U.S. Department of Energy
Hanford Site

February 9, 2021

21-ECD-000462

Mr. David Bowen, Program Manager
Nuclear Waste Program
Washington State Department of Ecology
3100 Port of Benton Boulevard
Richland, Washington 99354

Dear Mr. Bowen:

SUBMITTAL OF THE ENGINEERING EVALUATION REPORT FOR THE LIQUID EFFLUENT RETENTION FACILITY GROUNDWATER MONITORING, SGW-41072, REV. 2

This letter transmits the Engineering Evaluation Report (EER) for the Liquid Effluent Retention Facility (LERF) groundwater monitoring program.

This EER was developed in support of the proposed project to construct LERF Basin 41. A Class 3 Permit Modification (C3-LERF/ETF-2020-01) for the Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste, for the LERF and 200 Area Effluent Treatment Facility Operating Unit Group 3, includes the new permit condition III.3.R.4 which requires an updated EER be submitted to the Washington State Department of Ecology (Ecology). The Class 3 (C3-LERF/ETF-2020-01) permit modification is still in processing, and the second public comment period is expected to begin February 22, 2021.

This updated EER has been reviewed and finalized in conjunction with Ecology personnel. The EER includes certifications on pages iii and v of the Attachment. The EER is not part of a permit modification but rather supporting information for the groundwater monitoring program at LERF.

If you have any questions, please contact me, or your staff may contact Chris Kemp, Director, Environmental Compliance Division, Office of River Protection, on (509) 420-4680.

Sincerely,

Brian T. Vance

Digitally signed by Brian T. Vance
Date: 2021.02.09 13:29:52 -08'00'

Brian T. Vance
Manager

ECD:RLE

Attachment

cc w/attach:
J. Cantu, Ecology
W. R. Faught, CPCCo
J. S. Ni, CPCCo
^Operating Record (MSA)
Administrative Record (S-2-8)
Environmental Portal
WRPS Correspondence

cc w/o attach:
J. Bell, NPT
R. Buck, Wanapum
A. S. Carlson, Ecology
L. Contreras, YN
S. L. Dahl, Ecology
D. Einan, EPA
J. L. Foster, WRPS
K. G. Hall, Ecology
J. T. Hamilton, WRPS
A. Mayenna, Ecology
M. Murphy, CTUIR
J. H. Temple, Ecology
S. A. Thompson, WRPS
E. J. Van Mason, WRPS
M. Woods, ODOE

Attachment
21-ECD-000462

Engineering Evaluation Report for the Liquid Effluent Retention Facility Groundwater Monitoring

(217 Pages Including Cover Sheet)

SGW-41072
Revision 2

Engineering Evaluation Report for the Liquid Effluent Retention Facility Groundwater Monitoring

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

SGW-41072
Revision 2

Engineering Evaluation Report for the Liquid Effluent Retention Facility Groundwater Monitoring

Date Published
January 2021

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

APPROVED
By Julia Raymer at 1:47 pm, Jan 12, 2021

Release Approval Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

U.S. Department of Energy (Owner/Operator) Certification

The following certification statement is provided for SGW-41072, Rev. 2, *Engineering Evaluation Report for the Liquid Effluent Retention Facility Groundwater Monitoring*, which serves as permit reference material for the Liquid Effluent Retention Facility closure unit permit application, permit WA7890008967, Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste (Site-Wide Permit), Revision 8C, Part III, OUG-3, Addendum D, "Groundwater Monitoring."

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Brian T. Vance Digitally signed by Brian T. Vance
Date: 2021.02.09 13:28:58 -08'00'

B. T. Vance
U.S. Department of Energy
Richland Operations Office
Owner/Operator

Date

This page intentionally left blank.

CH2M HILL Plateau Remediation Company (Co-Operator) Certification

The following certification statement is provided for SGW-41072, Rev. 2, *Engineering Evaluation Report for the Liquid Effluent Retention Facility Groundwater Monitoring*, which serves as permit reference material for the Liquid Effluent Retention Facility closure unit permit application, permit WA7890008967, Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste (Site-Wide Permit), Revision 8C, Part III, OUG-3, Addendum D, "Groundwater Monitoring."

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

L. T. Blackford
President
CH2M HILL Plateau Remediation Company
Co-Operator

1/14/2021
Date

This page intentionally left blank.

SGW-41072, Rev. 2

Statement of certification:

I am a licensed Professional Engineer in the State of Washington, No. 41198, with a degree in Environmental Engineering. I have over 28 years of professional experience, including 15 years with groundwater systems. I reviewed the attached engineering study referenced as "Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report, SGW-41072, Rev. 2, CH2M HILL Plateau Remediation Company, Richland, Washington" and I certify that it demonstrates completeness in compliance with WAC 173-303-806(4)(a).

January 7, 2021

Leonard D. Habel, P.E.
Environmental Engineer
CH2M HILL Plateau Remediation Company

Date

This page intentionally left blank.

Contents

1 Introduction 1-1

2 Supporting Historical Information 2-1

2.1 Background 2-1
2.1.1 Facility Description 2-1
2.1.2 Operational History 2-5
2.2 Regulatory Basis 2-5
2.3 Waste Characteristics 2-6
2.4 Monitoring Network and Sampling History 2-8

3 Geology and Hydrogeology 3-1

3.1 Stratigraphy 3-1
3.2 Hydrogeology 3-6
3.3 Groundwater Flow System 3-8

4 Contaminant Migration Conceptual Model 4-1

4.1 Vadose Zone 4-1
4.2 Soil Moisture Factors 4-1
4.3 Hydrogeologic Considerations 4-2
4.4 Groundwater Chemistry 4-2

5 Calculation Methods 5-1

5.1 Groundwater Elevation Evaluation Method Selection 5-1
5.2 Particle Tracking 5-3

6 Calculations 6-1

6.1 Assumptions and Inputs for Groundwater Elevation Analysis 6-1
6.2 Particle-Tracking Assumptions and Input 6-1
6.2.1 Particle Starting Locations 6-2
6.2.2 Migration Parameters 6-2
6.3 Calculation Steps 6-3
6.3.1 Groundwater Elevation Grids 6-3
6.3.2 Particle Tracking 6-4

7 Simulation Results and Conclusions 7-1

7.1 Groundwater Elevation Maps 7-1
7.2 Particle Pathlines 7-1
7.3 Monitoring Well Network Recommendations 7-8

8 Identification of Site-Specific Monitoring Constituents 8-1

8.1 Selection Process for Monitoring Constituents 8-1

8.1.1 Evaluation of Effluent Streams Previously Received at LERF 8-1
8.1.2 Evaluation of WTP Liquid Effluent 8-3
8.1.3 Evaluation of Effluent Streams Recently Received at LERF 8-4
8.2 Results of Selection of Groundwater Monitoring Constituents 8-5
9 Groundwater Monitoring 9-1
9.1 Final Status Groundwater Monitoring Program Determination 9-1
9.2 Point of Compliance Monitoring 9-1
9.3 Proposed Groundwater Monitoring Network 9-1
9.3.1 Groundwater Monitoring Well 299-E26-14 9-5
9.3.2 Groundwater Monitoring Well 299-E26-10 9-5
9.3.3 Groundwater Monitoring Well 299-E26-15 9-5
9.3.4 Groundwater Monitoring Well 299-E26-79 9-6
9.3.5 Groundwater Monitoring Well LERF_PW-1 9-6
9.3.6 Groundwater Monitoring Well LERF_PW-2 9-6
9.4 Constituent List and Frequency 9-7
9.5 Statistical Method 9-9
10 Routine Evaluation of the Monitoring Network 10-1
11 References 11-1

Appendices

A Liquid Effluent Retention Facility Monitoring Data Summary ..... A-i
B Topographic Map ..... B-i
C Plume Maps ..... C-i
D Well As-Built Diagrams and Proposed Well Locations ..... D-i
E Inventory Screening for the Liquid Effluent Retention Facility Basins ..... E-i
F Evaluation of Waste Treatment and Immobilization Plant Liquid Effluent Waste Constituents….. ..... F-i
G Updated Inventory Screening for the Liquid Effluent Retention Facility Basins, 2016 to 2019 ..... G-i

Figures

Figure 1-1. Location Map for LERF 1-2
Figure 2-1. Location of LERF and the 200 East Area 2-2
Figure 2-2. LERF Liner System Schematic 2-4
Figure 2-3. Wells Used During Interim Status Monitoring of LERF 2-10
Figure 3-1. General Stratigraphy at the Hanford Site 3-2
Figure 3-2. Southwest-to-Northeast Geologic Cross Section Showing the Stratigraphy Below LERF 3-3

Figure 3-3. Northwest-to-Southeast Geologic Cross Section Showing the Stratigraphy Below LERF 3-4
Figure 4-1. Major Ion Distribution in Groundwater at Wells in Vicinity of LERF (2009 Data) 4-4
Figure 4-2. Time Series of Changes in Total Dissolved Solids Load in Groundwater at Selected Wells in Vicinity of LERF 4-6
Figure 5-1. Groundwater Monitoring Network Evaluated for LERF 5-2
Figure 5-2. Particle Release Locations, Control Points, and Uniform Calculational Grid at LERF 5-4
Figure 7-1. Groundwater Elevation Map for LERF, 2017 7-2
Figure 7-2. Groundwater Elevation Map for LERF, 2018 7-3
Figure 7-3. Groundwater Elevation Map for LERF, 2019 7-4
Figure 7-4. Particle Paths – LERF, 2017 7-5
Figure 7-5. Particle Paths – LERF, 2018 7-6
Figure 7-6. Particle Paths – LERF, 2019 7-7
Figure 7-7. Final Monitoring Well Network for LERF 7-9
Figure 9-1. Proposed Final Status Groundwater Monitoring Network for LERF 9-3

Tables

Table 1-1. Pertinent Requirements 1-3
Table 2-1. Dangerous Wastes Identified for LERF in the Hanford Facility RCRA Permit Part A Application 2-7
Table 2-2. Interim Status and Final Status Monitoring Plans 2-9
Table 4-1. Range of Specific Conductance, Derived TDS, and Selected Ion Concentrations Observed in Well 299-E34-7 4-5
Table 6-1. Aquifer Transport Parameter Values 6-2
Table 8-1. Revised Monitoring Constituents Associated with Previous Effluent Streams 8-2
Table 8-2. Monitoring Constituents Associated with WTP Liquid Effluent 8-3
Table 8-3. Monitoring Constituents Associated with Recent Waste Effluent Received at LERF 8-5
Table 8-4. Proposed Monitoring Constituents for LERF 8-5
Table 9-1. Attributes for Wells in the LERF Groundwater Monitoring Network 9-4
Table 9-2. Monitoring Wells and Sample Schedule for LERF 9-8
Table 9-3. Proposed Monitoring Constituents for LERF 9-8

This page intentionally left blank.

Terms

AEA	*Atomic Energy Act of 1954*
bgs	below ground surface
CCU	Cold Creek unit
CY	calendar year
DOE	U.S. Department of Energy
DST	double-shell tank
DWMU	dangerous waste management unit
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ETF	Effluent Treatment Facility
HDPE	high-density polyethylene
HSU	hydrostratigraphic unit
K_d	distribution coefficient
LERF	Liquid Effluent Treatment Facility
MEUK	multi-event universal kriging
OU	operable unit
OUG	operating unit group
RCRA	*Resource Conservation and Recovery Act of 1976*
Rlm	Ringold lower mud unit
Rwia	Ringold Formation member of Wooded Island – unit A
Rwie	Ringold Formation member of Wooded Island – unit E
SALDS	State-Approved Land Disposal Site
TDS	total dissolved solids
TEDF	Treated Effluent Disposal Facility
TOC	total organic carbon
TOX	total organic halogen
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*

TRIM	Tikhonov Regularized Inverse Method
WTP	Waste Treatment and Immobilization Plant

1 Introduction

This engineering evaluation report provides information to support the revised final status groundwater monitoring for the Liquid Effluent Retention Facility (LERF) based on evaluation of contaminants associated with LERF and the expected migration behavior of contaminants in the unit. This evaluation includes results of groundwater flow and particle migration simulations that were performed based on water elevation mapping techniques. LERF is an active, final status operating unit permitted under WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (hereinafter referred to as the Hanford Facility RCRA Permit) within Operating Unit Group (OUG) 3. This report provides supporting documentation regarding the protection of groundwater required by the *Resource Conservation and Recovery Act of 1976* (RCRA) permitting process for final status facilities.

LERF is located adjacent to the northeast corner of the 200 East Area of the Hanford Site in Washington State and overlies the 200-BP-5 Groundwater Operable Unit (OU) (Figure 1-1). Since 1995, LERF and the 200 Area Effluent Treatment Facility (ETF) have operated together as an aqueous waste treatment system that provides storage and treatment for a variety of aqueous mixed waste. LERF comprises multiple surface impoundments (basins). ETF is also a part of OUG-3 and provides for treatment of aqueous waste in containers.

This revised report incorporates an additional fourth operating basin at LERF (Basin 41) into the groundwater monitoring evaluation, revises the monitoring constituents to account for the future acceptance of condensate effluent from the Waste Treatment and Immobilization Plant (WTP) (hereinafter referred to as WTP liquid effluent), and revises the format and content to align with other engineering evaluation reports for groundwater monitoring prepared for 200 Area units.

The analysis documented in this report complies with WAC 173-303-806, “Dangerous Waste Regulations,” “Final Facility Permits,” which outlines the contents of the Part B permit application pertinent to the protection of groundwater. WAC 173-303-806(4)(a)(xx)(E) requires the preparation of detailed plans and an engineering report describing the proposed monitoring program to meet the requirements of WAC 173-303-645(8), “Releases from Regulated Units,” “General Groundwater Monitoring Requirements.” WAC 173-303-645(8) requires a groundwater monitoring system consisting of a sufficient number of wells installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer. These samples are intended to represent the quality of background groundwater that has not been affected by the leakage from a regulated unit, represent the quality of groundwater passing the point of compliance, and allow for the detection of contamination when dangerous waste constituents have migrated from the dangerous waste management unit (DWMU) to the uppermost aquifer.

WAC 173-303-806(4)(a)(xx)(E) specifies that a detailed plan describing the proposed groundwater monitoring program be included in the Part B application with this engineering evaluation report. This engineering evaluation report provides the technical basis for the groundwater monitoring that will be described in that plan. As groundwater monitoring under the detection monitoring program (WAC 173-303-645(9)) will be performed along with the general monitoring requirements (WAC 173-303-645(8)), this engineering evaluation report also provides the supporting information for the detection monitoring requirements. When the revised groundwater monitoring plan associated with this network is modified into the Hanford Facility Dangerous Waste Permit, it will replace any other groundwater monitoring plans associated specifically with LERF under final status.

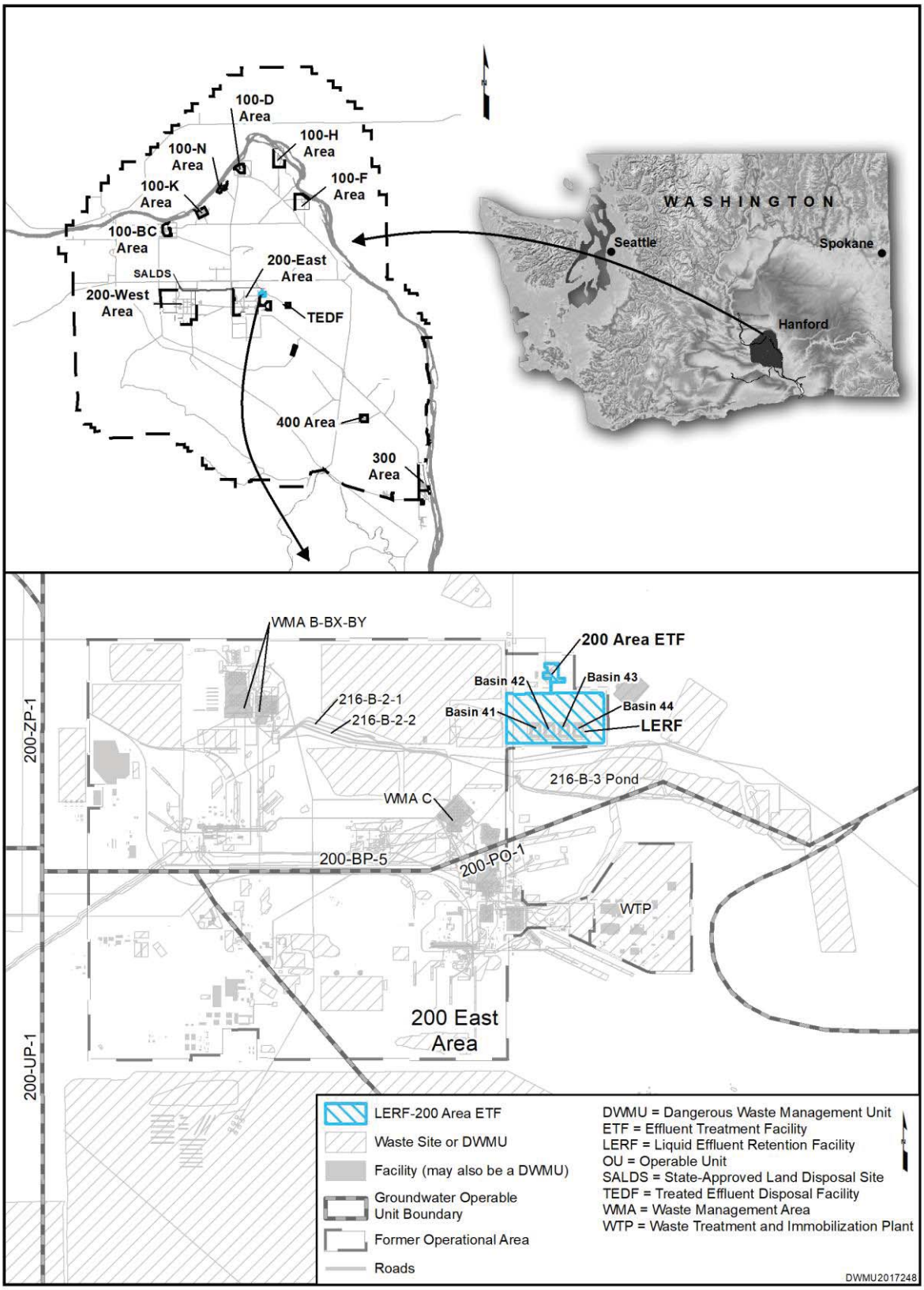


Figure 1-1. Location Map for LERF

In addition, this report provides information required by WAC 173-303-806(4)(a)(xx)(C) (topographic map), WAC 173-303-806(4)(a)(xx)(A) (summary of interim status groundwater monitoring data), and WAC 173-303-806(4)(a)(xx)(B) (hydrogeological information). Plume maps of regional contaminants in the area of the regulated unit are also provided.

Applicable groundwater monitoring requirements of WAC 173-303-645 and WAC 173-303-806(4)(a)(xviii) and (xx) are detailed in Table 1-1.

Table 1-1. Pertinent Requirements

Pertinent Requirement	Section Where Requirement is Addressed
WAC 173-303-806(4)(a)(xx)(A) A summary of the groundwater monitoring data obtained during the interim status period under 40 CFR 265.90 through 265.94, where applicable	Appendix A
WAC 173-303-806(4)(a)(xx)(B) Identification of the uppermost aquifer and aquifers hydraulically interconnected beneath the facility property, including groundwater flow direction and rate, and the basis for such identification (that is, the information obtained from hydrogeologic investigations of the facility area)	Section 3.2 Section 3.3
WAC 173-303-806(4)(a)(xx)(C) On the topographic map required under (a)(xviii) of this subsection, a delineation of the waste management area, the property boundary, the proposed "point of compliance" as defined under WAC 173-303-645(6), the proposed location of groundwater monitoring wells as required under WAC 173-303-645(8), and, to the extent possible, the information required in (a)(xx)(B) of this subsection	Appendix B
WAC 173-303-806(4)(a)(xx)(D)[a] A description of any plume of contamination that has entered the groundwater from a regulated unit at the time that the application was submitted that: (I) Delineates the extent of the plume on the topographic map required under (a)(xviii) of this subsection; (II) Identifies the concentration of each constituent throughout the plume or identifies the maximum concentrations of each constituent in the plume.	Appendix C
WAC 173-303-806(4)(a)(xx)(E) Detailed plans and an engineering report describing the proposed groundwater monitoring program to be implemented to meet the requirements of WAC 173-303-645(8)	Chapter 9

Table 1-1. Pertinent Requirements

Pertinent Requirement	Section Where Requirement is Addressed
WAC 173-303-806(4)(a)(xx)(F) If the presence of dangerous constituents has not been detected in the groundwater at the time of permit application, the owner or operator must submit sufficient information, supporting data, and analyses to establish a detection monitoring program which meets the requirements of WAC 173-303-645(9). This submission must address the following items specified under WAC 173-303-645(9): (I) A proposed list of indicator parameters, waste constituents, or reaction products that can provide a reliable indication of the presence of dangerous constituents in groundwater (II) A proposed groundwater monitoring system	Chapter 9
WAC 173-303-645(2)(a) Owners and operators subject to this section must conduct a monitoring and response program as follows: (iv) In all other cases, the owner or operator must institute a detection monitoring program under subsection (9) of this section.	Chapter 9
WAC 173-303-645(6)(a) The department will specify in the facility permit the point of compliance...at which monitoring must be conducted. The point of compliance is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units.	Section 9.2
WAC 173-303-645(8)(a) The groundwater monitoring system must consist of a sufficient number of wells, installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer that: (i) Represent the quality of background groundwater that has not been affected by leakage from a regulated unit; (ii) Represent the quality of groundwater passing the point of compliance. (iii) Allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer.	Section 9.3
WAC 173-303-645(8)(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must allow collection of representative groundwater samples. Wells must be constructed in such a manner as to prevent contamination of the samples, the sampled strata, and between aquifers and water bearing strata. Wells must meet the requirements applicable to resource protection wells, which are set forth in chapter WAC 173-160, “Minimum standards for construction and maintenance of wells.”	Section 9.3 Appendix D

Table 1-1. Pertinent Requirements

Pertinent Requirement	Section Where Requirement is Addressed
WAC 173-303-645(8)(h) The owner or operator will specify one of the following statistical methods to be used in evaluating groundwater monitoring data for each hazardous constituent which, upon approval by the department, will be specified in the unit permit. The statistical test chosen must be conducted separately for each dangerous constituent in each well. Where practical quantification limits (pqls) are used in any of the following statistical procedures to comply with (i)(v) of this subsection, the pql must be proposed by the owner or operator and approved by the department. Use of any of the following statistical methods must be protective of human health and the environment and must comply with the performance standards outlined in (i) of this subsection.	Section 9.5
WAC 173-303-645(8)(i) Any statistical method chosen under (h) of this subsection for specification in the unit permit must comply with [standards provided in WAC 173-303-645(8)(i)(i), (ii), (iii), (iv), (v), and (vi)] as appropriate.	Section 9.5
WAC 173-303-645(9)(a) The owner or operator must monitor for indicator parameters (e.g., pH, specific conductance, total organic carbon (TOC), total organic halogen (TOX), or heavy metals), waste constituents, or reaction products that provide a reliable indication of the presence of dangerous constituents in groundwater. The department will specify the parameters or constituents to be monitored in the facility permit, after considering the following factors: (i) The types, quantities, and concentrations of constituents in wastes managed at the regulated unit; (ii) The mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated zone beneath the waste management area; (iii) The detectability of indicator parameters, waste constituents, and reaction products in groundwater; and (iv) The concentrations or values and coefficients of variation of proposed monitoring parameters or constituents in the groundwater background.	Chapter 8 Chapter 9
WAC 173-303-645(9)(b) The owner or operator must install a groundwater monitoring system at the compliance point, as specified under subsection (6) of this section. The groundwater monitoring system must comply with subsection (8)(a)((ii), (b)[b], and (c) of this section.	Chapter 9

a. WAC 173-303-806(4)(a)(xx)(D), "Dangerous Waste Regulations," "Final Facility Permits," is not applicable because discharges from LERF have not created a contaminant plume in groundwater. However, plume maps of regional contaminants that are in the vicinity of LERF are included in Appendix C.

b. WAC 173-303-645(8)(b) "Releases from Regulated Units," is not applicable because LERF is one regulated unit. It is not being monitored as part of a group of regulated units.

LERF = Liquid Effluent Treatment Facility

Documented releases to the environment have not occurred at LERF. Details of the regulatory and groundwater monitoring history can be found in Chapter 2.

This report is organized as follows:

- Chapter 2 includes historical information to support the final status groundwater monitoring program determination.
- Chapter 3 describes the geology and hydrogeology of LERF.
- Chapter 4 describes the contaminant migration conceptual model.
- Chapter 5 describes groundwater flow simulations for the 200 East Area.
- Chapter 6 describes calculations performed to evaluate wells for the proposed LERF monitoring well network.
- Chapter 7 presents conclusions from the calculations performed in Chapters 5 and 6.
- Chapter 8 identifies the groundwater monitoring constituents of interest.
- Chapter 9 describes the proposed final status groundwater monitoring program.
- Chapter 10 describes how the monitoring well network will be maintained.
- Chapter 11 lists the references cited in this report.
- Appendix A contains the interim status groundwater monitoring data summary.
- Appendix B contains the topographic map.
- Appendix C contains regional plume maps in the vicinity of LERF.
- Appendix D contains well as-built diagrams.
- Appendix E contains the previous (Rev. 1) inventory screening for effluent accepted at LERF.
- Appendix F contains an evaluation of the WTP liquid effluent waste constituents.
- Appendix G contains an update to the inventory screening using effluent recently accepted at LERF.

2 Supporting Historical Information

2.1 Background

This chapter describes LERF and its operations, regulatory basis, waste characteristics, and interim status and previous final status groundwater monitoring history.

2.1.1 Facility Description

LERF is an operating facility comprising three lined surface impoundments (basins) that is located adjacent to the northeast corner of the 200 East Area of the Hanford Site (Figure 2-1). Construction of three basins at LERF (Basins 42, 43, and 44) was completed in 1991 using a dual-confinement barrier concept (i.e., dual basin liners and pipe-in-a-pipe transfer piping system) to minimize human exposure and the potential for accidental releases to the environment. A leachate detection, collection, and removal system and covers over the basins also reduce possible environmental or personnel exposure. The basins are located side by side, with 18 m (60 ft) of separation between each basin. Each basin is 100 by 82 m (330 by 270 ft), with a maximum fluid depth of 6.7 m (22 ft). Each of the three basins has an operating capacity of 29.5 million L (7.8 million gal) (Section C.1 in Addendum C of the Hanford Facility RCRA Permit).

Aqueous waste from LERF is pumped to ETF for treatment in a series of process units, or systems, that remove or destroy the dangerous waste constituents. The treated effluent is discharged to the State-Approved Land Disposal Site (SALDS) north of the 200 West Area.

The following description of LERF is from Section C.1 in Addendum C of the Hanford Facility RCRA Permit.

LERF receives aqueous waste through several inlets including the following:

- A pipeline that connects LERF with the 242-A Evaporator
- A pipeline from the 200 West Area
- A pipeline that connects LERF to the load-in station
- A series of sample ports located at each basin

Aqueous waste from LERF is pumped to the 200 Area ETF through one of two double-walled fiberglass transfer pipelines. Effluent from the 200 Area ETF also can be transferred back to the LERF through one of these transfer pipelines. These pipelines are equipped with leak detection located in the annulus between the inner and outer pipes. In the event that these leak detectors are not in service, the pipelines are visually inspected during transfers for leakage by opening the secondary containment drain lines located at the 200 Area ETF end of the transfer pipelines.

