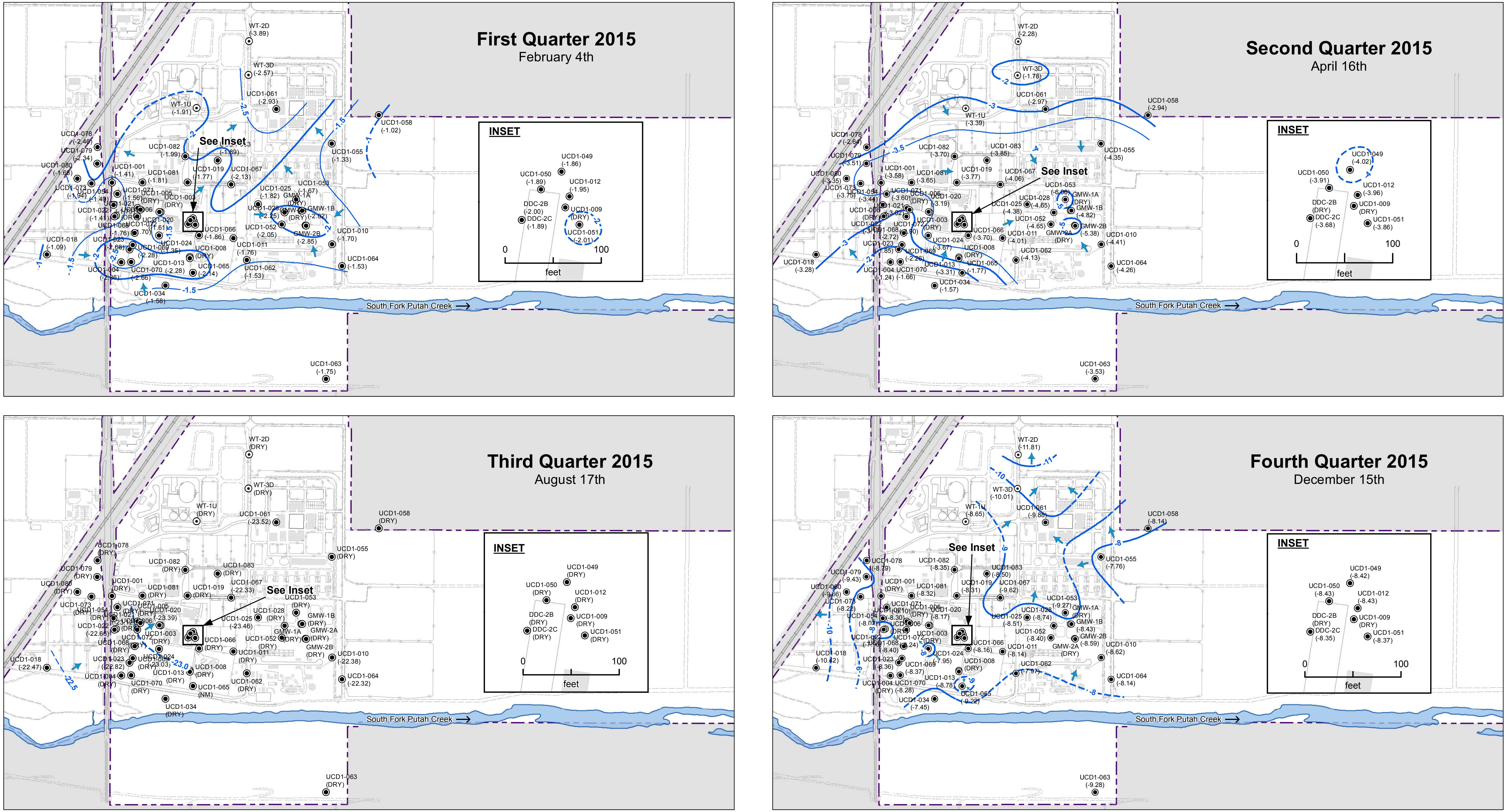


Figure 4-2. Groundwater Elevations in HSU-1 – Four Quarters 2014 - Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

Weiss Associates



Explanation

- ◉ Monitoring well
- ⊙ Wastewater treatment plant groundwater monitoring well
- Building
- South Fork Putah Creek
- Road
- Dirt road
- Railroad
- Fence

(1.00) Groundwater elevation, feet relative to mean sea level

1.0 Groundwater elevation contour, dashed where inferred, feet relative to mean sea level

Groundwater flow direction, inferred

Surface water flow direction

UC Davis property boundary, approximately located

Acronyms/Abbreviations:
HSU - hydrostratigraphic unit
NM - not measured
UC Davis - University of California, Davis

N

0
1,000
feet

Figure 4. Groundwater Elevations in HSU-1, Four Quarters 2015, Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

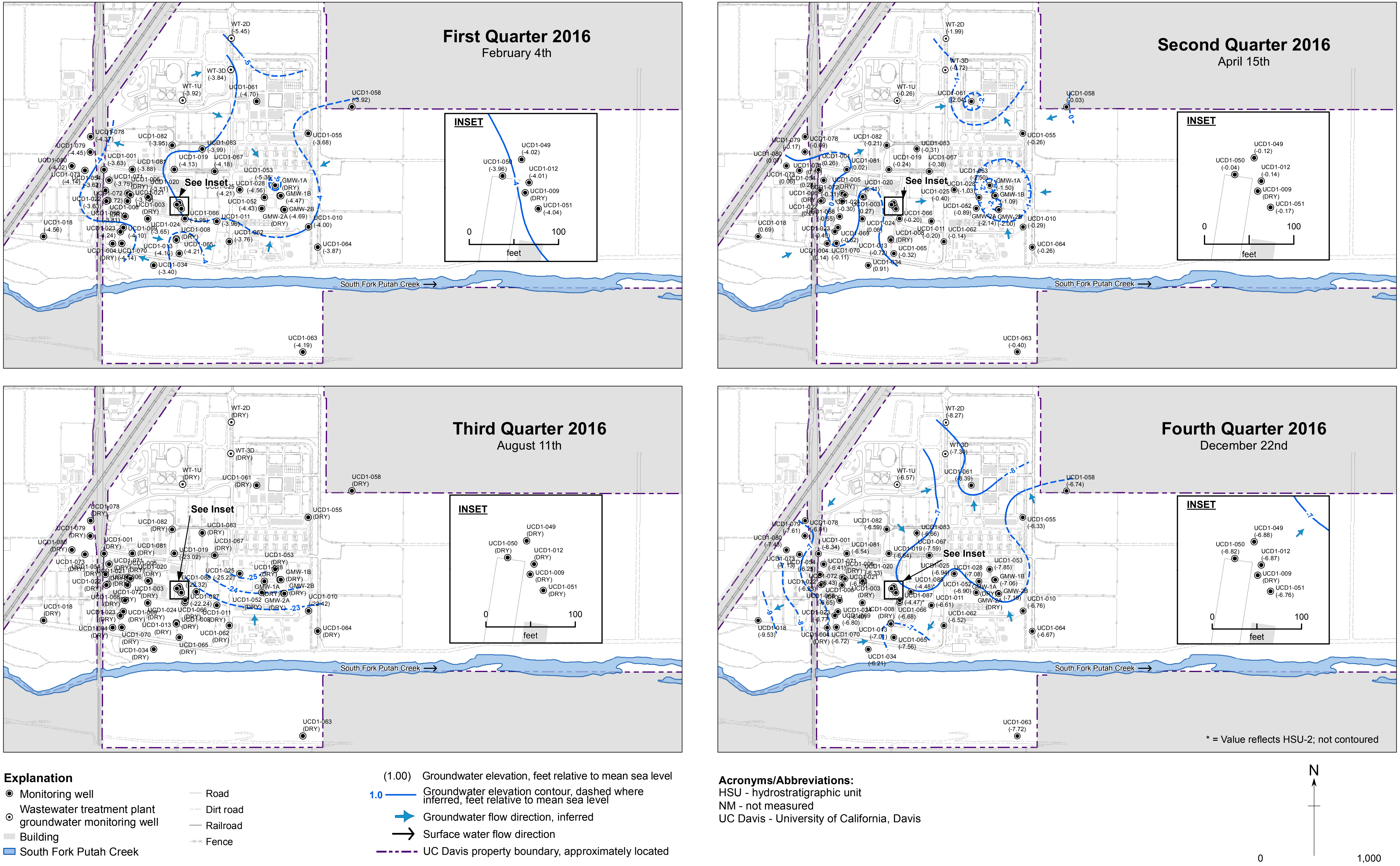
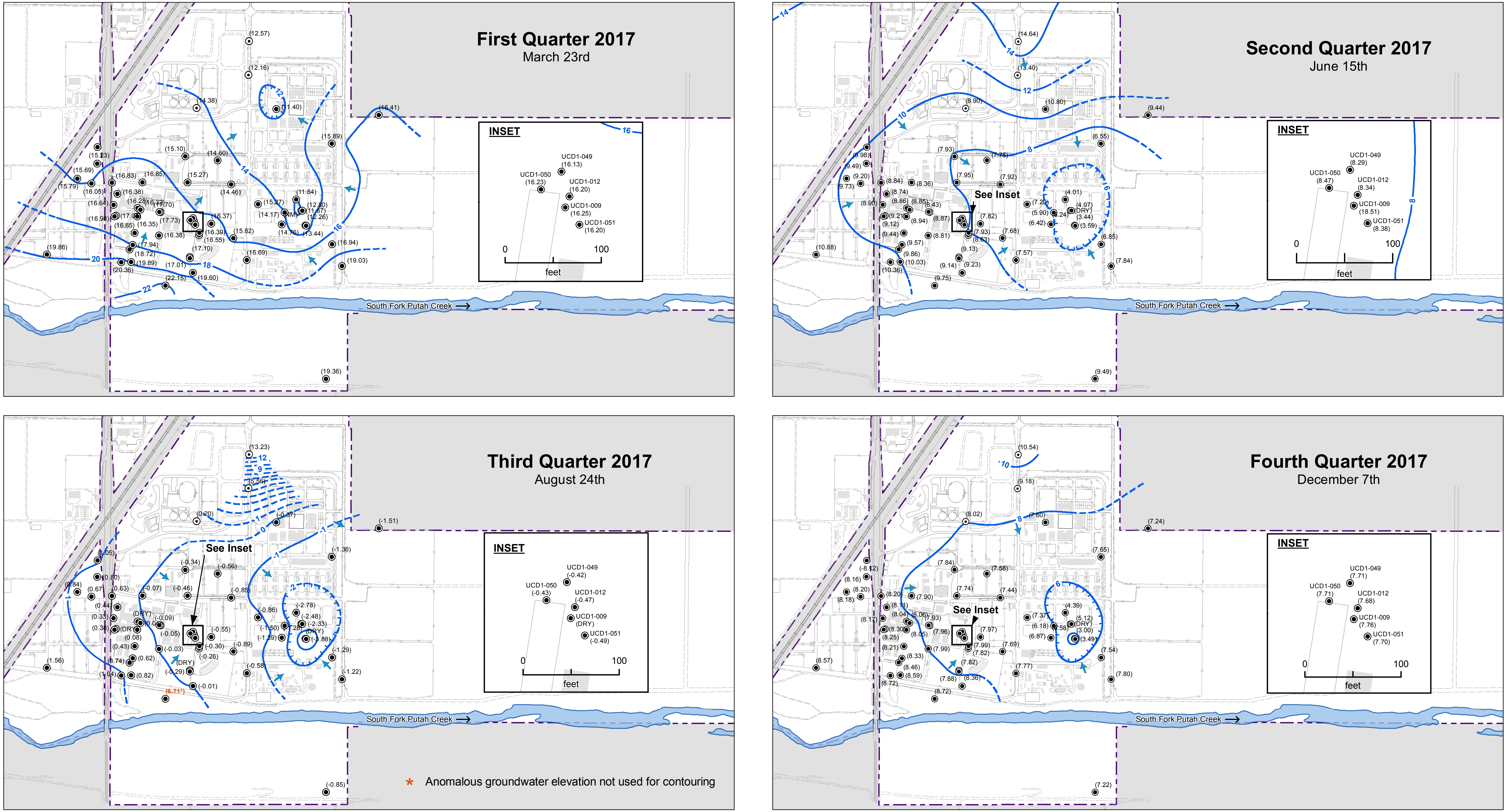


Figure 4. Groundwater Elevations in HSU-1, Four Quarters 2016, Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis



* Anomalous groundwater elevation not used for contouring

Explanation

- ● Monitoring well
- ⊙ Wastewater treatment plant groundwater monitoring well
- ▨ Building
- 🟦 South Fork Putah Creek
- Road
- Dirt road
- Railroad
- Fence
- (1.00) Groundwater elevation, feet relative to mean sea level
- 1.0 Groundwater elevation contour, dashed where inferred, feet relative to mean sea level
- Groundwater flow direction, inferred
- Surface water flow direction
- UC Davis property boundary, approximately located

Acronyms/Abbreviations:

HSU - hydrostratigraphic unit

NM - not measured

UC Davis - University of California, Davis

Note:

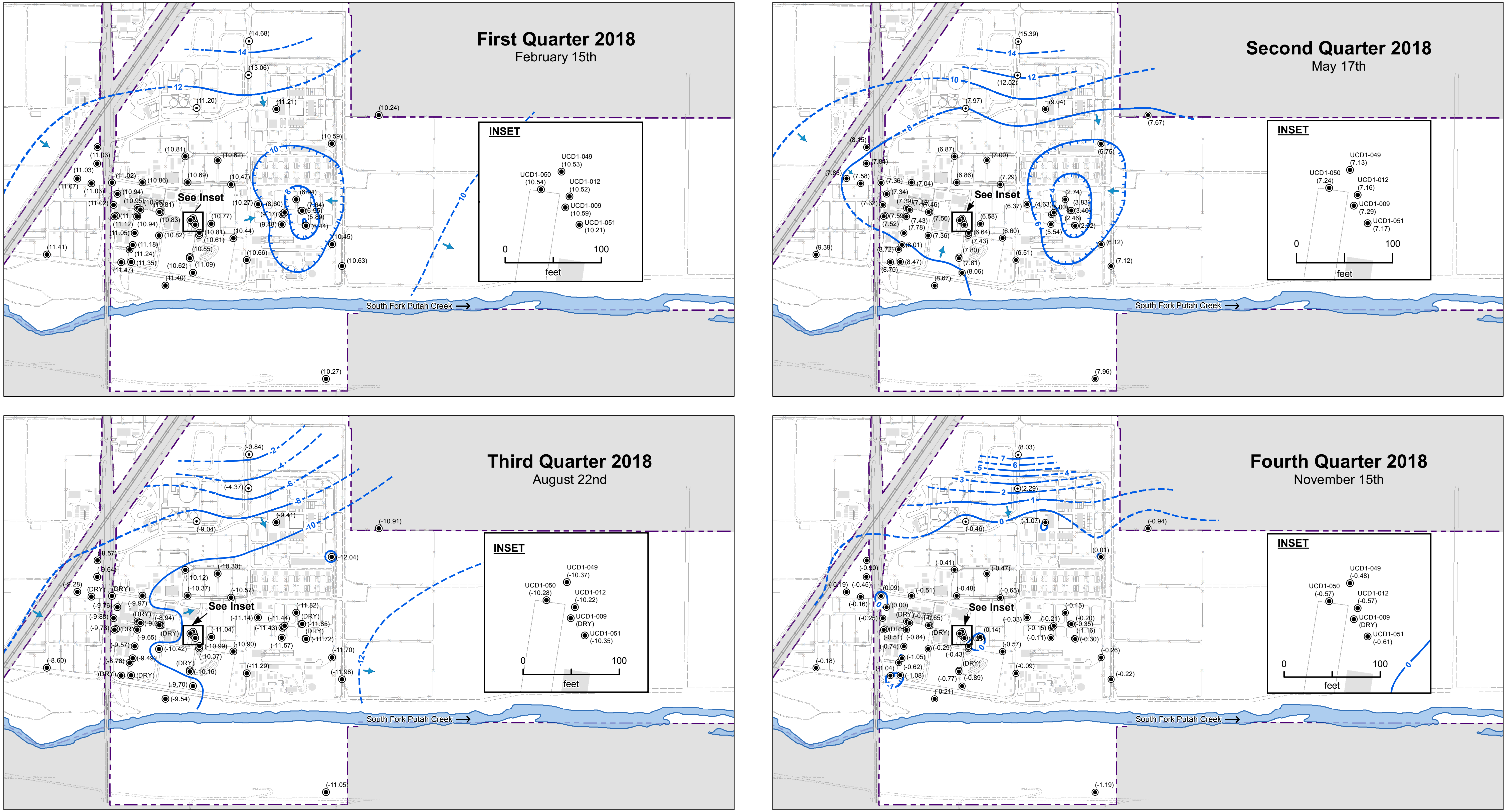
Well IDs not shown. See Figure 3. for Well IDs.

N

0 1,000

feet

Figure 5. Groundwater Elevations in HSU-1, Four Quarters 2017, Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis



Explanation

- ◉ Monitoring well
- ⊙ Wastewater treatment plant groundwater monitoring well
- ▭ Building
- 🟦 South Fork Putah Creek
- Road
- Dirt road
- Railroad
- Fence

(1.00) Groundwater elevation, feet relative to mean sea level

1.0 Groundwater elevation contour, dashed where inferred, feet relative to mean sea level

➡ Groundwater flow direction, inferred

→ Surface water flow direction

UC Davis property boundary, approximately located

Acronyms/Abbreviations:

HSU - hydrostratigraphic unit

NM - not measured

UC Davis - University of California, Davis

Note:

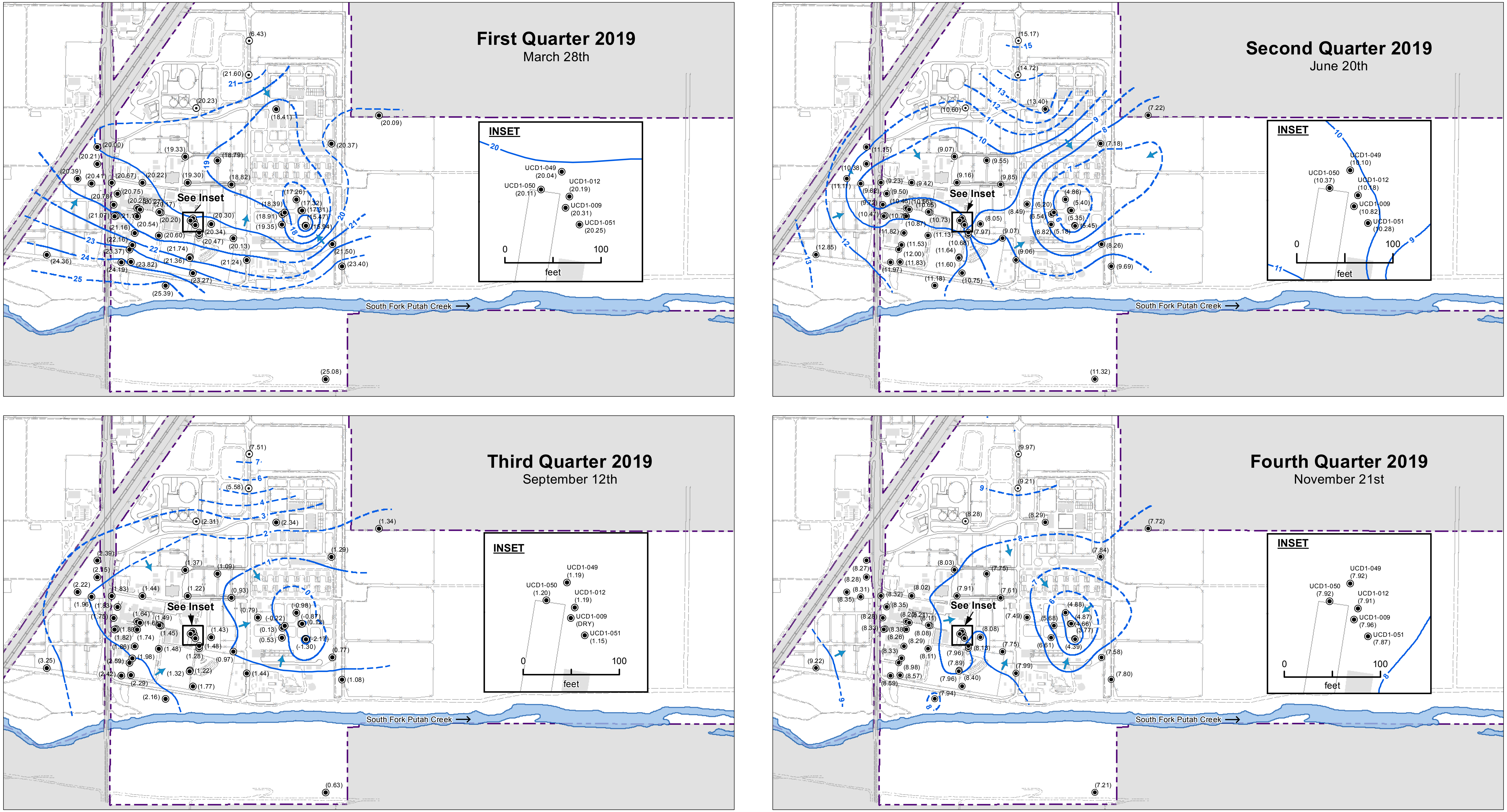
Well IDs not shown. See Figure 3. for Well IDs.

N

0 1,000

feet

Figure 5. Groundwater Elevations in HSU-1, Quarters 1 through 4, 2018, Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis



Explanation

- ⦿ Monitoring well
- ⊙ Wastewater treatment plant groundwater monitoring well
- ▭ Building
- 🟦 South Fork Putah Creek
- Road
- Dirt road
- Railroad
- Fence

(1.00)	Groundwater elevation, feet relative to mean sea level
1.0	Groundwater elevation contour, dashed where inferred, feet relative to mean sea level
➜	Groundwater flow direction, inferred
⟶	Surface water flow direction
-·-·-	UC Davis property boundary, approximately located

Acronyms/Abbreviations:
HSU - hydrostratigraphic unit
NM - not measured
UC Davis - University of California, Davis

Note:
Well IDs not shown. See Figure 3 for Well IDs.

N
0 1,000
feet

Figure 5. Groundwater Elevations in HSU-1, Quarters 1 through 4, 2019, Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

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Appendix D

Groundwater Monitoring Program Effectiveness Summary

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Table D-1. Groundwater Monitoring Program Effectiveness Summary

Well	Analyte	Detection Frequency	Concentration Units	Concentration Range	Comparison Criteria (CC)	Number of Results Above Criteria	95% UCL	WQC	95% UCL or Max[a] >WQC	Comments
COCs with Baseline Concentrations > Background (CC = Baseline)										
UCD1-021	Nitrate as N	17/17	mg/L	20–30	27	9	28	10	Yes	Minor exceedance of baseline; no increasing trend
UCD1-023	Carbon-14	20/20	pCi/L	11–45.7	22.1	10	32	2000	No	
UCD1-054	Mercury	3/13	µg/L	0.0348–0.072	0.072 J	1	NA	2	No	
UCD1-068	Selenium	28/28	µg/L	1.53–3.98	2.24	13	2.7	50	No	
UCD1-070	Carbon-14	25/26	pCi/L	6.47–48.5	18.9	11	24	2000	No	
UCD1-071	Chromium	14/14	µg/L	34.8–58.7	49.1	3	47	50	No	
UCD1-071	Chromium (hexavalent)	19/19	µg/L	21–62	47	6	48	50	No	
UCD1-071	Mercury	4/17	µg/L	0.0518–0.219	0.0658 J	2	NA	2	No	
UCD1-072	Nitrate as N	18/18	mg/L	18–26	23	1	22	10	Yes	Minor exceedance of baseline; no increasing trend
COCs with Baseline Concentrations ≤ Background (CC = Background)										
UCD1-021	Carbon-14	0/12	pCi/L	<7	<7	0	NA	2000	No	
UCD1-021	Radium-226	6/15	pCi/L	0.292–0.928	1.17	0	NA	5	No	
UCD1-023	Nitrate as N	12/12	mg/L	1.1–5.1	15	0	4.5	10	No	
UCD1-054	Cesium-137	0/13	pCi/L	<2.76	<5	0	NA	200	No	
UCD1-054	Chromium	13/13	µg/L	6.28–13.6	43.7	0	11	50	No	
UCD1-054	Chromium (hexavalent)	13/13	µg/L	5.1–12	40	0	9.8	50	No	
UCD1-054	Molybdenum	13/13	µg/L	2.26–3.11	3.13	0	2.9	100[b]	No	
UCD1-054	Silver	0/13	µg/L	<1	<1	0	NA	100	No	
UCD1-054	Strontium-90	0/13	pCi/L	<0.603	<1	0	NA	8	No	
UCD1-068	Carbon-14	1/16	pCi/L	6.32	<7	0	NA	2000	No	
UCD1-068	Nitrate as N	15/15	mg/L	6.2–13	15	0	11	10	Yes	Below site background
UCD1-068	Radium-226	7/18	pCi/L	0.308–2.04	1.17	3	NA	5	No	
UCD1-069	Formaldehyde	1/14	mg/L	0.012	13 J	0	NA	100[c]	No	
UCD1-069	Molybdenum	12/12	µg/L	1.03–1.81	3.13	0	1.6	100[b]	No	
UCD1-069	Nitrate as N	14/14	mg/L	3.1–14	15	0	11	10	Yes	Below site background
UCD1-070	Nitrate as N	13/13	mg/L	0.99–3	15	0	2.1	10	No	

Table D-1. Groundwater Monitoring Program Effectiveness Summary (continued)

Well	**Analyte**	**Detection Frequency**	**Concentration Units**	**Concentration Range**	**Comparison Criteria (CC)**	**Number of Results Above Criteria**	**95% UCL**	**WQC**	**95% UCL or Max[1] >WQC**	**Comments**
COCs with Baseline Concentrations ≤ Background (CC = Background) (continued)										
UCD1-071	Cesium-137	0/13	pCi/L	<3.46	<5	0	NA	200	No	
UCD1-071	Molybdenum	13/13	µg/L	0.6–3.29	3.13	1	1.3	100[b]	No	
UCD1-071	Silver	0/13	µg/L	<1	<1	0	NA	100	No	
UCD1-071	Strontium-90	0/13	pCi/L	<0.436	<1	0	NA	8	No	
UCD1-072	Carbon-14	0/15	pCi/L	<7	<7	0	NA	2000	No	
UCD1-072	Radium-226	6/17	pCi/L	0.32–4.6	1.17	1	NA	5	No	
MOCs with Baseline Concentrations > Background (CC = Baseline)										
UCD1-070	Zinc	11/12	µg/L	0.599–128	35.2	1	16	5000	No	
UCD1-071	Aluminum	6/9	µg/L	7.15–27.3	27.3 J	0	19	1000	No	
UCD1-072	Aluminum	8/13	µg/L	3.38–207	39.9	1	19	1000	No	
MOCs with Baseline Concentrations ≤ Background (CC = Background)										
UCD1-013	Chlordane	0/17	µg/L	<0.099	<0	0	NA	0.1	No	
UCD1-013	Dieldrin	1/18	µg/L	0.016	<0	1	NA	0.0018[b]	Yes	Single detection, probable outlier
UCD1-021	Aluminum	4/10	µg/L	4.06–9.49	5.86 J	2	NA	1000	No	
UCD1-021	Americium-241	0/9	pCi/L	<0.277	<0.71	0	NA	15	No	
UCD1-023	Mercury	2/10	µg/L	0.117–0.168	0.0479 J	2	NA	2	No	
UCD1-023	Zinc	9/12	µg/L	4.7–43.9	20.9	1	8.9	5000	No	
UCD1-068	Aluminum	7/13	µg/L	4.02–10.3	5.86 J	3	7	1000	No	
UCD1-068	Americium-241	0/13	pCi/L	<0.281	<0.71	0	NA	15	No	
UCD1-068	Chromium	15/15	µg/L	33–54.3	43.7	6	45	50	No	
UCD1-068	Nickel	13/13	µg/L	1.23–2.34	141	0	2.1	100	No	
UCD1-069	Aluminum	8/13	µg/L	4.05–1080	5.86 J	6	14	1000	No	
UCD1-069	Silver	0/9	µg/L	<1	<1	0	NA	100	No	
UCD1-070	Mercury	0/10	µg/L	<0.2	0.0479 J	0	NA	2	No	
UCD1-072	Americium-241	0/12	pCi/L	<0.318	<0.71	0	NA	15	No	

Notes:

[a] 95% UCL compared to water quality criterion when available, otherwise Max compared to water quality criterion
[b] U.S. Environmental Protection Regional Screening Level (RSL)
[c] California Notification Level
Detection frequency includes duplicate samples
MCLs are used as the water quality criterion unless noted.

Abbreviations:

95% UCL = 95% upper confidence level on the mean
COC = constituent of concern
Max = maximum concentration
MCL = maximum contaminant level
mg/L = milligrams per liter
µg/L = micrograms per liter
MOC = monitoring-only constituent
NA = UCL not available; the number of detected sample results was insufficient to determine a reliable UCL
pCi/L = picocuries per liter
RSL = Regional Screening Level
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. (See Table D.2, Radionuclide Drinking Water MCLs)

EPA (U.S. Environmental Protection Agency), 2020. *Regional Screening Level (RSL) - Generic Tables, Summary Table (TR=1E-6, HQ=1)*, https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables, last updated on May 1, 2020, accessed July 7, 2020.

SWRCB (State Water Resource Control Board), 2015. *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, last updated February 4, 2015, accessed June 29, 2020.

SWRCB (State Water Resource Control Board), 2018a. *Maximum Contaminant Levels and Regulatory Dates for Drinking Water, U.S. EPA vs California*, https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ccr/mcls_epa_vs_dwp.pdf, last updated October 2018, accessed June 26, 2020

SWRCB (State Water Resource Control Board), 2018b. *Secondary Drinking Water Standards*, https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ddw_secondary_standards.pdf, last updated October 1, 2018, accessed June 29, 2020.

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Appendix E

Interviews Summary and Transcripts

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Table E-1 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. "No response" in the last column of Table E-1 indicates that the individual did not respond to the interview request after a minimum of five communication attempts via phone message or email.

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

Person	Title	Role on DOE Areas Project	Response to Interview Request
Chris Wright	Environmental Manager, UC Davis EH&S Unit	UC Davis project manager	Yes, provided input in writing
Michael Bauer	Supervisor, UC Davis Grounds and Landscape Services	Grounds maintenance	No response
Ardie Dehghani	Campus Engineer, UC Davis DCM	Construction oversight	Yes, provided input in writing
Shari Gallagher	Business Manager, UC Davis CHE	Works at CHE (onsite)	Declined
Shanie McCarty	EH&S Specialist I, UC Davis CHE	Works at CHE (onsite)	No response
Kent Pinkerton	Director, UC Davis CHE	Works at CHE (onsite)	Yes, provided input verbally
Bret Steadman	Unit Operations Manager, California Raptor Center	Works at neighboring facility	Declined
Tatiana Viau	Animal Resource Manager, UC Davis Center for Equine Health	Works at neighboring facility	No response
Holly Hadlock	Remedial Project Manager	EPA Region 9	Yes, provided input verbally
Durin Linderholm	Engineering Geologist	CRWQCB	Declined[a]
John Bystra	Project Manager	DTSC	Yes, provided input in writing

Note:

[a] Indicated he has 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
DTSC California Department of Toxic Substances Control
EH&S = Environmental Health & Safety
EPA = United States Environmental Protection Agency
LEHR = Laboratory for Energy-Related Health Research
UC Davis = University of California, Davis

Potential interviewees were given the option of being interviewed in-person, by telephone, or by providing written responses via email. The five individuals listed below who agreed to provide input did so between March 23 and April 21, 2020. These five respondents represent EPA, DTSC, UC Davis EH&S Unit, UC Davis DCM, and UC Davis CHE. As indicated in Table E-1, two of the five individuals provided input verbally, with their responses recorded, transcribed, and transcriptions reviewed by them. The remaining three participants provided input in writing by completion the questionnaire. The questionnaire used for the interview, as well as the filled-in forms and/or the transcript recording of each interviewee's responses, is provided in Attachment E-1.

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 five years that would affect the protectiveness and effectiveness of the remedy.
- In terms of impact that the DOE Areas remedy has had on the community, one UC Davis respondent mentioned high costs. A second UC Davis respondent (CHE Director Kent Pinkerton) mentioned his understanding that bottled water had been provided to the neighbors and to CHE but did not know who was paying for it.[1]
- All respondents indicated they were not aware of any complaints, violations, incidents, or activities such as vandalism, trespassing, or emergency response involving the DOE Areas and remedy. UC Davis LEHR project manager Chris Wright mentioned that when his office (UC Davis EH&S Unit) was informed of a mowed-down dead elderberry bush, they needed to contact UC Davis staff responsible for vegetation control and perform additional training and outreach, in accordance with the SMP. The management of trees and large shrubs that need to be removed from DOE Areas was identified as an issue in the First Five-Year Review and the SMP was revised in 2019 to provide specific procedures for this.
- Four of the five respondents felt they were adequately informed about the DOE remedy and land-use restrictions, trained on their responsibilities regarding the remedy implementation (as appropriate), and knew where to obtain information about the remedy. However, CHE Director Kent Pinkerton indicated he did not feel well-informed and recommended that some sort of report be provided to him.

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[1] The bottled water program was terminated in the mid-2000s when it was demonstrated in the CERCLA Remedial Investigation that groundwater used by the community was not impacted by site activities.

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: 3/27/2020

Time: 15:30 PST

Type: ☐ Telephone ☐ Visit ☒ Completed Form ☐ Other ____________________

Location of Visit (only for in-person interview):

Contact Made By (only for in-person or phone interview):

Name:	**Title:**	**Organization:**

Individual Providing Input:

Name: Ardie Dehghani	**Title:** Director of Engineering	**Organization:** UC Davis

Telephone No: (530) 754-1008

E-Mail Address: adehghani@ucdavis.edu

Street Address: 255 Cousteau Place

City, State, Zip: Davis, Ca, 95617

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?

I have the engineering project managers in my group for few design and construction projects. I have been associated with LEHR project since 2013 with very limited technical involvement.

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?

I have knowledge about remediation measures developed for EPA review and approval. I am not exactly sure how to distinguish these with DOE area of LEHR

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

Assuming this question is related to those I mentioned in question #2, I believe so.

I am not aware of concerns except it cost too much.

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.

Not to my knowlege

Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process?

I believe so, based on reports provided for EPA review and approvals.

INTERVIEW RECORD CONTINUED

Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection?

I am not an expert in this area, but the engineering reports suggest so.

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?

Limited, I only know some of Campus activities for remedial design and discussions.

Question 8: Do you know where to get information about the DOE areas of LEHR?

Yes, Engineering reports and Internet.

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.

Our UC Davis groups are managing consultants that were/are developing detail engineering for the proposed solutions. I have been participating in high level discussions about cost, approvals, schedule, etc.

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.

Not to my knowledge.

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.

I do not know.

Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR?

No

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: 3/31/2020

Time: 2000

Type: ☐ Telephone ☐ Visit ☒ Completed Form ☐ Other ____________________________

Location of Visit (only for in-person interview):

Contact Made By (only for in-person or phone interview):

Name:	**Title:**	**Organization:**

Individual Providing Input:

Name: Chris Wright	**Title:** Environmental Manager	**Organization:** UC Davis

Telephone No: (530) 752-3044

E-Mail Address: cvwright@ucdavis.edu

Street Address: One Shields Avenue, 276 Hoagland Hall

City, State, Zip: Davis, CA, 95616

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?

I am the Environmental Manager for UC Davis, in this role I am the lead for all aspects of the LEHR project. This includes the direction and supervision of UC Davis LEHR support staff (primarily, Environmental Specialist Rachel Lauesen).

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?

I am familiar with the DOE remediation project at the LEHR site.

My impression of the DOE aspect of the project is that the project is well managed and is sufficiently protective of human health and the environment.

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

I am not aware of any effect the DOE remedy has had on the community.

I am not aware of any concerns.

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.

I am not aware of any events, incidents, or activities at the DOE Areas of LEHR such as vandalism, trespassing or emergency responses from local authorities.

Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process?

Yes. I am aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process.

INTERVIEW RECORD CONTINUED

Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection?

Yes. I feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection.

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?

Yes. I feel well informed about the activities and progress at the DOE Areas of LEHR.

Question 8: Do you know where to get information about the DOE areas of LEHR?

Yes.

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.

Yes. I, or other staff at my direction perform site visits, inspections, storm-water sampling. UC Davis manages aspects of the DOE remedy through a financial assistance grant funded by DOE.

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.

When my office was made aware of the mowed down dead elderberry bush reported in the most recent FYR, my office needed to contact UC Davis staff responsible for vegetation control and perform additional training and outreach.

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.

I am not aware of any significant changes in laws or regulations since the DOE remedy's start-up in 2011.

Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR?

No.

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:** 4/1/2020	**Time:** 8:28 AM

Type: ☐ Telephone ☐ Visit ☒ Completed Form ☐ Other ____________

Location of Visit (only for in-person interview):

Contact Made By (only for in-person or phone interview):

Name:	**Title:**	**Organization:**

Individual Providing Input:

Name: John Bystra	**Title:** Project Manager	**Organization:** DTSC

Telephone No: (916) 255-3669	**Street Address:** 8800 Cal Center Drive
E-Mail Address: john.bystra@dtsc.ca.gov	**City, State, Zip:** Sacramento, California, 95826

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?

I have been the DTSC project manager for the LEHR site since early 2009.

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?

I understand the DOE remedy, both the present components (the recorded Land Use Covenant (LUC) and Soil Management Plan) and the historical components (the historical investigations, leading to various soil excavations). I feel that the DOE Areas remedy at the LEHR site is protective of human health and the environment.

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

Historically, the UC Davis community voiced a variety of concerns concerning the DOE remedy at the LEHR site. Since around 2015-16, however, no significant concerns have been raised for the DOE Areas remedy at the LEHR site.

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.

I am not aware of any vandalism, trespassing, emergency responses from local authorities, or any other events, incidents, or activities at the DOE Areas of LEHR.

Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process?

I am aware of both the general soil restrictions at the DOE Areas of the LEHR site, as well as how and when DOE (or UC Davis on behalf of DOE) initiates the soil disturbance permit process.

INTERVIEW RECORD CONTINUED

Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection?

The remaining constituents of concern (COCs) in both soil and groundwater are at levels indicating that the sources of these COCs have likely been removed from DOE Areas at the LEHR site during historical soil excavations before recording of the LUC. Thus, I feel that the LUC restrictions are adequate at ensuring public, worker and student protection, now and likely in the future.

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?

Due to the routine meetings held for the LEHR site (at least 6 times a year, but usually closer to monthly), I feel well informed about activities and progress at the DOE Areas of the LEHR site.

Question 8: Do you know where to get information about the DOE areas of LEHR?

I have a number of contacts for DOE, UC Davis, and the consultants for both of these entities, so I feel I have information readily available to me about the DOE Areas of LEHR. Also, my access to DTSC's Envirostor allows me to review information about currently planned activities and historical activities leading to this point in time.

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.

In addition to the routine meetings the regulatory agencies have to discuss the LEHR site, there are other activities that augment these meetings, including site visits by the DTSC project team, DTSC presence at annual inspections for the LUC (on an as-needed basis), and other miscellaneous activities, as needed.

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.

To the best of my knowledge, there have been no significant complaints, violations, or other incidents associated with the site requiring a response from DTSC since I began with the project in 2009. Any DTSC issues with documents are resolved through the review, response and finalizing process for document review.

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.

While there have been no significant changes in laws or regulations since the DOE remedy's start up in 2011, there have been changes in the science of understanding vapor intrusion. These advances led to augmenting the last five-year review with data acquired for soil vapor in the subsurface and indoor air at DOE Areas, evaluating it, and verifying that the data identified no significant vapor intrusion is likely occurring at the DOE Areas at the LEHR site.

Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR?

I have no comments, suggestions, concerns, or recommendations at this time for the DOE Areas of the LEHR site.

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: 4/21/2020	Time: 14:00

Type: ☒ Telephone ☐ Visit ☐ Completed Form ☐ Other ____________________________

Location of Visit (only for in-person interview):

Contact Made By (only for in-person or phone interview):

Name: Mary Stallard	**Title:** Associate Hydrogeologist	**Organization:** Weiss Associates

Individual Providing Input:

Name: Kent Pinkerton	**Title:**	**Organization:** UC Davis

Telephone No: (530) 752-8334	**Street Address:** Bldg 3792, 1250 Old Davis Road
E-Mail Address: kepinkerton@ucdavis.edu	**City, State, Zip:** Davis, CA 95616

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?

My association with the work done at LEHR for anything that would be in terms of cleanup has been zero. I have been here since 1986 ... July 1, 1986 ... I was the first employee or University faculty member recruited to this site who did not have any DOE research funding, not that this was the reason for that. It was said more than once, "do you have any DOE funding" and I said "no" and again it was kind of made clear that I was the first faculty member onsite without DOE funding ... so that was almost 36 years ago.

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?

I am somewhat familiar with some of the things. I know that the water treatment facility where they would percolate the water though some sort of bags, I was familiar with that … but I realize that building was completely taken down. I understand that some of the water was let down into the groundwater. I do know that there is some sort of … I don't know if it's a cistern or some sort of water storage that has been completely entombed and is below ground where that building used to exist. I am aware that there are fairly substantial areas buildings that have been completely cleaned with no further contamination but have been left as not usable for future occupation and that is I don't think due to DOE but I think due to UC Davis policy, We were in the process of putting in an aquatic center here in which there was extensive blueprints done up for us, several thousand dollars … and I was not involved in that but that was abruptly stopped by the Office of Research at UC Davis saying, "No, you're not going to put in that kind of research center over areas that could potentially be declared as possibly contaminated." They were moving, but it was an official higher-up, probably over facilities that basically stopped it cold. I am totally confident that the DOE approach to removing the contamination through the Superfund program was successful. So that … I don't have any issues with; I do understand that there is some concern about there being perhaps in terms of the water, kind of a flow of nitrate contaminated water underground and I guess that's why you have those wells that monitor the groundwater. The only thing I find problemmatic is the University's approach to all of this.

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

The only thing that I'm aware of is that our neighbors receive, at no cost, bottled water and we here at the Center for Health and the Environment also receive bottled water; who's paying for that, I don't know … but we've been encouraged to not necessarily drink the water. The water fountains here, which are several located throughout the building, so that's all that I'm aware of.

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.

No, although I am a little bit … as Director of the Center, I think that it would be very helpful for me to know any activity for people who are not assigned to this facility for me to be aware of. I am aware, even in the last few weeks, there happen to be people who are onsite, they don't appear to be UC Davis people but I don't know; and they're working in areas that there are no buildings, and I don't have any idea of what it is they are doing - I wish I knew, as Director of the facility. It's only because of COVID-19 that I need to get out and walk around a little bit that I even noticed it. It's just in a very unusual spot … it's kind of in that area that I thought was where the low trenches were .. the low radiation trenches .. the open trenches that were there. There's a few boxes out there. There's one individual that seems to be busy doing something but I have no idea what is it and I have no idea why they're there or who's given them authority to be there. Now that you mention that (the beekeeper), that could be a possibility … they look like wooden boxes … kind of blue, a few of them and I just don't know what's going on so that could be who that individual is.

Question 5: Are you aware of restrictions on soil disturbance at the DOE Areas and how/when to initiate the soil disturbance permit process?

No. I am not aware of what the restrictions are; I'm only aware that we have a building that houses our cage cleaner and we have been told that that building must come down and we can no longer have our cage cleaning facility onsite. What I've been told is that once the building is removed, they will cement over that entire surface. And again, I have no idea what the rationale is around that.

INTERVIEW RECORD CONTINUED

Question 6: Do you feel the land-use restrictions in DOE areas have been adequate in terms of ensuring public, worker, and student protection?

I really could not give an opinion.

Several years ago, there was a proposal to bring the Department of Transportation diesel testing site here to Davis. One of the sites that was considered for doing this was the radiation field where the cobalt building is and so … I don't know … that suddenly stopped .. any discussion on that. I'm not sure I would have been happy to have a diesel testing facility when we're doing air quality research here and again, I think that would have caused … if it had been brought here, they definitely would have to do something with digging around in the soil. But that's basically "off the table".

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?

I do not feel well informed. I would recommend maybe some sort of report be given to me. I must say that a few years ago, there was some sort of public meetings about DOE/LEHR activities that I did attend; I don't think I found it very helpful.

Report more useful than a meeting? The public hearing usually are just someone who's going to gripe … but the idea that is it really helping us to understand progress or what eventual consideration should be … will we ever reach a point when we can put a new building onsite or is that never going to happen.

Question 8: Do you know where to get information about the DOE areas of LEHR?

Probably Shanie … and if she doesn't know then I would not know.

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.

For those of us who are based here at CHE, the answer is "no". For UC Davis, I would assume "yes", there probably have been regular meetings and discussions.

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.

It's clearly not anything that I have heard anything about … and I have been the Director since 2001. In terms of issues that we deal with and terms of our buildings … we had a building fire courtesy of physical facilities at UC Davis; that happened probably 3 years ago in May and we were not allowed to do anything - it shut us completely down. The building was not destroyed, just the electronics/control panel room … they said it was part of a mishap on renovation where live wires were left and it started the roof on fire. Not a great previous experience. On the positive side, we have a really nice building now.

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.

No. I'm not in a position to know if there's been any issues, certainly that's not impacted on any of us who are here year-round.

Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR?

No. Again, we're still going through a process that continues to remind us that at one time we were an area where lots of radiation and research was done; we continue to be reminded that there are certain buildings we cannot use and that there are other buildings that are going to be removed, not really explaining why they're being removed. Those are my only comments as Director. And … it would be helpful to have a little bit better communication, and I'm thinking with UC Davis, not necessarily DOE, with what they have in mind.

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: March 23, 2020	Time: 13:00

Type: X Telephone ☐ Visit ☐ Completed Form ☐ Other __________________

Location of Visit (only for in-person interview):

Contact Made By (only for in-person or phone interview):

Name: Mary Stallard	**Title:** Associate Hydrogeologist	**Organization:** Weiss Associates

Individual Providing Input:

Name: Holly Hadlock	**Title:** Remedial Project Manager	**Organization:** U.S. Environmental Protection Agency

Telephone No: (415) 972-3171 **E-Mail Address:** hadlock.holly @epa.gov	**Street Address:** 75 Hawthorne Street **City, State, Zip:** San Francisco, CA 94105

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 am EPA project manager for the site. December 2015.

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 do have knowledge of the project. I have not spent a lot of time looking back over historical documents, and DOE's remediation did take place before I started working on it. My impression is the cleanup has been adequate. I know DOE performed non-time critical removal actions in the late 1990s and early 2000s that involved the excavation and offsite disposal of contaminated soil and debris, and that post-excavation confirmation sampling showed that residual soil contamination was present in some locations. Potential environmental impacts from this residual contamination were subsequently addressed by DOE's remedial action which includes land use controls and groundwater monitoring. I've participated in inspections of DOE's land use controls and have reviewed the post-ROD groundwater monitoring results. Based on information EPA has reviewed, the DOE remedy appears to be protective of human health and the environment.

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

Response 3: The community there is rather remote because the site is at the very south end of the campus and the campus does have a transient nature being filled with students. I am not aware of any concerns. So, I am not aware of any effects positive or negative 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.

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 to the first part; no to the second part.

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: Yes.

Question 8: Do you know where to get information about the DOE areas of LEHR?

Response 8: Yes.

INTERVIEW RECORD CONTINUED

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 have regular meetings with the DOE representatives. I did participate in the most recent IC inspection; I believe this was in – I'll say – November 2019. So I think there is adequate communication with my office.

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.

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. Part of the Five-Year Review process is to look and see if there are changes in ARARs. I don't believe the last Five-Year Review found any changes to any laws and regulations.

Question 12: Do you have any comments, suggestions, concerns, or recommendations regarding the activities at the DOE Areas of LEHR?

Response 12: My only concern is a concerted effort needs to be into determining background concentrations for certain constituents. I know a report was submitted. DOE was proposing changing the way background is detected, or determined, because it meant then that maybe more work would need to be done down looking the road. And EPA's approach is, "No, we don't change how we determine background, but we might change what we then do with the information. We might not require certain work to be done, but we should not change the long-standing method we used to calculate background."

Appendix F

COC Exposure and Toxicity Evaluation

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F1.0 Introduction

Updates to exposure assumptions, intake equations, and toxicity data for established constituents of concern (COCs) for the U.S. Department of Energy (DOE) Areas at the Laboratory for Energy-Related Health Research (LEHR) are evaluated in this appendix. Human health risks from chemicals and radionuclides were estimated in the *Site-Wide Risk Assessment* (UC Davis 2004) (SWRA). The land-use assumptions in the SWRA resulted in identification of five potential human receptors for DOE Areas of responsibility at LEHR: (1) hypothetical future onsite residents, (2) construction workers, (3) onsite outdoor researchers, (4) onsite indoor researchers, and (5) trespassers.

After the SWRA, human health COCs were established for the DOE Areas in the Part B-Risk Characterization for DOE Areas (DOE 2005) (Risk Characterization). The human health COCs for each potential receptor and DOE Area are:

- Hypothetical future onsite residents at the Domestic Septic System 4 Area (DSS 4): benzo[*a*]anthracene, benzo[*a*]pyrene, benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, dibenzo[*a,h*]anthracene, and indeno[1,2,3-*cd*]pyrene.
- Construction workers at DSS 4: benzo[*a*]pyrene.
- Hypothetical future onsite residents at the Eastern Dog Pens Area (EDPs): dieldrin and strontium-90 (Sr-90).
- Hypothetical future onsite residents at the Southwest Trenches Area (SWTs): Sr-90.

No COCs were identified in DOE Areas for onsite outdoor researchers, onsite indoor researchers, or trespassers because the Risk Characterization concluded that no chemicals or radionuclides posed a significant risk to these receptors. Potential human exposure to the above-listed COCs is actively managed through the ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedy in the DOE Areas. An environmental covenant (DTSC 2014) (Covenant) was recorded to set environmental restrictions in the DOE Areas, including a restriction in the DSS 4 Area that prohibits residential use, use for day care for children, and cultivation of crops for human consumption. The Covenant restrictions were implemented to actively prevent hypothetical future onsite resident exposure to COCs at DSS 4. Annual inspections are conducted to verify adherence to the Covenant restrictions. While exposure pathways remain potentially complete for workers in the EDPs, SWTs, and DSS 4, exposure to contaminated soil in the DOE Areas is actively managed for these receptors as set forth in a soil management plan (DOE 2019). A summary of DOE Areas that have COCs, the potential receptors in DOE Areas, and their exposure status for each COC is presented in Table F-1.

Table F-1. DOE Areas, COCs, Receptors, and Exposure Status

DOE Area	**Constituent of Concern**	**Receptor Exposure Status by COC**							
		Hypothetical Future Onsite Resident		**Construction Worker**		**Onsite Outdoor and Indoor Researchers**		**Trespasser**	
		COC?	Exposure?	COC?	Exposure?	COC?	Exposure?	COC?	Exposure?
Domestic Septic System 4	Benzo[*a*]anthracene	**Yes**	no[a]	no	potential[b]	no	potential[b]	no	potential[b]
	Benzo[*a*]pyrene	**Yes**	no[a]	**Yes**	potential[b]	no	potential[b]	no	potential[b]
	Benzo[*b*]fluoranthene	**Yes**	no[a]	no	potential[b]	no	potential[b]	no	potential[b]
	Benzo[*k*]fluoranthene	**Yes**	no[a]	no	potential[b]	no	potential[b]	no	potential[b]
	Dibenzo[*a,h*]anthracene	**Yes**	no[a]	no	potential[b]	no	potential[b]	no	potential[b]
	Indeno[1,2,3-*cd*]pyrene	**Yes**	no[a]	no	potential[b]	no	potential[b]	no	potential[b]
Eastern Dog Pens	Dieldrin	**Yes**	potential[b]	no	potential[b]	no	potential[b]	no	potential[b]
	Strontium-90	**Yes**	potential[b]	no	potential[b]	no	potential[b]	no	potential[b]
Southwest Trenches	Strontium-90	**Yes**	potential[b]	no	potential[b]	no	potential[b]	no	potential[b]

Notes:
[a] Land-use covenant restrictions were implemented to actively protect against exposure (DTSC 2014).
[b] Exposure to contaminant in soil is possible for this receptor in this DOE Area.

Hypothetical residential receptors and construction workers exposure assumptions, intake equations, and COCs toxicity data were evaluated with respect to updates in risk assessment practice, and risks were recalculated and compared to the SWRA as presented below. Chemical COCs are addressed first, followed by the evaluation of Sr-90. Updates to exposure assumptions, intake equations, and toxicity data were also evaluated for onsite outdoor and indoor researchers and trespassers.

F2.0 Exposure Pathways

Updates to exposure pathway assumptions are evaluated in this section.

F2.1 Hypothetical Residential Receptor and Construction Worker Exposure

Hypothetical residential receptor and construction worker exposure pathways are summarized below and evaluated with respect to current practice.

F2.1.1 Hypothetical Future Residential Receptor Exposure

Human health risks to hypothetical future residential receptors in DOE Areas were estimated in the SWRA (UC Davis 2004) based on the sum of risks from:

- Soil ingestion
- Soil dermal exposure

- Aboveground plant ingestion
- Belowground plant ingestion
- External radiation
- Inhalation of dust and volatiles.

The *First Five-Year Review* (DOE 2016) concluded that the SWRA did not contain an adequate evaluation of the vapor intrusion component of the inhalation exposure pathway and recommended that vapor intrusion be fully evaluated to make a protectiveness determination for the existing remedy. To address this gap, DOE conducted a vapor intrusion investigation in 2017 and 2018. Human health risks from vapor-forming chemicals were estimated based on soil gas sample results and the estimated risks were characterized and reported in the *Vapor Intrusion Evaluation Report for the Former Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis*, which is included as an attachment to *Addendum to Laboratory for Energy-Related Health Research Federal Facility, University of California at Davis, Five-Year Review Report Dated September 15, 2016* (DOE 2018). The vapor intrusion investigation results indicated that vapor-forming chemicals in the DOE areas did not present an unacceptable risk under current or potential future land-use scenarios (including hypothetical future residential receptors) and the remedy was determined to be protective of human health and the environment (DOE 2018). No new COCs were identified in the vapor intrusion investigation.

Hypothetical future residential receptor exposure pathways remain unchanged from those evaluated in the SWRA, except the post-Record of Decision (ROD) (DOE 2009) land-use restrictions actively prevent resident exposure to COCs at DSS 4.

F2.1.2 Construction Worker Exposure

Human health risks to construction workers in DOE Areas were estimated in the SWRA based on the sum of risks from:

- Soil ingestion
- Soil dermal exposure
- External radiation
- Inhalation of dust and volatiles

Although construction workers exposure to external radiation was evaluated in the SWRA, no radioactive COCs were established. The only established COC for construction workers (benzo[*a*]pyrene) has a Henry's law constant that is less than 1 × 10^{-5} atmospheres-cubic meters per mole (atm-m^3/mole) and does not meet current criteria (EPA 2015; DTSC 2011) for inhalation of volatiles. The vapor intrusion investigation conducted in 2017 and 2018 (DOE 2018) was not applicable to construction workers because all construction worker activities are assumed to be conducted outdoors. Otherwise, construction workers exposure pathways remain unchanged from those evaluated in the SWRA.

F2.2 Chemical COC Exposure Parameters and Intake Calculations

Parameter values and intake equations used in the SWRA (UC Davis 2004) were evaluated with respect to current risk assessment practice.

Potential receptor parameter values used in the SWRA were compared to recommended values presented in the DTSC Note 1 default exposure factors (DTSC 2019a) 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, Chapter 13-Intake of Home-Produced Foods* (EPA 2011), *EPA Update for Chapter 9 of the Exposure Factors Handbook, Intake of Fruits and Vegetables* (EPA 2018), *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 the Sacramento area (UC Davis 2008; UC ANR 2020) were used as needed for this evaluation.

Intake equations used in the SWRA were compared with current common practice. The six polycyclic aromatic hydrocarbon (PAH) compounds identified as COCs in DSS 4 are mutagenic carcinogens, and intake equations were updated after the SWRA to account for early-life effects to child receptors (EPA 2005). The Covenant restrictions implemented in the DSS 4 Area actively protect children from exposure. Intake equations used in the SWRA remain current and applicable to all adult receptors with potentially complete exposure pathways to PAHs in the DSS 4 area (construction workers, onsite outdoor researchers, onsite indoor researchers).

Intake equations addressing volatilization to outdoor air were used in the SWRA, but volatility criteria for inhalation were updated after the SWRA was issued. According to current guidance (EPA 2015; DTSC 2011), a chemical is sufficiently volatile to consider inhalation exposure if its Henry's law constant is greater than 1×10^{-5} atm-m^3/mole, or its vapor pressure is greater than 1 millimeter of mercury (mm Hg). Benzo[*a*]anthracene meets these criteria. However, benzo[*a*]anthracene is only established as a COC for hypothetical residential receptors in DSS 4, and the implemented Covenant restrictions actively prevent resident exposure to COCs at DSS 4.

F2.2.1 Hypothetical Future Residential Receptors

F2.2.1.1 Residential Soil Ingestion

The comparison between parameters used in the SWRA and values recommended in the recent guidance documents (DTSC 2019a; EPA 2014) for the soil ingestion pathway is shown in Table F-2. These guidance documents recommend a shorter exposure duration and greater body weight for residential adults than the values used in the SWRA. There are no differences in resident child values. The cancer averaging time of 70 years (or 25,550 days) used in the SWRA remains current. For the age-adjusted adult, non-cancer averaging time is equal to the sum of resident adult and child exposure durations, making the current non-cancer averaging time 4 years shorter than was used in the SWRA because the resident adult exposure duration was reduced in the recent guidance by 4 years as shown in Table F-2.

Table F-2. Residential Soil Ingestion Comparison Parameters

Parameter	SWRA[a]	Recent Guidance[b,c]
Resident Adult Soil Ingestion Rate (mg/day)	100	100
Resident Child Soil Ingestion Rate (mg/day)	200	200
Resident Adult and Child Exposure Frequency (days/year)	350	350
Resident Adult Exposure Duration (years)	24	20
Resident Child Exposure Duration (years)	6	6
Resident Adult Body Weight (kilograms)	70	80
Resident Child Body Weight (kilograms)	15	15
Averaging Time,[d] cancer (days)	25,550	25,550
Age-Adjusted Resident Averaging Time,[e] non-cancer (days)	10,950	9,490

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, University of California, Davis, March.

[b] California Department of Toxic Substances Control, 2019. Human Health Risk Assessment (HHRA) Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities, Office of Human and Ecological Risk, April 9.

[c] 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.

[d] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.

[e] Averaging Time, non-cancer (days) = 365 days/year × sum of adult and child exposure durations (years).

Abbreviations:

mg/day = milligrams per day
SWRA = Site-Wide Risk Assessment

F2.2.1.2 Residential Dermal Contact

A comparison of dermal contact parameter values used in the SWRA to current parameter values obtained from DTSC 2019a and EPA 2014 is shown in Table F-3. As shown, the values for resident adult skin surface area and body weight are slightly larger, and the exposure duration is slightly less, while the resident child skin surface area is slightly less. No other differences were found between current parameter values and those used in the SWRA.

The SWRA used an Event Frequency (EvF) of one event per day, which is mathematically equal to the exposure time parameter (ET) of 24 hours per day provided in EPA 2014. The dermal contact equations in EPA 2020a do not contain EvF or ET, and their absence is also equal to an EvF of one event per day or an ET of 24 hours per day. Because dermal contact equations do not currently use these parameters, and their absence does not change the intake result, they were not used to calculate dermal contact intake in this evaluation.

A search was conducted to determine if more recent chemical-specific dermal absorption factors were published by EPA since the SWRA was issued. The most recent document identified in the search was 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 EPA were verified to be the same as those used in the SWRA.

Table F-3. Residential Dermal Contact Comparison Parameters

Parameter	SWRA[a]	Recent Guidance[b,c]
Resident Adult Skin Surface Area (cm^2)	5,700	6,032
Resident Child Skin Surface Area (cm^2)	2,800	2,373
Resident Adult Soil Adherence Factor (mg/cm^2)	0.07	0.07
Resident Child Soil Adherence Factor (mg/cm^2)	0.2	0.2
Dermal Absorption Factor	Chemical specific	Chemical specific[d]
Resident Adult and Child Event Frequency (events/day) or Exposure Time (hours/day)	1[e]	NA[e]
Resident Adult and Child Exposure Frequency (days/year)	350	350
Resident Adult Exposure Duration (years)	24	20
Resident Child Exposure Duration (years)	6	6
Resident Adult Body Weight (kilograms)	70	80
Resident Child Body Weight (kilograms)	15	15
Averaging Time,[f] cancer (days)	25,550	25,550
Age-Adjusted Resident Averaging Time,[g] non-cancer (days)	10,950	9,490

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, March.

[b] California Department of Toxic Substances Control, 2019. Human Health Risk Assessment (HHRA) Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities, Office of Human and Ecological Risk, April 9.

[c] 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.

[d] No change in chemical-specific dermal absorption factors from the SWRA. EPA's Supplemental Guidance for Dermal Risk Assessment (EPA 2004) is the current source for these factors.

[e] Resident adult and child soil event frequency and exposure time not used in equations for this evaluation as discussed above in Section F2.2.1.2.

[f] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.

[g] 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
SWRA = Site-Wide Risk Assessment

F2.2.1.3 Residential Plant Ingestion

The DTSC (2019a) and EPA (2014) 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 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 EPA's *Exposure Factors Handbook, Chapter 13-Intake of Home-Produced Foods* (EFH, Ch13) (EPA 2011). EFH, Ch13 provides ingestion rates for fruits and vegetables separately and according to nine age categories for mean and 95th percentile rates (Table 13-1, EFH Ch13). The EFH, Ch 13 rates are reported as grams wet weight per kilogram body weight per day. Thus, the values provided in EFH, Ch13 require conversion from wet weight to dry weight and must be multiplied by the receptor body weight to convert to kg DW/day. EPA's *Update for Chapter 9 of the Exposure Factors Handbook, Intake of Fruits and Vegetables* (EFH, Ch9) (EPA 2018) 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 2020) 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 9-53 of the EFH, Ch 9 (EPA 2018) 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 F-1. Dry weight conversion factors were determined by averaging the moisture contents for the fruits and vegetables selected above (87% and 89%, respectively). The percent dry weight is 1.0 (100%) 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 EFH, Ch 13 (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 values provided in Table 13-1 were averaged without age-weighting as age-weighted averages were verified to be slightly lower and less conservative than directly averaging the data. The averaged ingestion rates in grams wet weight per kilogram body weight per day were multiplied by the percent dry weight, receptor body weight, and 1 kilogram per 1000 grams to obtain ingestion rates in kilograms dry weight per day (see Attachment F-1).

A comparison of SWRA plant ingestion rates to the rates determined using the EFH Ch 9 and EFH Ch13 data is presented in Table F-4.

Table F-4. Plant Ingestion Rate Comparison Parameters

SWRA[a]		**Recent Guidance**[b,c]	
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

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, March.

[b] U.S. Environmental Protection Agency, 2011. Exposure Factors Handbook, Chapter 13-Intake of Home-Produced Foods, 2011 Edition, Washington, D.C., EPA/600/R-09/052F.

[c] U.S. Environmental Protection Agency, 2018. Update for Chapter 9 of the Exposure Factors Handbook, Intake of Fruits and Vegetables, Washington, D.C., EPA/600/R-09/052F, August.

Abbreviations:

kg DW/day = kilograms dry weight per day
SWRA = Site-Wide Risk Assessment

The EFH Ch 13 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 EFH Ch 13 data. Likewise, belowground fruit/vegetable ingestion rates from the SWRA were compared to vegetable ingestion rates determined from EFH Ch 13 data. Fruit ingestion rates determined from EFH Ch 13 data were lower than aboveground fruit/vegetable ingestion rates used in the SWRA. Vegetable ingestion rates determined from the EFH Ch 13 data were higher than belowground fruit/vegetable ingestion rates used in the SWRA. The values calculated from the EFH Ch 13 data were used in the calculations of updated risk estimates presented below.

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 & Technology* (Travis and Arms 1988) and remains widely used to calculate $TC_{s\text{-}p}$ for organic chemicals (LBNL 2007). The organic chemical 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 DSS 4.
2. Dieldrin at the EDPs.

The COCs at DSS 4 are classified as PAHs, and their $TC_{s\text{-}p}$ values reported in the SWRA (Table D.11, Appendix D; UC Davis 2004) were ≤0.02, except the $TC_{s\text{-}p}$ value for benzo[*k*]fluoranthene was reported as 1. Benzo[*k*]fluoranthene is chemically similar to the other PAH COCs.

The Travis and Arms formula was used to calculate $TC_{s\text{-}p}$ values (unitless) for organic COCs and compare them to $TC_{s\text{-}p}$ values (unitless) reported in the SWRA:

1. Benzo[*a*]anthracene, Calculated $TC_{s\text{-}p} = 0.018$; SWRA $TC_{s\text{-}p} = 0.02$
2. Benzo[*a*]pyrene, Calculated $TC_{s\text{-}p} = 0.011$; SWRA $TC_{s\text{-}p} = 0.011$
3. Benzo[*b*]fluoranthene, Calculated $TC_{s\text{-}p} = 0.018$; SWRA $TC_{s\text{-}p} = 0.010$
4. Benzo[*k*]fluoranthene, Calculated $TC_{s\text{-}p} = 0.011$; SWRA $TC_{s\text{-}p} = 1$
5. Dibenzo[*a,h*]anthracene, Calculated $TC_{s\text{-}p} = 0.0049$; SWRA $TC_{s\text{-}p} = 0.0053$
6. Indeno[1,2,3-*cd*]pyrene, Calculated $TC_{s\text{-}p} = 0.0052$; SWRA $TC_{s\text{-}p} = 0.056$
7. Dieldrin, Calculated $TC_{s\text{-}p} = 0.029$; SWRA $TC_{s\text{-}p} = 0.03$

$TC_{s\text{-}p}$ values calculated using the Travis and Arms formula were comparable with those reported in the SWRA, except the benzo[*k*]fluoranthene $TC_{s\text{-}p}$ value differed by 2 orders of magnitude and benzo[*b*]fluoranthene $TC_{s\text{-}p}$ values differed by almost a factor of 2. All $\log_{10} K_{ow}$ values were obtained from the EPA Regional Screening Levels table of chemical specific parameters (EPA 2020b). The $TC_{s\text{-}p}$ values presented in the SWRA were deemed usable for all COCs except benzo[*k*]fluoranthene and benzo[*b*]fluoranthene, for which values were obtained from Lawrence Berkeley National Laboratory's (LBNL) *Plant Uptake of Organic Pollutants from Soil: A Critical Review of Bioconcentration Estimates Based on Models and Experiments* (LBNL 2007). The $TC_{s\text{-}p}$ values published by LBNL for benzo[*k*]fluoranthene (0.011) and benzo[*b*]fluoranthene (0.018) agreed with the values calculated.

Contaminated Plant Fraction

The SWRA used a contaminated plant fraction (CPF) of 0.4 referenced to 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 DTSC 2019a and EPA 2014 is shown in Table F-5.

Residential adult exposure duration and body weight were changed to the values given in DTSC 2019a and EPA 2014. No other changes were made from the plant ingestion values used in the SWRA.

Table F-5. Plant Ingestion Pathway Standard Exposure Comparison Parameters

Parameter	SWRA[a]	Recent Guidance[b,c]
Resident Adult and Child Exposure Frequency (days/year)	350	350
Resident Adult Exposure Duration (years)	24	20
Resident Child Exposure Duration (years)	6	6
Resident Adult Body Weight (kilograms)	70	80
Resident Child Body Weight (kilograms)	15	15
Averaging Time,[a] cancer (days)	25,550	25,550
Age-Adjusted Resident Averaging Time,[b] non-cancer (days)	10,950	9,490

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, University of California, Davis, March.

[b] California Department of Toxic Substances Control, 2019. Human Health Risk Assessment (HHRA) Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities, Office of Human and Ecological Risk, April 9.

[c] 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.

[d] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.

[e] Averaging Time, non-cancer (days) = 365 days/year × sum of adult and child exposure durations (years).

Abbreviation:
SWRA = Site-Wide Risk Assessment

F2.2.1.4 Residential Inhalation

Vapor intrusion is a potentially complete exposure pathway for hypothetical future residential receptors. Whereas the SWRA did not adequately address vapor intrusion, the vapor intrusion investigation conducted in 2017 and 2018 thoroughly evaluated this exposure pathway, and the exposure parameters and equations used in the vapor intrusion evaluation (DOE 2018) remain current.

Inhalation intake for outdoor air was calculated in the SWRA in units of milligrams per kilogram-day (mg/kg-day), but inhalation intake equations have since been replaced by exposure concentration (EC) equations in units of micrograms per cubic meter (μg/m^3) (EPA 2009):

$$EC = (CA \times ET \times CF \times EF \times ED)/AT,$$

where

EC (μg/m^3) = exposure concentration

CA (mg/m^3) = contaminant concentration in air (CA = CS × [1/PEF + 1/VF]; discussed below)

ET (hours/day) = exposure time

CF (1000 μg/mg × 1 day/24 hours]) = conversion factor

EF (days/year) = exposure frequency

ED (years) = exposure duration

AT (days) = averaging time.

The above exposure concentration equation does not use receptor inhalation rate or body weight as was used in the SWRA intake equation, but now accounts for ET in hours per day.

The exposure concentration equation estimates concentration in air (CA) using the contaminant concentration in soil (CS), particulate emission factor (PEF), and volatilization factor (VF). For hypothetical future residents, the SWRA used a PEF published in 2002 by EPA Region 9 for calculating preliminary remediation goals (PRGs) (7.0×10^7 cubic meters per kilogram [m^3/kg]). The DTSC 2019a guidance recommends a residential receptor PEF of 1.36×10^9 m^3/kg and is equal to the default PEF presented in EPA's *Regional Screening Levels (RSLs) - User's Guide* (EPA 2020a). PEF values are not provided in EPA 2014. The residential receptor PEF recommended in DTSC 2019a was used in this evaluation.