Each basin is equipped with six sample risers constructed of 15.2 cm (6 in.) perforated pipe. A seventh sample riser in each basin is dedicated to influent aqueous waste receipt piping (except for aqueous waste received from the 242-A Evaporator), and an eighth riser in each basin contains liquid-level instrumentation. The risers extend along the sides of each basin from the top to the bottom of the basin and allows samples to be collected from any depth.

Aqueous waste from the 242-A Evaporator is transferred through piping that ties into piping at the catch basins. Under routine operations, a submersible pump is used to transfer aqueous waste from a LERF basin to the 200 Area ETF for processing or for basin-to-basin transfers.

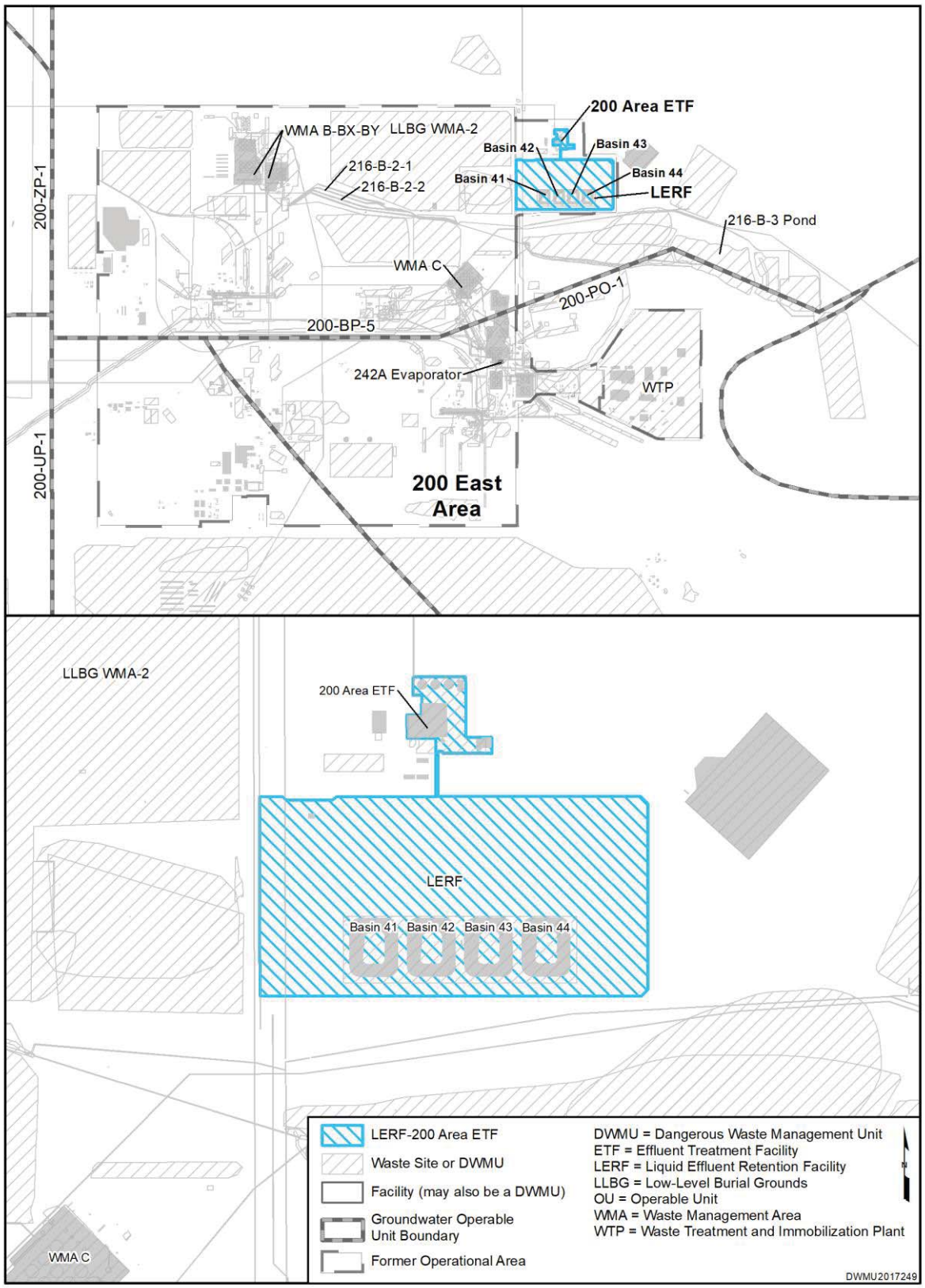


Figure 2-1. Location of LERF and the 200 East Area

Each basin consists of a multilayer liner system supported by a concrete anchor wall around the basin perimeter and a soil-bentonite clay underlayment. The multilayer liner system includes a primary liner in contact with the aqueous waste and a secondary liner that rests on the bentonite underlayment. Any aqueous waste leakage through the primary liner flows to a leachate collection system. The leachate flows to a sump at the northwest corner of each basin, where the leachate is pumped up the side slope and back into the basin above the primary liner. Each liner is constructed of high-density polyethylene (HDPE). A floating cover is stretched over each basin above the primary liner. These covers serve to keep unwanted material from entering the basins and minimize evaporation of the liquid contents.

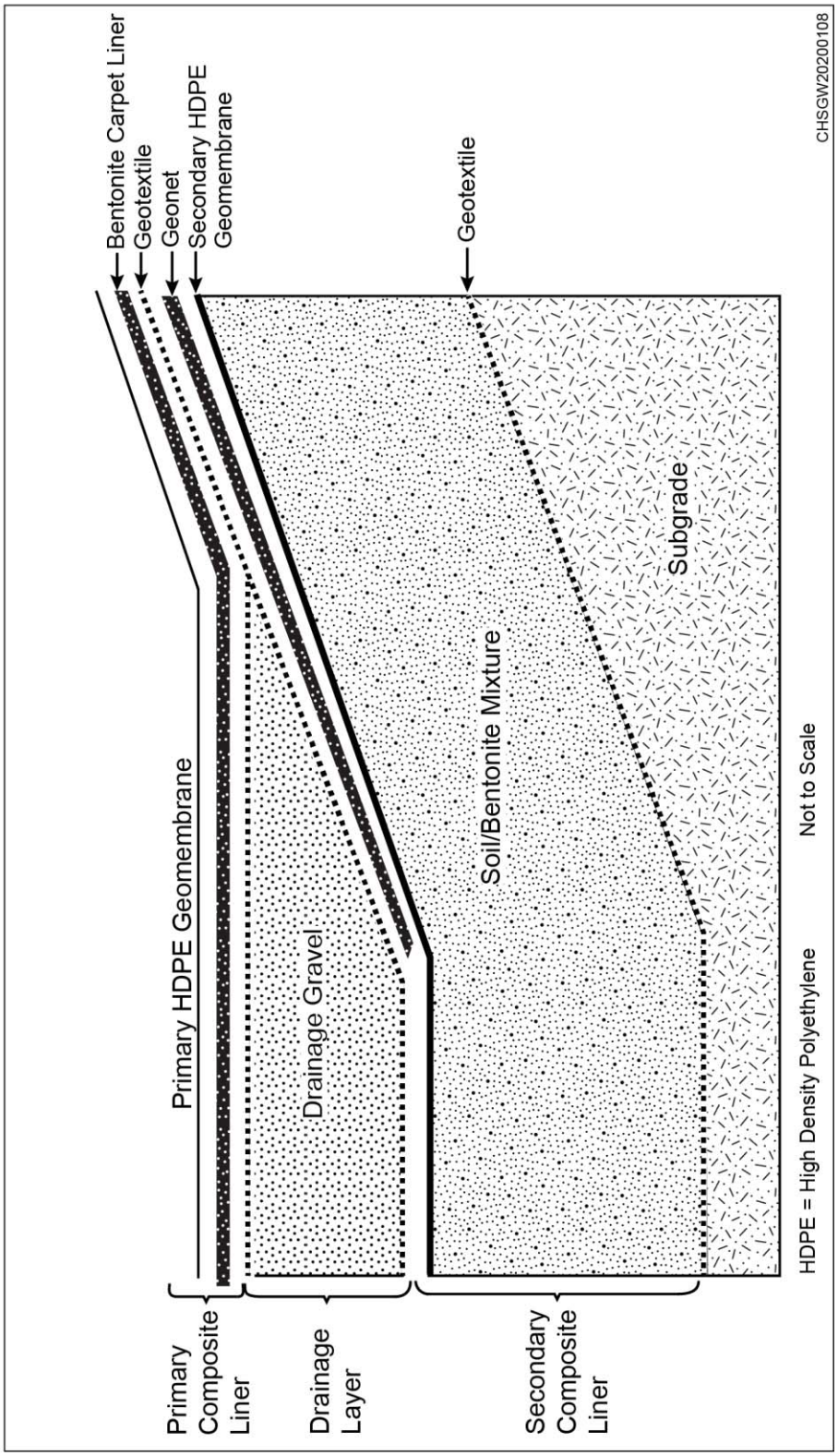
As described in Section C.5.2.1 of Addendum C of the Hanford Facility RCRA Permit, LERF employs a double-composite liner system with a leachate detection, collection, and removal system between the primary and secondary liners. Each basin is constructed with an upper or primary liner consisting of a HDPE geomembrane laid over a bentonite carpet liner. The lower or secondary liner in each basin is a composite of a geomembrane laid over a layer of soil/bentonite admixture.

Figure 2-2 provides a schematic of the liner system. The liner components, listed from the top to the bottom of the liner system, are the following:

- Primary 60-mil HDPE geomembrane
- Bentonite carpet liner
- Geotextile
- Drainage gravel (bottom) and geonet (sides)
- Geotextile
- Secondary 60-mil HDPE geomembrane
- Soil/bentonite admixture (3.0 ft [36 in.] on the bottom, 3.5 ft [42 in.] on the sides)
- Geotextile

The primary geomembrane, made of 60-mil (0.06 in.) HDPE, forms the basin surface that holds the aqueous waste. The secondary geomembrane, also 60-mil HDPE, forms a barrier surface for leachate that might penetrate the primary liner. The HDPE is chemically resistant to constituents in the aqueous waste and has a relatively high strength compared to other lining materials.

Since initial construction, LERF has consisted of three lined surface impoundment basins (Basins 42, 43, and 44). The location for the fourth basin (Basin 41) was excavated at the same time of the other basins, but was not completed. Completion of the fourth basin is now needed to provide additional capacity due to future receipt of double-shell tank (DST) condensate effluent (WTP liquid effluent) to be received at LERF from WTP. A 10.2 cm (4 in.) process condensate transfer line from WTP will be connected to LERF. The new waste stream will be conveyed to LERF and subsequently transferred to ETF for treatment.



Adapted from Figure C.16 in Addendum C of the Hanford Facility RCRA Permit.

Figure 2-2. LERF Liner System Schematic

2.1.2 Operational History

Waste management operations began at LERF and ETF in 1994 and 1995, respectively. LERF provides aqueous waste storage and treatment prior to final treatment in the 200 Area ETF. Treatment at LERF consists of flow and pH equalization (Section B.1.2 in Addendum B of the Hanford Facility RCRA Permit). The 200 Area ETF was intended and designed to treat a variety of mixed wastes. However, process condensate from the 242-A Evaporator was the only mixed waste initially identified for storage and treatment in the LERF and 200 Area ETF. As cleanup activities at the Hanford Site progressed, many of the aqueous wastes generated from site remediation and waste management activities were sent to LERF and 200 Area ETF for treatment and storage (Section B.1.2 in Addendum B of the Hanford Facility RCRA Permit).

2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, "Byproduct Material") stating that the hazardous waste components of mixed waste are subject to RCRA regulations. The hazardous waste components of mixed waste were determined to be subject to Washington State Department of Ecology (Ecology) authority to regulate these wastes since August 19, 1987.

In May 1989, DOE, the U.S. Environmental Protection Agency (EPA), and Ecology signed Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). This agreement established the roles and responsibilities of the agencies involved in regulating and controlling remedial restoration of the Hanford Site, which includes LERF. Groundwater monitoring is conducted at LERF in accordance with WAC 173-303-400(3), "Interim Status Facility Standards" (and, by reference, 40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring"), which requires monitoring to determine whether the dangerous waste constituents from LERF have entered the groundwater in the uppermost aquifer underlying LERF.

Dangerous waste is regulated under RCW 70.105, "Hazardous Waste Management," and its Washington State implementing regulations (WAC 173-303). Radionuclides in mixed waste may include "source, special nuclear, and byproduct materials" as defined in the *Atomic Energy Act of 1954* (AEA). The AEA states that these radionuclide materials are regulated at DOE facilities, exclusively by DOE, acting pursuant to its AEA authority. Radionuclide materials are not hazardous/dangerous wastes and, therefore, are not subject to regulation by the State of Washington under RCRA or RCW 70.105.

In 1990, groundwater monitoring at LERF was initiated, based on the interim status indicator evaluation program requirements of 40 CFR 265, Subpart F, and WAC 173-303-400. The unit was not yet constructed and the groundwater monitoring plan WHC-SD-EN-AP-024, *Interim Status Ground Water Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, Rev. 0, identified the locations for four planned wells (drilled in 1990) and sampling requirements to determine preoperational groundwater quality and establish critical means.

In 1994 and 1995, operation of LERF and the 200 Area ETF commenced, respectively. In 1998, LERF and the 200 Area ETF were incorporated as a final status unit in the Hanford Facility RCRA Permit; however, the final status monitoring plan was not yet approved and detection monitoring continued under the interim status plan. In 1999, one of the three downgradient wells became dry leaving the network with only two downgradient wells. Ecology granted a variance to the interim status monitoring requirement of three downgradient wells (Leja, 1999, "Variance from Interim Status Groundwater Monitoring Requirements at the Liquid Effluent Retention Facility") because of declining groundwater elevations in the vicinity and difficulty in siting a replacement downgradient well. However, in 2001, a second

downgradient well became dry, the variance was rescinded, and statistical evaluations of groundwater monitoring results were suspended (Goswami and Jamison, 2001, "Liquid Effluent Retention Facility (LERF) Unsaturated Zone Monitoring Alternatives Evaluation, Suspension of Groundwater Monitoring Statistical Evaluation Requirements, LERF RCRA Permit Modification, and Leachate Monitoring Performance Criteria").

In 2004, a groundwater evaluation plan (Attachment 34 in WA7890008967, 2004) was modified into the Hanford Facility RCRA Permit and two downgradient wells were drilled in 2008. In 2014, a new final status detection monitoring plan (DOE/RL-2013-46, Rev. 0, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*) was modified into the Hanford Facility RCRA Permit. Monitoring constituents included the indicator parameters as prescribed in 40 CFR 265.92(b)(3). Subsequent exceedances of the critical mean for specific conductance and pH occurred. In 2017, a revised monitoring plan (DOE/RL-2013-46, Rev. 1) was modified into the Permit that identified specific waste constituents for detection monitoring.

In 2020, plans to complete construction of Basin 41 at LERF are under way. The basin will provide additional capacity to process the future WTP liquid effluent waste stream. Addition of a new operating basin requires a reevaluation of groundwater monitoring system, which is provided in this report. A revised groundwater monitoring plan based on this report will be prepared and modified into the Hanford Facility RCRA Permit.

The Hanford Facility RCRA Permit specifies that final status groundwater monitoring program requirements will comply with WAC 173-303-645. This engineering evaluation report is prepared in accordance with WAC 173-303-806(4)(a)(xx)(E) and (F)(I) and (II) to implement the detection monitoring program requirements of WAC 173-303-645.

This engineering evaluation report also provides supporting information for Part B application general requirements of WAC 173-303-806(4)(a)(xx)(C) (topographic map), WAC 173-303-806(4)(a)(xx)(A) (summary of interim status groundwater monitoring data), and WAC 173-303-806(4)(a)(xx)(B) (hydrogeological information). Plume maps of regional contaminants in the vicinity of the regulated unit are provided.

2.3 Waste Characteristics

Aqueous wastes that are managed at LERF and 200 Area ETF include but are not limited to the following Hanford Site wastes (Section B.1.2 in Addendum B of the Permit):

- Contaminated groundwater from pump and treat remediation activities such as groundwater from the 200-UP-1 OU
- Purgewater from groundwater monitoring activities
- Water from deactivation activities, such as water from the spent fuel storage basins at deactivated reactors (e.g., 105N Reactor)
- Laboratory aqueous waste from unused samples and sample analyses
- Leachate from landfills, such as the mixed waste burial trenches
- Any dilute waste that may be accepted for treatment and within the scope of wastewaters that are delisted under terms of the revised delisting (40 CFR 261, Appendix IX, "Identification and Listing of Hazardous Waste," "Wastes Excluded Under 260.20 and 260.22," Table 2 incorporated by reference by WAC 173-303-910(3)), "Petitions."

Most of these aqueous wastes are accumulated in batches in LERF basins for interim storage and treatment through pH and flow equalization before final treatment in the 200 Area ETF. However, some aqueous wastes, such as 200-UP-1 OU groundwater, maybe treated on a flow-through basis in LERF en route to the 200 Area ETF for final treatment (Section B.1.2 in Addendum B of the Permit).

The 242-A process condensate is a dangerous waste because it is derived from a listed, dangerous waste stored in the Double-Shell Tank (DST) System (Section B.1.2 in Addendum B of the Permit). The DST waste is transferred to the 242-A Evaporator where the waste is concentrated through an evaporation process. The concentrated slurry waste is returned to the DST System; and the evaporated portion of the waste is recondensed, collected, and transferred as process condensate to LERF.

The WTP liquid effluent waste to be sent to LERF is a dangerous waste because it is derived from a listed, dangerous waste stored in the DST System (Section B.1.2 in 19-ECD-0069). The DST waste will be transferred to WTP for vitrification. Waste derived from the vitrification process will be transferred to the Effluent Management Facility (located at WTP) for additional treatment. The secondary waste from the Effluent Management Facility will be transferred to LERF for treatment at ETF. Aqueous waste from the analytical laboratory will also be transferred to LERF.

The dangerous wastes that may be managed at LERF are identified in the Hanford Facility RCRA Permit Part A Application (Table 2-1).

Table 2-1. Dangerous Wastes Identified for LERF in the Hanford Facility RCRA Permit Part A Application

Dangerous Waste Code	Contaminant Description*	Dangerous Waste Code	Contaminant Description*
D001	Ignitable waste	D034	Hexachloroethane
D002	Corrosive waste	D035	Methyl ethyl ketone
D003	Reactive waste	D036	Nitrobenzene
D004	Arsenic	D038	Pyridine
D005	Barium	D039	Tetrachloroethylene
D006	Cadmium	D040	Trichloroethylene
D007	Chromium	D041	2,4,5-Trichlorophenol
D008	Lead	D043	Vinyl chloride
D009	Mercury	F001	Spent halogenated solvents
D010	Selenium	F002	Spent halogenated solvents
D011	Silver	F003	Spent nonhalogenated solvents
D018	Benzene	F004	Spent nonhalogenated solvents
D019	Carbon tetrachloride	F005	Spent nonhalogenated solvents
D022	Chloroform	F039	Multisource leachate
D028	1,2-Dichloroethane	U210	Tetrachloroethylene
D029	1,1-Dichloroethylene	WT01	Extremely hazardous waste/toxic dangerous waste
D030	2,4-Dinitrotoluene	WT02	Dangerous waste/toxic dangerous waste

Table 2-1. Dangerous Wastes Identified for LERF in the Hanford Facility RCRA Permit Part A Application

Dangerous Waste Code	Contaminant Description*	Dangerous Waste Code	Contaminant Description*
D033	Hexachlorobutadiene	--	--

Source: WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology.

*Dangerous waste code contaminant descriptions are from WAC 173-303-090, "Dangerous Waste Regulations," "Dangerous Waste Characteristics"; WAC 173-303-104, "State-Specific Dangerous Waste Numbers"; and WAC 173-303-9904, "Dangerous Waste Sources List."

2.4 Monitoring Network and Sampling History

Table 2-2 identifies the interim status and final status groundwater monitoring plans implemented at LERF. Figure 2-3 provides the locations of wells discussed in this section. A summary of the monitoring history for LERF is presented in Appendix A. Appendix A also contains the interim status groundwater monitoring data collected at LERF network wells and meets the requirement of WAC 173-303-806(4)(a)(xx)(A). The status of the monitoring wells through the plans indicated in Table 2-2 is provided in Appendix A.

In 1990, the DOE initiated an interim status groundwater program at LERF as described in WHC-SD-EN-AP-024 (Rev. 0), prior to operation of the unit. The monitoring network included four planned wells (one upgradient and three downgradient) (Section 2.2 in WHC-SD-EN-AP-024, Rev. 0) and reported a groundwater flow direction to the west (Section 2.4.2 in WHC-SD-EN-AP-024, Rev. 0). Monitoring constituents included the contamination indicator parameters, groundwater quality parameters, and drinking water parameters required by 40 CFR 265.92(b), "Sampling and Analysis," and site-specific monitoring constituents (ammonium, iodine-129, and tritium) (Section 3.3.8 in WHC-SD-EN-AP-024, Rev. 0). In 1990, one upgradient well (299-E26-11) and three downgradient wells (299-E26-9, 299-E26-10, and 299-E35-2) were drilled (Section 12.2.1 in DOE/RL-91-03, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1990*).

Groundwater sampling was temporarily discontinued in June 1990 due to cancelation of the analytical laboratory contract. The Hanford Site sampling program resumed in June 1991 (Introduction in DOE/RL-92-03, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1991*). Sampling of the four LERF wells began in June 1991 (Section 13.2.2 in DOE/RL-92-03).

In 1991, a revision to the groundwater monitoring plan was issued to update the site-specific monitoring constituents to include aluminum, ammonium, and tritium (Table 3-1 in WHC-SD-EN-AP-024, Rev. 1, *Interim Status Groundwater Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*). In 1993, well 299-E26-9 was not able to be sampled due to declining water levels and was removed from the sampling schedule (Section 4.10.4 in DOE/RL-93-88, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*). However, sampling of the well began again in 1994 using equipment capable of obtaining samples in low-static water-level conditions (Section 4.8.4 in DOE/RL-94-136, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1994*).

In 1994 and 1995, operation of LERF and the 200 Area ETF commenced, respectively. In 1995, a change to WHC-SD-EN-AP-024, Rev. 1 (ECN 603891) was approved and revised the monitoring constituents by removing aluminum and adding 1-butanol, alkalinity, gross alpha, and gross beta.

In 1998, LERF was incorporated into the Hanford Facility RCRA Permit as a final status unit. PNNL-11620, *Liquid Effluent Retention Facility Final-Status Groundwater Monitoring Plan*, was submitted as the final status detection monitoring plan. The monitoring constituents in the final status plan included indicator constituents (nitrate, total organic carbon [TOC], total organic halogen [TOX], tritium, gross alpha, and gross beta), field parameters (pH, turbidity, temperature, and specific conductance), alkalinity, anions, and metals (filtered) (Table 4.1 in PNNL-11620). However, the final status monitoring plan was not yet approved by the regulators, and monitoring at LERF continued under the interim status plan (WHC-SD-EN-AP-024, Rev. 1 as revised by ECN 603891) (Section 5.10.2.9 in PNNL-12086, *Hanford Site Groundwater Monitoring for Fiscal Year 1998*).

Table 2-2. Interim Status and Final Status Monitoring Plans

Document	Date Issued	Monitoring Program[a]
WHC-SD-EN-AP-024, *Interim Status Ground Water Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, Rev. 0	1990	Interim Status Indicator Evaluation Program
WHC-SD-EN-AP-024, *Interim Status Ground Water Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, Rev. 1	1991	Interim Status Indicator Evaluation Program
Engineering Change Notice 603891, *Interim Status Groundwater Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*	1995	Interim Status Indicator Evaluation Program
PNNL-11620, *Liquid Effluent Retention Facility Final-Status Groundwater Monitoring Plan*; as modified into the Hanford Facility RCRA Permit, Rev. 0	1997	Final Status Detection Monitoring Program[b]
DOE/RL-2013-46, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*; as modified into the Hanford Facility RCRA Permit, Rev. 0	2013	Final Status Detection Monitoring Program
DOE/RL-2013-46, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*; as modified into the Hanford Facility RCRA Permit, Rev. 1	2017	Final Status Detection Monitoring Program

Note: Complete reference citations are provided in Chapter 11.

a. The indicator evaluation program satisfies the requirements of 40 CFR 265.92(b)(2), (b)(3), (d)(1), (d)(2) and (e), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." The final status detection monitoring program satisfies the requirements of WAC 173-303-645(9), "Releases from Regulated Units," "Detection Monitoring Program."

b. In 1998, LERF became a final status unit in Rev 4a of the Hanford Facility RCRA Permit; However, monitoring continued under WHC-SD-EN-AP-024, Rev. 1, because the final status groundwater monitoring plan was not yet approved by the regulators (Section 5.10.2.9 in PNNL-12086, *Hanford Site Groundwater Monitoring for Fiscal Year 1998*).

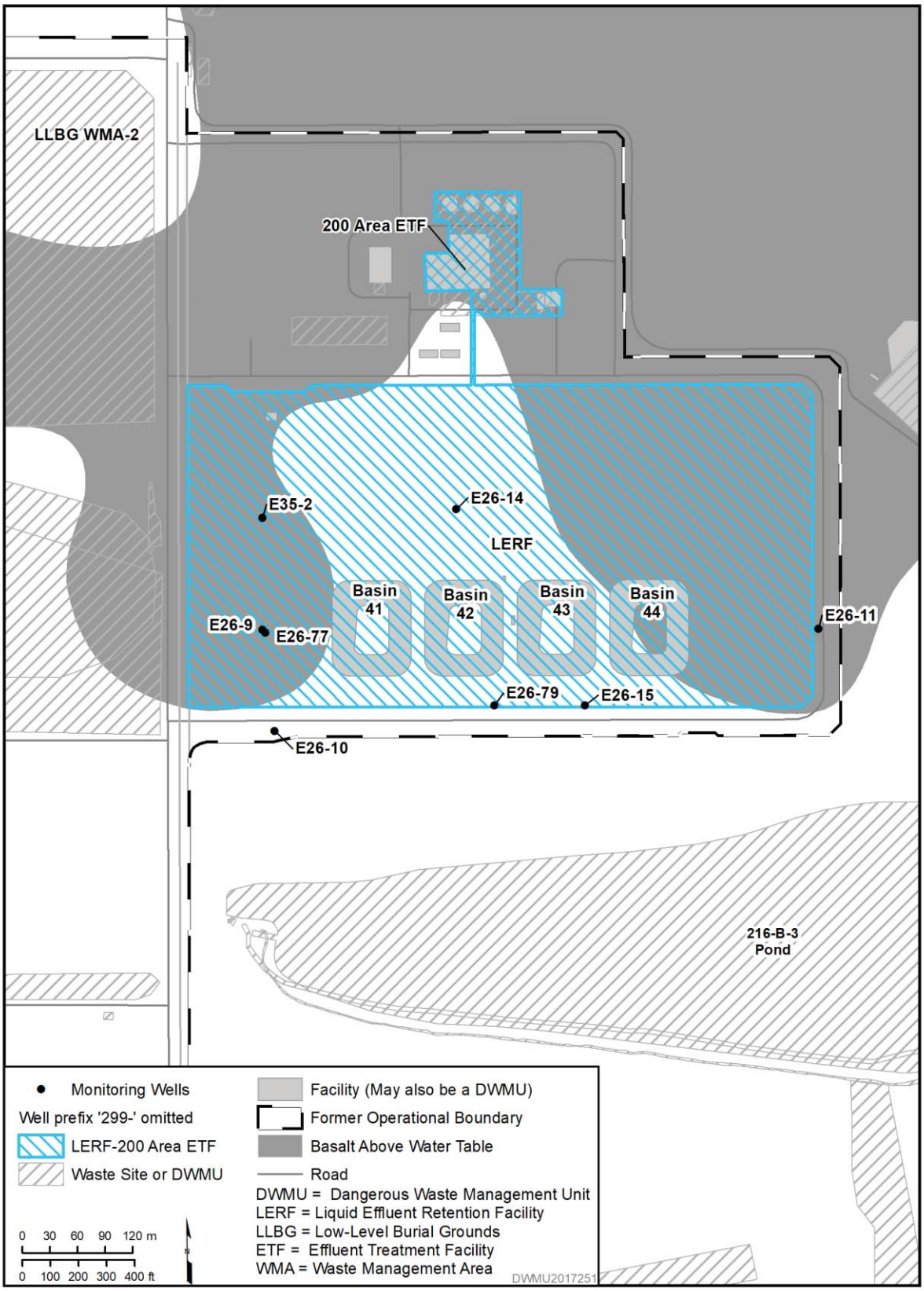


Figure 2-3. Wells Used During Interim Status Monitoring of LERF

In 1998, increased concentrations of calcium, magnesium, sodium, and sulfate were reported for the LERF network wells (Section 5.10.3.5 in PNNL-12086). Calcium, magnesium, and sulfate had been reported as progressively increasing in concentration since 1994. The report indicated that these results may indicate significant changes in groundwater chemistry.