As discussed previously, volatilization factors were not used in the SWRA for any of the established DOE Areas COCs. However, benzo[*a*]anthracene meets current volatility criteria (EPA 2015), with a Henry's law constant slightly greater than 1×10^{-5} atm-m^3/mole. The chemical-specific volatilization factor for benzo[*a*]anthracene is 4.41×10^6 m^3/kg (EPA 2020c) and was used to calculate exposure concentration for this COC.

Comparisons between values used in the SWRA for inhalation and those recommended in DTSC 2019a and EPA 2014 are shown in Table F-6.

Residential adult exposure duration was changed to the value given in DTSC 2019a and EPA 2014. The resident adult and child exposure time of 24 hours per day was added to satisfy the new exposure concentration equation. No other changes were made to the inhalation parameter values.

Table F-6. Residential Inhalation Exposure Comparison Parameters

Parameter	SWRA[a]	Recent Guidance[b,c]
Inhalation Rate (m^3/day)	20	NA[d]
Particulate Emission Factor (m^3/kg)	7.0×10^7	1.36×10^9 [e]
Volatilization Factor (m^3/kg)	NA[d]	Chemical specific[d]
Resident Adult and Child Air Exposure Time (hours/day)	NA[d]	24
Resident Adult and Child Exposure Frequency (days/year)	350	350
Resident Adult Exposure Duration (years)	24	20
Resident Child Exposure Duration (years)	6	6
Averaging Time,[f] cancer (days)	25,550	25,550
Age-Adjusted Resident Averaging Time,[g] non-cancer (days)	10,950	9,490

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, March.

[b] California Department of Toxic Substances Control, 2019. Human Health Risk Assessment (HHRA) Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities, Office of Human and Ecological Risk, April 9.

[c] 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.

[d] Discussed in Section F2.2.1.4.

[e] DTSC 2019a residential value and EPA RSL Users Guide default value.

[f] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.

[g] Averaging Time, non-cancer (days) = 365 days/year × sum of adult and child exposure durations (years).

Abbreviations:

m^3/day = cubic meters per day
m^3/kg = cubic meters per kilogram
NA = not applicable
SWRA = Site-Wide Risk Assessment

F2.2.2 Construction Workers

Construction worker parameter values used in the SWRA (UC Davis 2004) were referenced to EPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (EPA 2002). The DTSC 2019a guidance provides recommended values for construction worker exposure, but EPA 2014 did not and was not used.

F2.2.2.1 Construction Worker Soil Ingestion

The parameter value comparison for construction worker soil ingestion is shown in Table F-7. Parameter values used in the SWRA for construction worker soil ingestion were equivalent to the values recommended in DTSC 2019a, except body weight. The body weight was changed to 80 kilograms for this evaluation.

Table F-7. Construction Worker Soil Ingestion Comparison Parameters

Parameter	SWRA[a]	Recent Guidance[b]
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,[c] cancer (days)	25,550	25,550
Construction Worker Averaging Time,[d] non-cancer (days)	365	365

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, University of California, Davis, March.

[b] California Department of Toxic Substances Control, 2019. Human Health Risk Assessment (HHRA) Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities, Office of Human and Ecological Risk, April 9.

[c] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.

[d] Averaging Time, non-cancer (days) = 365 days/year × exposure duration (years).

Abbreviations:

mg/day = milligrams per day
SWRA = Site-Wide Risk Assessment

F2.2.2.2 Construction Worker Dermal Contact

The comparison for construction worker dermal contact is shown in Table F-8. Construction worker skin surface area, soil adherence factor, and body weight were changed to the values given in DTSC 2019a.

As discussed above, the dermal contact intake equation in current usage (EPA 2020a) does not contain event frequency or exposure time factors. An exposure time of 8 hours per day for construction workers appears reasonable, but factoring it into the current intake equation is less conservative. Thus, event frequency and exposure time were not used to calculate dermal contact intake in this evaluation.

As discussed above, a search was conducted to determine if more recent chemical-specific dermal absorption factors were published by EPA since the SWRA was issued. The most recent dermal absorption factors published by EPA (EPA 2004) were verified to be the same as those used in the SWRA. No changes to dermal absorption factors were made.

Table F-8. Construction Worker Dermal Contact Comparison Parameters

Parameter	SWRA[a]	Recent Guidance[b]
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[c]	Chemical specific[c]
Construction Worker Event Frequency (events/day) or Exposure Time (hours/day)	1	NA[a]
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,[d] cancer (days)	25,550	25,550
Construction Worker Averaging Time,[e] non-cancer (days)	365	365

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, University of California, Davis, March.

[b] California Department of Toxic Substances Control, 2019. Human Health Risk Assessment (HHRA) Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities, Office of Human and Ecological Risk, April 9.

[c] Discussed in Section F2.2.2.2.

[d] Averaging Time, cancer (days) = 365 days/year × 70 year lifetime.

[e] Averaging Time, non-cancer (days) = 365 days/year × exposure durations (years).

Abbreviations:

cm^2 = square centimeter
mg/cm^2 = milligrams per square centimeter
SWRA = Site-Wide Risk Assessment

F2.2.2.3 Construction Worker Inhalation

The comparison for construction worker inhalation parameters is shown in Table F-9. 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 F2.2.1.4 and no longer uses a receptor inhalation rate or body weight but does account for the receptor's exposure time (hours per day). The DTSC 2019a guidance does not provide an exposure time for construction workers, but 8 hours per day was used for construction workers, as given in EPA's *RSL Users Guide* (EPA 2020a). The DTSC 2019a construction worker particulate emission factor of 1×10^6 was used. No volatilization factor was used for the only established construction worker COC (benzo[*a*]pyrene) because it does not meet current volatilization criteria (EPA 2015).

Table F-9. Construction Worker Inhalation Comparison Parameters

Parameter	SWRA[a]	Recent Guidance[b]
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 (hours/day)	NA[c]	8[d]
Construction Worker Exposure Frequency (days/year)	250	250
Construction Worker Exposure Duration (years)	1	1
Construction Worker Body Weight (kilograms)	70	NA[c]
Construction Worker Averaging Time,[e] cancer (days)	25,550	25,550
Construction Worker Averaging Time,[f] non-cancer (days)	365	365

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, University of California, Davis, March.

[b] California Department of Toxic Substances Control, 2019. Human Health Risk Assessment (HHRA) Note Number 1, Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities, Office of Human and Ecological Risk, April 9.

[c] Discussed in Section F2.2.2.3.

[d] Exposure time not specified in DTSC 2019a. Construction worker exposure time from EPA *RSL Users Guide* (EPA 2020a).

[e] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.

[f] Averaging Time, non-cancer (days) = 365 days/year × exposure durations (years).

Abbreviations:

m^3/day = cubic meters per day
m^3/kg = cubic meters per kilogram
NA = not applicable
SWRA = Site-Wide Risk Assessment

F2.3 Chemical Constituent of Concern 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 1992, 2010, 2019) (OEHHA), the EPA Integrated Risk Information System (EPA 2020d) (IRIS), EPA Regional Screening Levels (EPA 2020b) (RSLs), and DTSC's HHRA Note 10 (DTSC 2019b). The comparison of chemical toxicity values is shown in Tables F-10 and F-11 for oral and inhalation toxicities, respectively.

Table F-10. Oral Chemical Toxicity Data

Constituent	Oral Cancer Slope Factor (mg/kg-day)$^{-1}$					Oral Reference Dose (mg/kg-day)				
	SWRA[a]	OEHHA	IRIS [b]	EPA [c]	DTSC[g]	SWRA[a]	OEHHA	IRIS[b]	EPA[c]	DTSC[g]
Benzo[*a*]anthracene	7.3E-01	1.2E+00[d]	--	1.0E-01	1.0E-01	--	--	--	--	--
Benzo[*a*]pyrene	7.3E+00	2.9E+00[e]	1.0E+00	1.0E+00	1.0E+00	--	--	3.0E-04	3.0E-04	3.0E-04
Benzo[*b*]fluoranthene	7.3E-01	1.2E+00[d]	--	1.0E-01	1.0E-01	--	--	--	--	--
Benzo[*k*]fluoranthene	1.2E+00	1.2E+00[d]	--	1.0E-02	1.0E-02	--	--	--	--	--
Dibenzo[*a,h*]anthracene	4.1E+00	4.1E+00[f]	--	1.0E+00	4.1E+00	--	--	--	--	--
Indeno[1,2,3-*cd*]pyrene	1.2E+00	1.2E+00[d]	--	1.0E-01	1.0E-01	--	--	--	--	--
Dieldrin	1.6E+01	--	1.6E+01	1.6E+01	1.6E+01	5.0E-05	--	5.0E-05	5.0E-05	5.0E-05

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, University of California, Davis, March.

[b] U.S. Environmental Protection Agency, 2020. Integrated Risk Information System, https://www.epa.gov/iris, URL last updated on June 30, 2020, accessed July 7, 2020.

[c] U.S. Environmental Protection Agency, 2020. Regional Screening Levels (RSLs) - Generic Tables, Tables as of: May 2020, https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables, URL last updated on May 1, 2020, accessed July 7, 2020.

[d] State of California Office of Environmental Health Hazard Assessment, 2019. Appendix A: Hot Spots Unit Risk and Cancer Potency Values, https://oehha.ca.gov/air/crnr/technical-support-document-cancer-potency-factors-2009, URL last updated May 2019, accessed February 18, 2020.

[e] State of California Office of Environmental Health Hazard Assessment, 2010. Public Health Goal for Benzo[*a*]pyrene in Drinking Water, https://oehha.ca.gov/media/downloads/water/chemicals/phg/091610benzopyrene_0.pdf, September, accessed February 18, 2020.

[f] State of California Office of Environmental Health Hazard Assessment, 1992. Expedited Cancer Potency Values and Proposed Regulatory Levels for Certain Proposition 65 Carcinogens, https://oehha.ca.gov/media/downloads/proposition-65/report/expcancer.pdf, accessed February 18, 2020.

[g] California Department of Toxic Substances Control, 2019. Human Health Risk Assessment (HHRA) Note 10, Table 1, https://dtsc.ca.gov/wp-content/uploads/sites/31/2019/02/HHRA-Note-10-2019-02-25.pdf, February 25.

Abbreviations:

-- = not available
EPA = U.S. Environmental Protection Agency
IRIS = Integrated Risk Information System
mg/kg-day = milligrams per kilogram per day
mg/kg-day^{-1} = inverse of milligrams per kilogram per day
OEHHA = State of California Office of Environmental Health Hazard Assessment
SWRA = Site-Wide Risk Assessment

Table F-11. Inhalation Chemical Toxicity Data

Constituent	**SWRA[a] (mg/kg-day)$^{-1}$**	**Inhalation Unit Risk (µg/m^3)$^{-1}$**				**SWRA[a] (mg/kg-day)**	**Inhalation Reference Concentration (µg/m^3)**			
		OEHHA[b]	**IRIS[c]**	**EPA[d]**	**DTSC[e]**		**OEHHA[b]**	**IRIS[c]**	**EPA[d]**	**DTSC[e]**
Benzo[*a*]anthracene	7.3E-01	1.1E-04	--	6.0E-05	1.1E-04	--	--	--	--	--
Benzo[*a*]pyrene	7.3E+00	1.1E-03	6.0E-04	6.0E-04	1.1E-03	--	--	2.0E-03	2.0E-03	2.0E-03
Benzo[*b*]fluoranthene	7.3E-01	1.1E-04	--	6.0E-05	1.1E-04	--	--	--	--	--
Benzo[*k*]fluoranthene	3.9E-01	1.1E-04	--	6.0E-06	1.1E-04	--	--	--	--	--
Dibenzo[*a,h*]anthracene	4.2E+00	1.2E-03	--	6.0E-04	1.2E-03	--	--	--	--	--
Indeno[1,2,3-*cd*]pyrene	3.9E-01	1.1E-04	--	6.0E-05	1.1E-04	--	--	--	--	--
Dieldrin	1.6E+01	--	4.6E-03	4.6E-03	4.6E-03	5.0E-05	--	--	--	2.0E-01

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, University of California, Davis, March.

[b] State of California Office of Environmental Health Hazard Assessment, 2019. Appendix A: Hot Spots Unit Risk and Cancer Potency Values, https://oehha.ca.gov/air/crnr/technical-support-document-cancer-potency-factors-2009, URL last updated May 2019, accessed February 18, 2020.

[c] U.S. Environmental Protection Agency, 2020. Integrated Risk Information System, https://www.epa.gov/iris, URL last updated on June 30, 2020, accessed July 7, 2020.

[d] U.S. Environmental Protection Agency, 2020. Regional Screening Levels (RSLs) - Generic Tables, Tables as of: May 2020, https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables, URL last updated on May 1, 2020, accessed July 7, 2020.

[e] California Department of Toxic Substances Control, 2019. Human Health Risk Assessment (HHRA) Note 10, Table 1, https://dtsc.ca.gov/wp-content/uploads/sites/31/2019/02/HHRA-Note-10-2019-02-25.pdf, February 25.

Abbreviations:

-- = not available
µg/m^3 = micrograms per cubic meter
(µg/m^3)$^{-1}$ = inverse of micrograms per cubic meter
EPA = U.S. Environmental Protection Agency
IRIS = Integrated Risk Information System
mg/kg-day = milligrams per kilogram per day
mg/kg-day^{-1} = inverse of milligrams per kilogram per day
OEHHA = State of California Office of Environmental Health Hazard Assessment
SWRA = Site-Wide Risk Assessment

F2.3.1 Oral Cancer Slope Factor

Oral cancer slope factors for the six PAH COCs were available from the OEHHA and were equal to or more conservative than the values used in the SWRA, except the OEHHA slope factor for benzo[*a*]pyrene was 60% lower than the SWRA value. 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 the IRIS dieldrin toxicity value is the same as used in the SWRA, but the benzo[*a*]pyrene toxicity value in the IRIS database is 86% lower than the SWRA value.

Oral cancer slope factors published by EPA Region 9 for RSL derivations 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 scaled to benzo[*a*]pyrene using Relative Potency Factors obtained from EPA's *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (EPA 1993). The oral cancer slope factors published by EPA for RSLs for these seven chemical COCs were less conservative or equal to the values used in the SWRA. Oral cancer slope factors published in DTSC's HHRA Note 10 for dieldrin and the PAH COCs have the same values and same source as those published by EPA Region 9 for RSL derivations, except DTSC's HHRA Note 10 uses the OEHHA oral cancer slope factor for dibenzo[*a*,*h*]anthracene.

For this evaluation, the most conservative of the recently published oral cancer slope factors from the OEHHA, IRIS, EPA, and DTSC were selected for the seven chemical COCs:

1. OEHHA: Benzo[*a*]anthracene (OEHHA 2019), benzo[*a*]pyrene (OEHHA 2010), benzo[*b*]fluoranthene (OEHHA 2019), benzo[*k*]fluoranthene (OEHHA 2019), dibenzo[*a*,*h*]anthracene (OEHHA 1992), and indeno[1,2,3-*cd*]pyrene (OEHHA 2019)
2. IRIS: Dieldrin (EPA 2020d)

F2.3.2 Oral Reference Dose

An oral reference dose was available for dieldrin, but not for the six PAH COCs when chemical hazards were estimated in the SWRA (UC Davis 2004). A review of toxicity data published by OEHHA, IRIS, EPA, and DTSC indicates no oral reference dose changes for these chemical COCs, except an oral reference dose has since been published for benzo[*a*]pyrene by the IRIS (EPA 2020d).

F2.3.3 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 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 F-11.

Inhalation unit risk factors were available from the OEHHA for the six PAH COCs but not dieldrin. Inhalation unit risk factors were published in the IRIS for dieldrin and benzo[*a*]pyrene but not the other five PAH COCs. Factors published by EPA Region 9 for RSL derivations 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 scaled to benzo[*a*]pyrene using Relative Potency Factors established by EPA (EPA 1993). Factors published in DTSC's HHRA Note 10 for the six PAH COCs are referenced to OEHHA, and the factor for dieldrin is referenced to IRIS. The OEHHA unit risk factors for PAH COCs and the IRIS unit risk factor for dieldrin were used in this evaluation.

F2.3.4 Non-Cancer Inhalation Toxicity Factors

Non-cancer inhalation toxicity values were unavailable from OEHHA, EPA, or IRIS for the chemical COCs, except an Inhalation Reference Concentration was available in IRIS for benzo[*a*]pyrene (EPA 2020d), and an Inhalation Reference Concentration was available in DTSC's HHRA Note 10 for dieldrin.

F2.4 Chemical Risk Calculation Results

Table F-12 presents the risk results from the SWRA (UC Davis 2004) and the risks updated for this Five-Year Review. The chemical risk calculation spreadsheets are presented in Attachments F-2a through F-2k. 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.

Table F-12. Human Health Risks by Exposure Route for Contaminants in Soil at the DOE Areas

Cancer Risk by Exposure Route									
	Constituent	**Exposure Point Concentration (0–10 ft)[a]**	**Soil Ingestion**	**Soil Dermal Exposure**	**Aboveground Plant Ingestion[b]**	**Belowground Plant Ingestion[b]**	**External Radiation**	**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
2nd Five Year Review			3.E-05	1.E-05	1.E-05	2.E-05	NA	9.E-08	7.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
2nd Five Year Review			5.E-05	2.E-05	1.E-05	2.E-05	NA	2.E-09	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
2nd Five Year Review			2.E-05	7.E-06	8.E-06	1.E-05	NA	2.E-10	5.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
2nd Five Year Review			1.E-05	4.E-06	3.E-06	4.E-06	NA	1.E-10	2.E-05
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
2nd Five Year Review			3.E-05	1.E-05	3.E-06	5.E-06	NA	1.E-09	5.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
2nd Five Year Review			7.E-06	2.E-06	7.E-07	1.E-06	NA	7.E-11	1.E-05
SWRA	Total								**5.E-04**
2nd Five Year Review									**3.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**
2nd Five Year Review			3.E-07	5.E-07	NA	NA	NA	9.E-9	**8.E-07**

Table F-12. Human Health Risks by Exposure Route for Contaminants in Soil at the DOE Areas (continued)

Cancer Risk by Exposure Route									
	Constituent	**Exposure Point Concentration (0–10 ft)[a]**	**Soil Ingestion**	**Soil Dermal Exposure**	**Aboveground Plant Ingestion[b]**	**Belowground Plant Ingestion[b]**	**External Radiation**	**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
2nd Five Year Review			4.E-07	1.E-07	3.E-07	6.E-07	NA	2.E-11	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
2nd Five Year Review			2.E-08	NA	1.E-06	NA	6.E-08	2.E-12	1.E-06
SWRA								Total	**4.E-06**
2nd 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**
2nd 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 SWRA 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%, 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. 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 = exposure pathway not applicable
SWRA = Site-Wide Risk Assessment

The total estimated risk to hypothetical future residential receptors at DSS 4 was 40% lower than was estimated in the SWRA. The estimated residential risk decreased for benzo[*k*]fluoranthene due to lower plant ingestion risk resulting from an updated soil-to-plant transfer coefficient. Estimated residential risks increased for the other five COCs due to early-life effects adjustments across exposure pathways and increases in belowground plant ingestion risk due to updated plant ingestion rates. However, all exposure pathways for hypothetical future residential receptors at DSS 4 are closed by the land-use restrictions that are actively maintained to prevent residential land use at DSS 4.

The total estimated risk to construction workers at DSS 4 decreased to a level below the 1×10^{-6} threshold. Estimated construction workers risks decreased for soil ingestion due to a lower benzo[*a*]pyrene toxicity value but increased to a lesser extent for dermal contact due to increases in skin surface area and soil adherence factor. Estimated construction workers inhalation risk increased but did not contribute significantly to the total risk.

The total estimated risk to hypothetical future residential receptors from dieldrin at the EDPs decreased by threefold. Changes in estimated risk were small for soil ingestion, dermal contact, and inhalation, but aboveground plant ingestion risk decreased significantly, while belowground plant ingestion risk increased.

F2.5 Radiological Risk

F2.5.1 Calculations Using RESRAD Onsite

Radiological risks were calculated in the SWRA using RESRAD version 6.21 developed by Argonne National Laboratory (ANL 2002). Risk coefficients for total cancer morbidity (i.e., cancer slope factors or risk coefficients) selected in RESRAD version 6.21 for the SWRA (UC Davis 2004) were referenced to the 2001 version of the Health Effects Assessment Summary Tables (EPA 2001) (HEAST 2001). Most values in HEAST 2001 were taken from Federal Guidance Report No. 13 (EPA 1999). RESRAD-ONSITE version 7.2 is the most recent update of ANL's RESRAD computer program (ANL 2016). RESRAD-ONSITE version 7.2 includes the ICRP60-based risk coefficients from DCFPAK 3.02 (EPA 2019a), which were used in this evaluation.

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 F-13.

Between HEAST 2001 and DCFPAK 3.02, the food ingestion risk factors are identical and external ground factors are essentially the same. The most noticeable change between HEAST 2001 and DCFPAK 3.02 is a fourfold increase in the inhalation risk factor. The soil ingestion risk factor decreased by 34% 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 F-3. The "area of contaminated zone" for the Southwest Trenches (2428 square meters [m^2]) was incorrect when compared to the area determined by the land surveyor (1785 m^2 = 19,222 square feet) (DTSC 2014). The surveyed area was used when risks were calculated for this Five-Year Review.

Table F-13. Comparison of Strontium-90 Risk Coefficients

Parameter	HEAST[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] U.S. Environmental Protection Agency, 2001. Radionuclide Carcinogenicity Slope Factors: Health Effects Assessment Summary Tables (HEAST), https://www.epa.gov/radiation/radionuclide-table-radionuclide-carcinogenicity-slope-factors, URL last updated on August 14, 2019, accessed April 28, 2020.

[b] U.S. Environmental Protection Agency, 2019. Tools for Calculating Radiation Dose and Risk, DC_PAK3.02, https://www.epa.gov/radiation/tools-calculating-radiation-dose-and-risk, URL last updated on September 26, 2019, accessed March 30, 2020.

Abbreviations:

DCFPAK = Dose Coefficient File Package
HEAST = Health Effects Assessment Summary Tables
pCi/g = picocuries per gram
SWRA – Site Wide Risk Assessment

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.

Plant ingestion rates were calculated using data from EPA’s EFH, Ch13 (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, vegetable, and grain consumption (FVGC) 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 EFH, Ch13 (EPA 2011) were combined and redistributed to provide FVGC and LVC ingestion rates for RESRAD input. Plant dry weight was determined using EFH Ch9 data (EPA 2018) as described above for the chemical risk evaluation. On the basis of RESRAD Onsite default whole diet ingestion rates, FVGC and LVC make up 92% and 8%, respectively, of plant ingestion. The FVGC and LVC calculation is shown in Attachment F-4. A comparison between plant ingestion rates used in the SWRA for RESRAD and those determined for RESRAD in this evaluation is shown in Table F-14.

Table F-14. Comparison of Plant Ingestion Rates

Parameter	SWRA[a]	Recent Guidance[b,c]
Fruit, grain, and vegetable consumption (kg DW/year)	5.1	9.69
Leafy vegetable consumption (kg/DW/year)	5.1	0.84

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, University of California, Davis, March.

[b] U.S. Environmental Protection Agency, 2011. Exposure Factors Handbook, Chapter 13-Intake of Home-Produced Foods, 2011 Edition, Washington, D.C., EPA/600/R-09/052F.

[c] U.S. Environmental Protection Agency, 2018. Update for Chapter 9 of the Exposure Factors Handbook, Intake of Fruits and Vegetables, Washington, D.C., EPA/600/R-09/052F, August.

Abbreviation:

kg DW/year = kilograms dry weight per year

The combined ingestion rates of FVGC and LVC in the SWRA (UC Davis 2004) and this Five-Year Review are 10.2 versus 10.53 kg DW/year, respectively, and are only slightly different. 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 7.2. 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.

Strontium-90 risk was recalculated for the EDPs and Southwest Trenches Area using RESRAD Onsite version 7.2 with DCFPAK 3.02 risk factors, the corrected land-survey areas, and the updated plant ingestion rates.

F2.5.2 Radiological Risk Calculation Results

The updated risk calculation results are shown in Table F-12. As shown, total Sr-90 risks are unchanged from those estimated in the SWRA (UC Davis 2004). 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.

F3.0 Onsite Researchers and Trespassers

Human health risks to 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 exposure assumptions, parameter values, intake equations, and toxicity values to determine if any changes indicate significant risks to these receptors from the COCs.

F3.1 Exposure Pathways

F3.1.1 Onsite Indoor Researcher Exposure

Human health risks to onsite indoor researchers from chemical COCs in DOE Areas were estimated in the SWRA based on the sum of risks from three exposure pathways:

- Soil ingestion
- External radiation
- Inhalation of volatiles in indoor air (vapor intrusion)

The exposure pathways identified in the SWRA for onsite indoor researchers in DOE Areas remain reasonable. Based on the Risk Characterization for DOE Areas (DOE 2005), none of the DOE Areas COCs apply to onsite indoor researchers.

Vapor intrusion exposure for onsite indoor researchers in the DOE Areas was not adequately addressed in the SWRA. Vapor intrusion for onsite indoor researchers ("commercial scenario") was addressed in the vapor intrusion investigation conducted in 2017 and 2018 (DOE 2018). The results of the investigation indicated that vapor-forming chemicals in the DOE areas did not present an unacceptable risk under current or potential future land-use scenarios, and the remedy was determined to be protective of human health and the environment (DOE 2018). No new chemical COCs were identified in the vapor intrusion investigation for onsite indoor researchers ("commercial scenario").

F3.1.2 Onsite Outdoor Researcher and Trespasser Exposure

Human health risks to onsite outdoor researchers and trespassers from chemical COCs in DOE Areas were estimated in the SWRA based on the sum of risks from four exposure pathways:

- Soil ingestion
- Soil dermal exposure
- External radiation
- Inhalation of dust and volatiles

The exposure pathways identified in the SWRA for onsite outdoor researchers and trespassers in DOE Areas remain reasonable. Based on the Risk Characterization for DOE Areas (DOE 2005), none of the DOE Areas COCs apply to onsite outdoor researchers or trespassers. Vapor intrusion is not an applicable exposure pathway because all onsite outdoor researcher and trespasser activities are assumed to be conducted outdoors.

F3.2 Chemical Intake

F3.2.1 Soil Ingestion

EPA's recommended soil ingestion rates for outdoor and indoor workers (EPA 2014) did not change since the SWRA was issued in 2004 (Table F-15). The calculation of soil ingestion intake would decrease slightly for onsite outdoor and indoor researchers because adult body weight changed from 70 to 80 kilograms upon EPA 2014. Body weight is a denominator term as shown below in the soil ingestion intake equation, and this increase in body weight results in a 12% lower soil ingestion intake value for both onsite outdoor and indoor researchers.

Table F-15. Worker Soil Ingestion Comparison Parameters

Parameter	SWRA[a]	Recent Guidance[b]
Outdoor Worker IR (mg/day)	100	100
Indoor Worker IR (mg/day)	50	50
Outdoor Worker EF (days/year)	225	225
Indoor Worker EF (days/year)	250	250
Outdoor and Indoor Worker ED (years)	25	25
Outdoor and Indoor Worker BW (kilograms)	70	80
Outdoor and Indoor Worker AT[c] cancer (days)	25,550	25,550
Outdoor and Indoor Worker AT[d] non-cancer (days)	9,125	9,125

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, University of California, Davis, March.

[b] 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.

[c] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.

[d] Averaging Time, non-cancer (days) = 365 days/year × worker exposure duration (years).

Abbreviations:

mg/day = milligrams per day
SWRA = Site-Wide Risk Assessment

The soil ingestion intake for onsite indoor researchers is about half the intake of onsite outdoor researchers. The equation is

$$\text{Soil ingestion intake} = \frac{\text{CS} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where,

CS = concentration in soil

IR = soil ingestion rate

EF = exposure frequency

ED = exposure duration

BW = body weight

AT = averaging time.

Trespasser soil ingestion parameter assumptions used in the SWRA were based on teenagers and do not correspond with the child or adult values presented in EPA 2014. The SWRA assumption that trespassers would be teenagers appears reasonable. Adult trespassers are more likely to be involved in theft or homeless encampment. Theft would not be focused on the DOE Areas, which do not contain valuable items, and homeless encampment would be reclassified as residential exposure. Child trespassers of ages below the teen years would likely be quickly noticed, apprehended, and removed from the site with corrective actions taken. The teenage trespasser exposure parameter values selected in the SWRA appear conservative (listed below). The assumed body weight of 31 kilograms is an underestimated denominator term that would result in a conservative intake. Body weight statistics reported by the U.S. Centers for Disease Control and Prevention for 50th percentile females between ages 13 and 18 were 45–57 kilograms, and 50th percentile males in the same age bracket were 45–67 kilograms (CDC 2000). In addition, the assumed 50 days per year exposure frequency and 6-year exposure duration appear to be conservative estimations of these numerator terms. The DOE Areas do not contain features that are attractive to teenage activity, and the assumed exposure frequency would equate to nearly once per week. The trespasser exposure parameters are

IR = 100 milligrams per day

EF = 50 days per year

ED = 6 years

BW = 31 kilograms

AT cancer = 25,550 days

AT non-cancer = 2,190 days

Based on the soil ingestion intake equation, the trespasser exposure parameter values shown above, and EPA 2014 values for outdoor workers, the trespasser has significantly lower cancer and non-cancer intake than outdoor researchers (86% lower for cancer intake; 43% lower for non-cancer intake). Teenager intake increases by a factor of 3 for PAH COCs when accounting for carcinogenic early-life effects (EPA 2005). However, early-life effects intake for trespassers would still be 59% lower than outdoor workers intake.

F3.2.2 Dermal Contact

The SWRA assumed that onsite indoor researchers do not have significant dermal contact exposure to soil and this assumption remains reasonable, but this pathway is complete for onsite outdoor researchers and trespassers. After the SWRA was issued, new values were published in EPA 2014 for worker skin surface area, soil adherence factor, and body weight (Table F-16), but chemical-specific dermal absorption factors (EPA 2004), exposure frequency, exposure duration, and averaging time did not change.

Table F-16. Worker Dermal Contact Comparison Parameters

Parameter	SWRA[a]	Recent Guidance[b]
Onsite Outdoor Researcher (Worker) Skin Surface Area (cm^2)	3,300	3,527
Onsite Outdoor Researcher (Worker) Soil Adherence Factor (mg/cm^2)	0.2	0.12
Dermal Absorption Factor	Chemical specific[c]	Chemical specific[c]
Onsite Outdoor Researcher (Worker) Exposure Frequency (days/year)	225	225
Onsite Outdoor Researcher (Worker) Exposure Duration (years)	25	25
Onsite Outdoor Researcher (Worker) Body Weight (kilograms)	70	80
Onsite Outdoor Researcher (Worker) Averaging Time,[d] cancer (days)	25,550	25,550
Onsite Outdoor Researcher (Worker) Averaging Time,[e] non-cancer (days)	9,125	9,125

Notes:

[a] University of California, Davis, 2004. Revised LEHR/SCDS Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, March.

[b] 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.

[c] No change in chemical-specific dermal absorption factors from the SWRA (0.13 PAHs; 0.1 dieldrin). EPA's Supplemental Guidance for Dermal Risk Assessment (EPA 2004) is the current source for these factors.

[d] Averaging Time, cancer (days) = 365 days/year × 70-year lifetime.

[e] Averaging Time, non-cancer (days) = 365 days/year × worker exposure duration (years).

Abbreviations:

cm^2 = square centimeter
mg/cm^2 = milligrams per square centimeter
SWRA = Site-Wide Risk Assessment

The soil dermal contact intake equation is shown. The slight increase in worker skin surface area, decrease in soil adherence factor, and slight increase in body weight result in an overall 44% decrease in dermal intake for onsite outdoor researchers. The equation is

$$\text{Soil dermal contact intake} = \frac{CS \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where

CS = concentration in soil

SA = skin surface area

AF = soil adherence factor

ABS = dermal absorption factor

EF = exposure frequency

ED = exposure duration

BW = body weight

AT = averaging time

As was the case with soil ingestion, dermal contact parameter assumptions used in the SWRA for teenage trespassers do not correspond with the child or adult values presented in EPA 2014. Review of the following trespasser exposure parameters established in the SWRA for dermal contact indicates the values remain reasonable.

SA = 5200 square centimeters

AF = 0.2 milligrams per square centimeter

ABS = 0.13 PAHs; 0.1 dieldrin

EF = 50 days per year

ED = 6 years

BW = 31 kilograms

AT cancer = 25,550 days

AT non-cancer = 2190 days

Based on the soil dermal contact intake equation, the trespasser exposure parameter values shown above, and EPA 2014 values for workers, the trespasser has lower cancer intake, but higher non-cancer intake than outdoor researchers (66% lower cancer intake; 41% higher non-cancer intake). Teenager intake increases by a factor of 3 for PAH COCs when accounting for carcinogenic early-life effects (EPA 2005), making trespassers intake nearly equal to that of outdoor workers.

F3.2.3 Inhalation

Vapor intrusion is a potentially complete exposure pathway for onsite indoor researchers. While the SWRA did not adequately address vapor intrusion, the vapor intrusion investigation conducted in 2017 and 2018 thoroughly evaluated this exposure pathway and the exposure parameters and equations used in the vapor intrusion evaluation (DOE 2018) remain current.

As discussed previously, outdoor air inhalation intake was calculated in the SWRA (UC Davis 2004) for chemicals in units of mg/kg-day, but current equations calculate inhalation intake in units of concentration ($\mu g/m^3$). Direct comparison of these approaches is not possible. Updated inhalation intake for onsite outdoor researchers was calculated using the current equation (Section F2.2.1.4) and current exposure parameters (EPA 2014). Updated inhalation intake for trespassers was calculated using the current intake equation, a conservative exposure time of 12 hours per day, and the exposure frequency (50 days per year) and exposure duration (6 years) established in the SWRA. Benzo[*a*]anthracene is the only chemical COC that meets current criteria to be classified as volatile, and its volatilization factor of 4.41×10^6 m^3/kg (EPA 2020c) was used in the inhalation intake equation for that COC. The particulate emission factor of 1.36×10^9 m^3/kg (EPA 2020c) remains unchanged from the SWRA.

F3.3 Chemical Toxicity and Risk

F3.3.1 Carcinogenic

Chemical COC oral cancer slope factor data applicable to soil ingestion and dermal contact risk calculations are shown in Table F-10. Oral slope factors used in the SWRA for benzo[*k*]fluoranthene, dibenzo[*a,h*]anthracene, indeno[1,2,3-*cd*]pyrene, and dieldrin remain current, indicating that the risks to onsite outdoor researchers would decrease slightly for these four chemicals due to the slight decreases in soil ingestion intake and dermal intake values for workers. As discussed above, onsite indoor researcher and trespasser intake is less than or equal to onsite outdoor researcher intake, indicating estimated risks for these receptors are less than or equal to those of onsite outdoor researchers. The oral slope factor for benzo[*a*]pyrene decreased by 60%, indicating a significant decrease in risk. Thus, updates to soil ingestion and dermal contact risks were deemed unnecessary for benzo[*a*]pyrene, benzo[*k*]fluoranthene, dibenzo[*a,h*]anthracene, indeno[1,2,3-*cd*]pyrene, and dieldrin.