In January 1999, the critical mean for specific conductance was exceeded at wells 299-E26-9 and 299-E26-10, and a groundwater quality assessment plan and report were submitted to Ecology in March 1999 (PNNL, 1999, *Groundwater Assessment Plan and Report for the 200 East Area Liquid Effluent Retention Facility*). The report concluded that LERF had not contributed to groundwater contamination based on (1) nitrate results from samples from LERF basins, (2) leachate results, and (3) current and historical groundwater results from the LERF network and regional monitoring wells (Chapter 3 in PNNL, 1999). The report recommended that the critical mean for specific conductance be re-established to more accurately reflect the background conditions at the unit (Chapter 3 in PNNL, 1999).

In July 1999, Ecology was notified that downgradient well 299-E26-9 was sample dry (Section 2.9.2.12 in PNNL-13116, *Hanford Site Groundwater Monitoring for Fiscal Year 1999*). In September, Ecology issued a variance from the interim status requirement of at least three downgradient wells in the monitoring network by allowing monitoring to proceed with only two downgradient wells (Leja, 1999, "Variance from Interim Status Groundwater Monitoring Requirements at the Liquid Effluent Retention Facility"). The variance was granted because of declining groundwater elevations in the vicinity and difficulty in siting a replacement downgradient well and was to be in effect for no longer than 18 months or until one the remaining wells became sample dry. By that time, a permanent method for monitoring was to be designed and implemented to fulfill final status requirements. PNNL-13116 reported that downgradient well 299-E35-2 had less than 1 m (3.3 ft) of water remaining and it was not known if samples from the well could be collected in the next 1-year period (Section 2.9.2.12 in PNNL-13116).

In January 2001, a second downgradient well (299-E35-2) became sample dry, leaving the network with one upgradient well (299-E26-11) and one downgradient well (299-E26-10), and the variance granted by Ecology was rescinded (Section 2.9.2.12 in PNNL-13404, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*). Ecology suspended statistical evaluations of groundwater monitoring and provided intent to modify the LERF permit to impose creation of an alternative monitoring program (Goswami and Jamison, 2001, "Liquid Effluent Retention Facility (LERF) Unsaturated Zone Monitoring Alternatives Evaluation, Suspension of Groundwater Monitoring Statistical Evaluation Requirements, LERF RCRA Permit Modification, and Leachate Monitoring Performance Criteria").

Between 2001 and 2004, DOE and Ecology evaluated alternative monitoring plans, developed and finalized a groundwater evaluation plan, and planned the implementation of the plan (Attachment 34, [WA7890008967, 2004]). In 2004, Ecology modified the Hanford Facility RCRA Permit by adding Attachment 34 which called for determining the groundwater flow characteristics of the unconfined aquifer, including an assessment of barometric pressure fluctuations in the LERF monitoring wells and the potential for these fluctuations to affect hydraulic gradient and groundwater flow direction determinations.

In 2007, SGW-35756, *Water-Level Barometric Response Analysis for the Liquid Effluent Retention Facility Monitoring Wells*, reported that the water-level response characteristics indicated that the aquifer is confined at well 299-E26-11 and unconfined at well 299-E26-10 (Chapter 5 in SGW-35756).

In 2008, two new downgradient wells were drilled, bringing the network to one upgradient well (299-E26-11) and three downgradient wells (299-E26-10, 299-E26-77, and 299-E26-79). In 2009, a characterization report was issued (SGW-41072, *Liquid Effluent Retention Facility Characterization*

Report, Rev. 0) to document the status of the groundwater investigation and site characterization activities at LERF.

In 2011, new upgradient well 299-E26-14 was drilled to acquire more hydrologic data (Section 3.4.13.4 in DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*). The well was to be sampled in 2012, followed by a characterization report to recommend whether the well should be added to the existing network. In 2011, the LERF network comprised one upgradient well (299-E26-11), three downgradient wells (299-E26-14, 299-E26-77, and 299-E26-79), and one well for evaluation (299-E26-14) (Table B-22 in DOE/RL-2011-118).

In 2012, the monitoring constituents were changed to include alkalinity, gross alpha, ammonium, anion, gross beta, metals, phenols, and volatile organic compounds (Table 3-23 in SGW-55438, *Hanford Site Groundwater Monitoring for 2012: Supporting Information*) based on the 1998 final status plan (PNNL-11620) that was previously modified into the permit.

In 2014, a revised final status detection monitoring plan for LERF (DOE/RL-2013-46, Rev. 0) was modified into the Hanford Facility RCRA Permit. The plan identified indicator parameters for statistically based comparisons and proposed a modified network, based on statistical evaluations of the water table gradient magnitude and flow direction. The dangerous constituents and indicators of groundwater contamination included carbon tetrachloride, pH, specific conductance, TOC, and TOX (Table D-7 in DOE/RL-2013-46, Rev. 1). Hexavalent chromium was included for sampling as a potential indicator parameter (Table D-7). Major anions, major cations, and alkalinity were sampled semiannually for geochemical evaluation (Table D-6). For detection monitoring, the network included upgradient well 299-E26-14 and downgradient well 299-E26-79, and a planned downgradient well (299-E26-15) (Sections D1 and D3.4 in DOE/RL-2013-46, Rev. 1). Wells 299-E26-10 and 299-E26-77 were included for water-level measurements only (Section D1). Also in 2014, TOC values had risen significantly in upgradient well 299-E26-14, and additional analyses were planned for 2015 to characterize the source of the carbon (Section 9.10.4 in DOE/RL-2015-07, *Hanford Site Groundwater Monitoring Report for 2014*).

In 2015, DOE notified Ecology of increased TOC values in upgradient well 299-E26-14 (15-AMRP-0149, "Notification of Upward Trending Total Organic Carbon Background Concentrations in Groundwater at the Liquid Effluent Retention Facility"). Based on the additional characterization analyses performed for the well, the most likely cause was dissolved organic matter, such as fulvic and/or humic acids (Section 2.11 in DOE/RL-2016-12, *Hanford Site RCRA Groundwater Monitoring Report for 2015*). Also in 2015, well 299-E26-15 was drilled; sampling of the well was to begin in 2016 (Section 2.11 in DOE/RL-2016-12).

In 2016, specific conductance exceeded the critical mean at well 299-E26-15. DOE notified Ecology of the exceedance on August 22, 2016 (16-AMRP-0252, "Notification of Groundwater Sampling Results Exceeding Specific Conductance for the Liquid Effluent Retention Facility 2013 Monitoring Well Network Plan Per 40 CFR 265.93(2)(d)(1)"), and verification samples were collected at the well in September. The average results for the field and two laboratory split samples were below the critical mean. A demonstration report concluded that LERF did not cause the exceedance; it was likely caused by analytical error (Chapter 1 in DOE/RL-2016-71, *Demonstration of Other Source or Natural Variation Causing Elevated Specific Conductance in Groundwater at the Liquid Effluent Retention Facility (LERF) Point of Compliance*). The report recommended revising the monitoring plan for LERF (Chapter 4 in DOE/RL-2016-71).

In the July 2017 sampling event, two indicator parameters (pH at well 299-E26-79 and specific conductance at well 299-E26-15) appeared to have exceeded critical mean values in downgradient wells (Section 2.10 in DOE/RL-2017-65, *Hanford Site RCRA Groundwater Monitoring Report for 2017*). DOE notified Ecology and proceeded with verification sampling activities. However, Ecology concluded that no exceedance had occurred based on the following factors (Section 2.10 in DOE/RL-2017-65):

- DOE demonstrated that longer well purging is required at well 299-E26-79 to obtain a representative pH measurement. Because the pH measurement was within the appropriate pH range of results, there was no exceedance.
- Well 299-E26-15 was not yet part of the LERF well network in August 2017, so data from the well did not yet pertain to the LERF groundwater monitoring program.

Average specific conductance also exceeded the critical mean value in upgradient well 299-E26-14 in July 2017.

In November 2017, a revised groundwater monitoring plan for LERF (DOE/RL-2013-46, Rev. 1) was modified into the Hanford Facility RCRA Permit. Monitoring constituents included waste constituents (as required under WAC 173-303-645(9)(a)) (1-butanol, carbon tetrachloride, hexavalent chromium, and n-nitrosodimethylamine); regional upgradient constituents (nitrate and sulfate); well casing/groundwater quality parameters (metals and alkalinity); and field parameters (dissolved oxygen, oxidation reduction potential, pH, temperature, and turbidity) each of which were to be sampled quarterly for the first 2 years of monitoring to establish new baseline concentrations, followed by semiannual sampling (Table D-7 in DOE/RL-2013-46, Rev. 1). If any waste constituents were detected at downgradient wells in the first 2 years of sampling then an immediate sample for the volatile organic compounds (if 1-butanol or carbon tetrachloride was detected), metals (if hexavalent chromium was detected), or semivolatile organic compounds (if n-nitrosodimethylamine was detected) identified in Table D-8 would be collected (Section D.3.1.1). The monitoring network included one upgradient well (299-E26-14) and two downgradient (point of compliance) wells (299-E26-15 and 299-E26-79) (Table D-7 and Section D.3.2 in DOE/RL-2013-46, Rev. 1). Wells 266-E26-10 and 299-E26-77 were included for water-level measurement only (Table D-7 and Section D.3.1 in DOE/RL-2013-46, Rev. 1).

In 2018, quarterly sampling to determine baseline conditions began under the revised plan. Concentrations of the waste constituents (1-butanol, carbon tetrachloride, hexavalent chromium, and n-nitrosodimethylamine) were less than laboratory detection in 2018 (Section 2.10 in DOE/RL-2018-65, *Hanford Site RCRA Groundwater Monitoring Report for 2018*). Nitrate was greater than the 45 mg/L drinking water standard in upgradient well 299-E26-14 and downgradient well 299-E26-79 due to a regional plume. Sulfate was elevated throughout the eastern part of the 200 East Area, and concentrations were above the 250 mg/L federal secondary drinking water standard at well 299-E26-15 (Section 2.10 in DOE/RL-2018-65).

This page intentionally left blank.

3 Geology and Hydrogeology

This chapter describes the local geology and hydrogeology beneath LERF and is intended to provide a brief overview of the current understanding of the site. The information provided is summarized from several sources, including Chapter 3 in SGW-41702, Rev. 1, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report*; Section 3.1.3 in WHC-SD-EN-TI-012, *Geologic Setting of the 200 East Area*: *An Update*; Section 5.4.1.1 in WHC-SD-EN-TI-019, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*; Section 2.5 in PNNL-19277, *Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex)*; and Section 4.3.1 in WHC-MR-0204, *200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary Report*. The information provided in the following sections is in alignment with ECF-HANFORD-13-0029, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington*, Rev. 5, and CP-60925, *Model Package Report: Central Plateau Vadose Zone Geoframework, Version 1.0*.

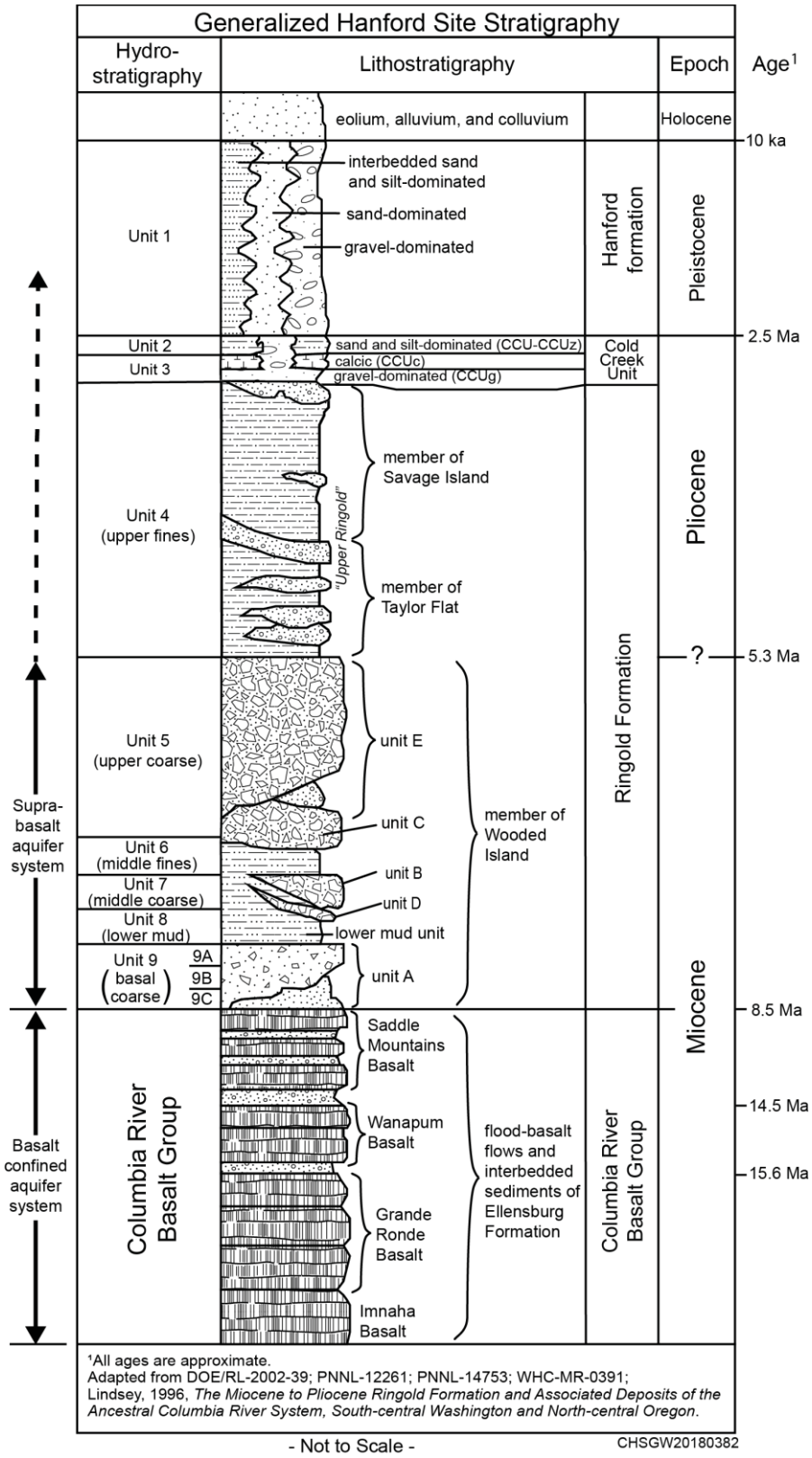
In addition, Chapter 3 in PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington;* Section 2.2 in SGW-54165, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site*; and Chapter 4.0 in WHC-SD-EN-TI-012 provide information on the hydrogeology of the 200 East Area and vicinity.

3.1 Stratigraphy

The generalized stratigraphy of the Hanford Site is shown in Figure 3-1. Geologic cross sections that include selected wells near LERF show the geologic units underlying the area (Figures 3-2 and 3-3). The stratigraphy beneath LERF consists of approximately 60 to 69 m (198 to 225 ft) of unconsolidated to semiconsolidated sediments overlying basalt bedrock of the Columbia River Basalt Group (Figures 3-2 and 3-3). The sedimentary units present beneath LERF are (from youngest to oldest) as follows:

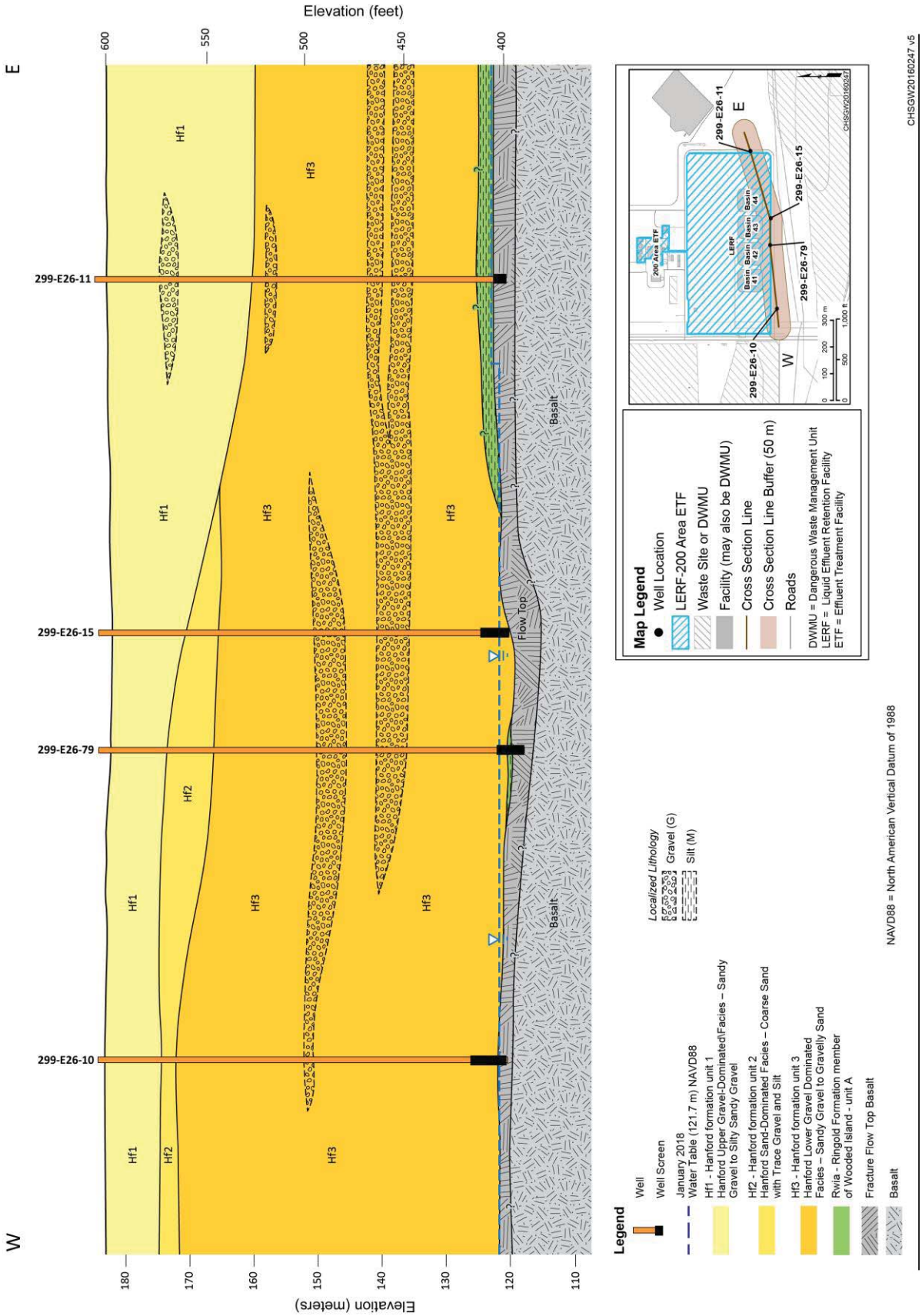
- Sand and gravel backfill, and scattered amounts of eolian silty sand
- Sand and gravel of the Hanford formation:
  - Upper gravel-dominated facies (Hf1)
  - Middle sand-dominated facies (Hf2)
  - Lower gravel-dominated facies (Hf3)
- Sand and gravel of the Ringold Formation member of Wooded Island - unit A (Rwia)

The Hanford formation (equivalent to hydrostratgraphic unit 1 [HSU 1]) is an informal stratigraphic unit consisting of uncemented gravel, sand, and silt deposited by the late Pleistoscene Missoula cataclysmic glacial floods (Section 3.1.3.3 in WHC-SD-EN-TI-012). The Hanford formation consists of three facies sub-units (silt dominated, sand dominated, and gravel dominated), which grade into one another both vertically and laterally with distance from the main high-energy flood currents (Section 2.5.2 in PNNL-19277). On the Central Plateau, the Hanford formation is sometimes further delineated into Hf1, Hf2, and Hf3 lithostratigraphic sequences. Units Hf1 and Hf3 consist of coarse-grained, basalt-rich, sandy gravels with varying amounts of silt/clay, and are sometimes difficult to differentiate in those areas where the intervening sandy Hf2 sequence is absent. The Hf2 sequence is dominated by sand to gravelly sand, with minor sandy gravel or silt/clay interbeds. Both the sand-dominated and gravel-dominated sequences are present near LERF, and the Hanford formation ranges in thickness from approximately 59 to 66 m (193 to 215 ft) (Figures 3-2 and 3-3).



Note: Complete reference citations are provided in Chapter 11.

Figure 3-1. General Stratigraphy at the Hanford Site



CHSGW20160247 v5

Figure 3-2. Southwest-to-Northeast Geologic Cross Section Showing the Stratigraphy Below LERF

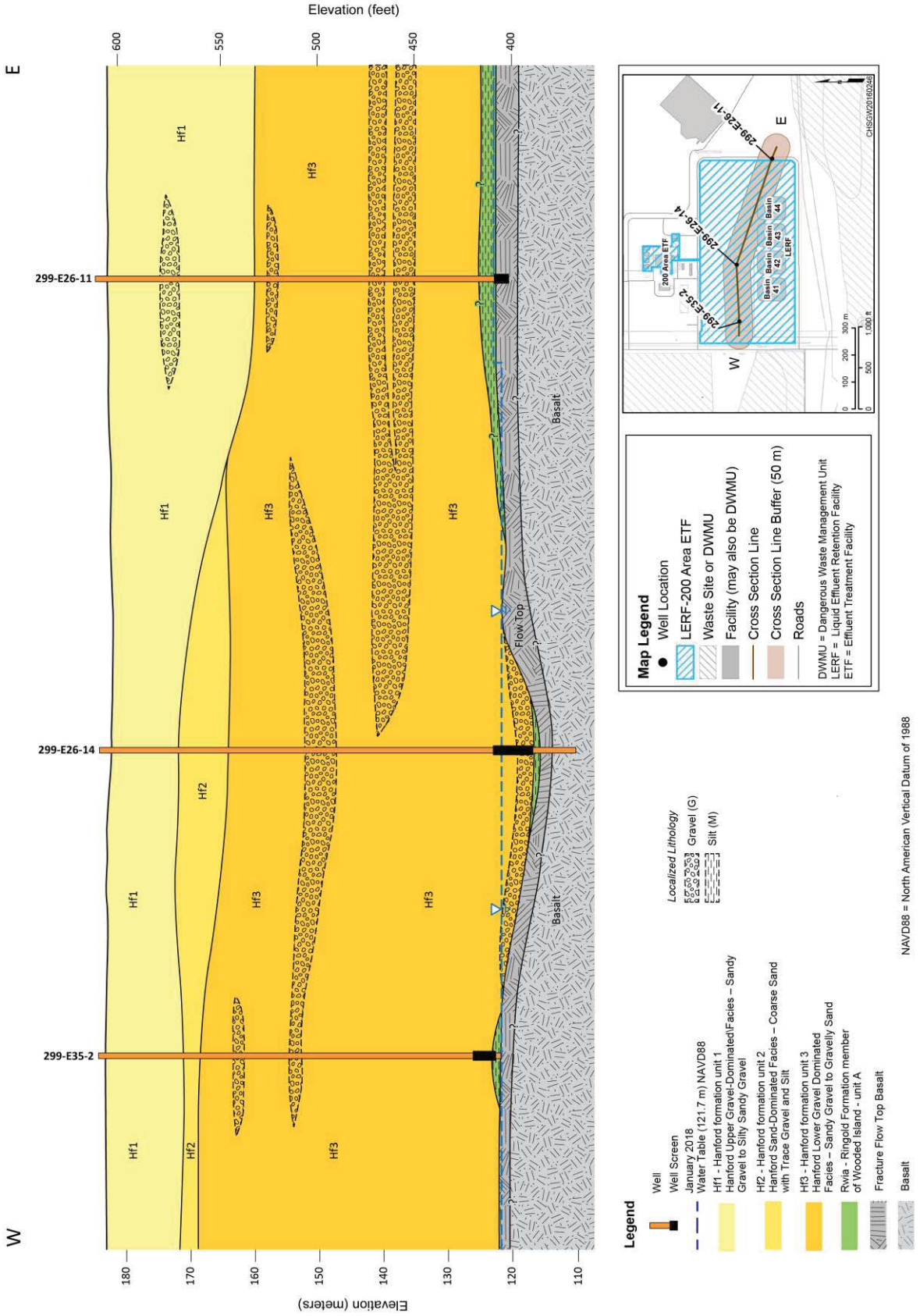


Figure 3-3. Northwest-to-Southeast Geologic Cross Section Showing the Stratigraphy Below LERF

The Hanford formation upper gravel-dominated sequence (Hf1) is the shallowest stratigraphic unit present beneath LERF and overlies the Hanford formation sand-dominated sequence (Hf2) (Figures 3-2 and 3-3). Based on observations of outcrop and intact core samples, the Hanford formation gravel sequence is interpreted to consist of the high-energy, gravel-dominated facies interbedded with lenticular and discontinuous layers of the sand-dominated facies. Silt-dominated facies may also be present beneath LERF, although they probably constitute a relatively small percentage of the total. Cementation was not observed in the Hf1 unit, but calcium carbonate was observed in wells drilled near LERF (Sections 3.2 and 3.3 in SGW-41702, Rev. 0, *Liquid Effluent Retention Facility Characterization Report*).

Where present, the Hanford formation sand-dominated facies (Hf2) overlies the lower gravel-dominated facies (Hf3) beneath the central and western part of LERF and pinches out to the east (Figures 3-2 and 3-3). Fine- to coarse-grained sand dominates the Hf2 sequence with lenses of silty sand to sandy gravel. Cementation is very minor or absent in the Hf2 unit, and total calcium carbonate content is generally a few weight percent or less. In the eastern part of LERF, the Hf2 unit appears to have been incised by high-energy Ice Age floods associated with the Hanford formation upper gravel-dominated facies (Figure 3-1).

The unconsolidated lower gravel-dominated facies of the Hanford formation (Hf3) overlies the basalt beneath LERF where the Rwia is not present (Figures 3-2 and 3-3) and generally consists of poorly sorted pebble to boulder gravel, fine- to coarse-grained basaltic sand, and variable amounts of silt. Discontinuous sand and silt beds may be interbedded throughout sequences of gravel-dominated facies. Gravel clasts are predominantly basalt, which range from 60% to 80% (Section 3.2.3.1 in DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*), with lesser amounts of granite, quartzite, and gneiss clasts (Section 3.1.3.3 in WHC-SD-EN-TI-012).

The Ringold Formation consists of Miocene-Pliocene fluvial and lacustrine clastic sediment deposited by the ancestral Columbia River system and, where present, unconformably overlies the Miocene-age Columbia River Basalt Group. The Ringold Formation underlying the Hanford formation at LERF is the informal member of Wooded Island (Chapter 5 of BHI-00184, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*). The member of Wooded Island was further divided into five gravel-dominated, fluvial depositional units, separated by widespread overbank, paleosol, and lacustrine deposits (Figure 3-1). The Rwia (equivalent to HSU 9) is the only unit considered to be present in the vicinity of LERF.

LERF is located along the southern flank of a major west-northwest/east-southeast-trending cataclysmic flood channel (Section 3.1.3 in SGW-41702, Rev. 1). Remnant muds associated with the Ringold period exist to the east and northwest of LERF but do not form a confining layer (Section 8.1 in WHC-SD-EN-EV-024, *Site Characterization Report for the Liquid Effluent Retention Facility*). In 1994, X-ray fluorescence analysis, field observations, and borehole log data at well 299-E26-11 indicated the presence of fine-grained sediments at 59.5 m (195 ft) below ground surface (Section 4.3.9.2 in WHC-SD-EN-EV-024).

Additionally, low-permeability sediments were encountered from 65.5 to 66.1 m (215 to 217 ft) below ground surface during drilling of well 299-E26-14 (Section 3.1.2 in SGW-41072, Rev. 1). The sediments were described as 95% silt and 5% gravel. Photographic review of this sediment layer, presented in Appendix B of SGW-51467, *Borehole Summary Report for the Installation of Two RCRA Groundwater Monitoring Wells in the 200 Areas, FY2011*, shows a distinct texture and color change from the overlying Hanford sandy gravels. The reddish brown hue and yellow tints associated with this layer correlate well with the distal overbank description provided in BHI-00184. Other characteristics associated with this layer

included no reaction to hydrochloric acid, similar to Ringold sediments described at well 299-E26-11. An alternative explanation may be that the apparent Ringold sediments are reworked, removed from one location and deposited at this location, possibly associated with cataclysmic glacial fluvial floods (Section 3.1.2 in SGW-41072, Rev. 1).

The uppermost basalt unit beneath LERF is the Elephant Mountain Member of the Saddle Mountains Basalt, which generally declines to the south-southeast toward the axis of the Cold Creek syncline. The basalt surface contains some depressions and channels and ranges in elevation (NAVD88, *North American Vertical Datum of 1988*) from approximately 125 m (410 ft) north of LERF in the vicinity of the 200 Area ETF to 115 m (377 ft) south of LERF (Section 5.5 in SGW-41072, Rev. 1).The upper 3 to 4 m (9.8 to 13 ft) of the Elephant Mountain Member is interpreted to be a permeable flow-top unit. The flow-top unit is characterized by weathering rinds, vesicular cuttings, and relatively faster drilling rates than the competent basalt below it (Sections 3.1 and 3.2 of SGW-41072, Rev. 1).

3.2 Hydrogeology

The thickness of suprabasalt sediments beneath the LERF basins ranges from 60 to 69 m (198 to 225 ft). The vadose zone comprises unconsolidated to weakly cemented, muddy sandy, pebble-cobble gravels to gravelly sand, with occasional layers of sand and/or muddy sand. The gravel content is generally about 60%. Significantly more cobbles were described in the north and south boreholes than to the east and west of the LERF basins.

Groundwater beneath LERF occurs as an unconfined aquifer in glaciofluvial sediments and deeper, confined aquifers within the Columbia River Basalt Group. The uppermost unconfined aquifer beneath LERF occurs within the gravel-dominated Hf3 unit and the upper portion of the fractured basalt flow top (Figures 3-2 and 3-3). The thickness of the unconfined aquifer ranges from thin to moderate (e.g., from possibly not present to greater than 8 m [26.25 ft]) (Section 2.10 in DOE/RL-2018-65). The unconfined aquifer extends to the east of LERF and just west of well 299-E26-11, where barometric analyses indicate semiconfined conditions. This determination is consistent with the rise in groundwater elevation when drilling advanced through the lower Ringold sediments present at this well, causing the groundwater elevation to rise nearly 3.1 m (10 ft) in the temporary casing (Chapter Drilling and Sediment Sampling, Section 299-E26-11, in WHC-MR-0235, *Borehole Completion Data Package for the Liquid Effluent Retention Facility*). The westward extent of the Ringold sediments is uncertain; however, it has been portrayed to pinch out west of well 299-E26-11 and east of wells 299-E26-14 and 299-E26-15 (Figures 3-2 and 3-3).

The most recent estimates of hydraulic gradients and linear velocities at LERF were reported in ECF-HANFORD-19-0132, *Hydraulic Gradient and Average Linear Groundwater Velocity Calculations – Quarter 3 Calendar Year 2019*. The average values, for the hydraulic gradient and linear velocity at LERF were estimated to be 2.17 E-04 m/m and 7.23 E-03 m/d (23.7 E-03 ft/d), respectively. As discussed, the unconfined aquifer underlying LERF is considered to reside within the Hanford formation, transitioning into permeable basalt flow-top beneath the DWMU. Most of the LERF wells are screened at least partially in the fractured basalt flow-top. The hydraulic conductivity across the open-screened interval of most LERF wells is lower than the more typically permeable Hanford formation. Because of this, hydraulic properties considered more representative of the finer facies of the Hanford formation (similar in value to the properties of the Ringold Formation member of Wooded Island – unit E [Rwie]) than of the coarser Hanford formation were used for calculations of the average linear velocity. The calculations use a hydraulic conductivity of 5 m/d (16.4 ft/d), which is the estimated conductivity for the Rwie (Section 4.2.3 of ECF-HANFORD-19-0132). This hydraulic conductivity is similar to the low

end of reported hydraulic conductivities calculated at LERF wells, ranging from 6 m/d to 134 m/d (19.7 ft/d to 439.6 ft/d) (Table 3-1 in SGW-41072, Rev. 1).

Structurally, the basalt beneath LERF is the southeastern extension of a series of second-order folds contained between the Cold Creek syncline and Gable Mountain anticline. Conceptually, this northwest-southeast-trending structural feature appears to have contributed to past preferential drainage (Section 3.1.1 in SGW-41702, Rev. 1).

The basalt flow top's fracturing, brecciation, and/or weathering may provide localized zones of higher permeability. Where these conditions exist and are in hydraulic communication with overlying saturated sediments, the basalt flow top is part of the overlying unconfined aquifer system (Section 3.2 in SGW-41702, Rev. 1). A 2009 seismic study indicated the basalt surface might be either heavily weathered or fractured (SGW-52162, *Seismic Reflection Investigation at the Liquid Effluent Retention Facility, 200 East Area, Hanford Site Richland, Washington*). Based on the seismic interpretations and basalt chip observations during a groundwater evaluation investigation near the LERF (SGW-41072, Rev. 0), it appears that the upper part of the basalt may be hydraulically connected to or included, the suprabasalt aquifer. Subsequent groundwater chemistry and hydrologic characterizations of the uppermost aquifer conducted during this investigation suggest that the permeable basalt flow top comprises much of the unconfined aquifer in the vicinity of the LERF basins (Chapter 4 and Figure 2-1 in SGW-41702, Rev. 0). A 2012 study that employed a suite of geophysical methods indicated the presence of the potentially permeable basalt zones in the vicinity of LERF and Low-Level Burial Grounds Trench 94 (SGW-52467, *Integrated Surface Geophysical Investigation Results at Liquid Effluent Retention Facility, 200 East Area, Hanford, Washington*). Several geophysical surveys completed in the vicinity of the LERF basins were able to define the topographic variations in the basalt surface.

Evaluations of drill cuttings, drilling rates, and water production noted during drilling also indicate at least some portion of the Elephant Mountain Member flow top functions as a component of the unconfined aquifer beneath LERF. The thickness of the fractured flow top ranges from 2 m (6.5 ft) at well 299-E26-77 (west of LERF) to 3.2 m (10.5 ft) at well 299-E26-79 (south of LERF), and 1.5 m (5 ft) at well 299-E26-11 (east of LERF). Approximately 6.1 m (20 ft) of basalt was drilled at well 299-E26-14, but appeared to be very competent basalt that likely forms the base of the aquifer (Section 5.6 in SGW-41702, Rev. 1). Well-specific hydrogeology pertaining to fractured basalt flow top is detailed in Section 3.2 and Chapter 5 in SGW-41702, Rev. 1.

The dense, interior portion of the basalt acts as a confining unit for underlying sedimentary interbeds, which form confined aquifers. The Rattlesnake Ridge interbed forms the uppermost, regionally extensive, confined aquifer within the Saddle Mountains Basalt (Figure 3-1) (Section 6.1.1 in RHO-RE-ST-12P, *An Assessment of Aquifer Intercommunication in the B Pond-Gable Mountain Pond Area of the Hanford Site*). Groundwater flow rates within the Rattlesnake Ridge interbed have been estimated between 0.7 and 2 m/yr (2.3 and 6.6 ft/yr), which is a considerably lower flow rate than most estimates for the overlying unconfined aquifer system. The sediment comprising the interbed consists mostly of sandstone (with silts and clays) and is much less permeable than the sediment in the unconfined aquifer. In addition, the magnitude of the hydraulic gradient is generally lower than in the unconfined aquifer (Section D3.1 in DOE/RL-2017-66, *Hanford Site Groundwater Monitoring Report for 2017*).

Possible interconnection between the unconfined aquifer and confined Rattlesnake Ridge aquifer near the site does exist. A large erosional window in the Elephant Mountain Member basalt flow is located to the north and northeast of the 200 East Area, in the Gable Gap area, and near West Lake (Figures 15 and 16 in RHO-RE-ST-12P), and may provide a pathway for groundwater movement between the two aquifers. Additionally, two other erosional "windows" have been identified through the Elephant Mountain basalt

(Section 6.1.3 in RHO-RE-ST-12P). This interconnection is further exemplified by (1) the indication of upward potential movement of water determined from water-level elevation measurements conducted in 1983 (Section 6.2.2.3 in RHO-RE-ST-12P); (2) the low barometric efficiencies in wells located near known or suspected areas of basalt erosion (Section 6.3 in RHO-RE-ST-12P); and (3) hydrogeochemical data that indicate a pattern of mixing of unconfined waters to the Rattlesnake Ridge aquifer (Chapter 7.0 in RHO-RE-ST-12P).

3.3 Groundwater Flow System

During the defense operational efforts at the Hanford Site (1943 to 1987), the groundwater elevation and flow direction throughout much of the 200 East Area were influenced by the persistent hydraulic mounding associated with planned discharges in the 200 West Area and with planned discharges within and near the 200 East Area. These include large-volume discharges to the 216-B-3 Pond (B Pond) system (located on the east side of the 200 East Area) and Gable Mountain Pond (i.e., 216-A-25 Pond, located to the north of the 200 East Area). This groundwater mounding is evident in hydrographs and water table maps up to, through, and in some locations beyond, the 1990s. Along the east and east-central part of the 200 East Area, the mounding generated a local hydraulic gradient to the southwest (Figures 5 through 10 in SGW-60338, *Historical Changes in Water Table Elevation and Groundwater Flow Direction at Hanford: 1944 to 2014*).

Water table elevations in the 200 East Area were at their highest during the Hanford Site's peak operating years (the 1960s through 1990s; Figure 2 in SGW-60338). The termination of discharges to the Gable Mountain Pond system in 1985 and subsequent termination of discharges to the B Pond system in 1993 resulted in the gradual dissipation of the 200 East Area groundwater mound. As groundwater elevations continued to decline, the water table became extremely flat throughout the 200 East Area. Because of the flat water table, it became difficult to estimate the direction of groundwater flow by measuring water levels and mapping the water table. Changes in groundwater elevations and associated hydraulic gradients and flow directions have become less discernible from year to year subsequent to the cessation of operational discharges. The changes in gradient magnitude have been accompanied by changes in groundwater flow direction, with most of the 200 East Area presently exhibiting a northwest-to-southeast flow direction. This flow direction suggests that the groundwater elevations and hydraulic gradients are approaching preoperational conditions at the Hanford Site.

Efforts have been made to obtain more accurate well survey elevations and measurements of the deviation from vertical for key monitoring wells in the 200 East Area. In 2019 there were 65 wells in what is termed the low-gradient monitoring network. The water-level measurements obtained from the low-gradient monitoring network were evaluated by generating digital grids of the mapped water table and performing trend surface analyses.

LERF is located in the northeastern part of the 200 East Area and overlies a hydrogeologic boundary between two aquifers that exhibit substantially different hydrogeological properties. Basalts of the Elephant Mountain Member of the Saddle Mountains Basalt Formation underlie a portion of LERF. However, some portions of LERF overlie or are located slightly north of the northern extent of the unconfined Hanford formation unconsolidated sediments that are typical of the 200 East Area. The unconfined aquifer underlying LERF is interpreted to reside within the Hanford formation, transitioning to permeable basalt flow-top beneath the DWMU. Most of the LERF wells are screened at least partially within the fractured basalt flow-top. The exact location where the basalts subcrop, and may locally contain, the water table is not perfectly known. The saturated thickness of the unconfined aquifer in the area beneath and immediately downgradient of the LERF facility area is typically small; ranging in most places between about 3 and 9 m (10 to 30 ft) within both the unconsolidated Hanford formation

sediments and the permeable basalt flow-top combined where present; and is underlain by competent basalt that limits the potential for vertical migration. In 2018, groundwater near LERF was interpreted to flow to the south (Section 2.10 in DOE/RL-2018-65). In ECF-200E-20-0013, *Groundwater Flow and Migration Calculations to Support the Assessment of the Liquid Effluent Retention Facility Monitoring Network,* an analysis of groundwater flow was performed to evaluate the efficacy of using groundwater monitoring wells near LERF for detection of releases to groundwater from the facility. This analysis is described in Chapters 5 through 7.

This page intentionally left blank.

4 Contaminant Migration Conceptual Model

The conceptual model for contaminant release and transport through the vadose zone to groundwater, summarized in the following sections, is based on the following assumptions:

- Average precipitation of approximately 17.2 cm/yr (6.8 in./yr) on the Hanford Site and recharge in the LERF area between 1.5 and 17 mm (0.06 and 0.67 in.) annually, depending on soil texture and vegetation (Table 4.15 in PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*).
- Net infiltration is assumed to occur under gravity drainage of precipitation on the soil surface.
- Leaching of mobile contaminants through soils, as a result of a release and infiltration, is assumed the main potential source for contamination to the vadose zone.
- As the mobile constituents in the vadose zone intercept and mix with groundwater in the unconfined aquifer, the constituents move laterally with groundwater flow.
- Extreme conditions or accidental releases are recognized as factors but would be addressed under emergency response/corrective actions.

4.1 Vadose Zone

Vadose zone thickness beneath LERF ranges from 60.5 to 62.2 m (198 to 204 ft). The majority of the vadose zone beneath LERF is composed of the Hanford formation (Figures 3-2 and 3-3). The unsaturated sediments above the water table affect how waste solutions move through the soil, how much is retained in the sediment column, and how much liquid waste eventually reaches the water table. The texture of the Hanford formation is loose to weakly cemented, muddy sandy, pebble-cobble gravels to gravelly sand, with occasional layers of sand and/or muddy sand. There were no significant zones of silt or clay above the aquifer that would indicate perching horizons in the suprabasalt sediments beneath the LERF vicinity (Section 3.1.3 in SGW-41072, Rev. 1).

As of 2018, the potential for migration of contamination from the vadose zone to groundwater is unlikely due to the lack of artificial recharge. With the completion of Basin 41, LERF will consist of four lined surface impoundment basins, using a dual-confinement barrier concept (i.e., dual-basin liners and pipe-in-a-pipe transfer piping system) to minimize human exposure and the potential for accidental releases to the environment. A leachate detection, collection, and removal system and the basin covers also reduce possible environmental or personnel exposure.

Infiltration of natural precipitation is the only potential force capable of moving hypothetical contaminants to the groundwater. Based on records from the Hanford Meteorological Station, the average annual precipitation at the Hanford Site between 1950 and 2015 has been 172 mm/yr (6.78 in./yr). Annual recharge in the LERF area has been estimated to be between 1.5 (0.06 in./yr) in a shrub-steppe vegetated area to 17 mm (0.67 in./yr) at a gravel-covered, nonvegetated area based on Table 4.15 in PNNL-14702. Thus, the risk of infiltration and the potential for vertical migration of contaminants is considered low because of low annual precipitation.

4.2 Soil Moisture Factors

Natural Hanford sediments below the near-surface zone affected by seasonal, diurnal, and plant evapotranspiration cycles generally have a moisture content of less than 10% by volume (Section 4.3.3.1 in WHC-SD-EN-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*). The potential contributor to moisture detected in the Hanford formation below

LERF is past-practice disposal at B Pond (Section 4.2.1 in PNNL-12261). However, the primary driver for transport of contamination from the LERF basins to the water table is hypothetical infiltration of water from a second basin liner or transfer piping release through the vadose zone.

The range of recharge rates (see Section 4.1) depends on a variety of factors, such as soil texture, existing soil moisture content, and vegetation cover. Moisture observations during and neutron moisture log data after drilling LERF monitoring wells do not indicate consistent zones of moisture in the vadose zone that could increase hydraulic conductivity and accelerate infiltration of potential contaminants. Additionally, the only low-permeability sediments beneath LERF are the Ringold sediments, which are generally located beneath the water table and overlie the basalt surface, where present. Some Ringold sediments are present to the east of the LERF basins above the water table but showed no indication of perched water conditions (Section 3.2 in SGW-41072, Rev. 1).

4.3 Hydrogeologic Considerations

Previous liquid waste disposal practices at B Pond, Plutonium-Uranium Extraction Cribs, and other facilities established localized water table mounds that elevated the water table throughout the 200 East Area. An artificial groundwater mound east of the 200 East Area that was created by past effluent disposal activities at the B Pond complex (Appendix D of DOE/RL-2016-67, *Hanford Site Groundwater Monitoring Report for 2016*) persisted for many years into the late 1990s. Pre-Hanford Site groundwater flow direction in the 200 East Area was generally toward the east or southeast (Table 1 in SGW-60338). Since that time, the liquid disposal to B Pond, Gable Mountain pond, and other disposal facilities has impacted local flow directions in the 200 East Area several times during Hanford Site operation. Hydrochemistry data indicate that wastewater discharge to the Treated Effluent Disposal Facility (TEDF) does not impact water quality of the uppermost unconfined aquifer within the 200 East Area, but no wells currently monitor the uppermost unconfined aquifer downgradient of the TEDF (Section 4.2.1 in PNNL-12261).

From 2013 to 2018, the water table elevation at LERF declined average of 1.8 cm/yr (0.7 in./yr) between 2013 and 2018 at LERF monitoring wells (Section 2.10 in DOE/RL-2018-65). Accompanying the historical changes in water level were changes in groundwater flow direction. Regionally, the groundwater in the 200 East Area flows from the northwest to the southeast. In 2018, groundwater near LERF was interpreted to flow to the south (Section 2.10 in DOE/RL-2018-65).

Remnant muds associated with the Ringold period exist to the east and northwest of LERF but do not form a confining layer (Section 8.1 in WHC-SD-EN-EV-024). However, analyses during drilling and post-development activities at well 299-E26-11 indicate semiconfined aquifer conditions may exist to the east of LERF (Section 3.2 and Figures 3-2 and 3-3).

As discussed in Section 3.2, fractured basalt flow-top may be hydraulically connected to the upper unconfined aquifer beneath LERF. The lateral extent of, and groundwater movement though, this subcrop are not perfectly known, but the effort to determine potential contaminant transport pathways is discussed in Chapters 5 through 7 of this report.

4.4 Groundwater Chemistry

The solubility and subsequent mobility of waste constituents in pore fluid depend on the chemical nature of the waste constituents, the volume of water and water contact time with the waste, and natural subsurface geochemical conditions. Many analyses of the unconfined aquifer groundwater have been completed at the Hanford Site. The groundwater is characterized as moderately alkaline ($7.8<pH<8.4$) (Section 2.1.9 in WHC-SD-WM-TI-730), with appreciable amounts of bicarbonate and very little natural

organic material. Vadose soil and groundwater are generally well aerated. The dissolved oxygen concentrations fall into the higher range for groundwater (7 to 10 mg/L). These general conditions favor sorption or retardation of many heavy metals (e.g., lead) and also favor stability of oxy anionic species, which enhance mobility for other metals (e.g., hexavalent chromium). Laboratory sorption studies have documented these effects and related mobility issues in Hanford Site media. These conditions tend to allow chlorinated solvents (e.g., carbon tetrachloride) to remain persistent, as these compounds normally degrade more rapidly in reduced groundwater environments.

Geochemically many of the dangerous waste constituents associated with LERF leachate are metal cations. Hanford Site sediments have low to moderate cation-exchange capacity and can sorb many metallic cations. Considering the substantial thickness of the vadose zone (60 m [197 ft]) and the cation-exchange capacity, dangerous waste metal constituents are expected to be adsorbed to soil particles during transport though the vadose zone. The metals, therefore, are not considered reliable indicators of the presence of dangerous constituents in the groundwater (Section 7.2 in SGW-41072, Rev. 1).

The distribution of major dissolved ions in groundwater was evaluated using samples collected in January 2009 from four wells in the vicinity of LERF (Section 4.2.1.1 in SGW-41072, Rev. 0). Stiff diagrams were prepared illustrating the equivalent concentrations of the cations calcium, magnesium, sodium, and potassium and anions chloride, bicarbonate, and sulfate. The Stiff diagrams (Figure 4-1) for well 299-E26-11 (2009 upgradient well) and well 299-E26-79 (downgradient well) illustrate clearly similar ion distributions, indicating that these wells interrogate groundwater of similar origin and apparent hydraulic communication between these locations.

Stiff diagrams for the January 2009 samples at two other downgradient wells (299-E26-10 on the southwest and 299-E26-77 to the west) are also shown in Figure 4-1. These two wells exhibit very similar ion concentrations and distribution to each other and similar overall distribution pattern to the other two wells; however, the overall ion concentrations in wells 299-E26-10 and 299-E26-77 are substantially higher than those exhibited by wells 299-E26-11 and 299-E26-79. This evaluation indicates that the groundwater to the west of and proximal to LERF is likely a common aquifer body.

Examination of historical groundwater monitoring results from the Hanford Environmental Information System database for wells proximal to LERF and in wells located further to the west of LERF reveals the likely source of the geochemical variations illustrated in the Stiff diagrams. Wells to the west of LERF have exhibited elevated and increasing concentrations of numerous common ions since mid-1993. These ions include sulfate, chloride, nitrate, bicarbonate, calcium, magnesium, and sodium and are most conveniently described for this illustration as the total dissolved solids (TDS) load in groundwater. In particular, well 299-E34-7, located approximately 500 m (1,640 ft) north-northwest of LERF, historically exhibited substantially elevated concentrations of all these ions. This well exhibited similar conditions to other nearby wells until November 1996, when the groundwater TDS content in that well exhibited an upward inflection followed by a steady increase in TDS to a peak of about 1,600 mg/L TDS (estimated from specific conductance in µS/cm x 0.65) observed in October 2002. Selected ion concentrations in that well in November 1996 and October 2002 are shown in Table 4-1.

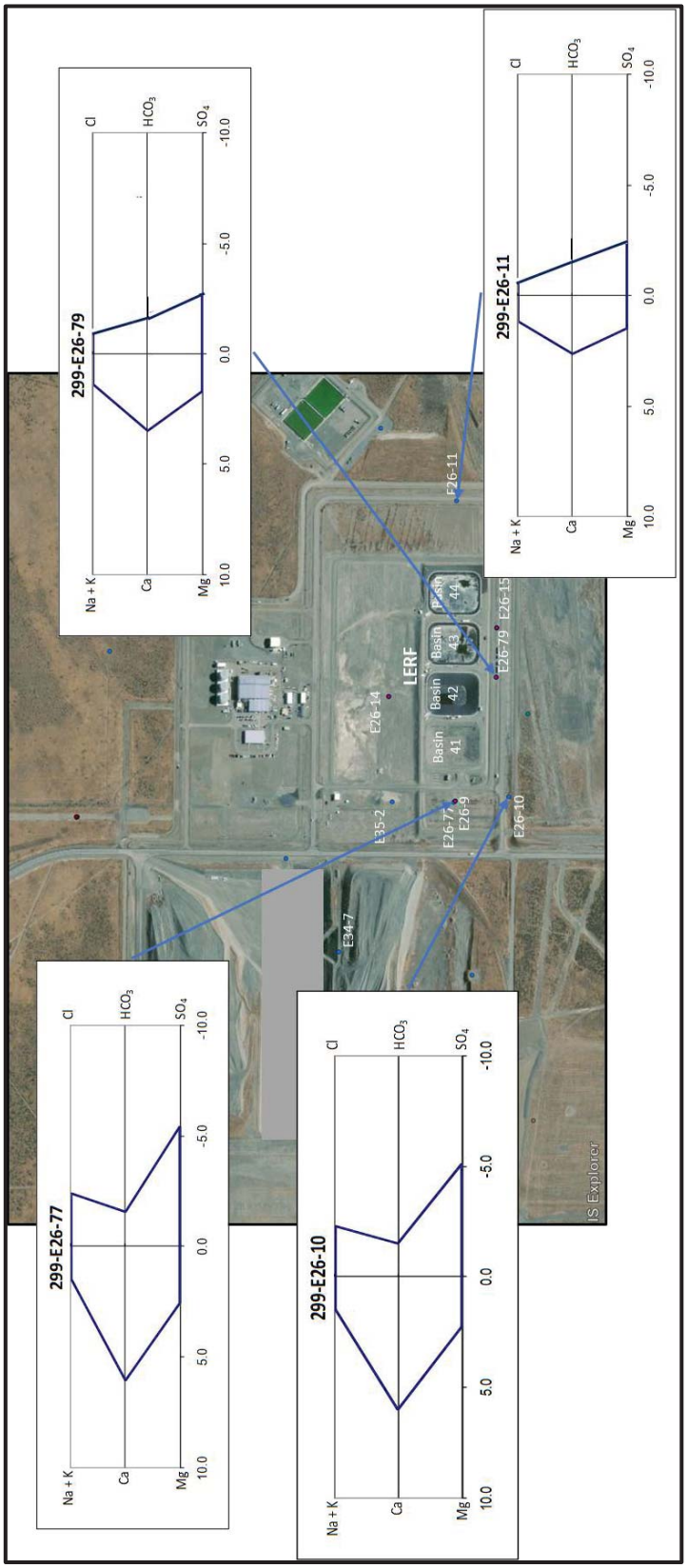


Figure 4-1. Major Ion Distribution in Groundwater at Wells in Vicinity of LERF (2009 Data)

Table 4-1. Range of Specific Conductance, Derived TDS, and Selected Ion Concentrations Observed in Well 299-E34-7

Parameter	November 1996 Measurement	October 2002 Measurement
Specific conductance (µS/cm)	396	2458
Derived TDS (mg/L)*	257	1598
Sulfate (mg/L)	62	655
Chloride (mg/L)	17	356
Nitrate (mg/L)	81	145
Bicarbonate (mg/L)	87	110
Calcium (mg/L)	34	339
Magnesium (mg/L)	12	90
Sodium (mg/L)	21	56

*TDS are derived from empirical relationship: estimated mg/L TDS = µS/cm specific conductance x 0.65 (In-Situ, Inc., 2005, "Total Dissolved Solids from conductivity").