Oral slope factors increased by 64% for benzo[*a*]anthracene and benzo[*b*]fluoranthene, indicating an increase in estimated risk for these compounds. Soil ingestion and dermal contact risks were calculated for these two chemicals using the current slope factors shown in Table F-10 and current exposure parameters presented above. The results indicated soil ingestion risks remain below 1×10^{-6} for onsite outdoor and indoor researchers and trespassers for all chemical COCs, except the estimated soil ingestion risk for onsite outdoor researchers was 1×10^{-6} for benzo[*a*]anthracene. Dermal contact risk estimation results for both onsite outdoor researchers and trespassers were 3×10^{-6} for benzo[*a*]anthracene and 1×10^{-6} for benzo[*b*]fluoranthene. These calculated risks are low, and benzo[*a*]anthracene and benzo[*b*]fluoranthene are spatially limited to a very small area several feet below ground surface in DSS 4 (DOE 2005). The likelihood of onsite outdoor and indoor researchers and trespassers receiving exposure to these chemicals is so low that the estimated risks can be characterized as negligible. In addition, any activities that might bring researchers in contact with the benzo[*a*]anthracene or benzo[*b*]fluoranthene contamination in subsurface soil would be managed according to Soil Management Plan requirements (DOE 2019) to reduce risks below the 1×10^{-6} risk threshold.

Vapor intrusion toxicity and risk are applicable to onsite indoor researchers and were evaluated in the vapor intrusion investigation conducted in 2017 and 2018. The toxicity values used in the vapor intrusion evaluation (DOE 2018) remain current, and the results indicated that vapor-forming chemicals in the DOE Areas did not present an unacceptable risk to onsite indoor researchers.

Risks to onsite outdoor researchers and trespassers from inhalation of dust and volatile chemicals in outdoor air were estimated for all chemical COCs using the current inhalation unit risk toxicity values (Table F-11) and current exposure parameters discussed above. The estimated inhalation risks ranged from 4×10^{-13} for inhalation of dieldrin (trespassers) to 8×10^{-9} for inhalation of benzo[*a*]anthracene (onsite indoor researchers). All the estimated inhalation risks were far below the 1×10^{-6} risk threshold and are insignificant.

F3.3.2 Noncarcinogenic

Noncarcinogenic toxicity data for chemical COCs are shown in Tables F-10 and F-11. The oral reference doses (Table F-10) apply to risk estimation for soil ingestion and dermal contact. For dieldrin, there was no change in the oral reference do se, but a new inhalation reference concentration was identified (see Table F-11, note f). Soil ingestion and dermal contact hazard quotients for dieldrin are expected to decrease for onsite outdoor researchers due to lower intake, as discussed above. Dieldrin hazard quotients for onsite indoor researchers (soil ingestion only) and trespassers (soil ingestion and dermal contact) are expected to be less than or equal to those of onsite outdoor researchers based on lower or equal intake as discussed above. Reestimations of soil ingestion and dermal contact hazard quotients were deemed unnecessary for dieldrin because they are expected to be lower than or equal to previous estimates. Vapor intrusion toxicity (onsite indoor researchers only) is not applicable to dieldrin because this chemical does not meet current volatility criteria (EPA 2015). Hazard quotients were calculated for dieldrin in outdoor air, and the results ranged from 5×10^{-9} for trespassers to 1×10^{-8} for onsite outdoor researchers.

Oral and inhalation reference doses were not available for PAH COCs when the SWRA was conducted, but EPA issued an oral reference dose and inhalation reference concentration for benzo[*a*]pyrene after the SWRA, as shown in Tables F-10 and F-11, respectively. Vapor intrusion toxicity (onsite indoor researchers only) is not applicable to benzo[*a*]pyrene because this chemical does not meet current volatility criteria (EPA 2015). Hazard quotients were calculated for onsite outdoor and indoor researchers and trespassers for exposure to benzo[*a*]pyrene, and the results ranged from 6×10^{-5} (trespasser inhalation of outdoor air) to 6×10^{-3} (outdoor researcher soil ingestion). All the estimated hazard quotients were far below the threshold of 1.0 and are insignificant.

F3.4 Radiological Risk

Strontium-90 is the only radiological COC in the DOE Areas, and its soil ingestion risk factor decreased since the SWRA (Table F-13). Dermal contact is not an exposure pathway for radionuclides, but external radiation from ground is a potentially complete exposure pathway and the current Sr-90 risk factor for external radiation is essentially unchanged from the value used in the SWRA (0.5% 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. Strontium-90 inhalation risks are expected to be several orders of magnitude lower than soil ingestion and external radiation risks (see Sr-90 risks in Table F-12). Reestimation of Sr-90 risks was deemed unnecessary for onsite outdoor and indoor researchers and trespassers because these risks are expected to be lower than or equal to previous estimates (soil ingestion and external radiation) or not contribute to the total estimated risk (inhalation).

F4.0 Conclusions

A recalculation of human health risks was completed for hypothetical future onsite residents and construction workers. Total estimated risks for hypothetical future onsite residents at the DSS 4 area, the EDPs, and the Southwest Trenches are either lower or unchanged from the 2004 SWRA. The total estimated risk for construction workers at the DSS 4 area is lower than the 1×10^{-6} risk threshold and less than that estimated in the 2004 SWRA. The evaluation of onsite researchers and trespasser exposure parameter values, intake equations, and toxicity values indicates that the existing COCs do not pose significant risks to these receptors. Thus, the remedy is protective with respect to the current evaluation of established human health risk COCs.

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Attachments F-1 through F-4

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Attachment F-1
Fruit and Vegetable ingestion Rate Calculations, Chemical Intake

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
Average moisture content	87.02%	
Average dry content	12.98%	100% - Moisture content

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)
Ages Birth to <6 years	4.4	15	0.0086	0.0609
Ages 6 to 50+ years	0.99	80	0.0103	0.0179

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
Average moisture content	89.32%	
Average dry content	10.68%	100% - Moisture content

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)
Ages Birth to <6 years	6.8	15	0.0108	0.0033
Ages 6 to 50+ years	3.3	80	0.028	0.0098

Notes:

[1] Moisture content values from Table 9-53 of EFH Chapter 9 (EPA 2018). Table provides values for raw and cooked. Most likely consumed state of garden item selected.

[2] Values from Table 13-1 of EFH Chapter 13 (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 F-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

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equations
Ingestion	Hypothetical Future On-Site Resident	Age-Adjusted Adult	DSS 4	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	cancer ADD/LADD (mg/kg-day) = $CS \times CF \times [(IR_{s,c} \times ED_{r,c\ 0\text{-}2} / BW_c) \times 10$ $+ (IR_{s,c} \times ED_{r,c\ 2\text{-}6} / BW_c) \times 3$ $+ (IR_{s,a} \times ED_{r,a\ 6\text{-}16} / BW_a)] \times 3$ $+ (IR_{s,a} \times ED_{r,a\ 16\text{-}26} / BW_a)] \times EF_r / AT$
				CF	Conversion Factor	0.000001	kg/mg	-	
				$IR_{s,a}$	Ingestion Rate	100	mg soil/day	UCD 2004	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a\ 6\text{-}16}$	Exposure Duration $_{6\text{-}16}$	10	years	EPA 2005	
				$ED_{r,a\ 16\text{-}26}$	Exposure Duration $_{16\text{-}26}$	10	years	EPA 2005	non-cancer ADD/LADD (mg/kg-day) = $CS \times CF \times [IR_{s,c} \times (ED_{r,c\ 0\text{-}2} + ED_{r,c\ 2\text{-}6}) / BW_c$ $+ IR_{s,a} \times (ED_{r,a\ 6\text{-}16} + ED_{r,a\ 16\text{-}26}) / BW_a]$ $\times EF_r / AT$
				BW_a	Body Weight	80	kg	DTSC 2019a and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Sum of child and adult ED, EPA 2005	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
		Child	DSS 4	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	cancer ADD/LADD (mg/kg-day) = $CS \times CF \times IR_{s,c} \times EF_r \times [ED_{r,c\ 0\text{-}2} \times 10$ $+ ED_{r,c\ 2\text{-}6} \times 3]/(BW_c \times AT)$
				CF	Conversion Factor	0.000001	kg/mg	-	
				$IR_{s,c}$	Ingestion Rate	200	mg soil/day	UCD 2004	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,c\ 0\text{-}2}$	Exposure Duration $_{0\text{-}2}$	2	years	EPA 2005	non-cancer ADD/LADD (mg/kg-day) = $CS \times CF \times IR_{s,c} \times EF_r \times [ED_{r,c\ 0\text{-}2}$ $+ ED_{r,c\ 2\text{-}6}]/(BW_c \times AT)$
				$ED_{r,c\ 2\text{-}6}$	Exposure Duration $_{2\text{-}6}$	4	years	EPA 2005	
				BW_c	Body Weight	15	kg	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	Sum of child ED, EPA 2005	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	

Attachment F-2a Continued. 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

Dermal	Hypothetical Future On-Site Resident	Age-Adjusted Adult	DSS 4	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	cancer ADD/LADD (mg/kg-day) = $CS \times CF \times ABS \times [(SA_c \times AF_c \times ED_{r,c\,0\text{-}2} / BW_c) \times 10 + (SA_c \times AF_c \times ED_{r,c\,2\text{-}6} / BW_c) \times 3 + (SA_a \times AF_a \times ED_{r,a\,6\text{-}16} / BW_a) \times 3 + (SA_a \times AF_a \times ED_{r,a\,16\text{-}26} / BW_a)] \times EF_r / AT$
				CF	Conversion Factor	0.000001	kg/mg	-	
				SA_a	Skin Surface Area	6,032	cm^2	DTSC 2019a and EPA 2014	
				AF_a	Soil Adherence Factor	0.07	mg/cm^2-event	UCD 2004	
				ABS	Dermal Absorption Factor	Note[1]	unitless	-	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a\,6\text{-}16}$	Exposure Duration $_{6\text{-}16}$	10	years	EPA 2005	non-cancer ADD/LADD (mg/kg-day) = $CS \times CF \times ABS \times [SA_c \times AF_c \times (ED_{r,c\,0\text{-}2} + ED_{r,c\,2\text{-}6}) / BW_c + SA_a \times AF_a \times (ED_{r,a\,6\text{-}16} + ED_{r,a\,16\text{-}26}) / BW_a] \times EF_r / AT$
				$ED_{r,a\,16\text{-}26}$	Exposure Duration $_{16\text{-}26}$	10	years	EPA 2005	
				BW_a	Body Weight	80	kg	DTSC 2019a and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Sum of child and adult ED, EPA 2005	
				AT_c	Averaging Time (cancer)	25,500	days	UCD 2004	
		Child	DSS 4	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	cancer ADD/LADD (mg/kg-day) = $CS \times CF \times SA_c \times AF_c \times ABS \times EF_r \times [ED_{r,c\,0\text{-}2} \times 10 + ED_{r,c\,2\text{-}6} \times 3] /(BW_c \times AT)$
				CF	Conversion Factor	0.000001	kg/mg	-	
				SA_c	Skin Surface Area	2,373	cm^2	DTSC 2019a and EPA 2014	
				AF_c	Soil Adherence Factor	0.2	mg/cm^2-event	UCD 2004	
				ABS	Dermal Absorption Factor	Note[1]	unitless	-	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	non-cancer ADD/LADD (mg/kg-day) = $CS \times CF \times SA_c \times AF_c \times ABS \times EF_r \times [ED_{r,c\,0\text{-}2} + ED_{r,c\,2\text{-}6}] /(BW_c \times AT)$
				$ED_{r,c\,0\text{-}2}$	Exposure Duration $_{0\text{-}2}$	2	years	EPA 2005	
				$ED_{r,c\,2\text{-}6}$	Exposure Duration $_{2\text{-}6}$	4	years	EPA 2005	
				BW_c	Body Weight	15	kg	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	Sum of child ED, EPA 2005	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	

Notes:

[1] Chemical-specific dermal absorption factors for hypothetical future on-site resident shown at the bottom of Attachment F-2d.

Abbreviations:

cm^2 - square centimeters
DTSC - California Department of Toxic Substances Control
EPA - United States Environmental Protection Agency
kg/mg - kilogram per milligram
mg/kg - milligram per kilogram
UCD - University of California, Davis

References:

DTSC 2019a, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA 2005, *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*
EPA 2014, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Parameter Values*
UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment F-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

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equations
Ingestion	Hypothetical Future On-Site Resident	Age-Adjusted Adult	DSS 4	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	cancer ADD/LADD (mg/kg-day) = $CS \times TC_{s\text{-}p} \times CPF$ $\times \{[(CR_{ag,c} + CR_{bg,c}) \times ED_{r,c\ 0\text{-}2} / BW_c] \times 10$ $+ [(CR_{ag,c} + CR_{bg,c}) \times ED_{r,c\ 2\text{-}6} / BW_c] \times 3$ $+ [(CR_{ag,a} + CR_{bg,a}) \times ED_{r,a\ 6\text{-}16} / BW_a] \times 3$ $+ [(CR_{ag,a} + CR_{bg,a}) \times ED_{r,a\ 16\text{-}26} / BW_a]\} \times EF_r / AT$
				$CR_{ag,a}$	Fruit/Vegetable Ingestion Rate, above ground	0.0103	kg DW/day	Calculated, EPA 2011 and EPA 2018	
				$CR_{bg,a}$	Fruit/Vegetable Ingestion Rate, below ground	0.028	kg DW/day	Calculated, EPA 2011 and EPA 2018	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a\ 6\text{-}16}$	Exposure Duration $_{6\text{-}16}$	10	years	EPA 2005	
				$ED_{r,a\ 16\text{-}26}$	Exposure Duration $_{16\text{-}26}$	10	years	EPA 2005	
				BW_a	Body Weight	80	kg	DTSC 2019a and EPA 2014	non-cancer ADD/LADD (mg/kg-day) = $CS \times TC_{s\text{-}p} \times CPF$ $\times \{[(CR_{ag,c} + CR_{bg,c}) \times (ED_{r,c\ 0\text{-}2} + ED_{r,c\ 2\text{-}6}) / BW_c]$ $+ [(CR_{ag,a} + CR_{bg,a}) \times (ED_{r,a\ 6\text{-}16} + ED_{r,a\ 16\text{-}26}) / BW_a]\}$ $\times EFr / AT$
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Sum of child and adult ED, EPA 2005	
				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 F-12	mg/kg	UCD 2004	cancer ADD/LADD (mg/kg-day) = $CS \times TC_{s\text{-}p} \times CPF \times (CR_{ag,c} + CR_{bg,c}) \times EF_r$ $\times [ED_{r,c\ 0\text{-}2} \times 10 + ED_{r,c\ 2\text{-}6} \times 3] / (BW_c \times AT)$
				$CR_{ag,c}$	Fruit/Vegetable Ingestion Rate, above ground	0.0086	kg DW/day	Calculated, EPA 2011 and EPA 2018	
				$CR_{bg,c}$	Fruit/Vegetable Ingestion Rate, below ground	0.0108	kg DW/day	Calculated, EPA 2011 and EPA 2018	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,c\ 0\text{-}2}$	Exposure Duration $_{0\text{-}2}$	2	years	EPA 2005	non-cancer ADD/LADD (mg/kg-day) = $CS \times TC_{s\text{-}p} \times CPF \times (CR_{ag,c} + CR_{bg,c}) \times EF_r$ $\times [ED_{r,c\ 0\text{-}2} + ED_{r,c\ 2\text{-}6}] / (BW_c \times AT)$
				$ED_{r,c\ 2\text{-}6}$	Exposure Duration $_{2\text{-}6}$	4	years	EPA 2005	
				BW_c	Body Weight	15	kg	UCD 2004	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	Sum of child ED, EPA 2005	
				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 soil-to-plant transfer coefficients shown at the bottom of Attachment F-2d.

References:

DTSC 2019a, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA 2005, *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*
EPA, 2011, *Exposure Factors Handbook,* Chapter 13
EPA, 2014, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Parameter Values*
EPA, 2018, Exposure Factors Handbook, Chapter 9
UCD 2004, Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California

Abbreviations:

DSS - Domestic 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
mg/kg - milligrams per kilogram
UCD - University of California, Davis

Attachment F-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 and Volatile Chemicals

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equations
Inhalation	Hypothetical Future On-Site Resident	Age-Adjusted Adult	DSS 4	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	cancer EC (ug/m^3) = CS × (1/PEF + 1/VF) × CF × ET_r × EF_r × (10 × $ED_{r,c\ 0-2}$ + 3 × $ED_{r,c\ 2-6}$ + 3 × $ED_{r,a\ 6-16}$ + $ED_{r,a\ 16-26}$) / AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	DTSC 2019a	
				VF	Volatilization Factor	Note[1]	m^3/kg	-	
				CF	Conversion Factor	42	(µg/mg)(day/hours)	-	
				ET_r	Exposure Time	24	hours/day	EPA 2014	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	non-cancer EC (ug/m^3) = CS × (1/PEF + 1/VF) × CF × ET_r × EF_r × ($ED_{r,c\ 0-2}$ + $ED_{r,c\ 2-6}$ + $ED_{r,a\ 6-16}$ + $ED_{r,a\ 16-26}$) / AT
				$ED_{r,a\ 6-16}$	Exposure Duration $_{6-16}$	10	years	EPA 2005	
				$ED_{r,a\ 16-26}$	Exposure Duration $_{16-26}$	10	years	EPA 2005	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Sum of child and adult ED, EPA 2005	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
		Child	DSS 4	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	cancer EC (ug/m^3) = CS × (1/PEF + 1/VF) × CF × ET_r × EF_r × (10 × $ED_{r,c\ 0-2}$ + 3 × $ED_{r,c\ 2-6}$) / AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	DTSC 2019a	
				VF	Volatilization Factor	Note[1]	m^3/kg	-	
				CF	Conversion Factor	41.7	(µg/mg)(day/hours)	-	
				ET_r	Exposure Time	24	hours/day	EPA 2014	non-cancer EC (ug/m^3) = CS × (1/PEF + 1/VF) × CF × ET_r × EF_r × ($ED_{r,c\ 0-2}$ + $ED_{r,c\ 2-6}$) / AT
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,c\ 0-2}$	Exposure Duration $_{0-2}$	2	years	EPA 2005	
				$ED_{r,c\ 2-6}$	Exposure Duration $_{2-6}$	4	years	EPA 2005	
				AT_{nc}	Averaging Time (non-cancer)	2,190	days	Sum of child ED, EPA 2005	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	

Notes:

[1] Chemical-specific volatilization factor.

Abbreviations:
DTSC - California Department of Toxic Substances Control
EPA - United States 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 2019a, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA 2005, *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*
EPA 2014, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Parameter Values*
UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment F-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

					EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
				Chemical of Potential Concern	Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfDo/RfCi		Hazard Quotient
Medium	Exposure Medium	Exposure Point	Exposure Route				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]anthracene	3.80E+00	mg/kg	2.5E-05	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	3.0E-05	1.5E-05	mg/kg-day	NA	mg/kg-day	NA
				Benzo[a]pyrene	2.40E+00	mg/kg	1.6E-05	mg/kg-day	2.9E+00	(mg/kg-day)$^{-1}$	4.5E-05	9.3E-06	mg/kg-day	3.0E-04	mg/kg-day	3.1E-02
				Benzo[b]fluoranthene	2.70E+00	mg/kg	1.8E-05	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	2.1E-05	1.0E-05	mg/kg-day	NA	mg/kg-day	NA
				Benzo[k]fluoranthene	1.50E+00	mg/kg	9.8E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	1.2E-05	5.8E-06	mg/kg-day	NA	mg/kg-day	NA
				Dibenzo[a,h]anthracene	1.10E+00	mg/kg	7.2E-06	mg/kg-day	4.1E+00	(mg/kg-day)$^{-1}$	2.9E-05	4.3E-06	mg/kg-day	NA	mg/kg-day	NA
				Indeno[1,2,3-cd]pyrene	8.60E-01	mg/kg	5.6E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	6.74E-06	3.3E-06	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								1.4E-04					3.1E-02
			Dermal	Benzo[a]anthracene	3.80E+00	mg/kg	8.3E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	9.9E-06	5.4E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo[a]pyrene	2.40E+00	mg/kg	5.2E-06	mg/kg-day	2.9E+00	(mg/kg-day)$^{-1}$	1.5E-05	3.4E-06	mg/kg-day	3.0E-04	mg/kg-day	1.1E-02
				Benzo[b]fluoranthene	2.70E+00	mg/kg	5.9E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	7.1E-06	3.8E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo[k]fluoranthene	1.50E+00	mg/kg	3.3E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	3.9E-06	NA	mg/kg-day	NA	mg/kg-day	NA
				Dibenzo[a,h]anthracene	1.10E+00	mg/kg	2.4E-06	mg/kg-day	4.1E+00	(mg/kg-day)$^{-1}$	9.8E-06	NA	mg/kg-day	NA	mg/kg-day	NA
				Indeno[1,2,3-cd]pyrene	8.60E-01	mg/kg	1.9E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	2.2E-06	NA	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								4.8E-05					1.1E-02
	Plants		Above Ground Plant Ingestion	Benzo[a]anthracene	3.80E+00	mg/kg	9.8E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	1.2E-05	6.7E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo[a]pyrene	2.40E+00	mg/kg	3.4E-06	mg/kg-day	2.9E+00	(mg/kg-day)$^{-1}$	9.9E-06	2.3E-06	mg/kg-day	3.0E-04	mg/kg-day	7.8E-03
				Benzo[b]fluoranthene	2.70E+00	mg/kg	6.3E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	7.5E-06	4.3E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo[k]fluoranthene	1.50E+00	mg/kg	2.1E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	2.5E-06	1.5E-06	mg/kg-day	NA	mg/kg-day	NA
				Dibenzo[a,h]anthracene	1.10E+00	mg/kg	7.5E-07	mg/kg-day	4.1E+00	(mg/kg-day)$^{-1}$	3.1E-06	5.2E-07	mg/kg-day	NA	mg/kg-day	NA
				Indeno[1,2,3-cd]pyrene	8.60E-01	mg/kg	6.2E-07	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	7.4E-07	4.3E-07	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								3.5E-05					7.8E-03
			Below Ground Plant Ingestion	Benzo[a]anthracene	3.80E+00	mg/kg	1.5E-05	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	1.9E-05	1.3E-05	mg/kg-day	NA	mg/kg-day	NA
				Benzo[a]pyrene	2.40E+00	mg/kg	5.4E-06	mg/kg-day	2.9E+00	(mg/kg-day)$^{-1}$	1.6E-05	4.4E-06	mg/kg-day	3.0E-04	mg/kg-day	1.5E-02
				Benzo[b]fluoranthene	2.70E+00	mg/kg	9.9E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	1.2E-05	8.1E-06	mg/kg-day	NA	mg/kg-day	NA
				Benzo[k]fluoranthene	1.50E+00	mg/kg	3.3E-06	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	4.0E-06	2.8E-06	mg/kg-day	NA	mg/kg-day	NA
				Dibenzo[a,h]anthracene	1.10E+00	mg/kg	1.2E-06	mg/kg-day	4.1E+00	(mg/kg-day)$^{-1}$	4.9E-06	9.7E-07	mg/kg-day	NA	mg/kg-day	NA
				Indeno[1,2,3-cd]pyrene	8.60E-01	mg/kg	9.8E-07	mg/kg-day	1.2E+00	(mg/kg-day)$^{-1}$	1.2E-06	8.0E-07	mg/kg-day	NA	mg/kg-day	NA
			Exp. Route Total								5.6E-05					1.5E-02

Attachment F-2d Continued. 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

				Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfDo/RfCi		Hazard Quotient
Medium	Exposure Medium	Exposure Point	Exposure Route				Value	Units	Value	Units		Value	Units	Value	Units	
Surface and Subsurface Soil (0-10 feet)	Fugitive Dust and Volatile Chemicals	DSS 4	Inhalation	Benzo[a]anthracene	3.80E+00	mg/kg	8.5E-04	$\mu g/m^3$	1.1E-04	$(\mu g/m^3)^{-1}$	9.4E-08	8.3E-04	ug/m^3	NA	$\mu g/m^3$	NA
				Benzo[a]pyrene	2.40E+00	mg/kg	1.7E-06	$\mu g/m^3$	1.1E-03	$(\mu g/m^3)^{-1}$	1.9E-09	1.7E-06	ug/m^3	2.0E-03	$\mu g/m^3$	8.5E-04
				Benzo[b]fluoranthene	2.70E+00	mg/kg	2.0E-06	$\mu g/m^3$	1.1E-04	$(\mu g/m^3)^{-1}$	2.2E-10	1.9E-06	ug/m^3	NA	$\mu g/m^3$	NA
				Benzo[k]fluoranthene	1.50E+00	mg/kg	1.1E-06	$\mu g/m^3$	1.1E-04	$(\mu g/m^3)^{-1}$	1.2E-10	1.1E-06	ug/m^3	NA	$\mu g/m^3$	NA
				Dibenzo[a,h]anthracene	1.10E+00	mg/kg	8.0E-07	$\mu g/m^3$	1.2E-03	$(\mu g/m^3)^{-1}$	9.57E-10	7.8E-07	ug/m^3	NA	$\mu g/m^3$	NA
				Indeno[1,2,3-cd]pyrene	8.60E-01	mg/kg	6.2E-07	$\mu g/m^3$	1.1E-04	$(\mu g/m^3)^{-1}$	6.86E-11	6.1E-07	ug/m^3	NA	$\mu g/m^3$	NA
			Exp. Route Total								9.7E-08					8.5E-04
		Exposure Point List 1 Total									2.84E-04					6.6E-02

	Dermal Absorption Factor			Plant Transfer Factors		
				Above Ground	Below Ground	
	Cancer	Noncancer	References	plant/soil	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
RfDo - reference dose, oral
RfCi - reference concentration, inhalation
$\mu g/m^3$ - micrograms per cubic meter

References:

LBNL 2007, *Plant Uptake of Organic Pollutants from Soil: A Critical Review of Bioconcentration Estimates Based on Models and Experiments*

University of California, Davis, 2004, *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment*

Attachment F-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
Ingestion	On-Site Construction Worker	Adult	DSS 4	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) = $CS \times CF \times IR_{s,cw} \times EF_{s,cw} \times ED_{cw}$ $/(BW_a \times AT)$
				CF	Conversion Factor	0.000001	kg/mg	-	
				$IR_{s,cw}$	Ingestion Rate	330	mg soil/day	UCD 2004	
				$EF_{s,cw}$	Exposure Frequency	250	days/year	UCD 2004	
				ED_{cw}	Exposure Duration	1	years	UCD 2004	
				BW_a	Body Weight	80	kg	DTSC 2019a 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 F-12	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) = $CS \times CF \times SA_{s,cw} \times AF_{s,cw} \times ABS$ $\times EF_{s,cw} \times ED_{cw} /(BW_a \times AT)$
				CF	Conversion Factor	1.00E-06	(kg/mg)	-	
				$SA_{s,cw}$	Skin Surface Area	6,032	cm^2	DTSC 2019a	
				$AF_{s,cw}$	Soil Adherence Factor	0.8	mg/cm^2-event	DTSC 2019a	
				ABS	Dermal Absorption Factor	Note[1]	unitless	-	
				$EF_{s,cw}$	Exposure Frequency	250	days/year	UCD 2004	
				ED_{cw}	Exposure Duration	1	years	UCD 2004	
				BW_a	Body Weight	80	kg	DTSC 2019a 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 F-2g.

Abbreviations:

cm^2 – square centimeters
DTSC - California Department of Toxic Substances Control
EPA - United States Environmental Protection Agency
kg – kilogram
kg/mg - kilogram per milligram
mg/kg - milligram per kilogram
UCD - University of California, Davis

References:

DTSC 2019a, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA 2014, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Parameter Values*
UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment F-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 and Volatile Chemicals

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Inhalation	On-Site Construction Worker	Adult	DSS 4	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	EC ($\mu g/m^3$) $=CS \times (1/PEF + 1/VF) \times CF \times ET_{cw} \times EF_{s,cw} \times ED_{cw} / AT$
				PEF	Particulate Emission Factor	1.0E+06	m^3/kg	DTSC 2019a	
				VF	Volatilization Factor	Note[1]	m^3/kg	-	
				CF	Conversion Factor	41.7	(μg/mg)(day/hours)	-	
				ET_{cw}	Exposure Time	8	hours/day	EPA 2019a	
				$EF_{s,cw}$	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	

Notes:

[1] Only COC (benzo[a]pyrene) not volatile. No volatilization factor (EPA 2019c).

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 2019a, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA 2019a, *Regional Screening Levels (RSLs) - User's Guide, November 2019*
EPA 2019c, *Regional Screening Levels (RSLs) - Calculator: November 2019*
UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment F-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

					EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfDo/RfCi		Hazard Quotient
Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	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	2.9E+00	(mg/kg-day)$^{-1}$	2.8E-07	6.8E-06	mg/kg-day	3.0E-04	mg/kg-day	2.3E-02
			Exp. Route Total								2.8E-07					2.3E-02
			Dermal	Benzo[a]pyrene	2.40E+00	mg/kg	1.84E-07	mg/kg-day	2.9E+00	(mg/kg-day)$^{-1}$	5.3E-07	1.3E-05	mg/kg-day	3.0E-04	mg/kg-day	4.3E-02
			Exp. Route Total								5.3E-07					4.3E-02
	Fugitive Dust		Dust Inhalation	Benzo[a]pyrene	2.40E+00	mg/kg	7.83E-06	µg/m^3	1.1E-03	(µg/m^3)$^{-1}$	8.6E-09	5.5E-04	µg/m^3	2.0E-03	µg/m^3	2.7E-01
			Exp. Route Total								8.6E-09					2.7E-01
		Exposure Point List 1 Total									8.2E-07					3.4E-01

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
RfDo - reference dose, oral
RfCi - reference concentration, inhalation
μ/m^3 - micrograms per cubic meter

Attachment F-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

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Ingestion	Hypothetical Future On-Site Resident	Age-Adjusted Adult	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) = $CS \times CF \times [(IR_{s,a} \times ED_{r,a} / BW_a) + (IR_{s,c} \times ED_{r,c} / BW_c)] \times EF_r / AT$
				CF	Conversion Factor	0.000001	kg/mg	-	
				$IR_{s,a}$	Ingestion Rate	100	mg soil/day	UCD 2004	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a}$	Exposure Duration	20	years	DTSC 2019a and EPA 2014	
				BW_a	Body Weight	80	kg	DTSC 2019a and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Sum of child and adult ED, DTSC 2019a and EPA 2014	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
		Child	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) = $CS \times CF \times IR_{s,c} \times EF_r \times ED_{r,c} /(BW_c \times AT)$
				CF	Conversion Factor	0.000001	kg/mg	-	
				$IR_{s,c}$	Ingestion Rate	200	mg soil/day	UCD 2004	
				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 F-2h Continued. 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

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Dermal	Hypothetical Future On-Site Resident	Age-Adjusted Adult	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) = $CS \times CF \times ABS$ $\times [(SA_a \times AF_a \times ED_{r,a} / BW_a)$ $.+ (SA_c \times AF_c \times ED_{r,c} / BW_c)]$ $\times EF_r / AT$
				CF	Conversion Factor	0.000001	kg/mg	-	
				SA_a	Skin Surface Area	6,032	cm^2	DTSC 2019a and EPA 2014	
				AF_a	Soil Adherence Factor	0.07	mg/cm^2-event	UCD 2004	
				ABS	Dermal Absorption Factor	0.1	unitless	dieldrin ABS, UCD 2004	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a}$	Exposure Duration	20	years	DTSC 2019a and EPA 2014	
				BW_a	Body Weight	80	kg	DTSC 2019a and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Sum of child and adult ED, DTSC 2019a and EPA 2014	
				AT_c	Averaging Time (cancer)	25,500	days	UCD 2004	
		Child	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) = $CS \times CF \times SA_c \times AF_c \times ABS$ $\times EF_r \times ED_{r,c}/(BW_c \times AT)$
				CF	Conversion Factor	0.000001	kg/mg	-	
				SA_c	Skin Surface Area	2,373	cm^2	DTSC 2019a and EPA 2014	
				AF_c	Soil Adherence Factor	0.2	mg/cm^2-event	UCD 2004	
				ABS	Dermal Absorption Factor	0.1	unitless	dieldrin ABS, UCD 2004	
				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	

Abbreviations:

cm^2 - square centimeters	kg/mg - kilogram per milligram
DTSC - California Department of Toxic Substances Control	mg/kg - milligram per kilogram
EPA - United States Environmental Protection Agency	UCD - University of California, Davis

References:

DTSC 2019a, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*

EPA 2014, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Parameter Values*

UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment F-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

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Ingestion	Hypothetical Future On-Site Resident	Age-Adjusted Adult	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) = $CS \times CPF \times \{[ED_{r,a} / BW_a \times (TC_{s\text{-}p} \times CR_{ag,a} + TC_{s\text{-}p} \times CR_{bg,a})] + [ED_{r,c} / BW_c \times (TC_{sp} \times CR_{ag,c} + TC_{s\text{-}p} \times CR_{bg,c})]\} \times EF_r / AT$
				$CR_{ag,a}$	Fruit/Vegetable Ingestion Rate, above ground	0.0103	kg DW/day	Calculated, EPA 2011 and EPA 2018	
				$CR_{bg,a}$	Fruit/Vegetable Ingestion Rate, below ground	0.028	kg DW/day	Calculated, EPA 2011 and EPA 2018	
				EF_r	Exposure Frequency	350	days/year	UCD 2004	
				$ED_{r,a}$	Exposure Duration	20	years	DTSC 2019a and EPA 2014	
				BW_a	Body Weight	80	kg	DTSC 2019a and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Sum of child and adult ED, DTSC 2019a and EPA 2014	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
				$TC_{s\text{-}p}$	Transfer Coefficient (soil-to-plant)	0.03	unitless	dieldrin $TC_{s\text{-}p}$, UCD 2004	
				CPF	Contaminated Plant Fraction	0.40	unitless	UCD 2004	
		Child	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	ADD/LADD (mg/kg-day) = $[(CS \times TC_{s\text{-}p} \times CPF \times CR_{ag,c}) + (CS \times TC_{s\text{-}p} \times CPF \times CR_{bg,c})] \times EF_r \times ED_{r,c} / (BW_c \times AT)$
				$CR_{ag,c}$	Fruit/Vegetable Ingestion Rate, above ground	0.0086	kg DW/day	Calculated, EPA 2011 and EPA 2018	
				$CR_{bg,c}$	Fruit/Vegetable Ingestion Rate, below ground	0.0108	kg DW/day	Calculated, EPA 2011 and EPA 2018	
				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	
				$TC_{s\text{-}p}$	Transfer Coefficient (soil-to-plant)	0.03	unitless	dieldrin $TC_{s\text{-}p}$, UCD 2004	
				CPF	Contaminated Plant Fraction	0.40	unitless	UCD 2004	

Abbreviations:
DSS - Domestic 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
mg/kg - milligrams per kilogram
UCD - University of California, Davis

References:
DTSC 2019a, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA, 2011, *Exposure Factors Handbook,* Chapter 13
EPA, 2014, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Parameter Values*
EPA, 2018, Exposure Factors Handbook, Chapter 9
UCD 2004, Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California

Attachment F-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 and Volatile Chemicals

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation
Inhalation	Hypothetical Future On-Site Resident	Age-Adjusted Adult	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	EC (ug/m^3) = CS × (1/PEF + 1/VF) × CF × ET_r × EF_r × ($ED_{r,a}$ + $ED_{r,c}$) / AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	DTSC 2019a	
				VF	Volatilization Factor	Note[1]	m^3/kg	-	
				CF	Conversion Factor	41.7	(µg/mg)(day/hours)	-	
				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 2019a and EPA 2014	
				AT_{nc}	Averaging Time (non-cancer)	9,490	days	Sum of child and adult ED, DTSC 2019a and EPA 2014	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	
		Child	Eastern Dog Pens	CS	Chemical Concentration in Soil	See Table F-12	mg/kg	UCD 2004	EC (ug/m^3) = CS × (1/PEF + 1/VF) × CF × ET_r × EF_r × $ED_{r,c}$ / AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	DTSC 2019a	
				VF	Volatilization Factor	Note[1]	m^3/kg	-	
				CF	Conversion Factor	41.7	(µg/mg)(day/hours)	-	
				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)	2,190	days	Based on $ED_{r,c}$, UCD 2004	
				AT_c	Averaging Time (cancer)	25,550	days	UCD 2004	

Notes:

[1] Volatilization factor is not applicable to this calculation. The only constituent of concern involved in this calculation (dieldrin) does not meet current volatilization criteria (EPA 2019a).