TDS = total dissolved solids

Although the rate of increase in dissolved solids, as well as the observed maximum TDS load, exhibited at well 299-E34-7 is the most dramatic, other wells in the vicinity also exhibited steady increases in TDS over the same time period, and those increases started at the same time as the increase in well 299-E34-7. The wells exhibiting a notable increase in TDS load beginning in July 1993 include the following:

- 299-E27-10
- 299-E26-10
- 299-E26-9
- 299-E35-2
- 299-E34-7

The TDS load in each of these wells is dominated by sulfate, chloride, nitrate, bicarbonate, calcium, magnesium, and sodium. Figure 4-2 illustrates the observed time series of TDS load in these wells from 1988 to present. Some of these wells went dry due to declining water table elevation during this period and exhibit shortened monitoring periods. Wells 299-E26-10 and 299-E27-10 have the longest time series of wells to the west of LERF and exhibit continuing parallel increases and similar concentrations over time.

Wells in the immediate vicinity of LERF (i.e., 299-E26-11, 299-E26-14, 299-E26-15, and 299-E26-79) also exhibit parallel increases in TDS load and similar magnitude (Figure 4-2). Based on observations of TDS at well 299-E26-11, which has the longest monitoring record, these wells started to exhibit increasing TDS in early 2005. Well 299-E26-11, the most eastward of these wells, also exhibits the lowest TDS load. These observations suggest that the increases in TDS (and the associated component ions) are most likely due to migration of the dissolved ions from west to east beneath LERF and are not related to releases from LERF. As with the wells to the west of LERF, the proximal wells' TDS load is also dominated by sulfate, chloride, nitrate, bicarbonate, calcium, magnesium, and sodium.

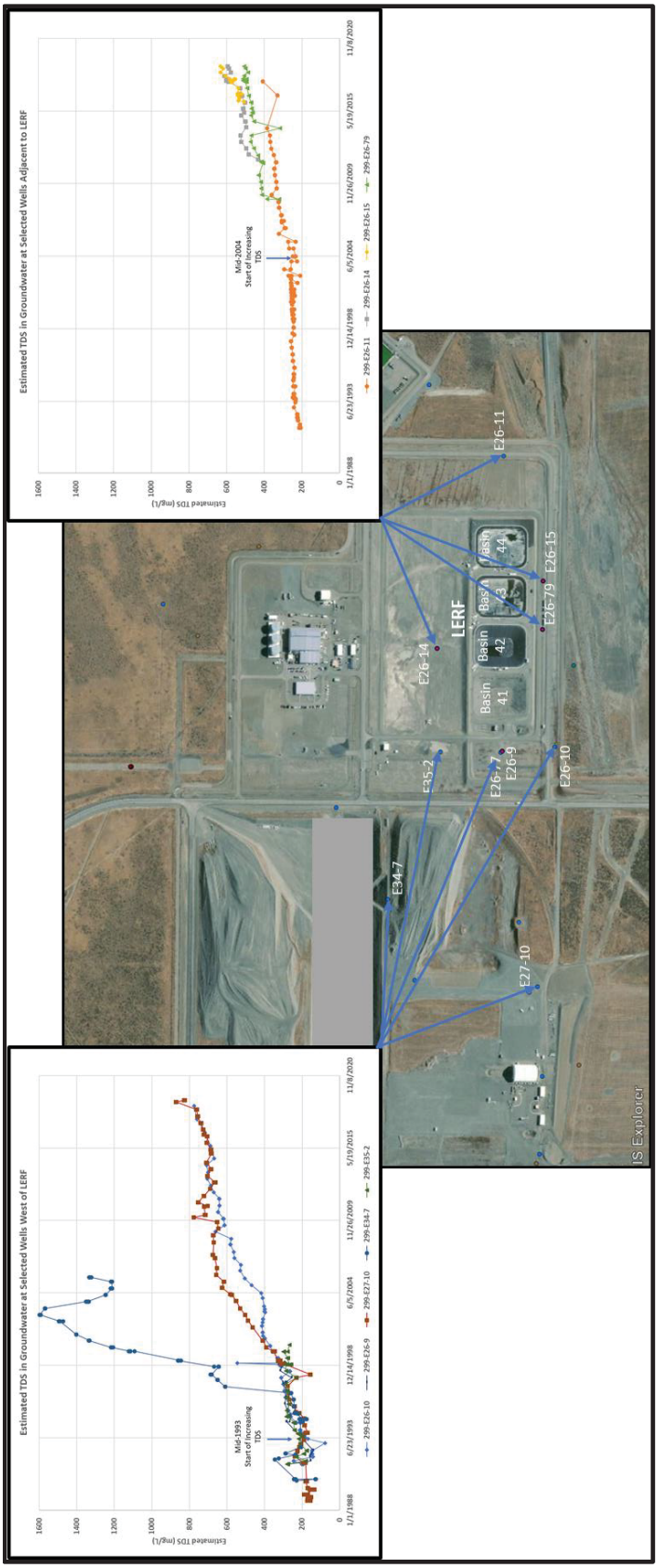


Figure 4-2. Time Series of Changes in Total Dissolved Solids Load in Groundwater at Selected Wells in Vicinity of LERF

The source of the dissolved ions resulting in the elevated and increasing TDS load in groundwater in the vicinity of LERF is not clearly defined. Dissolved material in groundwater may have originated from leaching of wastes disposed to nearby Low-Level Burial Grounds WMA-2, or alternatively it may have resulted from migration of waste constituents historically discharged to the B Ditch system to the south and west of LERF, including the 216-B-2-1 and 216-B-2-2 Ditches.

This page intentionally left blank.

5 Calculation Methods

A systematic series of calculations was performed to evaluate whether the groundwater monitoring wells in the vicinity LERF (Figure 5-1) likely would detect increases in concentrations of contaminants in groundwater arising from potential releases from LERF that reach the underlying water table. The calculations, described in ECF-200E-20-0013, were focused on evaluating potential future releases, rather than addressing the effects of preexisting contamination. The calculations involved groundwater elevation analysis based on discrete measured groundwater levels and estimation of horizontal contaminant migration potential using particle tracking. The methods selected to accomplish these steps are discussed in this chapter.

The closest monitoring wells to LERF were evaluated for use in the well network. Those wells are 299-E26-10, 299-E26-11, 299-E26-14, 299-E26-15, 299-E26-77, and 299-E26-79, each of which are screened across the top of the unconfined aquifer (Table 2-36 in DOE/RL-2018-65).

5.1 Groundwater Elevation Evaluation Method Selection

To meet the objectives of this engineering evaluation, groundwater elevation mapping for 2017 through 2019 was performed for the 200 East Area using a combination of two methods. First, a regularized inverse interpolation technique that is referred to here as the Tikhonov Regularized Inverse Method (TRIM) was used for groundwater elevation mapping for the majority of the 200 East Area (i.e., where the water table lies within the unconsolidated sedimentary aquifer materials). Then for the area of the basalt subcrop beneath LERF where the geographic domain of the simplified groundwater flow simulator underlying TRIM does not extend, the universal kriging method implemented in multi-event universal kriging (MEUK) (Tonkin et al., 2016, *Multi-event universal kriging [MEUK]*) was used to create groundwater elevation maps. The methods were combined and interpreted together to create maps of groundwater flow patterns.

TRIM was developed to evaluate the well networks for DWMUs in the 200 East Area in ECF-200E-18-0066, *Groundwater Flow and Migration Calculations to Assess Monitoring Networks in the 200 East Area Dangerous Waste Management Units*. An advantage of using TRIM is that it uses a simplified groundwater flow simulator as the underlying mechanism to interpolate between measured water levels resulting in piece-wise, continuous groundwater elevation grids that conserve flow and are suitable for tracking particles to evaluate likely groundwater flow paths. The lateral domain of the simplified groundwater flow simulator that underlies the TRIM calculations does not extend fully beneath the location of LERF because the TRIM was developed to evaluate water levels in the unconsolidated sediments, whereas a portion of LERF is located over the basalt subcrop. For this reason, MEUK was used to evaluate dominant groundwater flow directions within the basalt and combine this together with the results of TRIM analyses of the groundwater levels and flow within the unconfined Hanford formation, Cold Creek, and Rwie formations.

MEUK is a mapping technique combining universal kriging and the analytic element method, based upon that first documented in the water-level kriging program KT3D-H2O (Karanovic et al., 2009, “KT3D_H20: A Program for Kriging Water-Level Data Using Hydrologic Drift Terms”). MEUK is designed to create one or more groundwater elevation maps, each corresponding to a specific event, that can exhibit spatial relationships that persist over time.

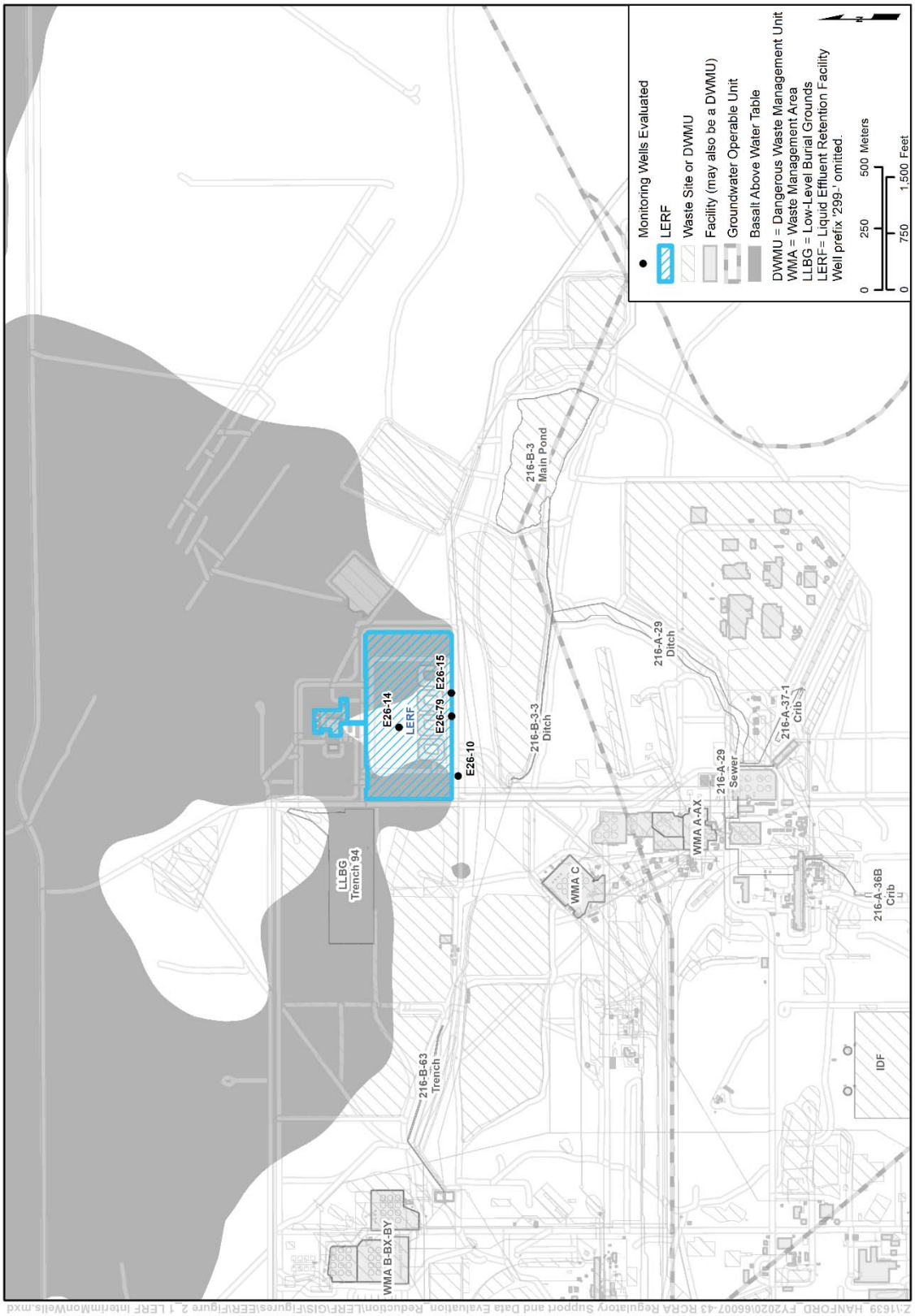


Figure 5-1. Groundwater Monitoring Network Evaluated for LERF

To create a smooth transition between basalt water table and TRIM water-level map, water levels from TRIM maps were extracted along the line representing the water table above the basalt formation and used as control points and added to the measured water levels as an input for MEUK kriging. These control points are shown in Figure 5-2. Because water levels in the wells in the basalt subcrop area are, with the exception of one measurement, only measured once a year in the spring, the water-level maps that were produced represent the flow conditions for the first quarters of each calendar year evaluated. The groundwater elevation map production for the first quarters of calendar years 2017, 2018, and 2019 are summarized in ECF-200E-20-0013.

After the grids were produced from the groundwater elevation mapping, these were used to perform particle tracking assuming advection and dispersion, to illustrate general patterns of migration for a hypothetical release that reaches the underlying water table from LERF.

5.2 Particle Tracking

The groundwater elevation maps depict general patterns of hydraulic gradients and groundwater flow, identifying likely directions of contaminant migration from a facility in case a release reaches the water table. Particle tracking provides a way to visualize the directions and potential paths of contaminant migration, enabling a more detailed assessment of a monitoring well network. Particle tracking was performed using the particle-tracking code mod-PATH3DU (Muffels et al., 2018, *User's Guide for mod-PATH3DU: A Groundwater Path and Travel-Time Simulator*).

Particle-tracking calculations assuming advective and dispersive migration were performed using a release of a large number of particles from LERF. Parameters used to calculate particle pathlines assume migration of a conservative (i.e., nonreactive) dissolved contaminant under representative conditions. Calculated particle pathlines illustrate how a hypothetical release to the water table from the facility would move and spread under conditions represented by each of the three mapped years (2017, 2018, and 2019). The particle-tracking calculations and outputs are based upon the one-time, instantaneous release of a large number of particles at the water table. This approach produces many pathlines, each of which depicts the hypothetical path of a particle of dissolved contaminant that reaches the water table beneath the facility. Because vadose zone travel time is not explicitly considered, the year of the hypothetical particle release is also the year that contamination reaches the water table.

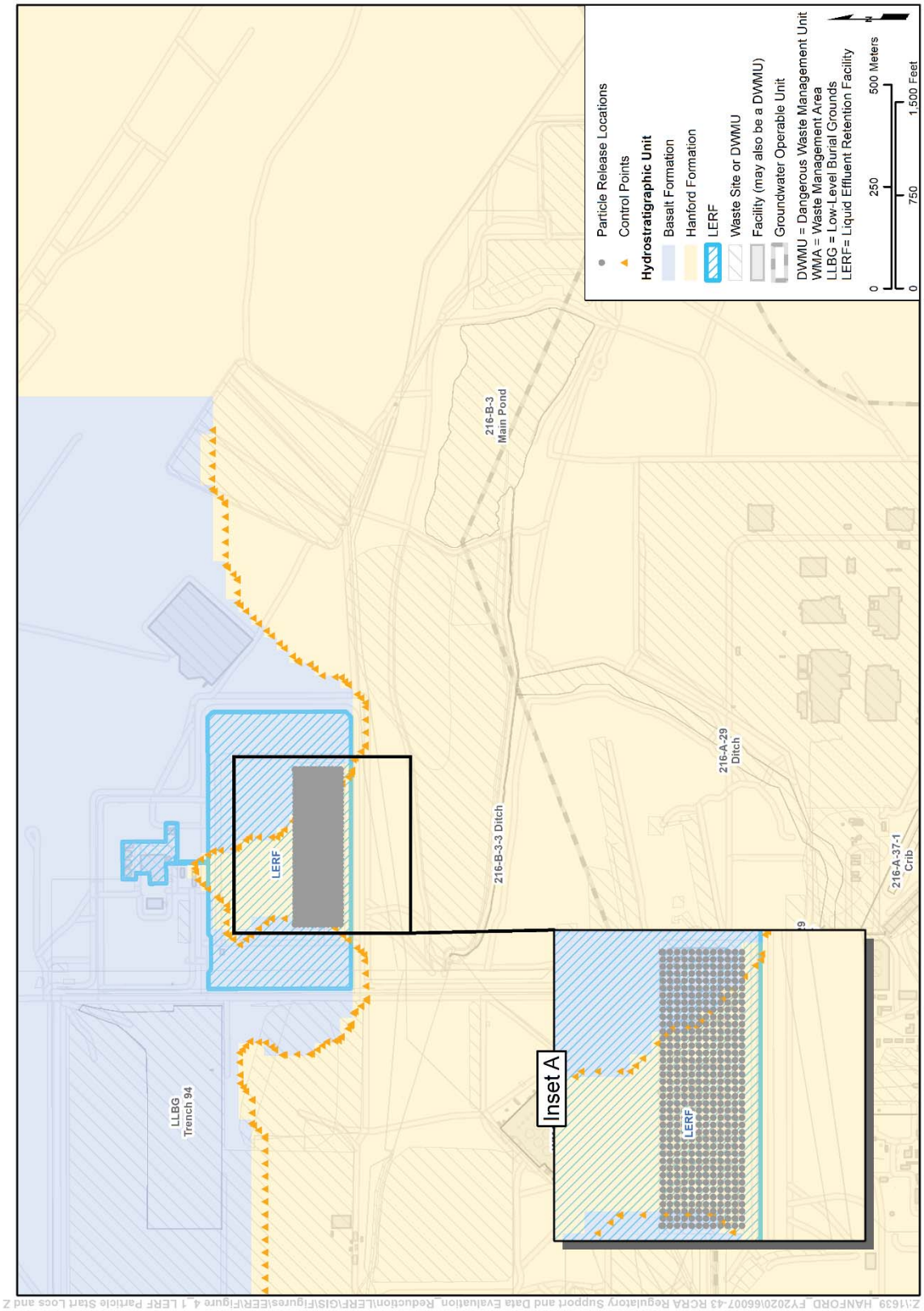


Figure 5-2. Particle Release Locations, Control Points, and Uniform Calculational Grid at LERF

6 Calculations

The assumptions, inputs, and calculation steps used to perform groundwater elevation mapping and particle tracking for LERF are discussed in this chapter. Additional details on the calculations are included in ECF-200E-20-0013.

6.1 Assumptions and Inputs for Groundwater Elevation Analysis

The primary inputs required to generate the piece-wise continuous grids of groundwater elevations are the average measured groundwater levels for the first quarters of calendar years 2017, 2018, and 2019. In the TRIM analysis, measurements for wells within the low-gradient evaluation network were prioritized in this effort, supplemented with water-level measurements from wells outside the low-gradient monitoring network. Because of the difference in accuracy of the water-level measurements obtained from the monitoring wells, relative "weights" were assigned to each monitoring well, which influence how closely TRIM fits each well's measurements. After the TRIM evaluation was implemented, evaluations at control points along the boundary between the TRIM domain and the basalt subcrop were determined. Those control point elevations were used along with the individual water-level measurements in wells screened within basalt formation for calendar years 2017, 2018, and 2019 as inputs to the water-level mapping of the basalt subcrop area using the MEUK method.

The accuracy of the resulting contours from the TRIM/MEUK evaluation throughout the 200 East Area and basalt subcrop is influenced by several factors, including the following:

- The accuracy of the measured or recorded water levels
- The number, distribution, and location of monitoring wells
- The relationship between the vertical open interval(s) of the monitoring wells and those of any extraction or injection wells, where present

These potential sources of error mean that the maps only approximate actual conditions. The water-level and particle pathline maps are considered reasonable approximations that provide value and utility in the interpretation of the likely direction of groundwater movement. The maps also help identify areas downgradient of the 200 East Area facilities that likely would be impacted by a potential release that reaches the underlying water table. Considering multiple groundwater elevation events (i.e., in this case, multiple years) in the analysis helps to develop a reasonable estimate of potential migration pathways under the different conditions represented by those events.

Part of simplifying the model used in the TRIM portion of this analysis involved creating zones of uniform hydraulic conductivity in the sediments within which the water table resides. Three HSU zones, representing the Hanford formation, CCU, and Rwie, were delineated. Delineation of the HSU zones was prepared by intersecting the Central Plateau Groundwater Model water table grid with the three-dimensional geological model (ECF-Hanford-13-0029, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington*, Rev. 1). Within each of these delineated HSU zones, the hydraulic conductivity was defined as homogeneous for purposes of defining initial parameter values.

6.2 Particle-Tracking Assumptions and Input

The inputs to the particle-tracking calculations are composed of a shapefile with the starting locations of particles, the piece-wise continuous grids of groundwater elevations obtained from the combined TRIM and MEUK analysis, and the migration parameter values.

Particle-tracking calculations specific to LERF were performed to represent one-time releases to the water table that occur simultaneously from LERF. The particle releases represent a hypothetical instantaneous release from LERF that reaches the water table. This release scenario does not incorporate any aspects of transport through the overlying vadose zone. After particles enter the groundwater, particle movement is predominantly horizontal, with minor components of vertical migration in response to limited infiltration from groundwater recharge. The monitoring wells were assumed to be screened across the water table so that samples collected from them reflect the quality of water at or close to the water table. Because particle tracking relies on the outputs (mapped groundwater elevations) computed using TRIM and MEUK, the assumptions and limitations that underlie the preparation of those maps using TRIM and MEUK are implicit in any subsequent particle tracking.

6.2.1 Particle Starting Locations

The starting locations for particle-tracking calculations represent the area over which a potential release from a given facility likely would impact the underlying water table, assuming vertical transport through the vadose zone. Particle releases were located at plausible release sites within each facility. For the analysis performed for LERF, release locations were established throughout the footprint of the basins (Figure 5-2). Ten particles were released and tracked from each release location to provide the density of particles in space and time required for performing detailed calculations, randomizing the seed values for the dispersion calculations. For LERF, 4,000 particles were released and tracked in the simulations performed for each of the three simulations (years).

6.2.2 Migration Parameters

Only a few parameters are required to perform the migration calculations using the groundwater elevation maps and particle-tracking methods developed here. The parameters used to represent dissolved contaminant migration are considered representative of local conditions for a conservative (i.e., nonreactive) solute dissolved within groundwater.

Particle tracking that considers advection and dispersion relies upon the assumption that the values of the dispersion coefficients in the two principal directions (longitudinal and transverse) are representative of physical processes that act to disperse dissolved constituents in groundwater at the scale of the calculations. The values of the dispersivity parameters used in this evaluation are shown in Table 6-1.

The parameters of mobile (effective) porosity and hydraulic conductivity (also shown in Table 6-1) are defined specific to the formations that underlie LERF.

Table 6-1. Aquifer Transport Parameter Values

Property		Value	Comments
Hydraulic conductivity	Hanford Formation	15000 m/d (49,213 ft/d)	CP-47631
	Basalt Formation	1.5 m/d (4.9 ft/d)	Based on transmissivity value of 46 m^2/d reported in Sweeney (1994) and approximate thickness of 30 m for basalt Elephant Mountain Member reported in the same report
Effective porosity	Hanford Formation	0.25	CP-47631
	Basalt Formation	0.04	Sweeney, 1994 (Table 6-1, value for Saddle Mountain Basalt Flow top [<5%])

Table 6-1. Aquifer Transport Parameter Values

Property	Value	Comments
Longitudinal dispersivity	3.5 m (11.5 ft)	Introduced for stability of the transport calculations using recommendation from the MT3DMS manual (Zheng and Wang, 1999)
Transverse dispersivity	0.7 m (2.3 ft)	20% of longitudinal (DOE/RL-2008-56)
Vertical dispersivity	0.0 m (0.0 ft)	DOE/RL-2008-56

References: CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.4.5*, Rev. 4

DOE/RL-2008-56, *200 West Area Pre-Conceptual Design for Final Extraction/Injection Well Network: Modeling Analyses*.

Zheng, C., and P. Wang, 1999, *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide*.

MT3DMS = Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems

6.3 Calculation Steps

The primary purpose of the calculations was to estimate directions of potential contaminant migration in order to assess the efficacy of the geographical distribution of wells in the monitoring network. The following steps were taken to produce the results presented in this evaluation.

6.3.1 Groundwater Elevation Grids

To prepare the groundwater elevation grids, first average values of the water-level measurements for the first quarters of calendar years 2017, 2018, and 2019 were obtained for each monitoring well. These water-level elevation data in the area of the unconsolidated sedimentary aquifer (e.g., the TRIM domain) were used as the calibration targets for the analysis conducted using TRIM as described in ECF-200E-20-0013. The TRIM analysis produced output that was considered representative of a reasonable correspondence between the calculated and measured groundwater elevations while also producing contours and hydraulic gradients that comport with the generally understood conditions at each of the 200 East Area facilities.

Water levels were then extracted from the TRIM maps at control points (Figure 5-2) located along the line representing the basalt subcrop. These water levels were then used along with the water elevation data for wells within the extent of the basalt subcrop as input for kriging using MEUK.

Water-level grids produced using TRIM and MEUK were then merged together and exported as a single water-level grid encompassing the basalt formation on the north and the Hanford formation sediments on the south for use in the particle-tracking calculations. Merging of the two grids was accomplished using the Mosaic capability provided by Golden Software's Surfer® geospatial analysis software (Version 16). The Grid-Mosaic enables two (or more) grids of different size, spacing, or extent to be combined into a common grid. In this case, the two grids – the unconsolidated aquifer calculated using TRIM and the basalt subcrop calculated using MEUK – were combined such that in the area where only the first (TRIM) grid is present, that formed the basis of the combined grid; where only the second (MEUK) grid was

® Surfer is a registered trademark of Golden Software, LLC, Golden, Colorado.

present (i.e., beyond the calculation domain of the TRIM), the MEUK grid formed the basis of the combined grid; and, in the area of overlap of the two grids, the first (i.e., TRIM) grid formed the basis of the combined grid. Using these piece-wise continuous grids as the basis, the steps described below were implemented to perform the calculations and to produce results specific to potential releases at LERF.

6.3.2 Particle Tracking

For the particle-tracking calculations, a file representing particle starting locations was prepared to use as input to the mod-PATH3DU program. Particles were released at the water table simultaneously from all particle starting locations to reflect a potential water table impact during each calendar year evaluated (2017, 2018, or 2019). Ten particles were released and tracked from each particle starting location using a different random seed value for the dispersion calculations. The maximum tracking time was adjusted to allow enough time for the majority of the particles to pass by the locations of the monitoring wells.

Then mod-PATH3DU was executed to produce a pathline output file. A post-processing program was executed to convert the pathline output file into shapefile format, which list particle locations and times.

7 Simulation Results and Conclusions

This chapter presents the results and conclusions from the calculations conducted to produce results that depict general patterns of hydraulic gradients, groundwater flow, and likely migration in the vicinity of LERF. The groundwater elevation maps produced for calendar years 2017, 2018, and 2019 form the basis for the particle-tracking calculations. Particle tracking was performed to simulate a hypothetical instantaneous release to the water table from all particle release locations within LERF. The outputs of particle-tracking calculations include the following:

- Maps of groundwater elevations for the first quarters of each of the three simulated years (2017, 2018, and 2019)
- Maps of calculated particle pathlines for the flow conditions determined for each of the three simulated years

The maps groundwater elevations are presented in Section 7.1, maps of particle pathlines are presented in Section 7.2, and Section 7.3 present the conclusions from this evaluation of the monitoring well network.

7.1 Groundwater Elevation Maps

Figures 7-1 through 7-3 show a portion of the 200 East Area regional groundwater elevation maps produced from the piece-wise continuous grids resulting from application of TRIM and MEUK, focused on the area around LERF. These maps were produced using the outputs from TRIM and MEUK for the first quarters of calendar years 2017 through 2019. The grids underlying these groundwater elevation maps were used as the basis for the subsequent particle tracking-calculations.

7.2 Particle Pathlines

Figures 7-4 through 7-6 depict the particle pathlines developed based on the groundwater elevation grids obtained from application of TRIM and MEUK and given a release of a large number of particles at LERF. The calculations of particle pathlines accounted for both advection and dispersion, therefore depicting the patterns that the migration of contaminants might display for the groundwater conditions determined for the first quarters of calendar years 2017, 2018, and 2019. Figures 7-4 through 7-6 depict the particle paths calculated after 54 years of travel, by which time it was determined that the majority of the particles would have arrived at or passed by the groundwater monitoring wells.

The goal of well placement is for the well locations to span the range of particle pathline distribution as released from LERF. The particle-tracking maps show that under the evaluated range of conditions, there is an area of particle pathlines south of Basin 41 of LERF where there is no corresponding monitoring well. Well LERF_PW-1 is proposed in this area south of Basin 41 as part of the final monitoring network. The extent of the basalt outcrop is highly uncertain in the area of LERF. The extent shown (estimated in 2017) produces what appears to be areas of significantly higher particle density due to the particles traveling around the southern extensions of the subcrop and results in the curvature of the tracks around these subcrop extensions and the subsequent spreading of the particle tracks. However, the extent of subcrop is not known in this area and flow near the eastern extent of the particle tracks is not well defined due to this uncertainty. Locating a well in this area (LERF_PW-2) would have the benefit of increasing the understanding of groundwater flow direction in this complicated area. Further evaluation of this area should be performed before locating the LERF_PW-2 well. The location of the proposed wells LERF_PW-1 and LERF_PW-2 are shown in Figures 7-4 through 7-6.

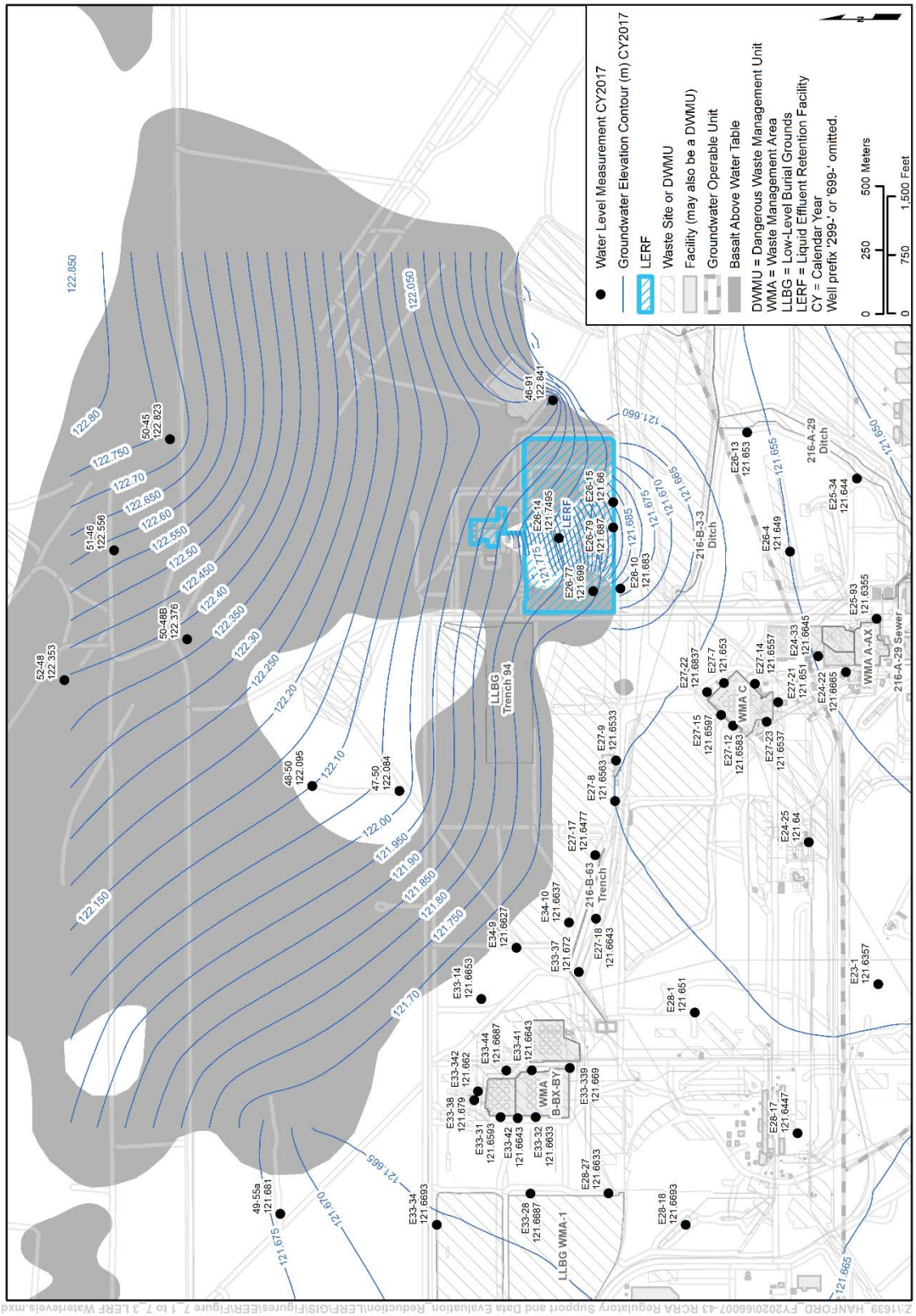


Figure 7-1. Groundwater Elevation Map for LERF, 2017

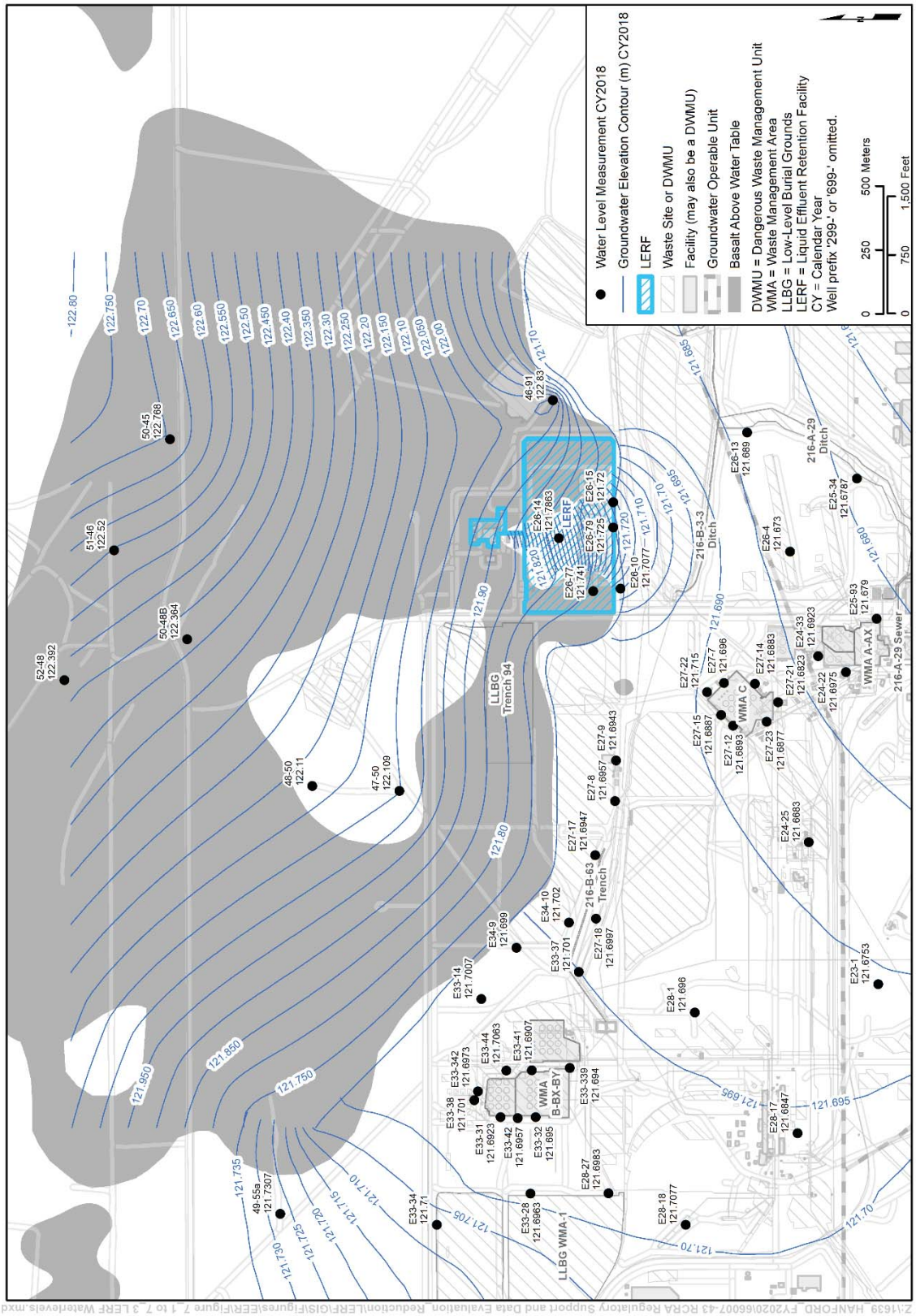


Figure 7-2. Groundwater Elevation Map for LERF, 2018

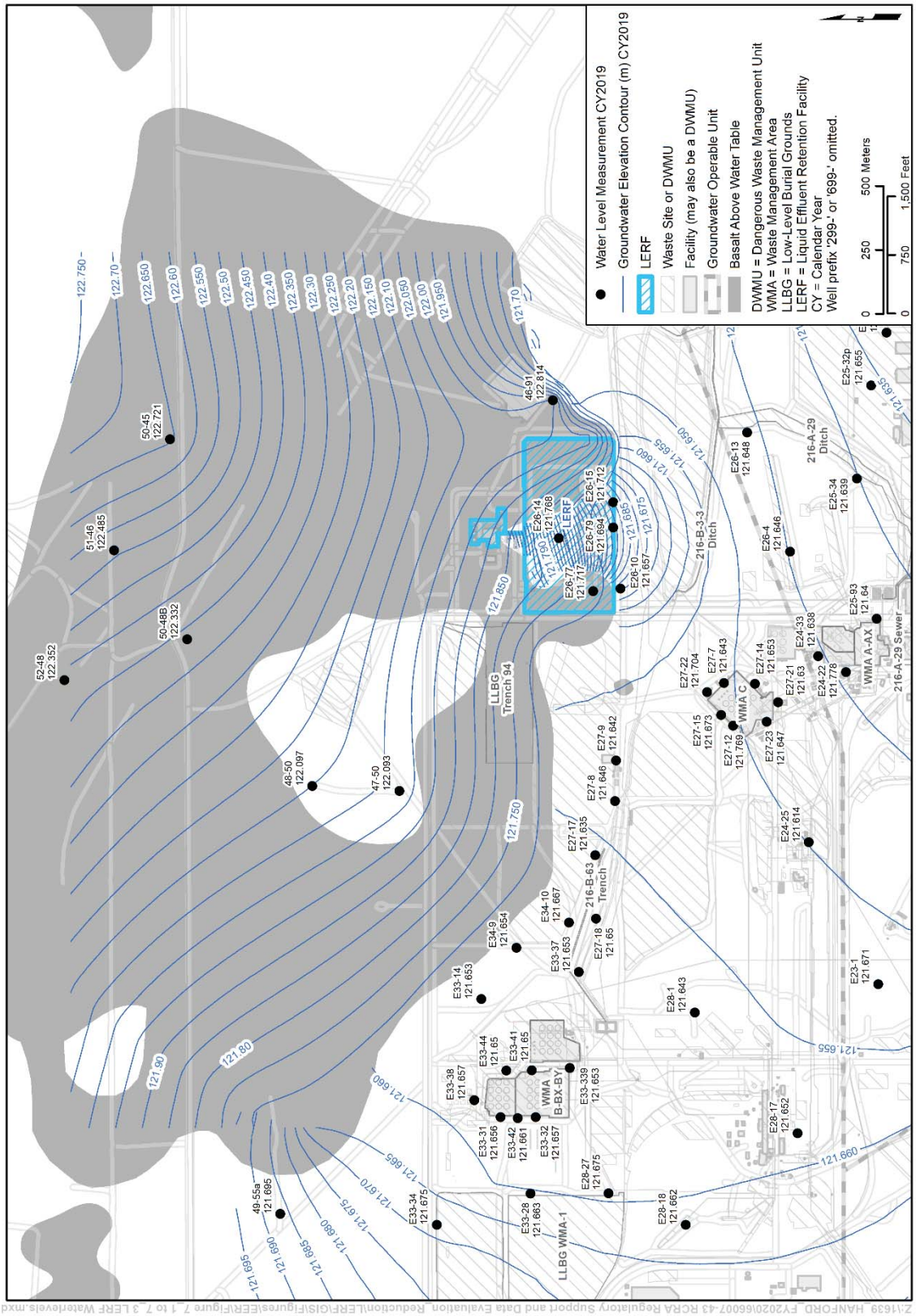


Figure 7-3. Groundwater Elevation Map for LERF, 2019

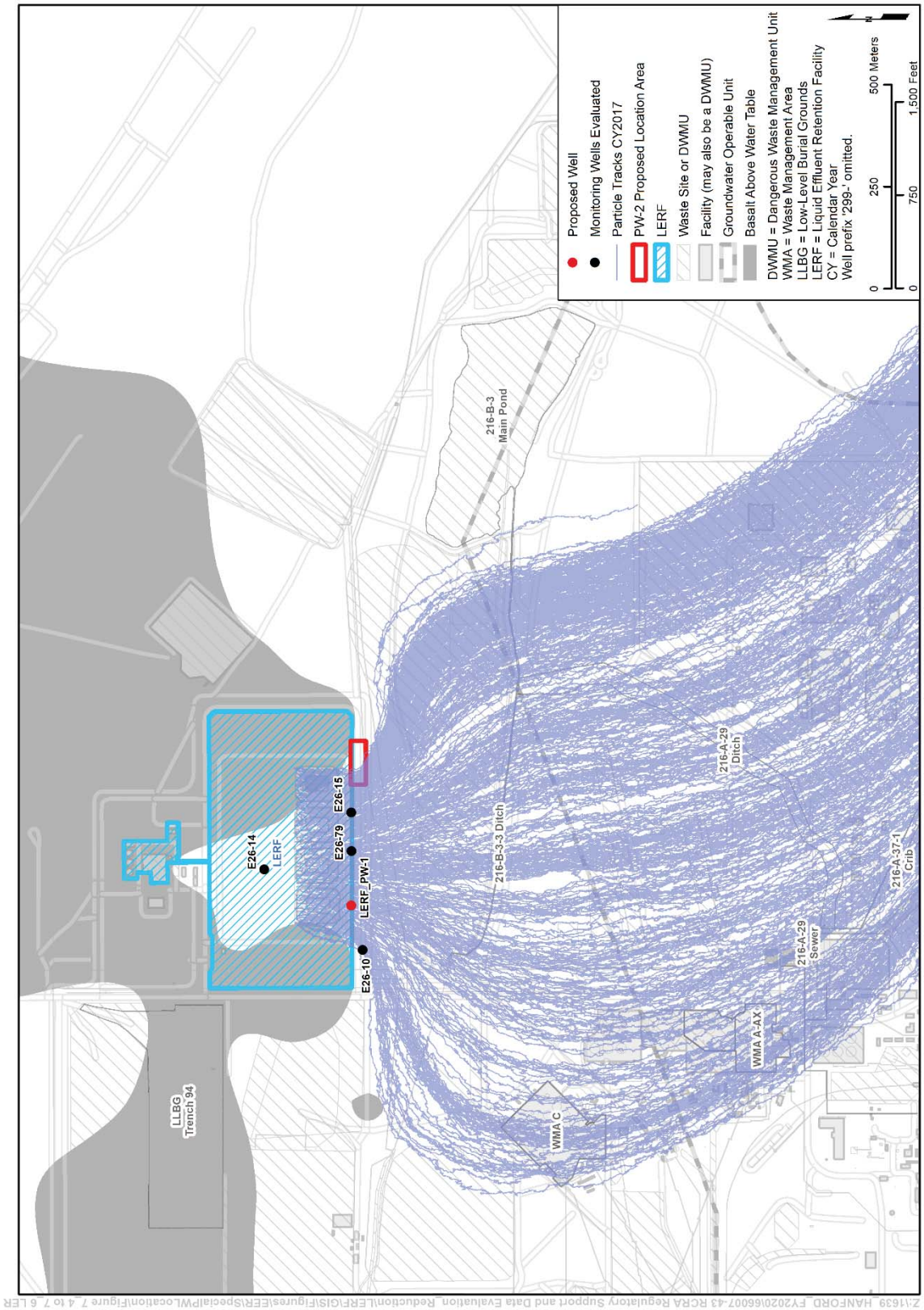


Figure 7-4. Particle Paths – LERF, 2017

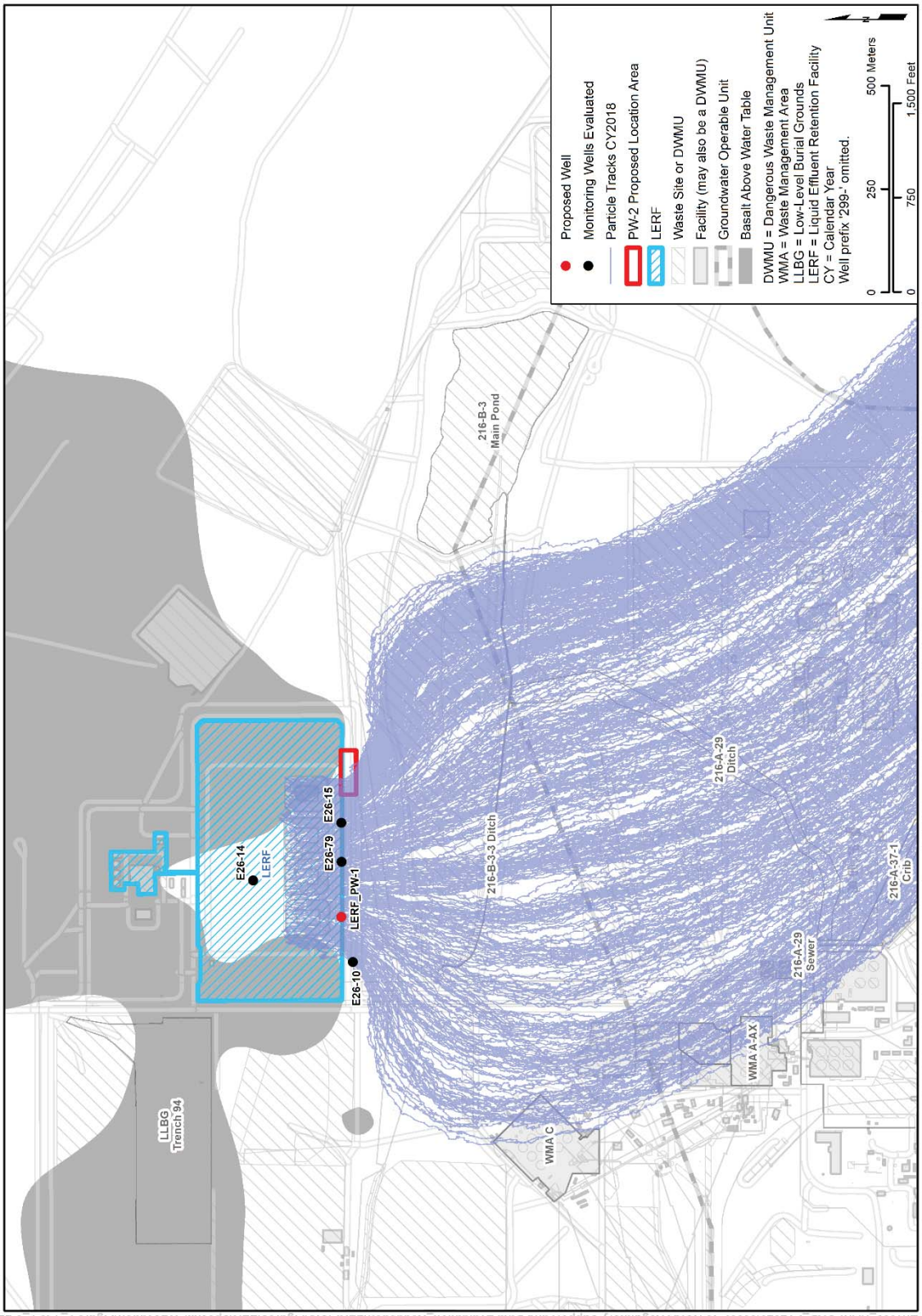


Figure 7-5. Particle Paths – LERF, 2018

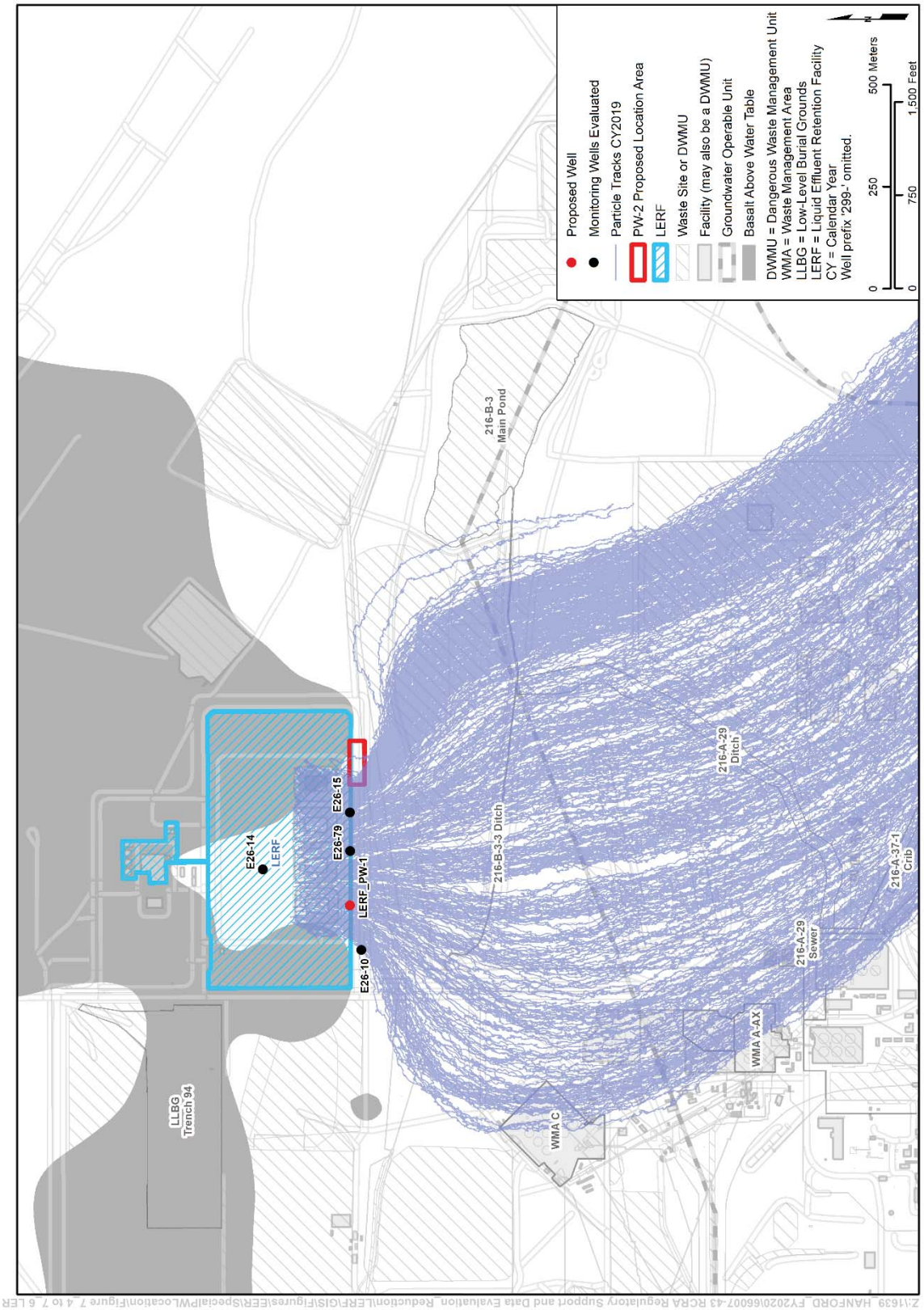


Figure 7-6. Particle Paths – LERF, 2019

7.3 Monitoring Well Network Recommendations

The goal of well placement is for the well locations to span the range of particle pathline distribution as released from LERF. Based on the results of the calculations presented in ECF-200E-20-0013 and summarized herein, the proposed final status groundwater monitoring well network for detecting a potential release from LERF includes four existing monitoring wells and up to two proposed new wells.

The existing wells proposed for use in the final status groundwater monitoring well network are downgradient wells 299-E26-10, 299-E26-15, and 299-E26-79 and upgradient well 299-E26-14. Well LERF_PW-1 is proposed as a downgradient well. An additional well, LERF_PW-2, is recommended in the vicinity shown in Figures 7-3 through 7-6 after additional evaluation of the basalt subcrop in the area is performed; therefore, LERF_PW-2 represents the general location of a future potential well. The calculations based on the three (2017 through 2019) groundwater elevation analyses indicate that the recommended downgradient groundwater monitoring wells are well placed for detecting a release to the water table from LERF.

The final status monitoring well network proposed for LERF is shown in Figure 7-7 and consists of upgradient well 299-E26-14 and downgradient wells 299-E26-10, 299-E26-15, 299-E26-79, LERF_PW-1, and LERF_PW-2. These wells are discussed further in Section 9.3.