Abbreviations:

DTSC - California Department of Toxic Substances Control
EPA - United States 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 2019a, *Human Health Risk Assessment Note 1, Recommended DTSC Default Exposure Factors*
EPA 2014, *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Parameter Values*
UCD 2004, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment, LEHR/SCDS Environmental Restoration, Davis, California*

Attachment F-2k. 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		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfDo/RfCi		Hazard Quotient
							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	7.70E-09	mg/kg-day	1.6E+01	(mg/kg-day)$^{-1}$	1.2E-07	2.1E-08	mg/kg-day	5.0E-05	mg/kg-day	4.1E-04
			Exp. Route Total								1.2E-07					4.1E-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	9.8E-04
			Exp. Route Total								2.9E-07					9.8E-04
			Below Ground Plant Ingestion	Dieldrin	1.90E-02	mg/kg	3.5E-08	mg/kg-day	1.6E+01	(mg/kg-day)$^{-1}$	5.54E-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		Inhalation	Dieldrin	1.90E-02	mg/kg	4.98E-09	µg/m^3	4.6E-03	(µg/m^3)$^{-1}$	2.3E-11	1.3E-08	µg/m^3	2.0E-01	µg/m^3	6.7E-08
			Exp. Route Total								2.3E-11					6.7E-08
		Exposure Point List 1 Total									1.4E-06					4.7E-03

	Dermal Absorption Factor			Plant Transfer Factors		
				Above Ground	Below Ground	
	Cancer	Noncancer	References	plant/soil	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

RfDo - reference dose, oral
RfCi - reference concentration, inhalation
µ/m^3 - micrograms per cubic meter

Attachment F-3

RESRAD-ONSITE Input Parameters, Resident Adult

RESRAD-ONSITE 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	

RESRAD-ONSITE 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-ONSITE 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 F-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

Attachment F-4 Continued. Fruit and Vegetable ingestion Rate Calculations, Radiation Exposure

Notes:

[1] Moisture content values from Table 9-53 of EFH, Chapter 9 (US EPA 2018). Table provides values for raw and cooked. Most likely consumed state of garden item selected.

[2] Values from Table 13-1 of EFH, Chapter 13 (US 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 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:

EFH - Exposure Factors Handbook
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 7.2 (ANL 2016)

Appendix G

Non-COC Exposure and Toxicity Evaluation

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G1.0 Introduction

To review the protectiveness of the assumptions made during the Site-Wide Risk Assessment (UC Davis 2004) (SWRA), and consistent with U.S. Environmental Protection Agency (EPA) guidance (EPA 2009), up-to-date toxicity information developed by EPA and the California Department of Toxic Substances Control (DTSC) for chemicals and radionuclides detected in soil at the U.S. Department of Energy (DOE) Areas, but not identified as chemical constituents of concern (COCs) in the Record of Decision (DOE 2009) (ROD), was reviewed to determine if any of these constituents could pose a risk to human health. Chemical constituents and radionuclides were evaluated separately, as described below.

G1.1 Chemical Constituent Evaluation

The following steps were followed to evaluate whether chemical 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. The Integrated Risk Information System (IRIS) Assessments List (EPA 2020a) was used to identify constituents with toxicity updates released since the risk characterization element of the SWRA was conducted in 2005 (DOE 2005).
2. Chemicals detected in DOE Area soil samples (SWRA; Tables 2.1 through 2.9, 2.20, 2.22, and 2.24 [UC Davis 2004]) having toxicity updates released in IRIS since 2005 were then identified.
3. For constituents identified in Step 2, the 2002 residential soil preliminary remediation goals (PRGs) used in the screening stage of the SWRA (UC Davis 2004) were compared to November 2020 residential soil regional screening levels (EPA 2020b) (RSLs) to assess which constituents have a 2020 RSL lower than the 2002 PRG and, therefore, warranted further evaluation.

As shown in Table G-1, the toxicity updates resulted in a lower or new RSL for three constituents detected in DOE Areas soil samples: 2-methylnaphthalene, pentachlorophenol, and phenol. However, detections for each of these constituents in all DOE Areas were well below these RSLs.

In addition, the 2002 PRGs were also compared with the 2020 DTSC-modified Screening Levels (DTSC-SLs) in DTSC Human Health Risk Assessment (HHRA) Note 3 (DTSC 2020). The DTSC-SLs incorporate Human Health Risk Assessment Note 10 toxicity criteria (DTSC 2019). All constituents with DTSC-SLs lower than the 2002 PRGs, or not included in the 2002 PRGs, were carried forward and compared with the DOE Areas soil sample data. For these constituents, only arsenic and hexavalent chromium were detected above the DTSC-SLs in the DOE Areas soil samples. Although soil arsenic concentrations exceed the 0.11 milligram per kilogram (mg/kg) screening level, they are well within natural background concentrations for the site, as discussed in detail in the SWRA risk characterization report (DOE 2005). Hexavalent chromium concentrations in DOE Areas soil samples were also determined to be below background (DOE 2005).

Based on this risk screening, toxicity updates, as expressed in the 2020 RSLs and DTSC-SLs, did not result in the identification of additional chemical COCs in the DOE Areas.

Table G-1. Risk Screening of Detected Chemicals Not Previously Identified as Constituents of Concern

Substance Name	2002 PRG[b]	2020 RSL[c]	Maximum Site Concentrations[a] milligrams per kilogram (mg/kg)											
			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	0.0.69 J	0.0567 J	ND	ND	ND	NA	NA	0.0263 J	ND	ND
Pentachlorophenol	3.0	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 Site-Wide Risk Assessment (UC Davis 2004); maximum concentration detected in the area.
[b] EPA Region 9 residential soil PRG used in the Site-Wide Risk Assessment (UC Davis 2004).
[c] EPA 2020 residential soil RSL (EPA 2020b).

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

G1.2 Radionuclide Evaluation

A tiered risk assessment process consistent with the First Five-Year Review was followed to determine if any radionuclide constituents detected in one or more DOE Areas but not previously identified as COCs present a human health risk based on the latest available toxicity information. As discussed below, since the screening evaluation conducted in the Tier 1 assessment suggested that risks associated with some radionuclides not previously identified as COCs may exceed 1×10^{-6} based on newer toxicity values, a Tier 2 assessment and risk characterization were performed to confirm the screening results.

G1.2.1 Tier 1 Screening

EPA's calculator for Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites (EPA 2019a) was used to establish screening levels for the site using current cancer slope factors for radionuclides. Because of the large number of isotopes that have been analyzed for in the DOE Areas, the PRGs were only calculated for radionuclides potentially exceeding background based on a background comparison performed in 2004, as discussed in Section 6.7 of the SWRA and documented in Appendix B of the SWRA (UC Davis 2004). This background comparison should be considered a screening level evaluation as it does not consider known depth stratification of certain radionuclides and the data have not been fully evaluated for outliers. However, it provides a reasonable statically based evaluation which is acceptable for Tier 1 screening. The SWRA Appendix B background evaluation results are included in Attachment G-1.

EPA's PRG calculator was revised in 2016 and 2017 to include several PRG output options based on source term and progeny equilibrium assumptions and now assigns a highly conservative default assumption that there is no decay of the selected parent isotope and that all of the progeny remain in secular equilibrium with the parent (i.e., the concentration of the parent and progeny are equal to each other) for the duration of the 26-year exposure period. This contrasts significantly with the former "isotope +D" approach used by EPA's model that included decay of the parent and progeny over time while maintaining secular equilibrium within the decay chain. EPA's new default approach has the effect of dramatically lowering the PRGs in cases where the parent isotope has a half-life of less than the exposure duration. While this approach is generally not applicable to releases at LEHR, it errors on the side of remedy protection and the conceptual disconnects can be corrected in the Tier 2 assessment. Therefore, DOE has opted to retain the default output option provided in the model for use in Tier 1 screening.

Table G-2 shows the comparison between the 2002 and 2019 PRGs and those radionuclides for each DOE Area that were detected above the 2019 PRG and also identified as above background in Appendix B of the SWRA (UC Davis 2004). About 50% of the values identified as exceeding the 2019 PRGs also exceeded the 2002 PRG (shown in boldface italics in Table G-2), which means these radionuclides were previously evaluated for the same areas in the SWRA and the source of toxicity values has changed. In most cases, however, risk characterization information developed by DOE in 2005 (DOE 2005) still applies. The values shown highlighted in yellow in Table G-2 are new potential COCs that have not previously been evaluated.

As shown in Table G-2, radionuclides that potentially exceed the 2019 PRGs include americium-241, bismuth-212, bismuth-214, carbon-14, cesium-137, cobalt-60, lead-210, lead-214, plutonium-241, radium-226, strontium-90, thallium-208, thorium-228, thorium-232, thorium-234, tritium, uranium-233/234, uranium-235, and uranium-238.

G1.2.2 Tier 2 Risk Evaluation

Because the Tier 1 screening evaluation indicated that risks associated with some radionuclides not previously identified as COCs may exceed 1×10^{-6} based on newer toxicity values, a Tier 2 risk evaluation was conducted using Argonne National Laboratory's (ANL) Residual Radiation computer program RESRAD Onsite. The RESRAD risk evaluation was only conducted when a radionuclide was potentially above background and the 2019 PRG.

Radiological risks were calculated in the SWRA using RESRAD version 6.21 developed by Argonne National Laboratory (ANL 2002). Risk coefficients for total cancer morbidity (i.e., cancer slope factors) selected in RESRAD version 6.21 for the SWRA were referenced to the 2001 version of the Health Effects Assessment Summary Tables (EPA 2001) (HEAST 2001). Most values in HEAST 2001 were taken from Federal Guidance Report No. 13 (EPA 1999). RESRAD-ONSITE version 7.2 is the most recent update of ANL's RESRAD computer program (ANL 2016). RESRAD-ONSITE version 7.2 includes the ICRP60-based risk coefficients from DCFPAK 3.02 (EPA 2019b), which were used in this evaluation.

The two most conservative exposure scenarios in the SWRA, the hypothetical resident and onsite outdoor researcher, were selected for evaluation. If a constituent were to be identified as a potential COC for residential or onsite researcher receptors, risks would also be evaluated for the indoor researcher, construction worker, and trespasser exposure scenarios established in the SWRA. The exposure pathways used in this evaluation for the hypothetical resident and onsite outdoor researcher are identical to those established in the SWRA.

Parameter values used in RESRAD for the SWRA (UC Davis 2004) were reviewed; a copy is included in Attachment G-2. The defined "area of contaminated zone" used in the SWRA RESRAD calculations for Domestic Septic System (DSS 3), DSS 4, the Radium/Strontium (Ra/Sr) Treatment Systems, and Southwest Trenches (SWT) areas was found inaccurate when compared to the areas determined in 2014 by land surveys conducted for recording the land use covenant (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 G-3. The updated lengths and areas were used in the RESRAD ONSITE calculations performed in 2020.

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Table G-2. Radionuclides Identified as Potentially Above Background[a] and Lowest Preliminary Remediation Goal Not Previously Identified as Constituents of Concern

				DSS 1	DSS 3	DSS 4	DSS 5	DSS 6	DSS 7	DOE Disposal Box	Dry Wells A–E	EDP	Ra/Sr Treatment System	SWT	WDP
	2002 PRG	**Half-Life**	**2019 PRG**	**Maximum Site Radionuclide Concentration[b] (pCi/g)**											
Americium-241	1.87E+00	432 years	1.04E-02							**3.30E-02**			**8.47E-02**	***3.22E+00***	
Bismuth-212+D	2.26E+04	60.6 minutes	1.67E-02					**4.50E-01**							
Bismuth-214+D	8.19E+03	19.9 minutes	2.53E-03					**6.10E-01**							
Carbon-14	4.56E-01	5730 years	4.12E-01	***2.10E+00***									***2.38E+00***	***5.84E+00***	***1.13E+01***
Cesium-137+D	5.97E-02	30.2 years	3.03E-02		***1.26E-01***									***1.18E+00***	***1.15E-01***
Cobalt-60	3.61E-02	5.27 years	8.06E-03						**9.00E-03**	**1.10E-02**	**1.10E-02**	**1.50E-02**		**1.00E-02**	**2.8E-02**
Lead-210	1.50E-01	22.3 years	3.01E-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***
Lead-214	4.63E+04	26.8 minutes	2.47E-03					**7.5E-01**							
Plutonium-241	4.06E+02	14 years	1.04E-02							**1.07E+00**			**6.82E-01**	**5.17E-01**	
Radium-226+D	1.24E-02	1600 years	1.82E-03								***6.75E-01***				
Strontium-90+D	2.31E-01	28.8 years	3.61E-03	***4.00E-01***	***5.91E-01***	**8.00E-02**	***1.31E+00***		***2.70E-01***	***2.80E-01***	**1.53E-01**	***8.3E+00*** [c]	***2.18E+00***	***1.57E+01*** [c]	***5.66E+00***
Thallium-208	2.26E+04	3.1 minutes	6.61E-03					**2.42E-01**							
Thorium-228	1.54E-01	1.9 years	7.06E-03							***7.68E-01***	***7.71E-01***		***1.12E+00***	***8.94E-01***	***1.02E+00***
Thorium-232+D	3.10E+00	1.4E+10 years	1.74E-03							**8.20E-01**	**8.76E-01**				
Thorium-234+D	1.33E+03	24.1 days	1.78E-03								**1.05E+00**				
Tritium	2.28E+00	12.3 years	6.12E-02									**1.21E+00**		***5.20E+00***	
Uranium-233/234	3.86E+00	1.6E+05/2.5E+05 years	1.79E-03								**5.70E-01**				
Uranium-235+D	1.95E-01	7.0E+08 years	6.23E-03			**1.60E-01**	**6.31E-02**	**1.60E-01**	**1.00E-01**						***3.17E-01***
Uranium-238+D	7.42E-01	4.5E+09 years	1.76E-03								**5.99E-01**				***1.67E+00***

Notes:

[a] Based on comparative background evaluation results for the 0–10 foot depth interval described in Section 6.7 and provided in Appendix B of the Site-Wide Risk Assessment (UC Davis 2004) and Table 25 of the Former Western Dog Pens Backfill Risk Assessment (DOE 2007).

[b] From the Site-Wide Risk Assessment (UC Davis 2004); maximum concentrations used in Tier 1 screening.

[c] Previously established constituent of concern (DOE 2009). Not applicable to this evaluation.

All values are in picocuries per grams (pCi/g)

Bold indicates concentration above the 2019 PRG

Italics indicates concentration above the 2002 PRG

Highlighted yellow **bold**/no italics indicates that risk assessment/characterization of this radionuclide in the specified area has not been previously performed.

Abbreviations:

+D = plus daughter product
DOE = U.S. Department of Energy
DSS = Domestic Septic System
EDP = Eastern Dog Pens
PRG = Preliminary Remediation Goal
Ra/Sr = Radium/Strontium
SWT = Southwest Trenches
UC Davis = University of California, Davis
WDP = Western Dog Pens

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Table G-3. Comparison of Site-Wide 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	3237	3249	61	61
Ra/Sr Treatment System	688	1399	53	53
Southwest Trenches	2428	1785	55	55

Abbreviations:
NR = not reported
Ra/Sr = Radium/Strontium

The same areas and lengths used in the SWRA for DSS 1, DSS 5, DSS 6, DSS 7, the DOE Disposal Box, and WDPs were used in 2020, since survey data were not available.

Residential receptor plant ingestion rates were established in the SWRA based on consumption of garden produce in supplement to the resident's total produce ingestion. Default plant ingestion rates provided in RESRAD were not used in the SWRA because they are based on subsistence farming in which plants grown in onsite soil are the only source of produce ingested by the receptor. After the SWRA was issued, ingestion rate data for home-produced fruits and vegetables were published in the EPA's Exposure Factors Handbook, Chapter 9 (EPA 2018) and Chapter 13 (EPA 2011), and these data were used to calculate updated plant ingestion rates.

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 F.

The residential receptor 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 6.21 and remains the default in RESRAD Onsite version 7.2. No change to the residential receptor soil ingestion rate was made in this evaluation. The onsite outdoor researcher soil ingestion rate used in the RESRAD calculations for the SWRA was 18.25 grams per year and remains unchanged 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. Other model parameters used in this evaluation were consistent with those used in the SWRA (Attachment G-2).

G1.2.3 Exposure Point Concentrations

The 95% 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. For radionuclides not evaluated in the SWRA and if data were sufficient, 95% UCLs were calculated; otherwise, maximum detected activity concentrations were used. The 95% 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% UCL EPCs determined in the Former WDPs Backfill Risk Assessment (DOE 2007) were used. The 95% UCLs were calculated for thorium-232 in the DOE Disposal Box and Dry Wells A–E areas and thorium-234 in the Dry Wells A–E area and used as EPCs for RESRAD calculations. The EPC inputs for RESRAD are shown in Table G-4 and Table G-5.

Table G-4. Revised Risk Estimate for Hypothetical Onsite Resident for Detected Radionuclides Not Previously Identified as Constituents of Concern

Constituent	EPC (pCi/g)[a]	Basis	Soil Ingestion	Plant Ingestion	External Radiation	Inhalation	Total Cancer Risk[b]
Domestic Septic System 1							
Carbon-14	1.8	95% UCL[c]	8E-13	1E-10	2E-12	1E-11	1E-10
Lead-210	1.6	95% UCL[c]	6E-08	9E-08	4E-08	4E-10	2E-07
Strontium-90	0.36	95% UCL[c]	4E-10	2E-08	4E-08	1E-12	5E-08
Domestic Septic System 3							
Cesium-137	0.015	95% UCL[c]	1E-10	9E-10	3E-07	2E-14	3E-07
Lead-210	0.9	95% UCL[c]	7E-07	1E-06	3E-08	3E-10	2E-06
Strontium-90	0.21	95% UCL[c]	5E-09	2E-07	3E-08	1E-12	3E-07
Domestic Septic System 4							
Lead-210	2.5	95% UCL[c]	1E-06	2E-06	8E-08	8E-10	3E-06
Strontium-90	0.08	max[d]	1E-09	5E-08	1E-08	4E-13	6E-08
Uranium-235/236	0.16	max[d]	3E-09	1E-09	1E-06	6E-11	1E-06
Domestic Septic System 5							
Strontium-90	1.3	max[c]	1E-09	5E-08	1E-07	5E-12	2E-07
Uranium-235	0.0631	max[d]	8E-11	3E-11	3E-07	2E-11	3E-07
Domestic Septic System 6							
Bismuth-212	0.45	max[d]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]
Bismuth-214	0.61	max[d]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]
Lead-214	0.75	max[d]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]
Thallium-208	0.242	max[d]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]
Uranium-235	0.16	max[d]	6E-10	2E-10	9E-07	5E-11	9E-07
Domestic Septic System 7							
Cobalt-60	0.0090	max[d]	2E-12	2E-11	2E-07	3E-15	2E-07
Lead-210	4.1	max[c]	3E-07	5E-07	1E-07	1E-09	1E-06
Strontium-90	0.27	max[c]	7E-10	3E-08	3E-08	1E-12	7E-08
Uranium-235	0.1	max[d]	4E-10	1E-10	5E-07	3E-11	5E-07

Table G-4. Revised Risk Estimate for Hypothetical Onsite Resident for Detected Radionuclides Not Previously Identified as Constituents of Concern (continued)

Constituent	EPC (pCi/g)[a]	Basis	Soil Ingestion	Plant Ingestion	External Radiation	Inhalation	Total Cancer Risk[b]
DOE Disposal Box							
Americium-241	0.033	max[d]	5E-10	8E-11	1E-08	2E-11	1E-08
Cobalt-60	0.011	max[d]	8E-12	9E-11	4E-07	4E-15	4E-07
Lead-210	0.95	95% UCL[c]	3E-07	4E-07	3E-08	3E-10	7E-07
Plutonium-241	1.07	max[d]	5E-10	8E-11	9E-09	2E-11	9E-09
Strontium-90	0.11	95% UCL[c]	9E-10	4E-08	2E-08	5E-13	6E-08
Thorium-228	0.68	95% UCL[c]	3E-09	5E-10	5E-06	1E-10	5E-06
Thorium-232	0.63	95% UCL[f]	2E-07	7E-07	8E-05	2E-09	8E-05
Dry Wells A–E							
Cobalt-60	0.011	max[d]	1E-11	1E-10	4E-07	4E-15	4E-07
Radium-226	0.63	95% UCL[c]	2E-07	6E-07	6E-05	4E-10	6E-05
Strontium-90	0.153	max[d]	2E-09	9E-08	2E-08	7E-13	1E-07
Thorium-228	0.771	max[d]	5E-09	8E-10	6E-06	2E-10	6E-06
Thorium-232	0.76	95% UCL[f]	3E-07	1E-06	1E-04	2E-09	1E-04
Thorium-234	0.845	95% UCL[f]	NA[e]	NA[e]	NA[e]	NA[e]	NA[e]
Uranium-233/234	0.57	max[d]	9E-09	1E-9	7E-07	2E-10	7E-07
Uranium-238	0.599	max[d]	1E-08	5E-09	8E-07	2E-10	8E-07
Eastern Dog Pens							
Cobalt-60	0.015	max[d]	8E-11	1E-09	6E-07	8E-15	6E-07
Lead-210	0.67	95% UCL[c]	2E-06	2E-06	2E-08	3E-10	4E-06
Tritium	1.21	max[d]	3E-11	1E-08	0E+00	0E+00	1E-08
Radium/Strontium Treatment Systems							
Americium-241	0.0847	max[d]	1E-08	2E-09	3E-08	6E-11	4E-08
Carbon-14	0.12	95% UCL[c]	3E-12	3E-09	2E-13	7E-12	3E-09
Plutonium-241	0.682	max[d]	3E-09	4E-10	6E-09	1E-11	9E-09
Strontium-90	0.25	95% UCL[c]	2E-08	8E-07	4E-08	1E-12	8E-07
Thorium-228	0.59	95% UCL[c]	2E-08	4E-09	5E-06	2E-10	5E-06
Southwest Trenches							
Americium-241	0.16	95% UCL[c]	2E-08	3E-09	5E-08	1E-10	8E-08
Carbon-14	0.55	95% UCL[c]	2E-11	1E-08	8E-13	4E-11	1E-08
Cesium-137	0.05	95% UCL[c]	1E-09	9E-09	1E-06	8E-14	1E-06
Cobalt-60	0.010	max[d]	6E-11	7E-10	4E-07	5E-15	4E-07
Lead-210	1.3	95% UCL[c]	3E-06	5E-06	5E-08	5E-10	8E-06
Plutonium-241	0.517	max[d]	2E-09	3E-10	5E-09	1E-11	7E-09
Thorium-228	0.59	95% UCL[c]	2E-08	4E-09	5E-06	2E-10	5E-06
Tritium	0.7	95% UCL[c]	1E-11	7E-09	0E+00	0E+00	7E-09
Western Dog Pens							
Carbon-14	0.58	95% UCL[g]	2E-11	4E-08	8E-13	1E-10	4E-08
Cesium-137	0.024	95% UCL[g]	7E-10	4E-09	6E-07	5E-14	6E-07
Cobalt-60	0.0112	max[h]	6E-11	8E-10	4E-07	7E-15	4E-07

Table G-4. Revised Risk Estimate for Hypothetical Onsite Resident for Detected Radionuclides Not Previously Identified as Constituents of Concern (continued)

Constituent	EPC (pCi/g)[a]	Basis	Soil Ingestion	Plant Ingestion	External Radiation	Inhalation	Total Cancer Risk[b]
Lead-210	1.2	95% UCL[g]	3E-06	4E-06	4E-08	6E-10	7E-06
Strontium-90	0.43	95% UCL[g]	3E-08	1E-06	7E-08	3E-12	1E-06
Thorium-228	0.61	95% UCL[g]	2E-08	4E-09	5E-06	2E-10	5E-06
Uranium-235	0.10	95% UCL[g]	1E-08	4E-09	7E-07	6E-11	7E-07
Uranium-238	0.71	95% UCL[g]	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.
[c] EPC from SWRA Tables 3.1 and 3.2 (UC Davis 2004).
[d] No EPC available in SWRA Table 3.2 and insufficient detected data for 95% UCL calculation; used maximum detected activity from SWRA Tables 2.1, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.20 (UC Davis 2004).
[e] RESRAD risk calculation not available for radionuclides that have a half-life shorter than 180-days.
[f] 95% UCL calculated using Pro UCL Version 5.1 (EPA 2016).
[g] EPC from Former Western Dog Pens Backfill Risk Assessment Table 4 (DOE 2007).
[h] No EPC available in Former Western Dog Pens Backfill Risk Assessment Table 4 and insufficient detected data for 95% UCL calculation; used maximum detected activity from Former Western Dog Pens Backfill Risk Assessment Table 2 (DOE 2007).

All radionuclides are at maximum dose/risk at time = 0 years, except for thorium-232 which peaks at 100 years, plutonium-241 (peaks at 30 years), and uranium-233/234 (peaks at 2700 years).

Abbreviations:
max = maximum concentration
NA = not available
pCi/g = picocuries per gram

Table G-5. Revised Risk Estimate for Onsite Outdoor Researcher for Detected Radionuclides Not Previously Identified as Constituents of Concern

Constituent	Surface/ Subsurface EPC (pCi/g)[a]	Surface/ Subsurface EPC Basis	Surface Soil Ingestion	External Radiation	Surface Soil Inhalation	Total Cancer Risk[b]
Domestic Septic System 1						
Carbon-14	NA / 1.8	NA / 95% UCL[c]	NA	7E-13	NA	7E-13
Lead-210	NA / 1.6	NA / 95% UCL[c]	NA	2E-08	NA	2E-08
Strontium-90	NA / 0.36	NA / 95% UCL[c]	NA	1E-08	NA	1E-08
Domestic Septic System 3						
Cesium-137	NA / 0.015	NA / 95% UCL[c]	NA	1E-07	NA	1E-07
Lead-210	NA / 0.9	NA / 95% UCL[c]	NA	1E-08	NA	1E-08
Strontium-90	NA / 0.21	NA / 95% UCL[c]	NA	1E-08	NA	1E-08
Domestic Septic System 4						
Lead-210	NA / 2.5	NA / 95% UCL[c]	NA	3E-08	NA	3E-08
Strontium-90	NA / 0.08	NA / max[d]	NA	5E-09	NA	5E-09

Table G-5. Revised Risk Estimate for Onsite Outdoor Researcher for Detected Radionuclides Not Previously Identified as Constituents of Concern (continued)

Constituent	Surface/ Subsurface EPC (pCi/g)[a]	Surface/ Subsurface EPC Basis	Surface Soil Ingestion	External Radiation	Surface Soil Inhalation	Total Cancer Risk[b]
Uranium-235	NA / 0.16	NA / max[d]	NA	4E-07	NA	4E-07
Domestic Septic System 5						
Strontium-90	NA / 1.3	NA / max[c]	NA	5E-08	NA	5E-08
Uranium-235	NA / 0.0631	NA / max[d]	NA	1E-07	NA	1E-07
Domestic Septic System 6						
Bismuth-212	NA / 0.45	NA / max[d]	NA	NA[e]	NA	NA[e]
Bismuth-214	NA / 0.61	NA / max[d]	NA	NA[e]	NA	NA[e]
Lead-214	NA / 0.75	NA / max[d]	NA	NA[e]	NA	NA[e]
Thallium-208	NA / 0.242	NA / max[d]	NA	NA[e]	NA	NA[e]
Uranium-235	NA / 0.16	NA / max[d]	NA	3E-07	NA	3E-07
Domestic Septic System 7						
Cobalt-60	NA / 0.0090	NA / max[d]	NA	1E-07	NA	1E-07
Lead-210	NA / 4.1	NA / max[c]	NA	5E-08	NA	5E-08
Strontium-90	NA / 0.27	NA / max[c]	NA	1E-08	NA	1E-08
Uranium-235	NA / 0.1	NA / max[d]	NA	2E-07	NA	2E-07
DOE Disposal Box						
Americium-241	NA / 0.033	NA / max[d]	NA	4E-09	NA	4E-09
Cobalt-60	NA / 0.011	NA / max[d]	NA	2E-07	NA	2E-07
Lead-210	NA / 0.95	NA / 95% UCL[c]	NA	1E-08	NA	1E-08
Plutonium-241	NA / 1.07	NA / max[d]	NA	3E-09	NA	3E-09
Strontium-90	NA / 0.11	NA / 95% UCL[c]	NA	6E-09	NA	6E-09
Thorium-228	NA / 0.68	NA / 95% UCL[c]	NA	2E-06	NA	2E-06
Thorium-232	NA / 0.63	NA / 95% UCL[f]	NA	3E-05	NA	3E-05
Dry Wells A–E						
Cobalt-60	NA / 0.011	NA / max[d]	NA	2E-07	NA	2E-07
Radium-226	NA / 0.63	NA / 95% UCL[c]	NA	2E-05	NA	2E-05
Strontium-90	NA / 0.153	NA / max[d]	NA	9E-09	NA	9E-09
Thorium-228	NA / 0.771	NA / max[d]	NA	3E-06	NA	3E-06
Thorium-232	NA / 0.76	NA / 95% UCL[f]	NA	4E-05	NA	4E-05
Thorium-234	NA / 0.845	NA / 95% UCL[f]	NA	NA[e]	NA	NA[e]
Uranium-233/234	NA / 0.57	NA / max[d]	NA	3E-07	NA	3E-07
Uranium-238	NA / 0.599	NA / max[d]	NA	3E-07	NA	3E-07
Eastern Dog Pens						
Cobalt-60	ND / 0.015	NA / max[d]	NA	3E-07	NA	3E-07
Lead-210	0.94 / 0.67	95% UCL[c]	2E-07	1E-08	1E-10	2E-07
Tritium	ND / 1.21	NA / max[d]	NA	0E-00	NA	0E-00

Table G-5. Revised Risk Estimate for Onsite Outdoor Researcher for Detected Radionuclides Not Previously Identified as Constituents of Concern (continued)

Constituent	Surface/ Subsurface EPC (pCi/g)[a]	Surface/ Subsurface EPC Basis	Surface Soil Ingestion	External Radiation	Surface Soil Inhalation	Total Cancer Risk[b]
Radium/Strontium Treatment Systems						
Americium-241	NA / 0.0847	NA / max[d]	NA	1E-08	NA	1E-08
Carbon-14	NA / 0.12	NA / 95% UCL[c]	NA	8E-14	NA	8E-14
Plutonium-241	NA / 0.682	NA / max[d]	NA	2E-09	NA	2E-09
Strontium-90	NA / 0.25	NA / 95% UCL[c]	NA	2E-08	NA	2E-08
Thorium-228	NA / 0.59	NA / 95% UCL[c]	NA	2E-06	NA	2E-06
Southwest Trenches						
Americium-241	3.2 / 0.16	max[c] / 95% UCL[c]	2E-08	2E-08	4E-10	4E-08
Carbon-14	ND / 0.55	NA / 95% UCL[c]	NA	3E-13	NA	3E-13
Cesium-137	ND / 0.05	NA / 95% UCL[c]	NA	4E-07	NA	4E-07
Cobalt-60	ND / 0.010	NA / max[d]	NA	2E-07	NA	2E-07
Lead-210	ND / 1.3	NA / 95% UCL[c]	NA	2E-08	NA	2E-08
Plutonium-241	ND / 0.517	NA / max[d]	NA	2E-09	NA	2E-09
Thorium-228	0.53 / 0.59	max[c] / 95% UCL[c]	2E-09	2E-06	5E-11	2E-06
Tritium	ND / 0.7	NA / 95% UCL[c]	NA	0E-00	NA	0E-00
Western Dog Pens						
Carbon-14	0.159 / 0.58	max[g] / 95% UCL[h]	5E-14	4E-13	3E-13	8E-13
Cesium-137	0.0276 / 0.024	95% UCL[f] / 95% UCL[h]	7E-11	2E-07	2E-14	2E-07
Cobalt-60	0.0112 / 0.0112	max[g] / max[g]	7E-12	2E-07	2E-15	2E-07
Lead-210	0.599 / 1.2	95% UCL[h] / 95% UCL[h]	1E-07	2E-08	8E-11	1E-07
Strontium-90	ND / 0.43	NA / 95% UCL[h]	NA	3E-08	NA	3E-08
Thorium-228	0.683 / 0.61	95% UCL[h] / 95% UCL[h]	3E-09	2E-06	8E-11	2E-06
Uranium-235	0.0407 / 0.10	95% UCL[f] / 95% UCL[h]	3E-10	3E-07	6E-12	3E-07
Uranium-238	0.469 / 0.71	95% UCL[f] / 95% UCL[h]	4E-09	4E-07	6E-11	4E-07

Notes:

[a] Surface EPC is for ground surface (0 feet) to 0.5 feet below ground surface. Subsurface EPC is for ground surface to 10 feet below ground surface.

[b] Total cancer risk is sum of risk contributions using all digits to be consistent with RESRAD output.

[c] EPC from SWRA Tables 3.1 and 3.2 (UC Davis 2004).

[d] No EPC available in SWRA Table 3.2 and insufficient detected data for 95% UCL calculation; used maximum detected activity from SWRA Tables 2.1, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.20 (UC Davis 2004).

[e] RESRAD risk calculation not available for radionuclides that have a half-life shorter than 180 days.

[f] 95% UCL calculated using Pro UCL Version 5.1 (EPA 2016).

[g] No surface or subsurface EPCs available in Former Western Dog Pens Backfill Risk Assessment Tables 3 and 4, respectively, and insufficient detected data for 95% UCL calculation; used maximum detected activity from Former Western Dog Pens Backfill Risk Assessment Tables 1 and 2 (DOE 2007).

[h] EPC from Former Western Dog Pens Backfill Risk Assessment Table 4 (DOE 2007).

All radionuclides are at maximum dose/risk at time = 0 years, except for thorium-232 which peaks at 100 years, plutonium-241 (peaks at 30 years), and uranium-233/234 (peaks at 2700 years).