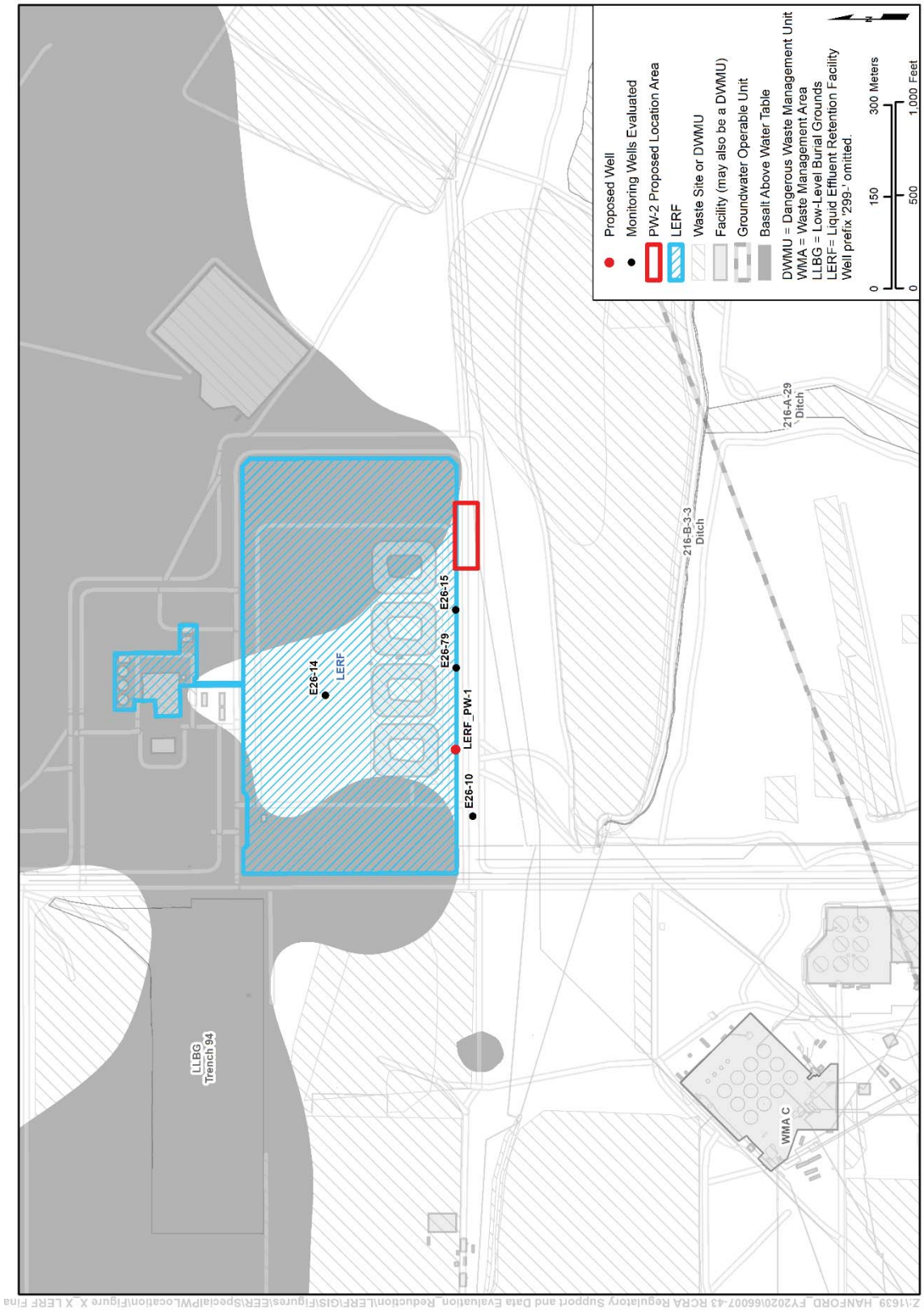


Figure 7-7. Final Monitoring Well Network for LERF

This page intentionally left blank.

8 Identification of Site-Specific Monitoring Constituents

An evaluation of the waste constituents associated with effluent that had been accepted at LERF was performed in the previous engineering evaluation report (Appendix E in SGW-41072, Rev. 1) to identify proposed groundwater monitoring constituents. For this revision, an evaluation of the waste constituents in the WTP liquid effluent was performed to determine what constituents should be added to the groundwater monitoring plan for LERF. Additionally, an evaluation of the waste constituents associated with effluent accepted at LERF since the last revision of this report was performed.

8.1 Selection Process for Monitoring Constituents

A summary of the selection process for monitoring constituents is presented in this section. Details of the evaluation process are presented in Appendix E (previous Rev. 1 evaluation of LERF effluent), Appendix F (additional WTP liquid effluent evaluation), and Appendix G (update to LERF effluent evaluation).

8.1.1 Evaluation of Effluent Streams Previously Received at LERF

Sample data as recent as 2016 for effluent that had been received at LERF and characterization samples of combined effluent in LERF basins were evaluated in Appendix E of SGW-41072, Rev. 1, to identify monitoring constituents. During the course of evaluating the WTP liquid effluent constituents, the screening process was evaluated and modified for this revised report. The modifications were intended to minimize changes to the Rev. 1 evaluation and better align to screening elements utilized for the WTP liquid effluent (Section 8.2 and Appendix F). Relative to the process used in SGW-41072, Rev. 1, the changes to the screening process are as follows:

- Removed the assumption regarding the detectability of waste constituents in the LERF basins at downgradient wells (50% dilution of constituent concentration from the source [LERF basins] to point of compliance wells)
- Added an evaluation to determine which of the proposed monitoring constituents are dangerous wastes
- Added a correction factor for the K_d values used in the mobility evaluation to account for the estimated gravel content in the vadose zone at LERF

The remaining elements of the screening process identified in Appendix E of SGW-41072, Rev. 1, were retained without further reevaluation.

The screening process for identifying waste constituents included the following steps:

- The detected constituents from the inventory were compared with the wastes identified in the following:
  - Appendix 5 of Ecology Publication 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*
  - HNF-3172, Rev. 8, *Liquid Waste Processing Facilities Waste Acceptance Criteria*
  - WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III, Operating Unit Group 3, Addendum A, Part A Form
  - WA7890008967, Part III, Operating Unit Group 3, Addendum B, Waste Analysis Plan

- The detected constituents found in the identified sources were first evaluated by comparing their maximum concentration in the LERF basins to action levels based on federal and state regulations. Constituents above their respective action levels were then evaluated on their mobility to groundwater.
- The detected constituents identified above their action levels were evaluated based on distribution coefficient (K_d). The constituents with a K_d less than or equal to 0.8 mL/g were identified for further evaluation for use in detection monitoring. A low K_d value generally indicates that a chemical has greater potential to migrate through the vadose zone and reach groundwater.
- Constituents that met both criteria (concentration at the source above the action level and greater mobility than 0.8 mL/g K_d) were further evaluated. The objective of final status groundwater monitoring is to monitor for releases of dangerous wastes from a regulated unit. However, not every chemical meeting the criteria above is a dangerous waste. Therefore, an evaluation to determine which waste constituents are dangerous wastes was performed by comparing the LERF effluent waste constituents to the following:
  - Dangerous wastes associated with the waste codes provided in the Part A Form for LERF and the ETF (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology).
  - Constituents identified in Appendix 5 of Ecology Publication No. 97-407.

Based on this evaluation, the waste constituents 1-butanol, carbon tetrachloride, chloroform, hexavalent chromium, n-nitrosodimethylamine, pentachlorophenol, and tetrachloroethene are proposed for detection monitoring based on the revised evaluation of effluent that has been received at LERF (Table 8-1). Relative to the previous (Rev. 1) evaluation, three additional constituents (chloroform, pentachlorophenol, and tetrachloroethene) are added for monitoring.

Table 8-1. Revised Monitoring Constituents Associated with Previous Effluent Streams

Waste Constituent	CAS Number
1-Butanol	71-36-3
Carbon tetrachloride	56-23-5
Chloroform	67-66-3
Hexavalent chromium	18540-29-9
n-Nitrosodimethylamine	62-75-9
Pentachlorophenol	87-86-5
Tetrachloroethene	127-18-4

Note: The revised evaluation in Appendix E added chloroform, pentachlorophenol, and tetrachloroethene as detection monitoring constituents for LERF.

CAS = Chemical Abstracts Service

8.1.2 Evaluation of WTP Liquid Effluent

The first steps of the screening process for WTP liquid effluent waste constituents are the same as performed for the waste constituents in the LERF basin effluents in SGW-41072, Rev. 1, and comprise the following:

- Constituents were first evaluated by comparing their expected maximum (for inorganic constituents) or estimated (for organic constituents) concentrations in the WTP liquid effluent to federal and state action levels for groundwater. Constituents above their respective action levels were further evaluated for use in detection monitoring.
- The constituents were then evaluated based on K_d. The K_d values used for the evaluation were corrected for the estimated gravel content in the vadose zone at LERF. The constituents with a K_d less than or equal to 0.8 mL/g were further evaluated for use in detection monitoring.

Additional screening information was compiled for the waste constituents as follows:

- Constituents that are dangerous wastes were identified by comparing to the (1) dangerous wastes identified from the LERF/ETF Part A Form and (2) Appendix 5 of Ecology Publication 97-407. WTP liquid effluent waste constituents that are not identified in either the Part A Form or Appendix 5 are not included as monitoring constituents.
- The analytical availability of constituents at commercial laboratories was evaluated. It is necessary to have a backup laboratory available for monitoring constituents required in the Hanford Facility RCRA Permit; therefore, constituents that are available for analysis at only one commercial laboratory (or at no commercial laboratory) are not included as monitoring constituents.

Constituents that met the following criteria are identified as WTP liquid effluent monitoring constituents for LERF (Table 8-2):

- Concentration in the WTP liquid effluent above the action level.
- K_d at or less than 0.8 mL/g.
- Identified from the LERF/ETF Part A Form waste codes or in Appendix 5 of Ecology Publication 97-407.
- Available for analysis at commercial laboratories

Table 8-2. Monitoring Constituents Associated with WTP Liquid Effluent

Waste Constituent	CAS Number
2-Methylphenol (o-Cresol)[a]	95-48-7
4-Methylphenol + 3-methylphenol (m- + p-Cresol)[a]	65794-96-9
Acrylonitrile	107-13-1
n-Nitrosodimethylamine[b] (n-Nitroso-n,n-dimethylamine)	62-75-9
n-Nitrosomorpholine	59-89-2

a. Total cresols was identified as a monitoring constituent for the WTP liquid effluent. Monitoring for total cresols will be performed using the isomers of cresol.

b. n-Nitrosodimethylamine (CAS 62-75-9) was included as a monitoring constituent in the previous version (Rev. 1) of this report.

Table 8-2. Monitoring Constituents Associated with WTP Liquid Effluent

Waste Constituent	CAS Number

CAS = Chemical Abstracts Service
WTP = Waste Treatment and Immobilization Plant

8.1.3 Evaluation of Effluent Streams Recently Received at LERF

To support this engineering evaluation report revision (Rev. 2), waste effluents received at LERF since Rev. 1 of this report were evaluated to determine if additional constituents should be included for detection monitoring (Appendix G). Sample data from the various effluent and characterization samples of combined effluent in the basins for calendar years (CYs) 2016 through 2019 were evaluated for the following:

- Determine if any of the detected waste constituents from the previous inventory evaluation (which included effluent data as recent as 2016) have a maximum concentration in the recent dataset that is greater than the previous maximum.
- Identify any waste constituents that are detected in the recent dataset but were not detected in the previous inventory evaluation.

Those waste constituents that were detected at higher maximum concentrations in the CY 2016 through 2019 dataset in comparison to the previous evaluation (Section 8.1.1), plus the waste constituents that were detected in the CY 2016 through 2019 dataset that were not detected in the previous evaluation, were then screened to determine if any should be added for detection monitoring at LERF.

- Comparison of maximum concentrations of constituents that were received into the LERF basins to action levels based on federal and state regulations. Constituents with concentrations above their respective action levels were further evaluated for use in detection monitoring.
- Comparison of mobility to groundwater based on distribution coefficient (K_d). A low K_d value generally indicates that a chemical has greater potential to migrate through the vadose zone and reach groundwater. The K_d values used for the evaluation were corrected for the estimated gravel content in the vadose zone at LERF. Constituents with a K_d less than or equal to 0.8 mL/g were identified for further evaluation for use in detection monitoring. K_d values were obtained from either the Cleanup Levels and Risk Calculation (CLARC) database (Ecology, 2020) or ECF-HANFORD-12-0023, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological and Radiological Analytes in the 100 Areas and 300 Area*.
- Identification of dangerous waste. The objective of final status groundwater monitoring is to monitor for releases of dangerous wastes from a regulated unit. However, not every chemical present in the LERF effluent is a dangerous waste. Therefore, an evaluation to determine which constituents are dangerous wastes was performed by comparing the LERF effluent constituents to the following:
  - Dangerous wastes associated with the waste codes provided in the Part A Form for LERF and ETF (WA7890008967, Revision 8c, Part III, OUG-3, Addendum A).
  - Constituents identified in Appendix 5 of Ecology Publication No. 97-407.
- The analytical availability of constituents at commercial laboratories was evaluated. It is necessary to have a backup laboratory available for monitoring constituents required in the Hanford Facility

RCRA Permit; therefore, constituents that are available for analysis at only one commercial laboratory (or at no commercial laboratory) are not included as monitoring constituents.

Based on the results of the LERF effluent (CY 2016 through 2019) evaluation, two waste constituents (1,4-dichlorobenzene and n-nitrosodimethylamine) are proposed for detection monitoring at LERF. Of these 2 constituents, n-nitrosodimethylamine is already identified as a monitoring constituent.

8.2 Results of Selection of Groundwater Monitoring Constituents

Based on the revised evaluation of the effluent wastes that were previously received at LERF (Table 8-1), future WTP liquid effluent (Table 8-2), and evaluation of recent waste effluent received at LERF (Table 8-3), 12 monitoring constituents are proposed (Table 8-4).

Table 8-3. Monitoring Constituents Associated with Recent Waste Effluent Received at LERF

Waste Constituent	CAS Number
1,4-Dichlorobenzene	106-46-7
n-Nitrosodimethylamine	62-75-9

CAS = Chemical Abstracts Service

Table 8-4. Proposed Monitoring Constituents for LERF

Waste Constituent	CAS Number
Inorganic	
Hexavalent chromium	18540-29-9
Volatile Organic Compounds	
1-Butanol (n-Butyl alcohol)	71-36-3
1,4-Dichlorobenzene	106-46-7
Acrylonitrile	107-13-1
Carbon tetrachloride	56-23-5
Chloroform	67-66-3
Tetrachloroethene	127-18-4
Semivolatile Organic Compounds	
2-Methylphenol (o-Cresol)	95-48-7
4-Methylphenol + 3-methylphenol (m- + p-Cresol)	65794-96-9
n-Nitrosodimethylamine	62-75-9
n-Nitrosomorpholine	59-89-2
Pentachlorophenol	87-86-5

CAS = Chemical Abstracts Service

This page intentionally left blank.

9 Groundwater Monitoring

This chapter includes a description of the proposed final status groundwater monitoring program and identifies the monitoring network, constituents to be sampled and analyzed, and the sample frequency. The revised final status groundwater monitoring plan will include corresponding details (e.g., sampling protocols, quality assurance project plan) necessary to meet the requirements of WAC 173-303-806(4)(xx)(E) and (F)(I) and (II).

9.1 Final Status Groundwater Monitoring Program Determination

The appropriate groundwater monitoring program (i.e., detection monitoring, compliance monitoring, corrective action monitoring) is determined using the requirements in WAC 173-303-645(2)(a). If there is no statistically significant evidence of a release (contamination) at the point of compliance, the DWMU is monitored under WAC 173-303-645(9), "Detection Monitoring Program." If groundwater monitoring has shown statistically significant evidence of a release (contamination) at the point of compliance, the DWMU is monitored under WAC 173-303-645(10), "Compliance Monitoring Program." If the groundwater protection standard (which may be defined at the time of the permit issuance or when dangerous constituents from a regulated unit have been detected [WAC 173-303-645(3)]) is exceeded, a corrective action program is implemented and the DWMU is monitored under WAC 173-303-645(11), "Corrective Action Program."

In 1998, LERF became a final status unit subject to detection monitoring under WAC 173-303-645(9). To date, a release to the environment has not been observed at LERF. Therefore, LERF will continue in detection monitoring under WAC 173-303-645(9) in the Hanford Facility Dangerous Waste Permit.

9.2 Point of Compliance Monitoring

The point of compliance is defined in WAC 173-303-645(6)(a) as "…a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units." WAC 173-303-645(6)(b) further states, "The waste management area is the limit projected in the horizontal plane of the area on which waste will be placed during the active life of a regulated unit. The waste management area includes horizontal space taken up by any liner, dike, or other barrier designed to contain waste in a regulated unit. If the facility contains more than one regulated unit, the waste management area is described by an imaginary line circumscribing the several regulated units."

The results of the water-table mapping described in Chapter 7 indicate that the locations of the five downgradient wells proposed for the monitoring well network (299-E26-10, 299-E26-15, 299-E26-79, LERF_PW-1, and LERF_PW-2) span the range of particle distribution as released from LERF. The well placement is suitable for detecting releases to the water table from LERF under the evaluated range of conditions. The proposed well locations comply with the intent of WAC 173-303-645(6), which is to delineate the vertical and horizontal limits of the waste management area in order to detect releases of waste constituents from the facility that would pose a potential risk to ground and surface water. The downgradient wells are proposed as the point of compliance wells. Additional details regarding selection of these wells are presented in Chapter 7.

9.3 Proposed Groundwater Monitoring Network

The proposed groundwater monitoring network for LERF consists of one background (upgradient) well and five point of compliance (downgradient) wells to monitor for potential releases to the water table from LERF (Figure 9-1). The monitoring well locations were evaluated based on water elevation mapping

and particle-tracking simulations representing flow conditions for three years (2017 through 2019). Results of the simulations are presented in Chapter 7.

Well attributes are summarized in Table 9-1 and Appendix D. Each of the proposed network wells have been or will be constructed according to WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells”. Each well is or will be screened in the upper unconfined aquifer in order to yield sufficient groundwater for representative sampling. Sections 9.3.1 through 9.3.6 provide details supporting the selection of each of the proposed locations.

Where possible, the groundwater monitoring network is intended to meet the requirements of WAC 173-303-645(8)(a). Groundwater conditions on the Central Plateau have been impacted in different ways throughout the history of the Hanford Site. A description of the impacts to groundwater flow direction pertaining to LERF is presented in Section 3.3. WAC 173-303-645(8)(a)(i) states that wells must be appropriately sited to, “Represent the quality of background groundwater that has not been affected by leakage from a regulated unit.” To meet the intent of WAC 173-303-645(8)(a)(i), a background (upgradient) well has been selected that would be representative of ambient conditions. It does not, however, represent groundwater not affected by Hanford Site operations. Characterization of the contaminated groundwater, including concentrations of dangerous constituents and parameters, will be performed after sufficient samples have been collected in the first 2 years of monitoring to conduct statistical analyses.

WAC 173-303-645(8)(g), states, “In detection monitoring…data on each dangerous constituent specified in the permit will be collected from background wells and at the compliance point(s). The number and kinds of samples collected to establish background must be appropriate for the form of statistical test employed, following generally accepted statistical principles. The sample size must be as large as necessary to ensure with reasonable confidence that a contaminant release to groundwater from a facility will be detected…” However, WAC 173-303-645(8)(h)(v) allows that, “Another statistical test method may be submitted by the owner or operator and approved by the department.” Selection of the statistical method for use in LERF is discussed in Section 9.5.

Based on current groundwater flow direction to the south, the selected point of compliance wells will provide representative samples of the quality of groundwater passing the point of compliance (WAC 173-303-645(8)(a)(ii)). These locations allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer (WAC 173-303-645(8)(a)(iii)).

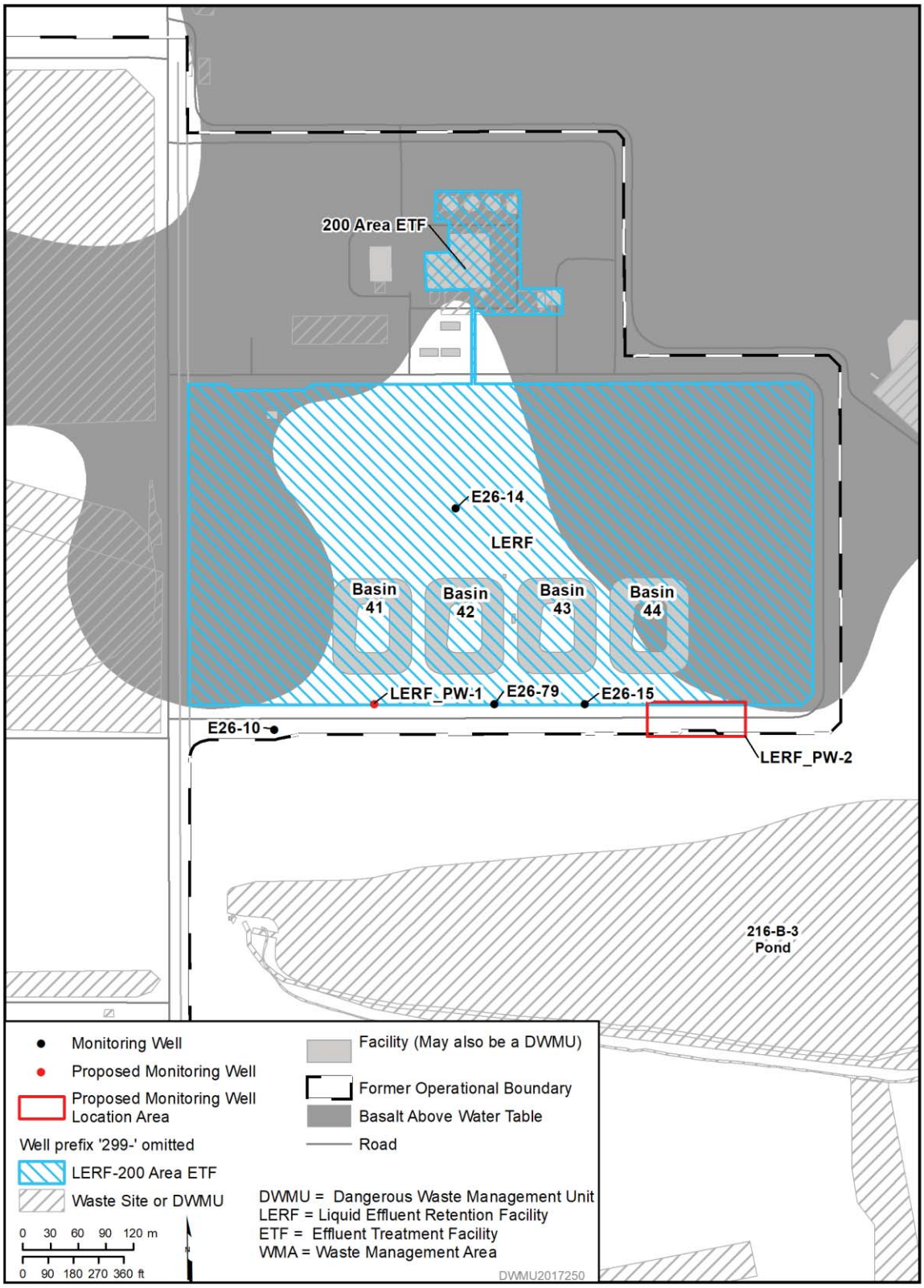


Figure 9-1. Proposed Final Status Groundwater Monitoring Network for LERF

Table 9-1. Attributes for Wells in the LERF Groundwater Monitoring Network

Well Name	Completion Date	Easting[a] (m)	Northing[a] (m)	Top of Casing Elevation (m [ft]) (NAVD88)	Water Table Elevation (m [ft]) (amsl)	Water Depth (m [ft] bgs)	Depth of Water in Screen (m [ft])	Water-Level Date
299-E26-10	1990	575589.0	137023.5	184.42 (605.05)	121.61 (398.98)	61.9 (203.1)	0.9 (3.0)	1/23/2020
299-E26-14	2011	575786.5	137264.5	183.22 (601.13)	121.69 (399.24)	60.8 (199.5)	5.0 (16.4)	1/9/2020
299-E26-15	2015	575926.5	137051.4	183.18 (600.99)	121.61 (398.98)	60.8 (199.5)	2.1 (7.0)	1/9/2020
299-E26-79	2008	575827.9	137051.5	183.12 (600.77)	121.62 (399.02)	60.7 (199.3)	6.4 (20.9)	1/9/2020
LERF_ PW-1	TBD	575698.0	137051.5	TBD	TBD	TBD	TBD	TBD
LERF_PW-2	TBD	TBD[b]	TBD[b]	TBD	TBD	TBD	TBD	TBD

Reference: NAVD88, *North American Vertical Datum of 1988.*

a. Coordinates are in Washington State Plane (south zone), NAD83, *North American Datum of 1983*; 1991 adjustment.

b. Well LERF_PW-2 is represented as a polygon in Figure 9-1 to show the general location of the well. The specific location for well LERF_PW-2 will be determined after new well LERF_PW-1 is installed and sampled for the first year.

amsl = above mean sea level

bgs = below ground surface

TBD = to be determined. Information will be obtained after well construction.

9.3.1 Groundwater Monitoring Well 299-E26-14

Groundwater monitoring well 299-E26-14 is proposed as a background well. It was constructed in 2011 and is compliant with the standards of WAC 173-160. This well is currently used in the final status groundwater monitoring network for LERF[1]. The well is upgradient of LERF and is screened from elevation 122.8 m (402.8 ft) to elevation 116.7 m (382.8 ft) (Appendix D). Based on 2020 water elevation data, well 299-E26-14 is screened across the upper 5.0 m (16.4 ft) of the uppermost unconfined aquifer (Table 9-1) and yields sufficient groundwater for representative sampling.

Water-table maps were produced and particle-tracking simulations were performed to evaluate the movement of groundwater and identify areas of the aquifer where a hypothetical release that impacts the water table beneath LERF would be most likely to migrate and be detectable (described in Chapters 5 through 7). Figures 7-1 through 7-6 indicate that the direction of groundwater flow is predominantly to the south-southeast at this well for the flow conditions evaluated. Figures 7-4 through 7-6 indicate that for the years mapped this well will remain upgradient of LERF under expected groundwater flow conditions.

9.3.2 Groundwater Monitoring Well 299-E26-10

Groundwater monitoring well 299-E26-10 is proposed as a point of compliance well. It was constructed in 1990 to the standards of WAC 173-160. This well is currently used in the final status groundwater monitoring network for LERF for water-level measurements, but is planned for use as a point of compliance well. The well is downgradient of LERF and is screened from elevation 125.4 m (411.6 ft) to elevation 120.7 m (396.0 ft) (Appendix D). Based on 2020 water elevation data, well 299-E26-10 is screened across the upper 0.9 m (3.0 ft) of the uppermost unconfined aquifer (Table 9-1) and yields sufficient groundwater for representative sampling.

Water-table maps were produced and particle-tracking simulations were performed to evaluate the movement of groundwater and identify areas of the aquifer where a hypothetical release that impacts the water table beneath LERF would be most likely to migrate and be detectable (described in Chapters 5 through 7). Figures 7-1 through 7-6 indicate that the direction of groundwater flow is predominantly to the south-southwest at this well for the flow conditions evaluated. Figures 7-4 through 7-6 indicate that for the years mapped well 299-E26-10 is located at the western extent of potential particle tracks.

9.3.3 Groundwater Monitoring Well 299-E26-15

Groundwater monitoring well 299-E26-15 is proposed as a point of compliance well. It was constructed in 2015 to the standards of WAC 173-160. This well is currently used in the final status groundwater monitoring network for LERF. The well is downgradient of LERF and is screened from elevation 124.2 m (407.3 ft) to elevation 119.5 m (392.0 ft) (Appendix D). Based on 2020 water elevation data, well 299-E26-79 is screened across the upper 2.1 m (7.0 ft) of the uppermost unconfined aquifer (Table 9-1) and yields sufficient groundwater for representative sampling.

Water-table maps were produced and particle-tracking simulations were performed to evaluate the movement of groundwater and identify areas of the aquifer where a hypothetical release that impacts the water table beneath LERF would be most likely to migrate and be detectable (described in Chapters 5 through 7). Figures 7-1 through 7-6 indicate that the direction of groundwater flow is predominantly to

[1] The current groundwater monitoring network for LERF is available in Table D-7 of Addendum D In the Hanford Facility RCRA Permit, Part III, OUG-3,

the south-southeast at this well for the flow conditions evaluated. Figures 7-4 through 7-6 indicate that for the years mapped, well 299-E26-15 is centrally located in the area of potential particle tracks.