Abbreviations:
max = maximum concentration
NA = not applicable
pCi/g = picocuries per gram

G2.0 Results and Conclusions

As shown in Table G-4, this risk reevaluation indicates that individual radionuclides not previously designated as COCs may present risks to onsite residents greater than 1×10^{-6} (1 in 1 million) in the DSS 3, DSS 4, DOE Disposal Box, Dry Wells A–E, EDPs, Ra/Sr Treatment Systems, SWTs, and WDP areas. Onsite resident risks potentially above 1×10^{-6} are attributable to:

- Lead-210 in the DSS 3, DSS 4, EDPs, SWTs, and WDPs
- Radium-226 in the Dry Wells A–E area
- Thorium-228 in the DOE Disposal Box, Dry Wells A–E, Ra/Sr Treatment Systems, SWTs, and WDP areas
- Thorium-232 in the DOE Disposal Box and Dry Wells A–E areas

The estimated risks associated with these radionuclides are:

- Lead-210; in the range of 1×10^{-6} to 1×10^{-5}
- Radium-226; at 6×10^{-5}
- Thorium-228; in the range of 1×10^{-6} to 1×10^{-5}
- Thorium-232; in the range of 1×10^{-5} to 1×10^{-4}

As shown in Table G-5, this risk reevaluation indicates that individual radionuclides not previously designated as COCs may present risks to onsite outdoor researchers greater than 1×10^{-6} (1 in 1 million) in the DOE Disposal Box, Dry Wells A–E, Ra/Sr Treatment Systems, SWTs, and WDP areas. Onsite outdoor researcher risks potentially above 1×10^{-6} are attributable to:

- Radium-226 in the Dry Wells A–E area.
- Thorium-228 in the DOE Disposal Box, Dry Wells A–E, Ra/Sr Treatment Systems, SWTs, and WDP areas.
- Thorium-232 in the DOE Disposal Box and Dry Wells A–E areas.

The estimated risks associated with these radionuclides are:

- Radium-226; at 2×10^{-5}.
- Thorium-228; in the range of 1×10^{-6} to 1×10^{-5}.
- Thorium-232; in the range of 1×10^{-5} to 1×10^{-4}.

Tables G-6 and G-7 compare the risk recalculated for each radionuclide by DOE Area with the risk presented in the Risk Characterization Report (DOE 2005), except recalculated WDPs risk is compared to the risk presented in the WDPs Backfill Risk Assessment (DOE 2007). The WDPs Backfill Risk Assessment was performed to account for changes in risk due to the installation of backfill in the former WDPs area after the SWRA. In addition, Tables G-6, G-7, and G-8 assesses the updated potential risks based on comparison with background levels, data quality, and other factors.

Changes in assumed land area (Table G-3) and toxicity values for constituents detected in the DOE Areas resulted in changes in calculated cancer risks. However, these changes do not affect the overall protectiveness of the remedy.

Tables G-6 and G-7 include risk characterization narratives. As discussed above, risk characterization was previously conducted for about 50% of the radionuclides evaluated. Since the characterization data have not changed beyond ongoing radioactive decay, the prior risk characterization remains relevant in these cases, and for brevity, the 2005 risk characterization report is referenced as the basis for the recommendations included in the tables. A more rigorous evaluation of the new radionuclides is provided. These new radionuclides are identified in the second column in Tables G-6 and G-7 as “Not calculated.”

As shown in Tables G-6 and G-7, the risk characterization did not identify COCs not previously identified in the DOE Areas, including those where no action/no further action remedies were specified in the ROD, for the hypothetical resident and onsite outdoor researcher. Because the SWRA showed that these receptors were more sensitive to risk impacts from both chemicals and radionuclides than the construction worker, indoor researcher, and trespasser, it can be clearly inferred from the results presented in this risk evaluation that the non-COCs do not present an actionable risk to these other receptors. Therefore, the remedies in place remain protective to all receptors in this regard.

Table G-6. Risk Summary, Risk Characterization and Recommendations for Onsite Resident for Detected Radionuclides Not Previously Identified as COC

Constituent	Total Cancer Risk SWRA-Part B[a]	Total Cancer Risk Five-Year Review	Risk Characterization Summary and Recommendations
Domestic Septic System 1			
Carbon-14	1×10^{-10}	1×10^{-10}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Lead-210	2×10^{-7}	2×10^{-7}	No further action. Estimated risk is unchanged from the SWRA and below the CERCLA point of departure of 10^{-6}.
Strontium-90	6×10^{-8}	5×10^{-8}	No further action. Estimated risk is slightly lower than was estimated in the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Domestic Septic System 3			
Cesium-137	3×10^{-7}	3×10^{-7}	No further action. Estimated risk is unchanged from the SWRA and below the CERCLA point of departure of 10^{-6}. Previous evaluation conducted in Risk Characterization for DOE Areas (DOE 2005) determined that no further action is warranted based on risk below 10^{-6} and concentrations consistent with background.
Lead-210	8×10^{-7}	2×10^{-6}	No further action. Previous evaluation (DOE 2005) determined that no further action is warranted based on lead-210 having an EPC lower than the background EPC with no localized areas of contamination. Furthermore, additional risk reduction is ongoing due to relatively short half-life (22.3 years).
Strontium-90	1×10^{-7}	3×10^{-7}	No further action. Estimated risk remains below the CERCLA point of departure of 10^{-6} with ongoing risk reduction due to relatively short half-life (29 years).
Domestic Septic System 4			
Lead-210	1×10^{-6}	3×10^{-6}	No further action. Previous evaluation (DOE 2005) determined that no further action is warranted based on only one sample (collected in 1997) above background and ongoing risk reduction due to relatively short half-life (22.3 years).
Strontium-90	Not calculated[b]	6×10^{-8}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Uranium-235	Not calculated[b]	1×10^{-6}	No further action. The number of uranium-235 samples and their detection frequency were insufficient to calculate an EPC based on the 95% upper confidence limit on the mean (95% UCL); therefore the highest detected activity concentration was used. However, the highest detected activity concentration presented in the SWRA was below the detection limit and less than the reported uncertainty for that sample. The estimated risk based on the highest detected activity concentration above the detection limit is 3×10^{-7}. Furthermore, land-use restrictions specified in a recorded covenant prohibit residential land use and control soil excavation at this location.
Domestic Septic System 5			
Strontium-90	2×10^{-7}	2×10^{-7}	No further action. Estimated risk is unchanged from the SWRA and below the CERCLA point of departure of 10^{-6}.
Uranium-235	Not calculated[b]	3×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}.
Domestic Septic System 6			
Bismuth-212	Not calculated[b]	Not calculated[c]	No further action. Bismuth-212 is a short-lived isotope (half-life = 60.5 minutes). Risk calculation not available in RESRAD for radionuclides having a half-life shorter than 180 days.
Bismuth-214	Not calculated[b]	Not calculated[c]	No further action. Bismuth-214 is a short-lived isotope (half-life = 19.7 minutes). Risk calculation not available in RESRAD for radionuclides having a half-life shorter than 180 days.
Lead-214	Not calculated[b]	Not calculated[c]	No further action. Lead-214 is a short-lived isotope (half-life = 26.8 minutes). Risk calculation not available in RESRAD for radionuclides having a half-life shorter than 180 days.
Thallium-208	Not calculated[b]	Not calculated[c]	No further action. Thallium-208 is a short-lived isotope (half-life = 3.1 minutes). Risk calculation not available in RESRAD for radionuclides having a half-life shorter than 180 days.
Uranium-235	Not calculated[b]	9×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Additionally, the number of uranium-235 samples and their detection frequency were insufficient to calculate an EPC based on the 95% upper confidence limit on the mean (95% UCL); therefore the highest detected activity concentration was used. However, the highest detected activity concentration presented in the SWRA was below the detection limit. The estimated risk based on the highest detected activity concentration above the detection limit is 1×10^{-7}.
Domestic Septic System 7			
Cobalt-60	Not calculated[b]	2×10^{-7}	No further action. Risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Lead-210	9×10^{-7}	1×10^{-6}	No further action. Previous evaluation (DOE 2005) determined that no further action is warranted based on marginal data quality, operational history indicating no discharge or release from DSS 7, and ongoing risk reduction due to relatively short half-life (22.3 years).
Strontium-90	6×10^{-8}	7×10^{-8}	No further action. The estimated risk increased by a small amount over that estimated in the SWRA but remains significantly below the CERCLA point of departure of 10^{-6} with ongoing risk reduction due to relatively short half-life (29 years).
Uranium-235	Not calculated[b]	5×10^{-7}	No further action. Risk is below the CERCLA point of departure of 10^{-6}. Maximum detected value of 0.04 pCi/g is only slightly above the background UTL of 0.039 pCi/g.
DOE Disposal Box			
Americium-241	Not calculated[b]	1×10^{-8}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Cobalt-60	Not calculated[b]	4×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Lead-210	6×10^{-7}	7×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6} and previous evaluation (DOE 2005) determined that the EPC is equivalent to the background EPC.
Plutonium-241	Not calculated[b]	9×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.

Table G-6. Risk Summary, Risk Characterization and Recommendations for Onsite Resident for Detected Radionuclides Not Previously Identified as COCs (continued)

Constituent	Total Cancer Risk SWRA-Part B[a]	Total Cancer Risk Five-Year Review	Risk Characterization Summary and Recommendations
Strontium-90	6×10^{-8}	6×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Thorium-228	5×10^{-6}	5×10^{-6}	No further action. Estimated risk is unchanged from SWRA. Previous evaluation (DOE 2005) determined that no further action is warranted based on marginal risk and short half-life indicating decay of anthropogenic fraction (if present) in 6.9 years from 2004. This evaluation also concluded that thorium-228 likely represents decay from naturally occurring thorium-232 rather than a thorium-228 release based on approximate secular equilibrium and given analytical uncertainty (see Attachment G-1).
Thorium-232	Not calculated[b]	8×10^{-5}	No further action. Thorium-232 was not used at the site, and previous evaluations (DOE 2005) determined that it is in approximate secular equilibrium with thorium-228 and that reported concentrations above the background screening value (2 out of 10 results) likely reflect analytical uncertainty rather than a release (see plot in Attachment G-1).
Dry Wells A–E			
Cobalt-60	Not calculated[b]	4×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Radium-226	4×10^{-5}	6×10^{-5}	No further action. Previous evaluations (DOE 2005) determined no further action warranted based on concentrations consistent with background.
Strontium-90	Not calculated[b]	1×10^{-7}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Thorium-228	6×10^{-6}	6×10^{-6}	No further action. Estimated risk is unchanged from SWRA. Previous evaluation (DOE 2005) determined that no further action is warranted based on marginal risk and short half-life indicating decay of anthropogenic fraction (if present) in 5 years from 2004. This evaluation also concluded that thorium-228 likely represents decay from naturally occurring thorium-232 rather than a thorium-228 release based on approximate secular equilibrium and given analytical uncertainty (see plot in Attachment G-1).
Thorium-232	Not calculated[b]	1×10^{-4}	No further action. Thorium-232 was not used at the site, and previous evaluations (DOE 2005) determined that it is in approximate secular equilibrium with thorium-228 and that reported concentrations above the background screening value (1 of 8 results) likely reflect analytical uncertainty rather than a release (see Attachment G-1).

Constituent	Total Cancer Risk SWRA-Part B[a]	Total Cancer Risk Five-Year Review	Risk Characterization Summary and Recommendations
Uranium-233/234	Not calculated[b]	7×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6} and maximum reported concentration (0.57 pCi/g) is less than the background screening level (0.68 pCi/g) in the SWRA.
Uranium-238	Not calculated[b]	8×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6} and maximum reported concentration (0.599 pCi/g) is less than the SWRA background screening level (0.65 pCi/g).
Eastern Dog Pens			
Cobalt-60	Not calculated[b]	6×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Lead-210	3×10^{-6}	4×10^{-6}	No further action. Previous evaluations (DOE 2005) concluded no further action was warranted because the site EPC is below the background EPC and the maximum detected activity concentration is below the background screening level. The small increase in estimated lead-210 risk from that calculated in the SWRA does not change this conclusion.
Tritium	Not calculated[b]	1×10^{-8}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Ra/Sr Treatment Systems			
Americium-241	Not calculated[b]	4×10^{-8}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Carbon-14	8×10^{-10}	3×10^{-9}	No further action. Estimated risk increased but remains significantly below the CERCLA point of departure of 10^{-6}.
Plutonium-241	Not calculated[b]	9×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Strontium-90	6×10^{-7}	8×10^{-7}	No further action. Previous evaluation (DOE 2005) concluded that no further action is warranted based on risk below 10^{-6} and total Site risk (due primarily to thorium-228) decreasing to below 10^{-6} in 3.5 years from 2004. The small increase in estimated strontium-90 risk from that reported in SWRA does not change this conclusion.
Thorium-228	5×10^{-6}	5×10^{-6}	No further action. Estimated risk is unchanged from SWRA. Previous evaluation (DOE 2005) determined that no further action is warranted because 97% of risk is attributable to background and decay to background would occur approximately 3.5 years from 2005.
Southwest Trenches			
Americium-241	8×10^{-8}	8×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Carbon-14	1×10^{-8}	1×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Cesium-137	1×10^{-6}	1×10^{-6}	No further action. Estimated risk is unchanged from the SWRA. Previous evaluation (DOE 2005) concluded that 71% of risk is attributable to background and that no further action is warranted because the decay-corrected risk (based on the period from 1999, when the most recent sample was collected, through 2004) is below 10^{-6}. Risk has further decreased due to decay (cesium-137 half-life is 30.2 years) in the 16 years since 2004.
Cobalt-60	Not calculated[b]	4×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Lead-210	6×10^{-6}	8×10^{-6}	No further action. Previous evaluations (DOE 2005) concluded no further action is warranted based on lack of correlation with site activities and analytical issues lead to likely overestimate of risk. Small increase in estimated risk over risk estimated in SWRA does not change this conclusion.
Plutonium-241	Not calculated[b]	7×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Thorium-228	5×10^{-6}	5×10^{-6}	No further action. Estimated risk is unchanged from SWRA. Previous evaluations (DOE 2005) concluded no further action is warranted because 98% of risk is attributable to background and decay to background would occur in less than 2 years from 2005.
Tritium	Not calculated[b]	7×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.

Table G-6. Risk Summary, Risk Characterization and Recommendations for Onsite Resident for Detected Radionuclides Not Previously Identified as COCs (continued)

Constituent	**Total Cancer Risk WDPs RA[d]**	**Total Cancer Risk Five-Year Review**	**Risk Characterization Summary and Recommendations**
Western Dog Pens			
Carbon-14	2×10^{-8}	4×10^{-8}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Cesium-137	6×10^{-7}	6×10^{-7}	No further action. Estimated risk is unchanged from WDPs RA. Previous evaluation (DOE 2007) indicated no further action warranted. Ongoing decay (cesium-137 half-life is 30.2 years) has further reduced risk in 22 years since most recent sample collected.
Cobalt-60	Not calculated[b]	4×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Lead-210	6×10^{-6}	7×10^{-6}	No further action. Previous evaluations conducted in the Western Dog Pens Backfill Risk Assessment (WDPs RA) (DOE 2007) concluded that no further action is warranted because risk values may be due to analytical errors, estimated risk did not significantly change after backfill (indicating largely background), and ongoing decay (lead-210 half-life is 22.3 years) continues to reduce risk. Small increase in estimated risk over risk estimated in WDPs RA does not change this conclusion.
Strontium-90	1×10^{-6}	1×10^{-6}	No further action. Previous evaluations (DOE 2007) concluded no further action is warranted based on analytical uncertainty and estimated risk attenuating to below 10^{-6} in 14 years from 2007.
Thorium-228	6×10^{-6}	5×10^{-6}	No further action. Estimated risk is slightly lower than was estimated in the WDPs RA. Previous evaluation (DOE 2007) determined that no further action is warranted because 89% of risk is attributable to background and decay to background would occur in 7 years from 2005.
Uranium-235	7×10^{-7}	7×10^{-7}	No further action. Estimated risk is unchanged from the WDPs RA (DOE 2007) and is below the CERCLA point of departure of 10^{-6}.
Uranium-238	1×10^{-6}	1×10^{-6}	No further action. Estimated risk is unchanged from the WDPs RA (DOE 2007). Previous evaluation (DOE 2007) determined that no further action was warranted because uranium-238 is not found in the EDPs, which had the same operational history as WDPs, nor in the waste from Southwest Trenches, which received waste from the WDPs, suggesting it is not related to site activities; the majority of the uranium-238 risk (69%) is attributable to background concentrations; and data quality issues with site characterization samples indicate that there is moderate uncertainty associated with the data used to derive this risk.

Notes:

[a] Risk values from *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment (Part B-Risk Characterization for DOE Areas)* (DOE 2005).

[b] An estimated risk was not calculated for this constituent because it was eliminated during the Tier 1 screening evaluations presented in the SWRA (UC Davis 2004) or WDPs RA (DOE 2007).

[c] RESRAD does not calculate risks for radionuclides having a half-life shorter than 180 days.

[d] Risk values from *Former Western Dog Pens Backfill Risk Assessment* (DOE 2007).

Abbreviation:

WDPs RA = Former Western Dog Pens Backfill Risk Assessment

Table G-7. Risk Summary, Risk Characterization and Recommendations for Onsite Outdoor Researcher for Detected Radionuclides Not Previously Identified as COCs

Constituent	Total Cancer Risk SWRA-Part B[a]	Total Cancer Risk Five-Year Review	Risk Characterization Summary
Domestic Septic System 1			
Carbon-14	7×10^{-13}	7×10^{-13}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Lead-210	1×10^{-8}	2×10^{-8}	No further action. The estimated risk increased by a small amount but is significantly below the CERCLA point of departure of 10^{-6}.
Strontium-90	1×10^{-8}	1×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Domestic Septic System 3			
Cesium-137	1×10^{-7}	1×10^{-7}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Lead-210	1×10^{-8}	1×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Strontium-90	1×10^{-8}	1×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Domestic Septic System 4			
Lead-210	3×10^{-8}	3×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Strontium-90	Not calculated[b]	5×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Uranium-235/236	Not calculated[b]	4×10^{-7}	No further action. The number of uranium-235 samples and their detection frequency were insufficient to calculate an EPC based on the 95% upper confidence limit on the mean (95% UCL); therefore, the highest detected activity concentration was used. However, the highest detected activity concentration presented in the SWRA was below the detection limit and less than the reported uncertainty for that sample. The estimated risk based on the highest detected activity concentration above the detection limit is 1×10^{-7}.
Domestic Septic System 5			
Strontium-90	5×10^{-8}	5×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Uranium-235	Not calculated[b]	1×10^{-7}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Domestic Septic System 6			
Bismuth-212	Not calculated[b]	Not calculated[c]	No further action. Bismuth-212 is short-lived isotope (half-life = 60.5 minutes). Risk calculation not available in RESRAD for radionuclides having a half-life shorter than 180 days.
Bismuth-214	Not calculated[b]	Not calculated[c]	No further action. Bismuth-214 is short-lived isotope (half-life = 19.7 minutes). Risk calculation not available in RESRAD for radionuclides having a half-life shorter than 180 days.
Lead-214	Not calculated[b]	Not calculated[c]	No further action. Lead-214 is short-lived isotope (half-life = 26.8 minutes). Risk calculation not available in RESRAD for radionuclides having a half-life shorter than 180 days.
Thallium-208	Not calculated[b]	Not calculated[c]	No further action. Thallium-208 is short-lived isotope (half-life = 3.1 minutes). Risk calculation not available in RESRAD for radionuclides having a half-life shorter than 180 days.
Uranium-235	Not calculated[b]	3×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Additionally, the number of uranium-235 samples and their detection frequency were insufficient to calculate an EPC based on the 95% upper confidence limit on the mean (95% UCL); therefore the highest detected activity concentration was used. However, the highest detected activity concentration presented in the SWRA was below the detection limit. The estimated risk based on the highest detected activity concentration above the detection limit is 4×10^{-8}.
Domestic Septic System 7			
Cobalt-60	Not calculated[b]	1×10^{-7}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Lead-210	4×10^{-8}	5×10^{-8}	No further action. The estimated risk increased by a small amount (1×10^{-8} increase) but remains significantly below the CERCLA point of departure of 10^{-6}.
Strontium-90	1×10^{-8}	1×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Uranium-235	Not calculated[b]	2×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Maximum detected value of 0.04 pCi/g is only slightly above the background UTL of 0.039 pCi/g.
DOE Disposal Box			
Americium-241	Not calculated[b]	4×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Cobalt-60	Not calculated[b]	2×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Lead-210	1×10^{-8}	1×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Plutonium-241	Not calculated[b]	3×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Strontium-90	7×10^{-9}	6×10^{-9}	No further action. Estimated risk is slightly less than was estimated in the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Thorium-228	2×10^{-6}	2×10^{-6}	No further action. Estimated risk is unchanged from SWRA. Previous evaluation (DOE 2005) determined that no further action is warranted based on marginal risk and short half-life indicating decay of anthropogenic fraction (if present) in 6.9 years from 2004. This evaluation also concluded that thorium-228 likely represents decay from naturally occurring thorium-232 rather than a thorium-228 release based on approximate secular equilibrium and given analytical uncertainty (see Attachment G-1).
Thorium-232	Not calculated[b]	3×10^{-5}	No further action. Thorium-232 was not used at the site, and previous evaluations (DOE 2005) determined that it is in approximate secular equilibrium with thorium-228 and that reported concentrations above the background screening value (2 out of 10 results) likely reflect analytical uncertainty rather than a release (see plot in Attachment G-1).

Table G-7. Risk Summary, Risk Characterization and Recommendations for Onsite Resident for Detected Radionuclides Not Previously Identified as COC (continued)

Constituent	Total Cancer Risk SWRA-Part B[a]	Total Cancer Risk Five-Year Review	Risk Characterization Summary
Dry Wells A–E			
Cobalt-60	Not calculated[b]	2×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Radium-226	2×10^{-5}	2×10^{-5}	No further action. Previous evaluations (DOE 2005) determined no further action warranted based on concentrations consistent with background.
Strontium-90	Not calculated[b]	9×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Thorium-228	3×10^{-6}	3×10^{-6}	No further action. Estimated risk is unchanged from SWRA. Previous evaluation (DOE 2005) determined that no further action is warranted based on marginal risk and short half-life indicating decay of anthropogenic fraction (if present) in 5 years from 2004. This evaluation also concluded that thorium-228 likely represents decay from naturally occurring thorium-232 rather than a thorium-228 release based on approximate secular equilibrium and given analytical uncertainty (see plot in Attachment G-1).
Thorium-232	Not calculated[b]	4×10^{-5}	No further action. Thorium-232 was not used at the site, and previous evaluations (DOE 2005) determined that it is in approximate secular equilibrium with thorium-228 and that reported concentrations above the background screening value (1 of 8 results) likely reflect analytical uncertainty rather than a release (see Attachment G-1).
Uranium-233/234	Not calculated[b]	3×10^{-7}	No further action. The estimated risk is below the CERCLA point of departure of 10^{-6}, and maximum reported concentration (0.57 pCi/g) is less than the background screening level (0.68 pCi/g) in the SWRA.
Uranium-238	Not calculated[b]	3×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}, and maximum reported concentration (0.599 pCi/g) is less than the SWRA background screening level (0.65 pCi/g).
Eastern Dog Pens			
Cobalt-60	Not calculated[b]	3×10^{-7}	Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Lead-210	3×10^{-7}	2×10^{-7}	No further action. The estimated risk is below the CERCLA point of departure of 10^{-6}.
Tritium	Not calculated[b]	0	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Ra/Sr Treatment Systems			
Americium-241	Not calculated[b]	1×10^{-8}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Carbon-14	7×10^{-14}	8×10^{-14}	No further action. The estimated risk increased slightly but remains significantly below the CERCLA point of departure of 10^{-6}.
Plutonium-241	Not calculated[b]	2×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Strontium-90	2×10^{-8}	2×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Thorium-228	2×10^{-6}	2×10^{-6}	No further action. Estimated risk is unchanged from SWRA. Previous evaluation (DOE 2005) determined that no further action is warranted because 97% of risk is attributable to background and decay to background would occur approximately 3.5 years from 2005.
Southwest Trenches			
Americium-241	9×10^{-8}	4×10^{-8}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Carbon-14	3×10^{-13}	3×10^{-13}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Cesium-137	4×10^{-7}	4×10^{-7}	No further action. The estimated risk is unchanged from the SWRA and below the CERCLA point of departure of 10^{-6}. The results of the Risk Characterization Report (DOE 2005) indicated the majority of the cesium-137 risk at the Southwest Trenches area (71%) was related to the background concentration, not to site activities, and spatial analysis showed that cesium-137 in soil is mainly localized in the southern portion of the area.
Cobalt-60	Not calculated[b]	2×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Lead-210	2×10^{-8}	2×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Plutonium-241	Not calculated[b]	2×10^{-9}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Thorium-228	2×10^{-6}	2×10^{-6}	No further action. Estimated risk is unchanged from SWRA. Previous evaluations (DOE 2005) concluded no further action is warranted because 98% of risk is attributable to background and decay to background would occur in less than 2 years from 2005.
Tritium	Not calculated[b]	0	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.

Table G-7. Risk Summary, Risk Characterization and Recommendations for Onsite Resident for Detected Radionuclides Not Previously Identified as COC (continued)

Constituent	Total Cancer Risk WDPs RA[d]	Total Cancer Risk Five-Year Review	Risk Characterization Summary and Recommendations
Western Dog Pens			
Carbon-14	4×10^{-13}	8×10^{-13}	No further action. Estimated risk is significantly below the CERCLA point of departure of 10^{-6}.
Cesium-137	2×10^{-7}	2×10^{-7}	No further action. The estimated risk is unchanged from the WDPs RA and below the CERCLA point of departure of 10^{-6}. Ongoing decay (cesium-137 half-life is 30.2 years) has further reduced risk in 22 years since most recent sample collected.
Cobalt-60	Not calculated[b]	2×10^{-7}	No further action. Estimated risk is below the CERCLA point of departure of 10^{-6}. Ongoing risk reduction due to relatively short half-life (5.3 years).
Lead-210	1×10^{-7}	1×10^{-7}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Strontium-90	3×10^{-8}	3×10^{-8}	No further action. Estimated risk is unchanged from the SWRA and significantly below the CERCLA point of departure of 10^{-6}.
Thorium-228	3×10^{-6}	2×10^{-6}	No further action. The estimated risk is slightly lower than was estimated in the WDPs RA. Previous evaluation (DOE 2007) determined that no further action is warranted because 89% of risk is attributable to background and decay to background would occur in 7 years from 2005.
Uranium-235	3×10^{-7}	3×10^{-7}	No further action. The estimated risk is unchanged from the WDPs RA and is below the CERCLA point of departure of 10^{-6}.
Uranium-238	4×10^{-7}	4×10^{-7}	No further action. Estimated risk is unchanged from the WDPs RA (DOE 2007). Previous evaluation (DOE 2007) determined that no further action was warranted because uranium-238 is not found in the EDPs, which had the same operational history as WDPs, nor in the waste from Southwest Trenches, which received waste from the WDPs, suggesting it is not related to site activities; the majority of the uranium-238 risk (69%) is attributable to background concentrations; and data quality issues with site characterization samples indicate that there is moderate uncertainty associated with the data used to derive this risk.

Notes:

[a] Risk values from *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment (Part B-Risk Characterization for DOE Areas)* (DOE 2005).

[b] An estimated risk was not calculated for this constituent because it was eliminated during the Tier 1 screening evaluations presented in the SWRA (UC Davis 2004) or WDPs RA (DOE 2007).

[c] RESRAD does not calculate risks for radionuclides having a half-life shorter than 180 days.

[d] Risk values from *Former Western Dog Pens Backfill Risk Assessment* (DOE 2007).

Abbreviation:

WDPs RA = Former Western Dog Pens Backfill Risk Assessment

G3.0 References

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Attachment G-1

Site Soil Background Documentation

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Table B.2
Background Comparison-DOE Box (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						DOE Box (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	2	10	20%	0.16	0.29	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	3	10	30%	0.12	0.16	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	3	10	30%	0.47	1.3	N/A	N/A	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	17	17	100%	0.442	0.65	NO	Mann-Whitney	SAME	0.48	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	10	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	4	10	40%	0.14	0.58	N/A	N/A	Det < 50%	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	9	10	90%	0.00422	0.033	YES	Max > UTL	Det < 50%	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	0	10	0%	0	0	NO	ND	Det < 50%	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	10	10	100%	5.9	8.2	NO	Mann-Whitney	LT BCKG	0.05	mg/Kg
BARIUM	49	49	100%	107	233	260	10	10	100%	177	231	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	10	10	100%	0.44	0.59	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	17	17	100%	0.16	0.417	NO	Mann-Whitney	SAME	0.06	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	17	17	100%	0.287	0.74	NO	Mann-Whitney	SAME	0.05	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	0	31	0%	0	0	NO	ND	Det < 50%	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	4	17	24%	0.09	0.27	YES	Max > UTL	Det < 50%	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	4	17	24%	0.006	0.014	YES	Max > UTL	Det < 50%	--	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	31	31	100%	91.7	140	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	10	10	100%	18.8	24.3	NO	Mann-Whitney	LT BCKG	0.01	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	4	17	24%	0.001	0.011	YES	Max > UTL	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	10	10	100%	36.4	48.9	NO	Mann-Whitney	SAME	0.12	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	1	10	10%	0.38	0.38	N/A	N/A	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	5	10	50%	0.11	0.8	N/A	N/A	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	0	10	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	4	10	40%	0.31	0.87	N/A	N/A	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	17	17	100%	4.9	13.5	NO	Mann-Whitney	SAME	0.07	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	17	17	100%	9.45	17.1	NO	Mann-Whitney	SAME	0.14	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	0	10	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	21	31	68%	0.0839	1.6	YES	Mann-Whitney	0	0.00	mg/Kg
IRON	10	10	100%	30500	46300	44000	10	10	100%	31800	40500	NO	Mann-Whitney	SAME	0.50	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	10	10	100%	6.2	9.2	NO	Mann-Whitney	SAME	0.18	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	11	17	65%	0.323	2.4	YES	Max > UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	17	17	100%	0.459	0.76	NO	Mann-Whitney	SAME	0.48	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	17	17	100%	0.345	0.75	NO	Mann-Whitney	SAME	0.05	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	10	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	10	10	100%	491	800	NO	Mann-Whitney	SAME	0.07	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	31	31	100%	0.097	3.9	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Methoxychlor	1	23	4%	2.1	2.1	N/E	3	10	30%	0.49	0.67	N/A	N/A	Det < 50%	--	ug/Kg
NICKEL	67	67	100%	143	503	330	10	10	100%	194	241	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg

Table B.2
Background Comparison-DOE Box (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						DOE Box (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	2	10	20%	0.16	0.29	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	3	10	30%	0.12	0.16	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	3	10	30%	0.47	1.3	N/A	N/A	Det < 50%	--	ug/Kg
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	31	31	100%	2.09	58.7	NO	Mann-Whitney	SAME	0.48	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	3	10	30%	0.426	1.07	YES	Max > UTL	Det < 50%	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	17	17	100%	9.61	12.8	NO	Mann-Whitney	SAME	0.06	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	24	24	100%	0.16	1.41	NO	Mann-Whitney	SAME	0.07	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	10	10	100%	0.442	0.632	NO	Mann-Whitney	SAME	0.39	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	10	10	100%	0.68	1.5	YES	Mann-Whitney	GT BCKG	0.01	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	0	10	0%	0	0	NO	ND	Det < 50%	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	10	17	59%	0.025	0.28	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	0	10	0%	0	0	NO	ND	Det < 50%	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	17	17	100%	0.147	0.224	NO	Mann-Whitney	SAME	0.34	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	10	10	100%	0.504	0.768	YES	Mann-Whitney	GT BCKG	0.00	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	10	10	100%	0.563	0.755	NO	Mann-Whitney	SAME	0.06	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	10	10	100%	0.474	0.82	YES	Mann-Whitney	GT BCKG	0.00	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	16	17	94%	0.18	1.13	NO	Mann-Whitney	SAME	0.35	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	10	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	7	17	41%	0.006	0.042	NO	Max < UTL	Det < 50%	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	10	10	100%	0.436	0.551	NO	Mann-Whitney	SAME	0.22	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	4	7	57%	0.04	0.12	NO	Mann-Whitney	SAME	0.39	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	10	10	100%	0.367	0.583	NO	Mann-Whitney	SAME	0.36	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	10	10	100%	61.3	73.1	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	10	10	100%	65.3	85.1	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.3
Background Comparison-Domestic Septic System 1 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 1 (0-10)							Mann-Whitney		
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	4	4	100%	0.492	0.59	NO	Max < UTL	n < 5	--	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	1	4	25%	2.1	2.1	N/A	N/A	n < 5	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	1	2	50%	0.00335	0.00335	NO	Max < UTL	n < 5	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	0	4	0%	0	0	NO	ND	n < 5	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	4	4	100%	6.6	8.1	NO	Max < UTL	n < 5	--	mg/Kg
BARIUM	49	49	100%	107	233	260	4	4	100%	190	220	NO	Max < UTL	n < 5	--	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	4	4	100%	0.35	0.49	NO	Max < UTL	n < 5	--	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	4	4	100%	0.309	0.334	NO	Max < UTL	n < 5	--	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	4	4	100%	0.311	0.51	NO	Max < UTL	n < 5	--	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	0	4	0%	0	0	NO	ND	n < 5	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	3	4	75%	0.159	2.1	YES	Max > UTL	n < 5	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	1	4	25%	0.00839	0.00839	NO	Max < UTL	n < 5	--	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	2	2	100%	0.38	0.68	N/A	N/A	n < 5	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	4	4	100%	79.1	100	NO	Max < UTL	n < 5	--	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	4	4	100%	17.1	25	NO	Max < UTL	n < 5	--	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	1	4	25%	0.008	0.008	YES	Max > UTL	n < 5	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	4	4	100%	33.9	56	NO	Max < UTL	n < 5	--	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	1	4	25%	2.9	2.9	N/A	N/A	n < 5	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	4	4	100%	5.5	9.3	YES	Max > UTL	n < 5	--	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	4	4	100%	9.24	17.6	YES	Max > UTL	n < 5	--	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	2	4	50%	0.361	0.683	YES	Max > UTL	n < 5	--	mg/Kg
IRON	10	10	100%	30500	46300	44000	4	4	100%	26700	35000	NO	Max < UTL	n < 5	--	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	4	4	100%	7.8	9	NO	Max < UTL	n < 5	--	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	1	4	25%	1.8	1.8	YES	Max > UTL	n < 5	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	4	4	100%	0.442	0.567	NO	Max < UTL	n < 5	--	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	4	4	100%	0.349	0.578	NO	Max < UTL	n < 5	--	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Manganese	10	10	100%	527	744	750	4	4	100%	467	890	YES	Max > UTL	n < 5	--	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	2	4	50%	0.065	0.16	NO	Max < UTL	n < 5	--	mg/Kg

Table B.3
Background Comparison-Domestic Septic System 1 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 1 (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
NICKEL	67	67	100%	143	503	330	4	4	100%	141	220	NO	Max < UTL	n < 5	--	mg/Kg
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	4	4	100%	9.3	11.8	NO	Max < UTL	n < 5	--	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	6	6	100%	0.38	0.62	NO	Mann-Whitney	SAME	0.32	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	2	2	100%	0.492	0.537	NO	Max < UTL	n < 5	--	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	2	4	50%	0.85	1.4	YES	Max > UTL	n < 5	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	0	4	0%	0	0	NO	ND	n < 5	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	2	4	50%	0.16	0.4	YES	Max > UTL	n < 5	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	2	2	100%	1.9	6.4	N/A	N/A	n < 5	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	0	4	0%	0	0	NO	ND	n < 5	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	4	4	100%	0.165	0.174	NO	Max < UTL	n < 5	--	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	2	2	100%	0.424	0.655	NO	Max < UTL	n < 5	--	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	2	2	100%	0.466	0.59	NO	Max < UTL	n < 5	--	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	2	2	100%	0.391	0.526	NO	Max < UTL	n < 5	--	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	3	4	75%	0.19	0.648	NO	Max < UTL	n < 5	--	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	4	0%	0	0	N/A	ND	n < 5	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	2	4	50%	0.003	0.015	NO	Max < UTL	n < 5	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	2	2	100%	0.439	0.543	NO	Max < UTL	n < 5	--	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	3	4	75%	0.01	0.0334	NO	Max < UTL	n < 5	--	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	2	2	100%	0.436	0.52	NO	Max < UTL	n < 5	--	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	4	4	100%	54.2	65	NO	Max < UTL	n < 5	--	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	4	4	100%	72.7	84	NO	Max < UTL	n < 5	--	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.4
Background Comparison-Domestic Septic System 3 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 3 (0-10)							Mann-Whitney		
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	0	7	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	0	7	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	0	7	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	30	30	100%	0.229	0.614	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	7	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	20	28	71%	0.063	161	N/A	N/A	Det < 50%	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	1	5	20%	0.0101	0.0101	NO	Max < UTL	Det < 50%	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	2	8	25%	1.1	1.2	NO	Max < UTL	Det < 50%	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	9	9	100%	3.6	10.6	NO	Mann-Whitney	SAME	0.42	mg/Kg
BARIUM	49	49	100%	107	233	260	9	9	100%	40.8	218	NO	Mann-Whitney	SAME	0.34	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	9	9	100%	0.12	0.53	NO	Mann-Whitney	LT BCKG	0.02	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	30	30	100%	0.151	0.438	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	30	30	100%	0.243	0.616	NO	Mann-Whitney	LT BCKG	0.01	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	10	25	40%	0.07	0.21	NO	Max < UTL	Det < 50%	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	0	6	0%	0	0	NO	ND	Det < 50%	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	6	30	20%	0.0049	0.126	YES	Max > UTL	Det < 50%	--	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	25	25	100%	26.5	174	NO	Mann-Whitney	LT BCKG	0.03	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	9	9	100%	7.5	23.5	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	1	30	3%	0.004	0.004	NO	Max < UTL	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	25	25	100%	11.2	59.3	NO	Mann-Whitney	SAME	0.06	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	7	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	1	7	14%	2.4	2.4	N/A	N/A	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	0	7	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	22	28	79%	0.13	294	N/A	N/A	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	6	6	100%	3.7	8.56	NO	Mann-Whitney	SAME	0.47	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	6	6	100%	5.68	16.6	NO	Mann-Whitney	SAME	0.31	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	1	28	4%	4	4	N/A	N/A	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	13	25	52%	0.048	0.273	NO	Mann-Whitney	SAME	0.16	mg/Kg
IRON	10	10	100%	30500	46300	44000	9	9	100%	10100	38200	NO	Mann-Whitney	SAME	0.17	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	25	25	100%	2.3	7.7	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	9	30	30%	0.48	4.4	YES	Max > UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	30	30	100%	0.237	0.688	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	30	30	100%	0.276	0.666	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	7	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	9	9	100%	258	790	NO	Mann-Whitney	SAME	0.40	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	25	25	100%	0.06	4.4	NO	Mann-Whitney	SAME	0.06	mg/Kg
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	7	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg

Table B.4
Background Comparison-Domestic Septic System 3 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 3 (0-10)										
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
NICKEL	67	67	100%	143	503	330	9	9	100%	33.9	266	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	23	25	92%	0.163	43.3	NO	Mann-Whitney	LT BCKG	0.01	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	0	5	0%	0	0	NO	ND	Det < 50%	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	30	30	100%	4.6	13	NO	Mann-Whitney	SAME	0.14	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	30	30	100%	0.264	0.616	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	29	29	100%	0.229	0.614	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	5	9	56%	0.59	1.7	NO	Mann-Whitney	SAME	0.45	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	2	25	8%	0.29	0.3	NO	Max < UTL	Det < 50%	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	16	25	64%	0.0281	0.591	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	3	9	33%	1.1	2.8	YES	Max > UTL	Det < 50%	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	30	30	100%	0.0715	0.212	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	5	5	100%	0.238	0.529	NO	Mann-Whitney	LT BCKG	0.03	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	5	5	100%	0.311	0.574	NO	Mann-Whitney	SAME	0.06	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	5	5	100%	0.184	0.48	NO	Mann-Whitney	LT BCKG	0.01	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	29	30	97%	0.366	4.11	NO	Mann-Whitney	SAME	0.26	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	7	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	1	6	17%	0.015	0.015	NO	Max < UTL	Det < 50%	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	5	5	100%	0.212	0.411	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	5	5	100%	0.139	0.463	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	9	9	100%	21.6	69.6	NO	Mann-Whitney	SAME	0.14	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	9	9	100%	37.9	258	YES	Mann-Whitney	GT BCKG	0.04	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.5
Background Comparison-Domestic Septic System 4 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 4 (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	0	5	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	1	5	20%	8.1	8.1	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	0	5	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	6	6	100%	0.342	0.7	NO	Mann-Whitney	LT BCKG	0.01	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	5	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	2	5	40%	16.7	179	N/A	N/A	Det < 50%	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	2	4	50%	0.00302	0.011	NO	Max < UTL	n < 5	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	0	3	0%	0	0	NO	ND	n < 5	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	6	6	100%	5.7	8.3	NO	Mann-Whitney	SAME	0.46	mg/Kg
BARIUM	49	49	100%	107	233	260	6	6	100%	99.4	179	NO	Mann-Whitney	LT BCKG	0.04	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	6	6	100%	0.26	0.402	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	6	6	100%	0.22	0.34	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	6	6	100%	0.326	0.505	NO	Mann-Whitney	LT BCKG	0.02	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	5	6	83%	0.18	0.78	NO	Mann-Whitney	SAME	0.41	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	1	6	17%	0.06	0.06	NO	Max < UTL	Det < 50%	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	4	6	67%	0.0107	0.0517	NO	Mann-Whitney	SAME	0.36	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	6	6	100%	159	319	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	6	6	100%	18.8	24.3	NO	Mann-Whitney	LT BCKG	0.03	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	0	6	0%	0	0	NO	ND	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	6	6	100%	20.8	64.6	NO	Mann-Whitney	SAME	0.28	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	5	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	0	5	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	0	5	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	3	5	60%	1	275	N/A	N/A	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	6	6	100%	4.07	6.2	NO	Mann-Whitney	SAME	0.13	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	6	6	100%	9.65	13.1	NO	Mann-Whitney	LT BCKG	0.02	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	1	5	20%	10.7	10.7	N/A	N/A	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	3	6	50%	0.036	0.925	NO	Mann-Whitney	SAME	0.16	mg/Kg
IRON	10	10	100%	30500	46300	44000	6	6	100%	29900	37800	NO	Mann-Whitney	SAME	0.33	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	7	7	100%	4.4	20.1	NO	Mann-Whitney	SAME	0.18	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	4	6	67%	0.26	4.7	YES	Max > UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	6	6	100%	0.384	0.548	NO	Mann-Whitney	LT BCKG	0.01	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	6	6	100%	0.392	0.617	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	5	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	6	6	100%	481	655	NO	Mann-Whitney	SAME	0.35	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	7	7	100%	0.24	3.5	NO	Mann-Whitney	SAME	0.20	mg/Kg

Table B.5
Background Comparison-Domestic Septic System 4 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 4 (0-10)							Mann-		
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	5	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
NICKEL	67	67	100%	143	503	330	6	6	100%	249	405	NO	Mann-Whitney	SAME	0.06	mg/Kg
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	4	5	80%	0.284	3.26	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	0	4	0%	0	0	NO	ND	n < 5	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	6	6	100%	8.7	11.4	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	6	6	100%	0.364	0.62	NO	Mann-Whitney	SAME	0.06	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	4	4	100%	0.342	0.431	NO	Max < UTL	n < 5	--	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	2	6	33%	1.23	2	YES	Max > UTL	Det < 50%	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	0	6	0%	0	0	NO	ND	Det < 50%	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	1	6	17%	0.08	0.08	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	0	6	0%	0	0	NO	ND	Det < 50%	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	6	6	100%	0.115	0.165	NO	Mann-Whitney	LT BCKG	0.01	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	4	4	100%	0.28	0.493	NO	Max < UTL	n < 5	--	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	4	4	100%	0.368	0.515	NO	Max < UTL	n < 5	--	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	4	4	100%	0.228	0.418	NO	Max < UTL	n < 5	--	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	6	6	100%	0.362	4.15	NO	Mann-Whitney	SAME	0.24	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	5	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	2	6	33%	0.0105	0.1905	NO	Max < UTL	Det < 50%	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	4	4	100%	0.287	0.496	NO	Max < UTL	n < 5	--	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	3	4	75%	0.0511	0.16	YES	Max > UTL	n < 5	--	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	4	4	100%	0.317	0.506	NO	Max < UTL	n < 5	--	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	6	6	100%	42.3	71.5	NO	Mann-Whitney	SAME	0.46	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	6	6	100%	41.5	144	NO	Mann-Whitney	SAME	0.08	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.6
Background Comparison-Domestic Septic System 5 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 5 (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	1	2	50%	0.585	0.585	NO	Max < UTL	n < 5	--	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	1	1	100%	8.6	8.6	NO	Max < UTL	n < 5	--	mg/Kg
BARIUM	49	49	100%	107	233	260	1	1	100%	213	213	NO	Max < UTL	n < 5	--	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	1	1	100%	0.55	0.55	NO	Max < UTL	n < 5	--	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	1	2	50%	0.394	0.394	NO	Max < UTL	n < 5	--	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	1	2	50%	0.428	0.428	NO	Max < UTL	n < 5	--	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	1	1	100%	0.13	0.13	NO	Max < UTL	n < 5	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	1	1	100%	110	110	NO	Max < UTL	n < 5	--	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	1	1	100%	24.4	24.4	NO	Max < UTL	n < 5	--	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	1	1	100%	49.6	49.6	NO	Max < UTL	n < 5	--	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	1	2	50%	9.08	9.08	YES	Max > UTL	n < 5	--	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	2	2	100%	6.48	13.5	NO	Max < UTL	n < 5	--	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	1	1	100%	0.339	0.339	YES	Max > UTL	n < 5	--	mg/Kg
IRON	10	10	100%	30500	46300	44000	1	1	100%	40300	40300	NO	Max < UTL	n < 5	--	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	1	1	100%	8.4	8.4	NO	Max < UTL	n < 5	--	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	1	2	50%	0.616	0.616	NO	Max < UTL	n < 5	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	1	2	50%	0.628	0.628	NO	Max < UTL	n < 5	--	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	1	2	50%	0.511	0.511	NO	Max < UTL	n < 5	--	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Manganese	10	10	100%	527	744	750	1	1	100%	719	719	NO	Max < UTL	n < 5	--	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	1	1	100%	0.35	0.35	NO	Max < UTL	n < 5	--	mg/Kg

Table B.6
Background Comparison-Domestic Septic System 5 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

Methoxychlor	1	23	4%	2.1	2.1	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
NICKEL	67	67	100%	143	503	330	1	1	100%	237	237	NO	Max < UTL	n < 5	--	mg/Kg
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	1	1	100%	0.758	0.758	N/A	N/A	n < 5	--	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	1	2	50%	11.6	11.6	NO	Max < UTL	n < 5	--	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	2	2	100%	0.2115	0.462	NO	Max < UTL	n < 5	--	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	1	1	100%	0.585	0.585	NO	Max < UTL	n < 5	--	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	1	1	100%	1.3	1.3	YES	Max > UTL	n < 5	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	1	2	50%	1.3125	1.3125	YES	Max > UTL	n < 5	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	1	2	50%	0.194	0.194	NO	Max < UTL	n < 5	--	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	1	2	50%	0.624	0.624	NO	Max < UTL	n < 5	--	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	1	2	50%	0.707	0.707	NO	Max < UTL	n < 5	--	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	1	2	50%	0.686	0.686	NO	Max < UTL	n < 5	--	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	1	2	50%	0.599	0.599	NO	Max < UTL	n < 5	--	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	1	0%	0	0	N/A	ND	n < 5	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	2	2	100%	0.0738	0.49	NO	Max < UTL	n < 5	--	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	1	2	50%	0.0631	0.0631	YES	Max > UTL	n < 5	--	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	2	3	67%	0.06195	0.506	NO	Max < UTL	n < 5	--	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	1	1	100%	65.8	65.8	NO	Max < UTL	n < 5	--	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	1	1	100%	82.3	82.3	NO	Max < UTL	n < 5	--	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.

-- - No Data

N/E - Not Established

N/A - Not applicable due to insufficient data

ND - Not Detected

GT BCKG - Greater than background

LT BCKG - Less than background

Table B.8
Background Comparison-Domestic Septic System 7 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 7 (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	2	2	100%	0.47	0.57	NO	Max < UTL	n < 5	--	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	--	--	--	--	--	YES	Max > UTL	Det < 50%	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	2	2	100%	8.2	8.6	NO	Max < UTL	n < 5	--	mg/Kg
BARIUM	49	49	100%	107	233	260	2	2	100%	240	270	YES	Max > UTL	n < 5	--	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	2	2	100%	0.4	0.45	NO	Max < UTL	n < 5	--	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	2	2	100%	0.32	0.33	NO	Max < UTL	n < 5	--	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	2	2	100%	0.306	0.322	NO	Max < UTL	n < 5	--	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	1	2	50%	0.003	0.003	NO	Max < UTL	n < 5	--	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	2	2	100%	9.7	22	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	2	2	100%	110	120	NO	Max < UTL	n < 5	--	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	2	2	100%	26	27	NO	Max < UTL	n < 5	--	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	2	2	100%	0.0083	0.009	YES	Max > UTL	n < 5	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	2	2	100%	59	60	NO	Max < UTL	n < 5	--	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	2	2	100%	6.6	9.9	YES	Max > UTL	n < 5	--	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	2	2	100%	13.4	17.3	YES	Max > UTL	n < 5	--	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
IRON	10	10	100%	30500	46300	44000	2	2	100%	36000	39000	NO	Max < UTL	n < 5	--	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	2	2	100%	8.9	9.3	NO	Max < UTL	n < 5	--	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	2	2	100%	3.2	4.1	YES	Max > UTL	n < 5	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	2	2	100%	0.476	0.482	NO	Max < UTL	n < 5	--	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	2	2	100%	0.356	0.391	NO	Max < UTL	n < 5	--	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Manganese	10	10	100%	527	744	750	2	2	100%	700	790	YES	Max > UTL	n < 5	--	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	1	2	50%	0.35	0.35	NO	Max < UTL	n < 5	--	mg/Kg

Table B.8
Background Comparison-Domestic Septic System 7 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

Constituent	Background (0-10)						Domestic Septic Tank 7 (0-10)					Greater than Background?	Rationale	Mann-Whitney Result	p	Units
	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect					
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
NICKEL	67	67	100%	143	503	330	2	2	100%	250	250	NO	Max < UTL	n < 5	--	mg/Kg
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	2	2	100%	30	120	N/A	N/A	n < 5	--	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	--	--	--	--	--	YES	Max > UTL	Det < 50%	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	2	2	100%	11.2	12.4	NO	Max < UTL	n < 5	--	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	4	4	100%	0.48	0.75	NO	Max < UTL	n < 5	--	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.05	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	2	2	100%	0.26	0.27	YES	Max > UTL	n < 5	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	2	2	100%	29	69	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	2	2	100%	0.138	0.162	NO	Max < UTL	n < 5	--	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	--	--	--	--	--	NO	Mann-Whitney	SAME	0.06	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	2	2	100%	0.35	0.5	NO	Max < UTL	n < 5	--	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	1	2	50%	0.0075	0.0075	NO	Max < UTL	n < 5	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	2	2	100%	0.04	0.1	YES	Max > UTL	n < 5	--	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	2	2	100%	64	66	NO	Max < UTL	n < 5	--	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	2	2	100%	85	92	YES	Max > UTL	n < 5	--	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.8
Background Comparison-Domestic Septic System 7 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 7 (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	2	2	100%	0.47	0.57	NO	Max < UTL	n < 5	--	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	--	--	--	--	--	YES	Max > UTL	Det < 50%	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	2	2	100%	8.2	8.6	NO	Max < UTL	n < 5	--	mg/Kg
BARIUM	49	49	100%	107	233	260	2	2	100%	240	270	YES	Max > UTL	n < 5	--	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	2	2	100%	0.4	0.45	NO	Max < UTL	n < 5	--	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	2	2	100%	0.32	0.33	NO	Max < UTL	n < 5	--	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	2	2	100%	0.306	0.322	NO	Max < UTL	n < 5	--	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	1	2	50%	0.003	0.003	NO	Max < UTL	n < 5	--	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	2	2	100%	9.7	22	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	2	2	100%	110	120	NO	Max < UTL	n < 5	--	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	2	2	100%	26	27	NO	Max < UTL	n < 5	--	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	2	2	100%	0.0083	0.009	YES	Max > UTL	n < 5	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	2	2	100%	59	60	NO	Max < UTL	n < 5	--	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	2	2	100%	6.6	9.9	YES	Max > UTL	n < 5	--	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	2	2	100%	13.4	17.3	YES	Max > UTL	n < 5	--	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
IRON	10	10	100%	30500	46300	44000	2	2	100%	36000	39000	NO	Max < UTL	n < 5	--	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	2	2	100%	8.9	9.3	NO	Max < UTL	n < 5	--	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	2	2	100%	3.2	4.1	YES	Max > UTL	n < 5	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	2	2	100%	0.476	0.482	NO	Max < UTL	n < 5	--	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	2	2	100%	0.356	0.391	NO	Max < UTL	n < 5	--	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
Manganese	10	10	100%	527	744	750	2	2	100%	700	790	YES	Max > UTL	n < 5	--	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	1	2	50%	0.35	0.35	NO	Max < UTL	n < 5	--	mg/Kg

Table B.8
Background Comparison-Domestic Septic System 7 (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank 7 (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
NICKEL	67	67	100%	143	503	330	2	2	100%	250	250	NO	Max < UTL	n < 5	--	mg/Kg
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	2	2	100%	30	120	N/A	N/A	n < 5	--	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	--	--	--	--	--	YES	Max > UTL	Det < 50%	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	2	2	100%	11.2	12.4	NO	Max < UTL	n < 5	--	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	4	4	100%	0.48	0.75	NO	Max < UTL	n < 5	--	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.05	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	2	2	100%	0.26	0.27	YES	Max > UTL	n < 5	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	2	2	100%	29	69	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	0	2	0%	0	0	NO	ND	n < 5	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	2	2	100%	0.138	0.162	NO	Max < UTL	n < 5	--	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	--	--	--	--	--	NO	Mann-Whitney	SAME	0.06	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	2	2	100%	0.35	0.5	NO	Max < UTL	n < 5	--	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	2	0%	0	0	N/A	ND	n < 5	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	1	2	50%	0.0075	0.0075	NO	Max < UTL	n < 5	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	2	2	100%	0.04	0.1	YES	Max > UTL	n < 5	--	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	--	--	--	--	--	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	2	2	100%	64	66	NO	Max < UTL	n < 5	--	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	2	2	100%	85	92	YES	Max > UTL	n < 5	--	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.9
Background Comparison-Domestic Septic System Dry Wells (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank Dry Wells (0-10)							Mann-Whitney Result		
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale		p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	10	10	100%	0.48	0.673	NO	Mann-Whitney	SAME	0.09	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	4	9	44%	0.77	6.2	N/A	N/A	Det < 50%	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	1	7	14%	0.0021	0.0021	NO	Max < UTL	Det < 50%	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	1	7	14%	1.13	1.13	N/A	N/A	Det < 50%	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	7	13	54%	0.69	1	NO	Max < UTL	Det < 50%	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	13	13	100%	5.9	10.8	YES	Mann-Whitney	GT BCKG	0.04	mg/Kg
BARIUM	49	49	100%	107	233	260	13	13	100%	148	253	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	13	13	100%	0.31	0.58	YES	Mann-Whitney	GT BCKG	0.01	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	10	10	100%	0.29	0.64	NO	Mann-Whitney	SAME	0.07	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	10	10	100%	0.417	0.68	NO	Mann-Whitney	SAME	0.16	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	3	13	23%	0.32	0.35	NO	Max < UTL	Det < 50%	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	3	10	30%	0.05	0.14	YES	Max > UTL	Det < 50%	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	5	10	50%	0.009	0.0775	NO	Mann-Whitney	SAME	0.19	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	3	3	100%	2.69	4.46	N/A	N/A	n < 5	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	13	13	100%	80.4	167	NO	Mann-Whitney	LT BCKG	0.01	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	13	13	100%	16.7	25.3	NO	Mann-Whitney	LT BCKG	0.02	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	1	10	10%	0.011	0.011	YES	Max > UTL	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	13	13	100%	30.5	52.4	YES	Mann-Whitney	GT BCKG	0.02	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	4	9	44%	0.76	6.7	N/A	N/A	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	10	10	100%	2.2	16.2	YES	Mann-Whitney	GT BCKG	0.01	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	10	10	100%	11.7	15.8	NO	Mann-Whitney	SAME	0.07	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	6	10	60%	0.112	0.971	NO	Mann-Whitney	SAME	0.16	mg/Kg
IRON	10	10	100%	30500	46300	44000	13	13	100%	30200	40300	YES	Mann-Whitney	GT BCKG	0.04	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	13	13	100%	5.5	14.4	NO	Mann-Whitney	SAME	0.16	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	5	10	50%	0.547	1.3	NO	Max < UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	10	10	100%	0.546	0.699	NO	Mann-Whitney	SAME	0.12	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	10	10	100%	0.492	0.73	NO	Mann-Whitney	SAME	0.16	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	13	13	100%	446	918	NO	Mann-Whitney	SAME	0.11	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	11	13	85%	0.09	1.4	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg

Table B.9
Background Comparison-Domestic Septic System Dry Wells (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Domestic Septic Tank Dry Wells (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
NICKEL	67	67	100%	143	503	330	13	13	100%	123	249	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	10	10	100%	0.744	23.5	NO	Mann-Whitney	SAME	0.32	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	0	7	0%	0	0	NO	ND	Det < 50%	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	10	10	100%	9.6	12.9	NO	Mann-Whitney	SAME	0.25	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	10	10	100%	0.43	0.675	YES	Mann-Whitney	GT BCKG	0.02	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	7	7	100%	0.568	0.673	NO	Mann-Whitney	SAME	0.07	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	5	13	38%	0.79	1.7	YES	Max > UTL	Det < 50%	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	9	13	69%	0.47	27.6	YES	Max > UTL	Det < 50%	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	6	10	60%	0.02	0.153	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	0	13	0%	0	0	NO	ND	Det < 50%	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	10	10	100%	0.146	0.22	NO	Mann-Whitney	SAME	0.09	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	7	7	100%	0.604	0.771	YES	Mann-Whitney	GT BCKG	0.00	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	7	7	100%	0.497	0.759	NO	Mann-Whitney	SAME	0.31	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	7	7	100%	0.325	0.875	YES	Mann-Whitney	GT BCKG	0.00	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	10	10	100%	0.502	1.05	YES	Mann-Whitney	GT BCKG	0.05	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	9	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	3	10	30%	0.012	0.051	NO	Max < UTL	Det < 50%	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	7	7	100%	0.486	0.57	YES	Mann-Whitney	GT BCKG	0.00	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	8	10	80%	0.0299	0.08	NO	Mann-Whitney	SAME	0.07	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	7	7	100%	0.461	0.599	YES	Mann-Whitney	GT BCKG	0.00	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	13	13	100%	56.8	82.9	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	13	13	100%	70.3	136	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.10
Background Comparison-Eastern Dog Pens (0-0.5)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background						Eastern Dog Pens (0-0.5)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
4,4'-DDE	8	10	80%	0.67	21	N/E	2	6	33%	0.3	6.4	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	2	6	33%	0.48	9.2	N/A	N/A	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	12	12	100%	0.426	0.6	NO	Mann-Whitney	SAME	0.05	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	4	6	67%	0.38	47.8	N/A	N/A	Det < 50%	--	ug/Kg
Americium-241	7	12	58%	0.007	0.047	0.014	--	--	--	--	--	YES	Max > UTL	N/A	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
BARIUM	49	49	100%	107	233	260	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	12	12	100%	0.269	0.49	NO	Mann-Whitney	LT BCKG	0.02	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	12	12	100%	0.371	0.461	NO	Mann-Whitney	SAME	0.07	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	0	6	0%	0	0	NO	ND	Det < 50%	--	pCi/g
Cesium-137	31	32	97%	0.013	0.132	0.043	9	12	75%	0.002	0.159	NO	Mann-Whitney	LT BCKG	0.01	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	6	6	100%	140	183	YES	Mann-Whitney	GT BCKG	0.02	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	3	12	25%	0.006	0.015	YES	Max > UTL	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	3	6	50%	0.76	223	N/A	N/A	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	1	6	17%	11.7	11.7	N/A	N/A	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	4	6	67%	0.4	43.4	N/A	N/A	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	6	6	100%	5.23	9.28	NO	Mann-Whitney	SAME	0.22	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	6	6	100%	12.3	15.3	NO	Mann-Whitney	SAME	0.28	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	5	6	83%	0.179	0.311	YES	Mann-Whitney	GT BCKG	0.04	mg/Kg
IRON	10	10	100%	30500	46300	44000	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
LEAD	11	11	100%	7	14.9	9.5	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	10	12	83%	0.26	2	YES	Max > UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	12	12	100%	0.465	0.604	NO	Mann-Whitney	LT BCKG	0.05	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	12	12	100%	0.458	0.532	NO	Mann-Whitney	SAME	0.12	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
MERCURY	30	30	100%	0.31	5.1	0.99	6	6	100%	0.26	0.6	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
NICKEL	67	67	100%	143	503	330	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg

Table B.10
Background Comparison-Eastern Dog Pens (0-0.5)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background						Eastern Dog Pens (0-0.5)							Mann-		
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Whitney Result	p	Units
Nitrate as Nitrogen (N)	10	10	100%	1.1	106	N/E	5	6	83%	0.475	1.05	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	--	--	--	--	--	YES	Max > UTL	N/A	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	12	12	100%	9.74	12.4	NO	Mann-Whitney	SAME	0.11	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	22	25	88%	0.08	1.68	NO	Mann-Whitney	SAME	0.18	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	6	6	100%	0.426	0.531	NO	Mann-Whitney	SAME	0.06	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	10	19	53%	0.0412	8.3	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	12	12	100%	0.137	0.19	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	6	6	100%	0.351	0.584	NO	Mann-Whitney	SAME	0.32	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	6	6	100%	0.347	0.698	NO	Mann-Whitney	SAME	0.15	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	6	6	100%	0.378	0.565	NO	Mann-Whitney	SAME	0.14	pCi/g
Thorium-234	6	8	75%	0.276	1.07	0.78	12	12	100%	0.31	0.88	NO	Mann-Whitney	SAME	0.41	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	0	8	0%	0	0	NO	ND	Det < 50%	--	pCi/g
Uranium-233/234	23	23	100%	0.375	0.606	0.68	6	6	100%	0.365	0.452	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Uranium-235	29	29	100%	0.0141	0.063	0.039	10	12	83%	0.0182	0.13	NO	Mann-Whitney	SAME	0.20	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	6	6	100%	0.378	0.447	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	--	--	--	--	--	YES	Max > UTL	N/A	--	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.11
Background Comparison-Eastern Dog Pens (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Eastern Dog Pens (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	7	37	19%	0.82	3.3	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	4	37	11%	0.3	6.4	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	6	37	16%	0.48	9.2	N/A	N/A	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	45	45	100%	0.306	0.618	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	37	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	13	37	35%	0.38	47.8	N/A	N/A	Det < 50%	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
BARIUM	49	49	100%	107	233	260	1	1	100%	22.8	22.8	NO	Max < UTL	n < 5	--	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	45	45	100%	0.192	0.49	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	45	45	100%	0.275	0.572	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	5	39	13%	0.0837	0.101	NO	Max < UTL	Det < 50%	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	34	45	76%	0.002	0.191	NO	Mann-Whitney	SAME	0.45	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	38	38	100%	6.5	251	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	1	1	100%	2	2	NO	Max < UTL	n < 5	--	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	3	45	7%	0.006	0.015	YES	Max > UTL	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	1	1	100%	2.2	2.2	NO	Max < UTL	n < 5	--	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	37	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	13	37	35%	0.76	223	N/A	N/A	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	2	37	5%	6.2	11.7	N/A	N/A	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	13	37	35%	0.4	43.4	N/A	N/A	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	39	39	100%	3.48	370	NO	Mann-Whitney	SAME	0.13	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	39	39	100%	7.16	86.7	NO	Mann-Whitney	SAME	0.15	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	0	37	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	36	39	92%	0.077	0.673	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
IRON	10	10	100%	30500	46300	44000	1	1	100%	3630	3630	NO	Max < UTL	n < 5	--	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	1	1	100%	0.56	0.56	NO	Max < UTL	n < 5	--	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	16	45	36%	0.26	2	YES	Max > UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	45	45	100%	0.314	0.648	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	45	45	100%	0.326	0.607	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	37	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	1	1	100%	161	161	NO	Max < UTL	n < 5	--	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	39	40	98%	0.09	14.6	NO	Mann-Whitney	SAME	0.41	mg/Kg
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	37	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
NICKEL	67	67	100%	143	503	330	1	1	100%	19.5	19.5	NO	Max < UTL	n < 5	--	mg/Kg

Table B.11
Background Comparison-Eastern Dog Pens (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Eastern Dog Pens (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	31	37	84%	0.351	10.1	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	0	2	0%	0	0	NO	ND	n < 5	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	45	45	100%	5.21	13.9	NO	Mann-Whitney	SAME	0.10	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	71	74	96%	0.08	1.68	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	39	39	100%	0.306	0.618	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	1	1	100%	0.42	0.42	NO	Max < UTL	n < 5	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	23	68	34%	0.023	8.3	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	45	45	100%	0.0875	0.219	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	39	39	100%	0.207	1.54	NO	Mann-Whitney	SAME	0.21	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	39	39	100%	0.218	1.26	NO	Mann-Whitney	SAME	0.05	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	39	39	100%	0.207	1.39	NO	Mann-Whitney	LT BCKG	0.02	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	44	45	98%	0.31	0.89	NO	Mann-Whitney	SAME	0.08	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	37	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	1	45	2%	1.21	1.21	YES	Max > UTL	Det < 50%	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	39	39	100%	0.245	0.513	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	41	45	91%	0.0096	0.13	NO	Mann-Whitney	SAME	0.32	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	39	39	100%	0.284	0.549	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	1	1	100%	3.8	3.8	NO	Max < UTL	n < 5	--	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	1	1	100%	6.9	6.9	NO	Max < UTL	n < 5	--	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.23
Background Comparison-Radium/Strontium Treatment System (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Radium/Strontium Treatment System (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	1	79	1%	0.49	0.49	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	6	79	8%	0.34	3.2	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	11	79	14%	0.39	133	N/A	N/A	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	85	85	100%	0.325	0.677	NO	Mann-Whitney	LT BCKG	0.01	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	79	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	32	79	41%	0.39	277	N/A	N/A	Det < 50%	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	23	85	27%	0.00177	0.0847	YES	Max > UTL	Det < 50%	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	3	3	100%	6	819	N/A	N/A	n < 5	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	2	34	6%	0.48	0.53	NO	Max < UTL	Det < 50%	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	79	79	100%	3.6	10	NO	Mann-Whitney	SAME	0.16	mg/Kg
BARIUM	49	49	100%	107	233	260	79	79	100%	84.7	317	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	79	79	100%	0.23	0.65	NO	Mann-Whitney	SAME	0.10	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	85	85	100%	0.219	0.451	NO	Mann-Whitney	LT BCKG	0.02	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	85	85	100%	0.292	0.554	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	26	79	33%	0.095	1.4	YES	Max > UTL	Det < 50%	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	22	85	26%	0.0281	2.38	YES	Max > UTL	Det < 50%	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	43	85	51%	0.00454	0.612	NO	Mann-Whitney	LT BCKG	0.01	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	79	79	100%	50.4	175	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	79	79	100%	10.6	30.6	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	1	85	1%	0.00562	0.00562	NO	Max < UTL	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	79	79	100%	19.9	182	YES	Mann-Whitney	GT BCKG	0.03	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	79	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	0	79	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	1	79	1%	2	2	N/A	N/A	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	32	79	41%	0.65	346	N/A	N/A	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	85	85	100%	2.17	11.1	YES	Mann-Whitney	GT BCKG	0.04	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	85	85	100%	9.79	24.6	NO	Mann-Whitney	SAME	0.23	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	0	79	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	51	79	65%	0.0624	0.841	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
IRON	10	10	100%	30500	46300	44000	61	61	100%	16500	45400	YES	Mann-Whitney	GT BCKG	0.05	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	99	99	100%	3.8	18	NO	Mann-Whitney	SAME	0.44	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	21	85	25%	0.334	1.13	NO	Max < UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	85	85	100%	0.357	0.74	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	85	85	100%	0.346	0.651	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	0	79	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	61	61	100%	276	895	NO	Mann-Whitney	SAME	0.11	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	79	79	100%	0.048	2.2	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	79	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
NICKEL	67	67	100%	143	503	330	80	80	100%	94.8	316	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg

Table B.23
Background Comparison-Radium/Strontium Treatment System (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Radium/Strontium Treatment System (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	94	96	98%	0.787	291	NO	Mann-Whitney	SAME	0.23	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	6	85	7%	0.335	0.682	YES	Max > UTL	Det < 50%	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	84	85	99%	7.11	14.4	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	85	85	100%	0.376	0.697	NO	Mann-Whitney	SAME	0.24	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	85	85	100%	0.325	0.677	NO	Mann-Whitney	LT BCKG	0.04	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	69	79	87%	0.52	2.1	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	25	79	32%	0.14	4.6	YES	Max > UTL	Det < 50%	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	41	90	46%	0.0151	2.18	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	5	79	6%	1.2	1.9	YES	Max > UTL	Det < 50%	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	85	85	100%	0.113	0.228	NO	Mann-Whitney	SAME	0.15	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	85	85	100%	0.314	1.12	YES	Mann-Whitney	GT BCKG	0.00	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	85	85	100%	0.306	1.09	NO	Mann-Whitney	SAME	0.24	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	85	85	100%	0.259	0.807	NO	Mann-Whitney	SAME	0.21	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	83	85	98%	0.333	0.956	NO	Mann-Whitney	SAME	0.38	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	79	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	0	85	0%	0	0	NO	ND	Det < 50%	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	85	85	100%	0.315	0.837	NO	Mann-Whitney	SAME	0.22	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	26	26	100%	0.0159	0.0378	NO	Mann-Whitney	LT BCKG	0.03	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	85	85	100%	0.324	0.825	NO	Mann-Whitney	SAME	0.34	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	79	79	100%	30.3	84.9	YES	Mann-Whitney	GT BCKG	0.01	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	79	79	100%	36.4	151	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.26
Background Comparison-Southwest Trenches (0-0.5)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background						Southwest Trenches (0-0.5)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
4,4'-DDE	8	10	80%	0.67	21	N/E	1	6	17%	1.7	1.7	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	1	6	17%	6.4	6.4	N/A	N/A	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	1	1	100%	0.457	0.457	NO	Max < UTL	n < 5	--	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	4	6	67%	0.71	1.6	N/A	N/A	Det < 50%	--	ug/Kg
Americium-241	7	12	58%	0.007	0.047	0.014	1	2	50%	3.22	3.22	YES	Max > UTL	n < 5	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	1	1	100%	1	1	NO	Max < UTL	n < 5	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	1	1	100%	8.6	8.6	NO	Max < UTL	n < 5	--	mg/Kg
BARIUM	49	49	100%	107	233	260	1	1	100%	174	174	NO	Max < UTL	n < 5	--	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	1	1	100%	0.5	0.5	NO	Max < UTL	n < 5	--	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	1	1	100%	0.291	0.291	NO	Max < UTL	n < 5	--	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	1	1	100%	0.518	0.518	NO	Max < UTL	n < 5	--	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
Cesium-137	31	32	97%	0.013	0.132	0.043	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	1	1	100%	121	121	NO	Max < UTL	n < 5	--	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	1	1	100%	23.1	23.1	NO	Max < UTL	n < 5	--	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	1	1	100%	41.5	41.5	NO	Max < UTL	n < 5	--	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	6	6	100%	0.64	6.5	N/A	N/A	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	1	1	100%	8.43	8.43	NO	Max < UTL	n < 5	--	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	2	2	100%	17.6	35	YES	Max > UTL	n < 5	--	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	3	6	50%	1	1.3	N/A	N/A	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	1	1	100%	0.0798	0.0798	YES	Max > UTL	n < 5	--	mg/Kg
IRON	10	10	100%	30500	46300	44000	1	1	100%	38700	38700	NO	Max < UTL	n < 5	--	mg/Kg
LEAD	11	11	100%	7	14.9	9.5	1	1	100%	7.3	7.3	NO	Max < UTL	n < 5	--	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	1	1	100%	0.583	0.583	NO	Max < UTL	n < 5	--	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	1	1	100%	0.584	0.584	YES	Max > UTL	n < 5	--	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	1	6	17%	0.58	0.58	N/A	N/A	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	1	1	100%	648	648	NO	Max < UTL	n < 5	--	mg/Kg
MERCURY	30	30	100%	0.31	5.1	0.99	1	1	100%	0.18	0.18	NO	Max < UTL	n < 5	--	mg/Kg
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
NICKEL	67	67	100%	143	503	330	1	1	100%	246	246	NO	Max < UTL	n < 5	--	mg/Kg

Table B.26
Background Comparison-Southwest Trenches (0-0.5)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background						Southwest Trenches (0-0.5)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
Nitrate as Nitrogen (N)	10	10	100%	1.1	106	N/E	1	1	100%	0.777	0.777	N/A	N/A	n < 5	--	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	1	1	100%	12.2	12.2	NO	Max < UTL	n < 5	--	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	1	1	100%	0.516	0.516	NO	Max < UTL	n < 5	--	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	1	1	100%	0.457	0.457	NO	Max < UTL	n < 5	--	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	1	1	100%	1.4	1.4	YES	Max > UTL	n < 5	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	0	1	0%	0	0	NO	ND	n < 5	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	1	1	100%	1.43	1.43	YES	Max > UTL	n < 5	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	1	1	100%	1.1	1.1	NO	Max < UTL	n < 5	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	1	1	100%	0.166	0.166	NO	Max < UTL	n < 5	--	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	1	1	100%	0.531	0.531	NO	Max < UTL	n < 5	--	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	1	1	100%	0.516	0.516	NO	Max < UTL	n < 5	--	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	1	1	100%	0.407	0.407	NO	Max < UTL	n < 5	--	pCi/g
Thorium-234	6	8	75%	0.276	1.07	0.78	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	6	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
Uranium-233/234	23	23	100%	0.375	0.606	0.68	1	1	100%	0.486	0.486	NO	Max < UTL	n < 5	--	pCi/g
Uranium-235	29	29	100%	0.0141	0.063	0.039	0	1	0%	0	0	NO	ND	n < 5	--	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	1	1	100%	0.51	0.51	NO	Max < UTL	n < 5	--	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	1	1	100%	69.7	69.7	NO	Max < UTL	n < 5	--	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	1	1	100%	73.4	73.4	NO	Max < UTL	n < 5	--	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.27
Background Comparison-Southwest Trenches (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Southwest Trenches (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	10	80	13%	1.1	99	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	25	80	31%	0.065	26.8	N/A	N/A	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	5	80	6%	3.7	276	N/A	N/A	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	66	67	99%	0.31	0.769	NO	Mann-Whitney	LT BCKG	0.03	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	0	80	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	54	80	68%	0.032	1700	N/A	N/A	Det < 50%	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	5	55	9%	0.0113	3.22	YES	Max > UTL	Det < 50%	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	18	67	27%	0.28	1.5	YES	Max > UTL	Det < 50%	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	67	67	100%	5.2	9.5	NO	Mann-Whitney	SAME	0.10	mg/Kg
BARIUM	49	49	100%	107	233	260	67	67	100%	111	286	YES	Mann-Whitney	GT BCKG	0.03	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	67	67	100%	0.27	0.64	NO	Mann-Whitney	SAME	0.44	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	65	67	97%	0.16	0.761	NO	Mann-Whitney	SAME	0.12	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	63	67	94%	0.349	0.622	NO	Mann-Whitney	SAME	0.27	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	0	67	0%	0	0	NO	ND	Det < 50%	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	31	69	45%	0.1	5.84	YES	Max > UTL	Det < 50%	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	15	69	22%	0.01	1.18	YES	Max > UTL	Det < 50%	--	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	12	12	100%	0.3	8.4	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	67	67	100%	58	314	NO	Mann-Whitney	SAME	0.46	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	67	67	100%	17.3	26.2	NO	Mann-Whitney	LT BCKG	0.01	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	6	67	9%	0.004	0.01	YES	Max > UTL	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	67	67	100%	24.5	51.5	NO	Mann-Whitney	SAME	0.41	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	1	80	1%	0.12	0.12	N/A	N/A	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	6	80	8%	0.41	70	N/A	N/A	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	1	80	1%	6	6	N/A	N/A	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	57	80	71%	0.12	1900	N/A	N/A	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	67	67	100%	0.5	12.5	NO	Mann-Whitney	SAME	0.27	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	69	69	100%	0.72	35	NO	Mann-Whitney	SAME	0.23	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	9	80	11%	0.87	3.8	N/A	N/A	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	38	67	57%	0.0798	1.06	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
IRON	10	10	100%	30500	46300	44000	67	67	100%	21000	44200	YES	Mann-Whitney	GT BCKG	0.01	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	67	67	100%	4.6	11	NO	Mann-Whitney	SAME	0.31	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	16	67	24%	0.12	1.61	YES	Max > UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	67	67	100%	0.398	0.76	NO	Mann-Whitney	SAME	0.21	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	67	67	100%	0.444	0.78	NO	Mann-Whitney	SAME	0.05	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	1	80	1%	0.58	0.58	N/A	N/A	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	67	67	100%	490	910	NO	Mann-Whitney	SAME	0.11	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	67	67	100%	0.1	6.1	NO	Mann-Whitney	LT BCKG	0.01	mg/Kg
Methoxychlor	1	23	4%	2.1	2.1	N/E	1	80	1%	1.1	1.1	N/A	N/A	Det < 50%	--	ug/Kg
NICKEL	67	67	100%	143	503	330	67	67	100%	86	420	NO	Mann-Whitney	SAME	0.13	mg/Kg

Table B.27
Background Comparison-Southwest Trenches (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Southwest Trenches (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	43	66	65%	0.22	485	NO	Mann-Whitney	LT BCKG	0.01	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	6	53	11%	0.338	0.517	YES	Max > UTL	Det < 50%	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	64	67	96%	9.85	15.3	NO	Mann-Whitney	SAME	0.38	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	80	81	99%	0.04	1.11	NO	Mann-Whitney	SAME	0.08	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	52	53	98%	0.383	0.769	NO	Mann-Whitney	SAME	0.22	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	17	67	25%	0.58	1.4	YES	Max > UTL	Det < 50%	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	8	67	12%	0.4	0.75	YES	Max > UTL	Det < 50%	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	31	68	46%	0.0498	15.7	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	9	9	100%	1.3	13	NO	Mann-Whitney	LT BCKG	0.01	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	--	--	--	--	--	N/A	N/A	N/A	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	6	67	9%	0.87	1.4	NO	Max < UTL	Det < 50%	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	67	67	100%	0.118	0.243	NO	Mann-Whitney	SAME	0.32	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	53	53	100%	0.336	0.894	YES	Mann-Whitney	GT BCKG	0.00	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	53	53	100%	0.28	1.12	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	53	53	100%	0.214	0.731	NO	Mann-Whitney	SAME	0.12	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	38	67	57%	0.06	1.54	NO	Mann-Whitney	SAME	0.43	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	80	0%	0	0	N/A	ND	Det < 50%	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	17	70	24%	0.0015	5.2	YES	Max > UTL	Det < 50%	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	53	53	100%	0.299	0.562	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	49	67	73%	0.01	0.136	NO	Mann-Whitney	LT BCKG	0.02	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	53	53	100%	0.303	0.593	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	67	67	100%	41	83.9	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	67	67	100%	48.6	150	YES	Mann-Whitney	GT BCKG	0.01	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.30
Background Comparison-Western Dog Pens (0-0.5)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background						Western Dog Pens (0-0.5)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	14	37	38%	0.14	3.8	N/A	No UTL	Det < 50%	--	ug/Kg
4,4'-DDE	8	10	80%	0.67	21	N/E	19	37	51%	1	21.1	NO	Mann-Whitney	SAME	0.05	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	20	37	54%	0.71	14.5	YES	Mann-Whitney	GT BCKG	0.02	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	48	48	100%	0.27	0.62	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	2	38	5%	0.75	11	N/A	No UTL	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	40	44	91%	0.55	680	N/A	No UTL	Det < 50%	--	ug/Kg
Americium-241	7	12	58%	0.007	0.047	0.014	--	--	--	--	--	N/A	--	N/A	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	8	9	89%	2	36.5	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	0	7	0%	0	0	N/A	ND	ND	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	7	7	100%	4.2	8.2	NO	Mann-Whitney	SAME	0.41	mg/Kg
BARIUM	49	49	100%	107	233	260	7	7	100%	89.6	168	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	6	7	86%	0.31	0.48	NO	Mann-Whitney	SAME	0.47	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	47	48	98%	0.08	0.573	NO	Mann-Whitney	SAME	0.30	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	47	48	98%	0.296	0.73	NO	Mann-Whitney	SAME	0.09	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	0	7	0%	0	0	N/A	ND	ND	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	7	39	18%	0.77	11.3	YES	Max > UTL	Det < 50%	--	pCi/g
Cesium-137	31	32	97%	0.013	0.132	0.043	26	48	54%	0.001	0.096	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	2	2	100%	1.2	7.2	N/A	No UTL	n < 5	--	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	14	14	100%	72	212	NO	Mann-Whitney	SAME	0.42	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	7	7	100%	11.7	22.5	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	6	48	13%	0.006	0.028	YES	Max > UTL	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	7	7	100%	18	39.8	NO	Mann-Whitney	LT BCKG	0.03	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	1	37	3%	1.4	1.4	N/A	No UTL	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	1	37	3%	1.3	1.3	N/A	No UTL	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	1	37	3%	1.1	1.1	N/A	No UTL	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	40	44	91%	0.39	849	N/A	No UTL	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	38	39	97%	1	16.5	YES	Mann-Whitney	GT BCKG	0.03	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	38	38	100%	9.8	22.3	YES	Mann-Whitney	GT BCKG	0.01	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	8	37	22%	0.65	13.4	N/A	No UTL	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	18	39	46%	0.049	1.02	YES	Max > UTL	Det < 50%	--	mg/Kg
IRON	10	10	100%	30500	46300	44000	7	7	100%	21000	41700	NO	Mann-Whitney	SAME	0.08	mg/Kg
LEAD	11	11	100%	7	14.9	9.5	7	7	100%	4.1	10.8	NO	Mann-Whitney	SAME	0.41	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	20	48	42%	0.2	3.3	YES	Max > UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	48	48	100%	0.317	0.744	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	48	48	100%	0.327	0.657	NO	Mann-Whitney	SAME	0.21	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	1	37	3%	1.8	1.8	N/A	No UTL	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	7	7	100%	512	882	NO	Mann-Whitney	SAME	0.25	mg/Kg
MERCURY	30	30	100%	0.31	5.1	0.99	36	39	92%	0.1	3.7	NO	Mann-Whitney	LT BCKG	0.01	mg/Kg
Methoxychlor	1	23	4%	2.1	2.1	N/E	0	38	0%	0	0	N/A	ND	ND	--	ug/Kg
NICKEL	67	67	100%	143	503	330	7	7	100%	109	318	NO	Mann-Whitney	LT BCKG	0.01	mg/Kg

Table B.30
Background Comparison-Western Dog Pens (0-0.5)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background						Western Dog Pens (0-0.5)							Mann-Whitney		
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Result	p	Units
Nitrate as Nitrogen (N)	10	10	100%	1.1	106	N/E	38	38	100%	0.21	34	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	--	--	--	--	--	N/A	--	N/A	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	48	48	100%	7.62	13.4	NO	Mann-Whitney	SAME	0.12	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	52	56	93%	0.11	1.08	NO	Mann-Whitney	LT BCKG	0.03	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	--	--	--	--	--	N/A	--	N/A	--	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	0	7	0%	0	0	N/A	ND	ND	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	0	7	0%	0	0	N/A	ND	ND	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	11	48	23%	0.05	5.66	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	2	2	100%	12	12	N/A	No UTL	n < 5	--	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	2	2	100%	6	8.8	N/A	No UTL	n < 5	--	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	0	7	0%	0	0	N/A	ND	ND	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	48	48	100%	0.112	0.272	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	--	--	--	--	--	N/A	--	N/A	--	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	--	--	--	--	--	N/A	--	N/A	--	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	--	--	--	--	--	N/A	--	N/A	--	pCi/g
Thorium-234	6	8	75%	0.276	1.07	0.78	30	48	63%	0.312	1.28	NO	Mann-Whitney	SAME	0.23	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	38	0%	0	0	N/A	ND	ND	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	2	7	29%	0.0105	0.012	NO	Max < UTL	Det < 50%	--	pCi/g
Uranium-233/234	23	23	100%	0.375	0.606	0.68	--	--	--	--	--	N/A	--	N/A	--	pCi/g
Uranium-235	29	29	100%	0.0141	0.063	0.039	11	48	23%	0.01	0.232	YES	Max > UTL	Det < 50%	--	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	14	32	44%	0.312	1.28	YES	Max > UTL	Det < 50%	--	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	7	7	100%	34.7	63.1	NO	Mann-Whitney	SAME	0.48	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	7	7	100%	45.9	130	NO	Mann-Whitney	SAME	0.16	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

Table B.31
Background Comparison-Western Dog Pens (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Western Dog Pens (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
4,4'-DDD	12	23	52%	0.38	5.2	N/E	28	166	17%	0.11	14.9	N/A	No UTL	Det < 50%	--	ug/Kg
4,4'-DDE	8	22	36%	0.67	21	N/E	62	166	37%	0.33	21.1	N/A	No UTL	Det < 50%	--	ug/Kg
4,4'-DDT	14	22	64%	0.33	10	N/E	63	166	38%	0.22	14.5	N/A	No UTL	Det < 50%	--	ug/Kg
Actinium-228	36	36	100%	0.31	0.778	0.64	167	173	97%	0.0814	0.781	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
alpha-BHC	2	23	9%	0.27	0.27	N/E	3	166	2%	0.37	11	N/A	No UTL	Det < 50%	--	ug/Kg
alpha-Chlordane	4	23	17%	0.48	4	N/E	150	214	70%	0.4	1210	N/A	No UTL	Det < 50%	--	ug/Kg
Americium-241	7	24	29%	0.007	0.047	0.014	2	5	40%	0.00585	0.00884	NO	Max < UTL	Det < 50%	--	pCi/g
Ammonia as Nitrogen (N)	8	10	80%	0.21	3.8	N/E	29	34	85%	0.61	36.5	YES	Mann-Whitney	GT BCKG	0.00	mg/Kg
ANTIMONY	1	30	3%	0.37	0.37	1.4	0	32	0%	0	0	N/A	ND	ND	--	mg/Kg
ARSENIC	11	11	100%	6.4	8.6	9.6	34	34	100%	4.2	8.8	NO	Mann-Whitney	SAME	0.16	mg/Kg
BARIUM	49	49	100%	107	233	260	34	34	100%	75.6	219	NO	Mann-Whitney	SAME	0.34	mg/Kg
Beryllium	48	48	100%	0.27	0.88	0.72	33	34	97%	0.23	0.55	NO	Mann-Whitney	SAME	0.45	mg/Kg
Bismuth-212	26	26	100%	0.263	0.656	0.43	161	173	93%	0.0456	0.71	NO	Mann-Whitney	SAME	0.31	pCi/g
Bismuth-214	38	38	100%	0.28	0.688	0.54	173	174	99%	0.114	1.09	NO	Mann-Whitney	SAME	0.35	pCi/g
CADMIUM	16	30	53%	0.07	0.42	0.51	5	34	15%	0.322	0.378	NO	Max < UTL	Det < 50%	--	mg/Kg
Carbon-14	5	29	17%	0.4	51.2	0.13	21	165	13%	0.3	11.3	YES	Max > UTL	Det < 50%	--	pCi/g
Cesium-137	47	75	63%	0.00532	0.275	0.012	67	173	39%	0.001	0.115	YES	Max > UTL	Det < 50%	--	pCi/g
CHLORIDE	11	11	100%	0.88	130	N/E	12	14	86%	0.57	13	NO	Mann-Whitney	LT BCKG	0.04	mg/Kg
CHROMIUM	68	68	100%	68.8	306	181	58	58	100%	72	273	NO	Mann-Whitney	LT BCKG	0.03	mg/Kg
COBALT	10	10	100%	20.4	30.3	31	34	34	100%	11.7	26.2	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Cobalt-60	6	37	16%	0.002	0.0265	0.006	16	173	9%	0.001	0.028	YES	Max > UTL	Det < 50%	--	pCi/g
COPPER	28	28	100%	20.1	63.8	60	34	34	100%	18	46.8	NO	Mann-Whitney	SAME	0.36	mg/Kg
delta-BHC	1	23	4%	2.4	2.4	N/E	1	166	1%	1.4	1.4	N/A	No UTL	Det < 50%	--	ug/Kg
DIELDRIN	3	23	13%	0.05	0.51	N/E	8	166	5%	0.28	3.7	N/A	No UTL	Det < 50%	--	ug/Kg
ENDRIN	1	23	4%	1.2	1.2	N/E	1	166	1%	1.1	1.1	N/A	No UTL	Det < 50%	--	ug/Kg
gamma-Chlordane	4	23	17%	0.41	3.6	N/E	150	214	70%	0.3	976	N/A	No UTL	Det < 50%	--	ug/Kg
Gross Alpha	30	30	100%	2.9	24.5	8.7	154	165	93%	1	16.5	NO	Mann-Whitney	SAME	0.15	pCi/g
Gross Beta	29	29	100%	9.54	18.4	15	163	164	99%	6.43	22.3	YES	Mann-Whitney	GT BCKG	0.05	pCi/g
Heptachlor epoxide	1	23	4%	0.43	0.43	N/E	18	166	11%	0.65	13.4	N/A	No UTL	Det < 50%	--	ug/Kg
Hexavalent Chromium	24	43	56%	0.0167	0.25	0.054	86	208	41%	0.034	1.17	YES	Max > UTL	Det < 50%	--	mg/Kg
IRON	10	10	100%	30500	46300	44000	34	34	100%	21000	46600	YES	Mann-Whitney	GT BCKG	0.04	mg/Kg
LEAD	29	29	100%	4.8	14.9	9.5	34	34	100%	4.1	10.8	NO	Mann-Whitney	SAME	0.38	mg/Kg
Lead-210	6	26	23%	0.703	2.49	1.6	54	173	31%	0.17	4.96	YES	Max > UTL	Det < 50%	--	pCi/g
Lead-212	37	37	100%	0.298	0.997	0.7	171	172	99%	0.185	0.75	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Lead-214	38	38	100%	0.299	0.928	0.58	172	172	100%	0.165	1.41	NO	Mann-Whitney	SAME	0.34	pCi/g
Lindane (gamma-BHC)	3	23	13%	0.28	0.56	N/E	2	166	1%	1	1.8	N/A	No UTL	Det < 50%	--	ug/Kg
Manganese	10	10	100%	527	744	750	34	34	100%	426	1010	NO	Mann-Whitney	SAME	0.26	mg/Kg
MERCURY	67	68	99%	0.14	5.1	0.63	177	197	90%	0.05	5.1	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Methoxychlor	1	23	4%	2.1	2.1	N/E	3	166	2%	2.4	3.3	N/A	No UTL	Det < 50%	--	ug/Kg
NICKEL	67	67	100%	143	503	330	34	34	100%	109	318	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg

Table B.31
Background Comparison-Western Dog Pens (0-10)
LEHR/SCDS Environmental Restoration
Davis, CA

	Background (0-10)						Western Dog Pens (0-10)									
Constituent	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	UTL	Number of Detects	Total Count	Det %	Minimum Detect	Maximum Detect	Greater than Background?	Rationale	Mann-Whitney Result	p	Units
Nitrate as Nitrogen (N)	28	28	100%	0.41	106	N/E	162	166	98%	0.11	85	NO	Mann-Whitney	LT BCKG	0.00	mg/Kg
Plutonium-241	2	24	8%	0.4	0.4	0.5	0	5	0%	0	0	N/A	ND	ND	--	pCi/g
Potassium-40	37	37	100%	8.3	15.4	14	173	173	100%	0.944	15.3	NO	Mann-Whitney	SAME	0.19	pCi/g
Radium-226	36	37	97%	0.26	0.83	0.75	202	215	94%	0.11	5.11	NO	Mann-Whitney	LT BCKG	0.01	pCi/g
Radium-228	26	26	100%	0.375	0.778	0.64	5	5	100%	0.472	0.513	NO	Mann-Whitney	SAME	0.07	pCi/g
SELENIUM	10	11	91%	0.23	1.4	1.2	12	34	35%	0.46	1.84	YES	Max > UTL	Det < 50%	--	mg/Kg
SILVER	1	30	3%	0.26	0.26	0.55	2	34	6%	0.097	0.1	NO	Max < UTL	Det < 50%	--	mg/Kg
Strontium-90	18	38	47%	0.0166	0.41	0.056	41	206	20%	0.02	5.66	YES	Max > UTL	Det < 50%	--	pCi/g
SULFATE	10	10	100%	2.6	130	N/E	14	14	100%	3.8	97	NO	Mann-Whitney	SAME	0.21	mg/Kg
SULFIDE	7	10	70%	0.55	18	N/E	11	14	79%	1.9	16	YES	Mann-Whitney	GT BCKG	0.03	mg/Kg
THALLIUM	6	30	20%	0.68	1.8	1.6	3	34	9%	2.48	4.34	YES	Max > UTL	Det < 50%	--	mg/Kg
Thallium-208	38	38	100%	0.095	0.306	0.22	172	172	100%	0.0335	0.272	NO	Mann-Whitney	LT BCKG	0.00	pCi/g
Thorium-228	48	48	100%	0.266	0.66	0.74	5	5	100%	0.555	1.02	YES	Mann-Whitney	GT BCKG	0.01	pCi/g
Thorium-230	49	49	100%	0.264	1.81	0.79	5	5	100%	0.518	0.821	NO	Mann-Whitney	SAME	0.31	pCi/g
Thorium-232	49	49	100%	0.216	0.67	0.75	5	5	100%	0.442	0.559	NO	Mann-Whitney	SAME	0.43	pCi/g
Thorium-234	23	26	88%	0.276	1.56	0.78	94	174	54%	0.312	1.67	NO	Mann-Whitney	SAME	0.36	pCi/g
Toxaphene	1	24	4%	340	340	N/E	0	166	0%	0	0	N/A	ND	ND	--	ug/Kg
TRITIUM	4	30	13%	0.0045	0.012	1.2	10	34	29%	0.0045	0.033	NO	Max < UTL	Det < 50%	--	pCi/g
Uranium-233/234	48	48	100%	0.355	0.625	0.68	5	6	83%	0.416	0.536	NO	Mann-Whitney	SAME	0.08	pCi/g
Uranium-235	66	66	100%	0.014	0.088	0.039	30	172	17%	0.01	0.317	YES	Max > UTL	Det < 50%	--	pCi/g
Uranium-238	48	48	100%	0.327	0.631	0.65	56	137	41%	0.312	1.67	YES	Max > UTL	Det < 50%	--	pCi/g
VANADIUM	11	11	100%	38.9	76.9	77	34	34	100%	34.7	77.5	YES	Mann-Whitney	GT BCKG	0.04	mg/Kg
ZINC	10	10	100%	37.6	87.2	87	34	34	100%	42.8	130	YES	Mann-Whitney	GT BCKG	0.02	mg/Kg

UTL - Upper tolerance limit, the 80 percent lower confidence limit of the 95th percentile.
-- - No Data
N/E - Not Established
N/A - Not applicable due to insufficient data
ND - Not Detected
GT BCKG - Greater than background
LT BCKG - Less than background

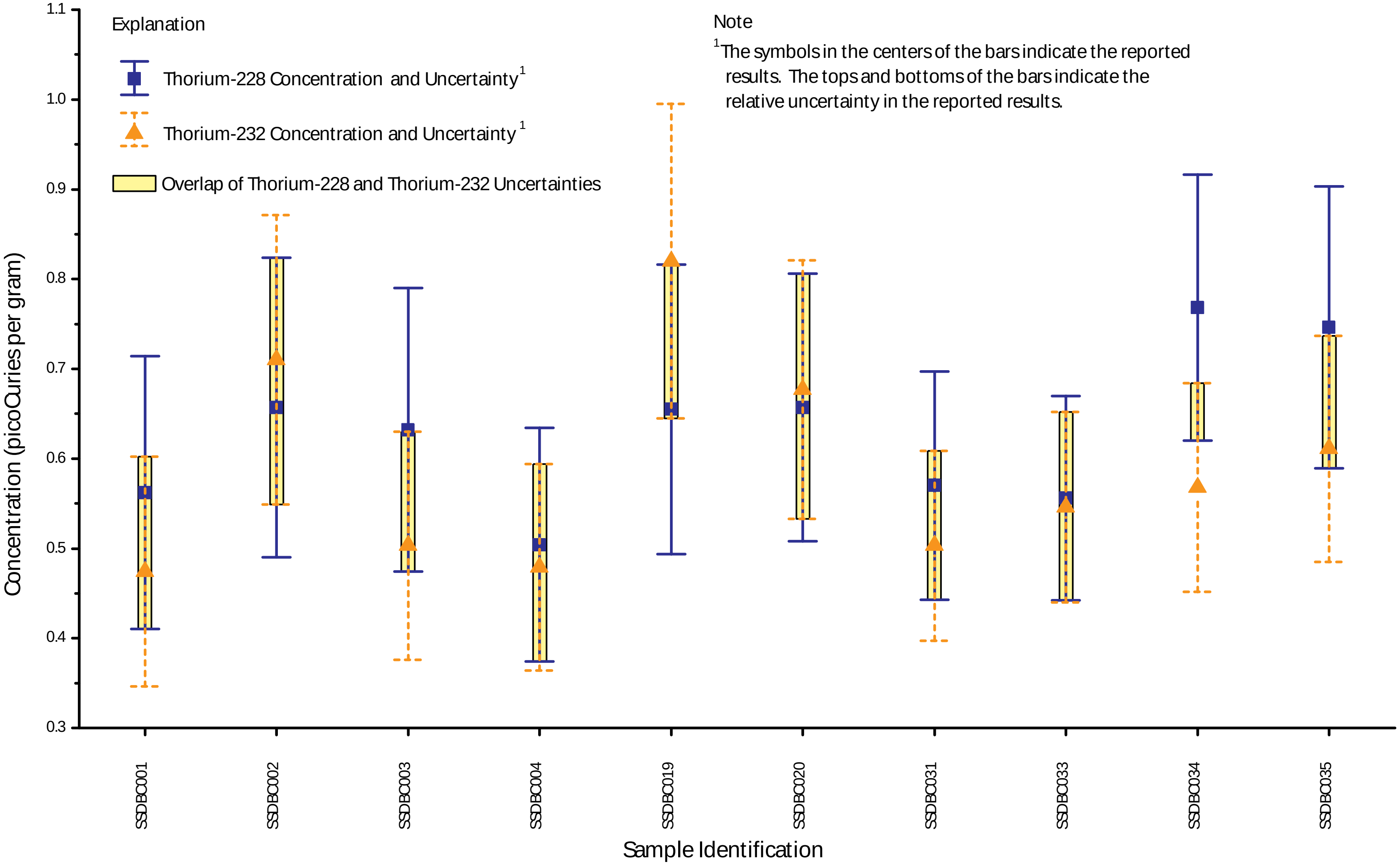

Figure E-2. Concentrations of Thorium-232 (parent) and Thorium-228 (daughter) Measured in Samples Collected from the DOE Box Area

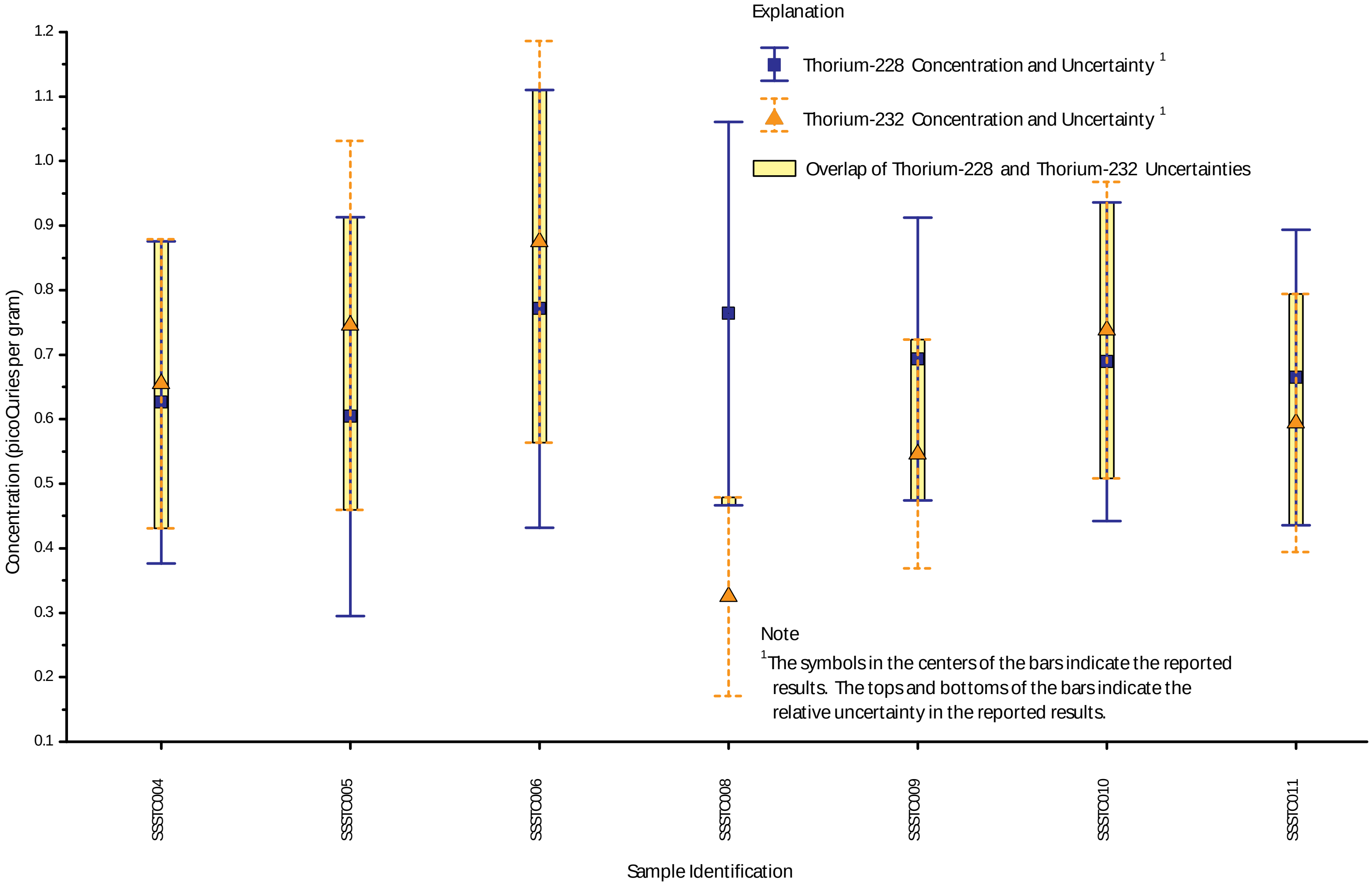

Figure E-7. Concentrations of Thorium-232 (parent) and Thorium-228 (daughter) Measured in Samples Collected from the Domestic Septic System Dry Wells A through E Area

Attachment G-2

RESRAD-OFFSITE Input Parameters

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Attachment G-2
RESRAD Input Parameters
Outdoor Researcher
LEHR/SCDS Environmental Restoration

Receptor	Outdoor Researcher
Pathways Selected	External Inhalation Soil 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	0.15 or 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 G-2
RESRAD Input Parameters
Outdoor Researcher
LEHR/SCDS Environmental Restoration

Receptor	Outdoor Researcher
Pathways Selected	External Inhalation Soil 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	25 yrs	USEPA, 2001
Indoor Dust Infiltration Rate	0.4	Default
External Gamma Shielding Factor	0.21	ANL, 2001b. Attachment C.
Indoor Time Fraction	0	
Outdoor Time Fraction	0.205	Based on 8 hour workday, 225 days/yr
Shape of Contaminated Zone	Circular	Default
Soil Ingestion	18.25 g/yr	USEPA, 2001
Household Water	0	Assumption that no water is pumped from site
Depth of Soil Mixing Layer	0.15 m	Default
Household Water	0	Assumption that no water is pumped from site
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
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	0.8333 1/hr	Assumes 10 ft ceiling
Building Room Height	3 m	Assumes 10 ft ceiling
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

Attachment G-2
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 G-2
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 G-2
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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