9.3.4 Groundwater Monitoring Well 299-E26-79

Groundwater monitoring well 299-E26-79 is proposed as a point of compliance well. It was constructed in 2008 to the standards of WAC 173-160. This well is currently used in the final status groundwater monitoring network for LERF. The well is downgradient of LERF and is screened from elevation 122.7 m (402.6 ft) to elevation 115.1 m (377.6 ft) (Appendix D). Based on 2020 water elevation data, well 299-E26-79 is screened across the upper 7.6 m (25 ft) of the uppermost unconfined aquifer (Table 9-1) and yields sufficient groundwater for representative sampling.

Water-table maps were produced and particle-tracking simulations were performed to evaluate the movement of groundwater and identify areas of the aquifer where a hypothetical release that impacts the water table beneath LERF would be most likely to migrate and be detectable (described in Chapters 5 through 7). Figures 7-1 through 7-6 indicate that the direction of groundwater flow is predominantly to the south-southeast at this well for the flow conditions evaluated. Figures 7-4 through 7-6 indicate that for the years mapped, well 299-E26-79 is centrally located in the area of potential particle tracks.

9.3.5 Groundwater Monitoring Well LERF_PW-1

Groundwater monitoring well LERF_PW-1 is a proposed point of compliance well. If the well location is approved, it will be constructed according to WAC 173-160. The proposed location for the well is downgradient of LERF. The screened interval of the well will be designed to yield sufficient groundwater for representative sampling when constructed.

Water-table maps were produced and particle-tracking simulations were performed to evaluate the movement of groundwater and identify areas of the aquifer where a hypothetical release that impacts the water table beneath LERF would be most likely to migrate and be detectable (described in Chapters 5 through 7). Figures 7-1 through 7-6 indicate that the direction of groundwater flow is predominantly to the south-southwest at this well for the flow conditions evaluated. Figures 7-4 through 7-6 indicate that for the years mapped, proposed well LERF_PW-1 is centrally located in the likely area of potential particle tracks.

9.3.6 Groundwater Monitoring Well LERF_PW-2

Groundwater monitoring well LERF_PW-2 is a proposed point of compliance well. Well LERF_PW-2 is represented as a polygon in Figure 9-1 to show the general location of the well. The specific location will be determined after new well LERF_PW-1 is installed and sampled for the first year. This will allow for collection of additional information to better cite the location, including hydrogeological and geophysical data that impacts groundwater flow and the water table.

When installed, the well will be constructed according to WAC 173-160. The proposed location for the well is downgradient of LERF. The screened interval of the well will be designed to yield sufficient groundwater for representative sampling when constructed. Well LERF_PW-2 is recommended in the vicinity shown in Figure 9-1 in the area south of Basin 44.

Water-table maps were produced and particle-tracking simulations were performed to evaluate the movement of groundwater and identify areas of the aquifer where a hypothetical release that impacts the water table beneath LERF would be most likely to migrate and be detectable (described in Chapters 5 through 7). Figures 7-1 through 7-6 indicate that the direction of groundwater flow is predominantly to the south-southeast at this well for the flow conditions evaluated. Figures 7-4 through 7-6 indicate that for

the years mapped, proposed well LERF_PW-2 is located on the eastern extent of the potential particle tracks.

9.4 Constituent List and Frequency

The proposed LERF final status groundwater monitoring network detailed in this report consists of one upgradient well (299-E26-14) and five downgradient wells (299-E26-10, 299-E26-15, 299-E26-79, LERF_PW-1, and LERF_PW-2). Each of the four existing wells is part of the LERF final status groundwater monitoring network; however, well 299-E26-10 is used for water-level measurement only (SGW-41072, Rev. 1). The monitoring network is shown in Figure 9-1.

For a detection monitoring program, WAC 173-303-645(9)(a) requires, "The owner or operator must monitor for indicator parameters (e.g., pH, specific conductance, total organic carbon, total organic halogen, or heavy metals), waste constituents, or reaction products that provide a reliable indication of the presence of dangerous constituents in groundwater. The department will specify the parameters or constituents to be monitored in the facility permit…" Based on the analysis in Chapter 8, 12 waste constituents were selected to detect groundwater impacts from dangerous waste releases at LERF.

Table 9-2 identifies the proposed monitoring network and sampling frequency for LERF. The proposed site-specific monitoring constituents (Table 9-3) were identified in Chapter 8 (Table 8-4) and will be sampled semiannually. Field measurements (dissolved oxygen, pH, specific conductance, temperature, and turbidity) will be collected each time a well is sampled. Water-level measurements at each monitoring well will be determined each time a sample is obtained (WAC 173-303-645(8)(f)). Analytical performance, data evaluation, reporting, sampling protocols, and quality assurance requirements will be specified in the revised final status groundwater monitoring plan to be prepared for LERF.

Statistical evaluation of sampling results will be performed for site-specific monitoring constituents (Table 9-3), as appropriate. Information on the statistical method is provided in Section 9.5.

When the revised final status groundwater monitoring plan for LERF is incorporated into the Hanford Facility Dangerous Waste Permit, it will replace any other groundwater monitoring plan(s) associated specifically with this DWMU.

Table 9-2. Monitoring Wells and Sample Schedule for LERF

Well Name	Purpose	WAC Compliant	Water Level	Site-Specific Constituents to Detect Release from Regulated Unit[a]	Field Parameters[b]
				Table 9-3	
299-E26-14	Upgradient	Y	Q/S	Q/S	Q/S
299-E26-10	Downgradient	Y	Q/S	Q/S	Q/S
299-E26-15	Downgradient	Y	Q/S	Q/S	Q/S
299-E26-79	Downgradient	Y	Q/S	Q/S	Q/S
LERF_ PW-1	Downgradient	Y	Q/S	Q/S	Q/S
LERF_PW-2	Downgradient	Y	Q/S	Q/S	Q/S

Note: Complete reference citations are provided in Chapter 11.

a. The site-specific monitoring constituents will be sampled quarterly for the first 2 years (eight samples) of monitoring at each well to determine baseline/background concentrations. After eight samples are collected, the sampling frequency will change to semiannually.

b. Field parameters include dissolved oxygen, pH, specific conductance, temperature, and turbidity.

Q = quarterly

S = semiannually

WAC = *Washington Administrative Code*

Y = well is, or will be, constructed as a resource protection well (WAC 173-160)

Table 9-3. Proposed Monitoring Constituents for LERF

Waste Constituent	CAS Number
1-Butanol	71-36-3
1,4-Dichlorobenzene	106-46-7
2-Methylphenol (o-Cresol)	95-48-7
4-Methylphenol + 3-methylphenol (m- + p-Cresol)	65794-96-9
Acrylonitrile	107-13-1
Carbon tetrachloride	56-23-5
Chloroform	67-66-3
Hexavalent chromium	18540-29-9
n-Nitrosodimethylamine (n-Nitroso-n,n-dimethylamine)	62-75-9
n-Nitrosomorpholine	59-89-2

Table 9-3. Proposed Monitoring Constituents for LERF

Waste Constituent	CAS Number
Pentachlorophenol	87-86-5
Tetrachloroethene	127-18-4

CAS = Chemical Abstracts Service

9.5 Statistical Method

WAC 173-303-645(8)(g) states, "In detection monitoring…data on each dangerous constituent specified in the permit will be collected from background wells and at the compliance point(s). The number and kinds of samples collected to establish background must be appropriate for the form of statistical test employed, following generally accepted statistical principles. The sample size must be as large as necessary to ensure with reasonable confidence that a contaminant release to groundwater from a facility will be detected…"

Detection monitoring at LERF will evaluate potential releases of dangerous waste using the Double Quantification rule from EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*. The Double Quantification rule states that "[a] confirmed exceedance is registered if any well-constituent pair in the '100% non-detect' group exhibits quantified measurements […] in two consecutive sample and resample events" (p. 6-11 in EPA 530/R-09-007). A sample result will be identified as detected if the concentration is above the practical quantitation limit.

Using the Double Quantification rule with an intra-well evaluation approach, detection of a monitoring constituent identified in Table 9-3 will be considered evidence of a potential release to groundwater. Consideration will be given to where the detection occurs (i.e., background well, point of compliance well, or both). If the constituent is determined to be present only in a background well, no further action will be required. If the constituent is detected in only a compliance well, subsequent actions are required. If the constituent is detected in a background well and one (or more) compliance wells, the sample results will be further evaluated to make a determination as to whether the presence of the constituent in the compliance well results from a release at LERF or results from another source.

A detailed description of the sample data evaluation process will be presented in the final status groundwater monitoring plan.

This page intentionally left blank.

10 Routine Evaluation of the Monitoring Network

The groundwater flow regime will evolve over time. Throughout the year, water-level measurements are also taken as part of routine sampling, and annually for water-level mapping. Analysis of groundwater elevation will be used to interpret changes in the groundwater flow regime. Evaluation of the continued suitability of the monitoring network will be performed annually in conjunction with the WAC 173-303-645(9)(e) determination of groundwater flow direction and rate in the uppermost aquifer. If the analysis suggests a change in the flow regime (e.g., changes resulting from a CERCLA remedy) that indicates that the likely migration direction of any hypothetical release is outside of or on the margins of the monitoring network for a DWMU, then particle tracking using the new groundwater flow conditions will be performed to re-evaluate the monitoring network for that DWMU.

Results of the reevaluation of the monitoring network may result in a proposal to add additional monitoring well locations. In a given year, the results may show that there is no impact to a DWMU, in which case no action would be taken. If an impact to a DWMU is shown, the network would be reevaluated and documented in an update to this engineering evaluation report that would be shared with Ecology and placed in the operating record. An update to the engineering report would not necessarily result in an update to the associated groundwater monitoring plan if there is no resulting change needed to the groundwater monitoring network. If a change in the groundwater monitoring network is determined, a permit modification with a revised groundwater monitoring plan would be performed in accordance with WAC 173-303-815, “Facility-Specific Permit Conditions.”

This page intentionally left blank.

11 References

10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=24aad4966ac52acbeba416c2c1114889&mc=true&node=pt10.4.962&rgn=div5.

15-AMRP-0149, 2015, "Notification of Upward Trending Total Organic Carbon Background Concentrations in Groundwater at the Liquid Effluent Retention Facility" (letter to J. Hedges, Washington State Department of Ecology, from R.J. Corey), U.S. Department of Energy, Richland Operations Office, Richland, Washington, April 28. Available at: https://pdw.hanford.gov/document/0081399H.

16-AMRP-0252, 2016, "Notification of Groundwater Sampling Results Exceeding Specific Conductance for the Liquid Effluent Retention Facility 2013 Monitoring Well Network Plan Per 40 CFR 265.93(2)(d)(1)" (letter to A.K. Smith, Washington State Department of Ecology, from K.W. Smith), U.S. Department of Energy, Office of River Protection, Richland, Washington, August 22. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0075370H.

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol25/xml/CFR-2010-title40-vol25-part261.xml.

Appendix IX, "Wastes Excluded Under 260.20 and 260.22."

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5.

265.90, "Applicability."

265.91, "Ground-Water Monitoring System."

265.92, "Sampling and Analysis."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

Atomic Energy Act of 1954, as amended, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at: https://www.gpo.gov/fdsys/pkg/USCODE-2010-title42/html/USCODE-2010-title42-chap23-divsnA.htm.

BHI-00184, 1995, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington,* Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0083482H.

CP-47631, 2017, *Model Package Report: Central Plateau Groundwater Model, Version 8.4.5*, Rev. 4, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0066449H.

CP-60925, *Model Package Report: Central Plateau Vadose Zone Geoframework, Version 1.0*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0065500H.

Ecology, 2020, Cleanup Levels and Risk Calculations (CLARC) database, Washington State Department of Ecology, Olympia, Washington. Available at: https://fortress.wa.gov/ecy/clarc/.

DOE/RL-91-03, 1991, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1990*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196047080.

DOE/RL-92-03, 1992, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1991*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196089863.

DOE/RL-93-88, 1994, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196094135.

DOE/RL-94-136, 1995, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1994*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196037232.

DOE/RL-2002-39, 2002, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0081471H.

DOE/RL-2008-56, 2012, *200 West Area Pre-Conceptual Design for Final Extraction/Injection Well Network: Modeling Analyses*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0081011H.

DOE/RL-2011-118, 2012, *Hanford Site Groundwater Monitoring for 2011*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington, Available at: https://pdw.hanford.gov/document/0091795.

DOE/RL-2013-46, 2013, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington, Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1406031319.

DOE/RL-2013-46, 2017, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility,* Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington, Available at: https://pdw.hanford.gov/document/0068832H.

DOE/RL-2015-07, 2015, *Hanford Site Groundwater Monitoring Report for 2014*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0080600H.

DOE/RL-2016-12, 2016, *Hanford Site RCRA Groundwater Monitoring Report for 2015*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0073391H.

DOE/RL-2016-67, 2017, *Hanford Site Groundwater Monitoring Report for2016,* Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0068229H.

DOE/RL-2016-71, *Demonstration of Other Source or Natural Variation Causing Elevated Specific Conductance in Groundwater at the Liquid Effluent Retention Facility (LERF) Point of Compliance*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0073627H.

DOE/RL-2017-65, 2018, *Hanford Site RCRA Groundwater Monitoring Report for 2017*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0066266H.

DOE/RL-2017-66, 2018, *Hanford Site Groundwater Monitoring Report for 2017*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0064709H.

DOE/RL-2018-65, 2019, *Hanford Site RCRA Groundwater Monitoring Report for 2018*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/AR-01118.2

ECF-200E-18-0066, 2018, *Groundwater Flow and Migration Calculations to Assess Monitoring Networks in the 200 East Area Dangerous Waste Management Units*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0064076H.

ECF-200E-20-0013, *Groundwater Flow and Migration Calculations to Support the Assessment of the Liquid Effluent Retention Facility Monitoring Network*, Rev. 0 pending, CH2M HILL Plateau Remediation Company, Richland, Washington.

ECF-HANFORD-12-0023, 2018, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological and Radiological Analytes in the 100 Areas and 300 Area*, Rev. 4, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0065283H.

ECF-Hanford-13-0029, 2015, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080813H.

ECF-HANFORD-13-0029, 2018, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington*, Rev. 5, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0064943H.

ECF-HANFORD-19-0132, *Hydraulic Gradient and Average Linear Groundwater Velocity Calculations – Quarter 3 Calendar Year 2019*, Rev. 0 pending, CH2M HILL Plateau Remediation Company, Richland, Washington.

Ecology, 1987, *Order No. DE 87-295*, Washington State Department of Ecology, Olympia, Washington, October 30. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0001164.

Ecology Publication No. 97-407, 2014, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*, Hazardous Waste and Toxics Reduction Program, Washington State Department of Ecology, Olympia, Washington. Available at: https://fortress.wa.gov/ecy/publications/documents/97407.pdf.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

EPA 530/R-09-007, 2009, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*, Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P10055GQ.TXT.

Goswami, D. and F. Jamison, 2001, "Liquid Effluent Retention Facility (LERF) Unsaturated Zone Monitoring Alternatives Evaluation, Suspension of Groundwater Monitoring Statistical Evaluation Requirements, LERF RCRA Permit Modification, and Leachate Monitoring Performance Criteria" (letter to Kevin Leary and Michael Thompson, U.S. Department of Energy), Washington State Department of Ecology, Richland, Washington, January 24. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8613096.

HNF-3172, 2016, *Liquid Waste Processing Facilities Waste Acceptance Criteria*, Rev. 8, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071839H.

In-Situ, Inc., 2005, "Total Dissolved Solids from conductivity," Technical Note 14, In-Situ, Inc., Fort Collins, Colorado.

Karanovic, M., M. Tonkin, and D. Wilson, 2009, "KT3D_H2O: A Program for Kriging Water Level Data Using Hydrologic Drift Terms," *Ground Water* 47(4):580-586.

Leja, S., 1999, "Variance from Interim Status Groundwater Monitoring Requirements at the Liquid Effluent Retention Facility" (letter to M.J. Furman, U.S. Department of Energy, Richland Operations Office), Washington State Department of Ecology, Richland, Washington, September 22. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2495684.

Lindsey, K.A., 1996, *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-central Washington and North-central Oregon*, Open File Report 96-8, Washington Division of Geology and Earth Resources, Washington State Department of Natural Resources, Olympia, Washington. Available at: http://www.dnr.wa.gov/Publications/ger_ofr96-8_ringold_formation.pdf.

Muffels, C., X. Wang, M. Tonkin, C. Neville, M. Ramadhan, and J.R. Craig, 2018, *User's Guide for mod-PATH3DU, A Groundwater Path and Travel-Time Simulator*, S.S. Papadopulos & Associates, Inc., Bethesda, Maryland. Available at: http://mp3du.sspa.com/man/.

NAD83, 1991, *North American Datum of 1983*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

NAVD88, 1988, *North American Vertical Datum of 1988*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

PNNL, 1999, *Groundwater Assessment Plan and Report for the 200 East Area Liquid Effluent Retention Facility* (Letter Report to Michael Thompson, U.S. Department of Energy, Richland Operations Office), Pacific Northwest National Laboratory, Richland, Washington, March 18. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071838H.

PNNL-11620, 1997, *Liquid Effluent Retention Facility Final-Status Groundwater Monitoring Plan*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.osti.gov/scitech/biblio/552795.

PNNL-12086, 1999, *Hanford Site Groundwater Monitoring for Fiscal Year 1998*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199091099.

PNNL-12261, 2000, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0906180659.

PNNL-13116, 2000, *Hanford Site Groundwater Monitoring for Fiscal Year 1999*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2736610. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2736978.

PNNL-13404, 2001, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2743868. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2786917.

PNNL-14548, 2004, *Hanford Site Groundwater Monitoring for Fiscal Year 2003*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14548.pdf.

PNNL-14702, 2006, *Vadose Zone Hydrogeology Data Package for Hanford Assessments,* Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://pdw.hanford.gov/document/0911300343.

PNNL-14753, 2006, *Groundwater Data Package for Hanford Assessments*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnl.gov/main/publications/external/technical_reports/PNNL-14753Rev1.pdf.

PNNL-19277, 2010, *Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://www.pnl.gov/main/publications/external/technical_reports/PNNL-19277.pdf.

RHO-RE-ST-12P, 1984, *An Assessment of Aquifer Intercommunication in the B Pond-Gable Mountain Pond Area of the Hanford Site*, Rockwell Hanford Operations, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196002251.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington.* Available at: http://app.leg.wa.gov/RCW/default.aspx?cite=70.105.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

SGW-35756, 2007, *Water-Level Barometric Response Analysis for the Liquid Effluent Retention Facility Monitoring Wells*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0906180656.

SGW-41072, 2009, *Liquid Effluent Retention Facility Characterization Report*, Rev. 0. CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0906160165.

SGW-41702, 2017, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report*, Rev. 1 CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0068831H.

SGW-54165, 2014, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0085682.

SGW-51467, 2012, *Borehole Summary Report for the Installation of Two RCRA Groundwater Monitoring Wells in the 200 Areas, FY2011*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0075562H.

SGW-52162, 2012, *Seismic Reflection Investigation at the Liquid Effluent Retention Facility, 200 East Area, Hanford Site Richland, Washington*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071843H.

SGW-52467, 2012, *Integrated Surface Geophysical Investigation Results at Liquid Effluent Retention Facility, 200 East Area, Hanford, Washington*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0073389H.

SGW-55438, 2013, *Hanford Site Groundwater Monitoring for 2012: Supporting Information*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0087999.

SGW-60338, 2017, *Historical Changes in Water Table Elevation and Groundwater Flow Direction at Hanford: 1944 to 2014*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0072270H.

Tonkin, Matthew J., Jonathan Kennel, William Huber, and John M. Lambie, 2016, "Multi-Event Universal Kriging (MEUK)," *Advances in Water Resources* 87:92-105.

WA7890008967, 2004, *Hanford Facility Resource Conservation and Recovery Act Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8, Attachment 34, Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D6170221.

WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Revision 8c, as amended, Washington State Department of Ecology. Available at: https://fortress.wa.gov/ecy/nwp/permitting/hdwp/rev/8c/.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303.

303-090, "Dangerous Waste Characteristics."

303-104, "State-Specific Dangerous Waste Numbers."

303-400, "Interim Status Facility Standards."

303-645, "Releases from Regulated Units."

303-806, "Final Facility Permits."

303-815, "Facility-Specific Permit Conditions."

303-910, "Petitions."

303-9904, "Dangerous Waste Sources List."

WHC-MR-0204, 1990, *200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary Report*, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196038070.

WHC-MR-0235, 1990, *Borehole Completion Data Package for the Liquid Effluent Retention Facility*, Westinghouse Hanford Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0075560H.

WHC-MR-0391, 1992, *Field Trip Guide to the Hanford Site*, Westinghouse Hanford Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/D196136627.

WHC-SD-EN-AP-024, 1990, *Interim Status Ground Water Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0009541.

WHC-SD-EN-AP-024, 1991, *Interim Status Ground Water Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, Rev. 1, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196068312.

Modified by:

Engineering Change Notice 603891, 1995, *Interim Status Groundwater Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, change notice for WHC-SD-EN-AP-024, Rev. 1, Earth and Environmental Technical Services, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196034139.

WHC-SD-EN-EV-024, 1994, *Site Characterization Report for the Liquid Effluent Retention Facility*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196090383.

WHC-SD-EN-TI-012, 1992, *Geologic Setting of the 200 East Area: An Update*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0019549.

WHC-SD-EN-TI-019, 1992, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=D196113608.

WHC-SD-WM-TI-730, 1996, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071840H.

Zheng, C., and P.P. Wang, 1999, *MT3DMS: A Modular Three-Dimensional Multi-Species Transport Model for Simulation of Advection, Dispersion and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide*, Contract Report SERDP-99-1, U.S. Army Engineer Research and Development Center, U.S. Army Corps of Engineers, Vicksburg, Mississippi. Available at: http://hydro.geo.ua.edu/mt3d/mt3dmanual.pdf.

Appendix A

Liquid Effluent Retention Facility Monitoring Data Summary

This page intentionally left blank.

A1 Introduction

Section 2.4 of the main document summarizes the groundwater monitoring history at the Liquid Effluent Retention Facility (LERF). In 1990, an interim status indicator parameter groundwater monitoring program under 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," was initiated. In January 1998, LERF, along with the 200 Area Effluent Treatment Facility, were incorporated into the Hanford Facility RCRA Permit as a final status unit and subject to a detection monitoring program in accordance with WAC 173-303-645(9), "Releases from Regulated Units," "Detection Monitoring Program."

The groundwater monitoring history of LERF through 2018 was compiled. Information from annual reporting documents and groundwater monitoring plans was utilized to compile a summary of wells in the LERF network, groundwater flow direction and rate, and monitoring constituents in a Microsoft® Excel® workbook. Interim status sampling data through January 1998 for each well are presented in separate Microsoft Excel workbooks. Sample data for each well were retrieved from the Hanford Environmental Information System database. The workbooks are contained in electronic files to accompany this report.

A2 References

15-AMRP-0149, "Notification of Upward Trending Total Organic Carbon Background Concentrations in Groundwater at the Liquid Effluent Retention Facility" (letter to J. Hedges, Washington State Department of Ecology, from R.J. Corey), U.S. Department of Energy, Richland Operations Office, Richland, Washington, April 28. Available at: https://pdw.hanford.gov/document/0081399H.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: https://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr264_main_02.tpl.

Appendix IX, "Ground-Water Monitoring List."

DOE/RL-91-03, 1991, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1990*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196047080.

DOE/RL-92-03, 1992, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1991*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196089863.

DOE/RL-93-88, 1994, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196094135.

® Microsoft and Excel are registered trademarks of Microsoft Corporation in the United States and other countries.

DOE/RL-94-136, 1995, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1994*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196037232.

DOE/RL-96-01, 1996, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1995*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196064360.

DOE/RL-2003-04, 2003, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D3818675.

DOE/RL-2008-01, 2008, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=00098824.

DOE/RL-2008-66, 2009, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0905131281. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0905131282.

DOE/RL-2010-11, 2010, *Hanford Site Groundwater Monitoring and Performance Report for 2009 Volumes 1 & 2*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084237.

DOE/RL-2011-01, 2011, *Hanford Site Groundwater Monitoring Report for 2010*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093693.

DOE/RL-2011-118, 2012, *Hanford Site Groundwater Monitoring for 2011*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington, Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091795.

DOE/RL-2013-22, 2013, *Hanford Site Groundwater Monitoring Report for 2012*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington, Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087974.

DOE/RL-2013-46, 2013, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington, Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1406031319.

DOE/RL-2013-46, 2017, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility,* Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington, Available at: https://pdw.hanford.gov/document/0068832H.

DOE/RL-2014-32, 2014, *Hanford Site Groundwater Monitoring Report for 2013*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084842.

DOE/RL-2015-07, 2015, *Hanford Site Groundwater Monitoring Report for 2014*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080600H.

DOE/RL-2016-12, 2016, *Hanford Site RCRA Groundwater Monitoring Report for 2015*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0073391H.

DOE/RL-2016-66, 2017, *Hanford Site RCRA Groundwater Monitoring Report for 2016*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0072146H.

DOE/RL-2016-71, *Demonstration of Other Source or Natural Variation Causing Elevated Specific Conductance in Groundwater at the Liquid Effluent Retention Facility (LERF) Point of Compliance*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0073627H.

DOE/RL-2017-65, 2018, *Hanford Site RCRA Groundwater Monitoring Report for 2017*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0066266H.

DOE/RL-2018-65, 2019, *Hanford Site RCRA Groundwater Monitoring Report for 2018*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/AR-01118.

PNNL-11470, 1997, *Hanford Site Groundwater Monitoring for Fiscal Year 1996*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199132964.

PNNL-11620, 1997, *Liquid Effluent Retention Facility Final-Status Groundwater Monitoring Plan*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.osti.gov/scitech/biblio/552795.

PNNL-11793, 1998, *Hanford Site Groundwater Monitoring for Fiscal Year 1997*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199132962.

PNNL-12086, 1999, *Hanford Site Groundwater Monitoring for Fiscal Year 1998*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199091099.

PNNL-13116, 2000, *Hanford Site Groundwater Monitoring for Fiscal Year 1999*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2736610. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2736978.

PNNL-13404, 2001, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2743868. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2786917.

PNNL-13788, 2002, *Hanford Site Groundwater Monitoring for Fiscal Year 2001*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2737262. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2740450.

PNNL-14187, 2003, *Hanford Site Groundwater Monitoring for Fiscal Year 2002*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2752375. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2755548.

PNNL-14548, 2004, *Hanford Site Groundwater Monitoring for Fiscal Year 2003*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14548.pdf.

PNNL-15070, 2005, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15070.pdf.

PNNL-15670, 2006, *Hanford Site Groundwater Monitoring for Fiscal Year 2005*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084078.

PNNL-16346, 2007, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084077.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

SGW-55438, 2013, *Hanford Site Groundwater Monitoring for 2012: Supporting Information*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087999.

WAC 173-303-645, "Dangerous Waste Regulations," "Releases from Regulated Units."*Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-645.

WHC-SD-EN-AP-024, 1990, *Interim Status Groundwater Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0009541.

WHC-SD-EN-AP-024, 1991, *Interim Status Groundwater Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, Rev. 1, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196068312.

Modified by:

Engineering Change Notice 603891, 1995, *Interim Status Groundwater Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, change notice for WHC-SD-EN-AP-024, Rev. 1, Earth and Environmental Technical Services, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196034139.

Appendix B

Topographic Map

This page intentionally left blank.

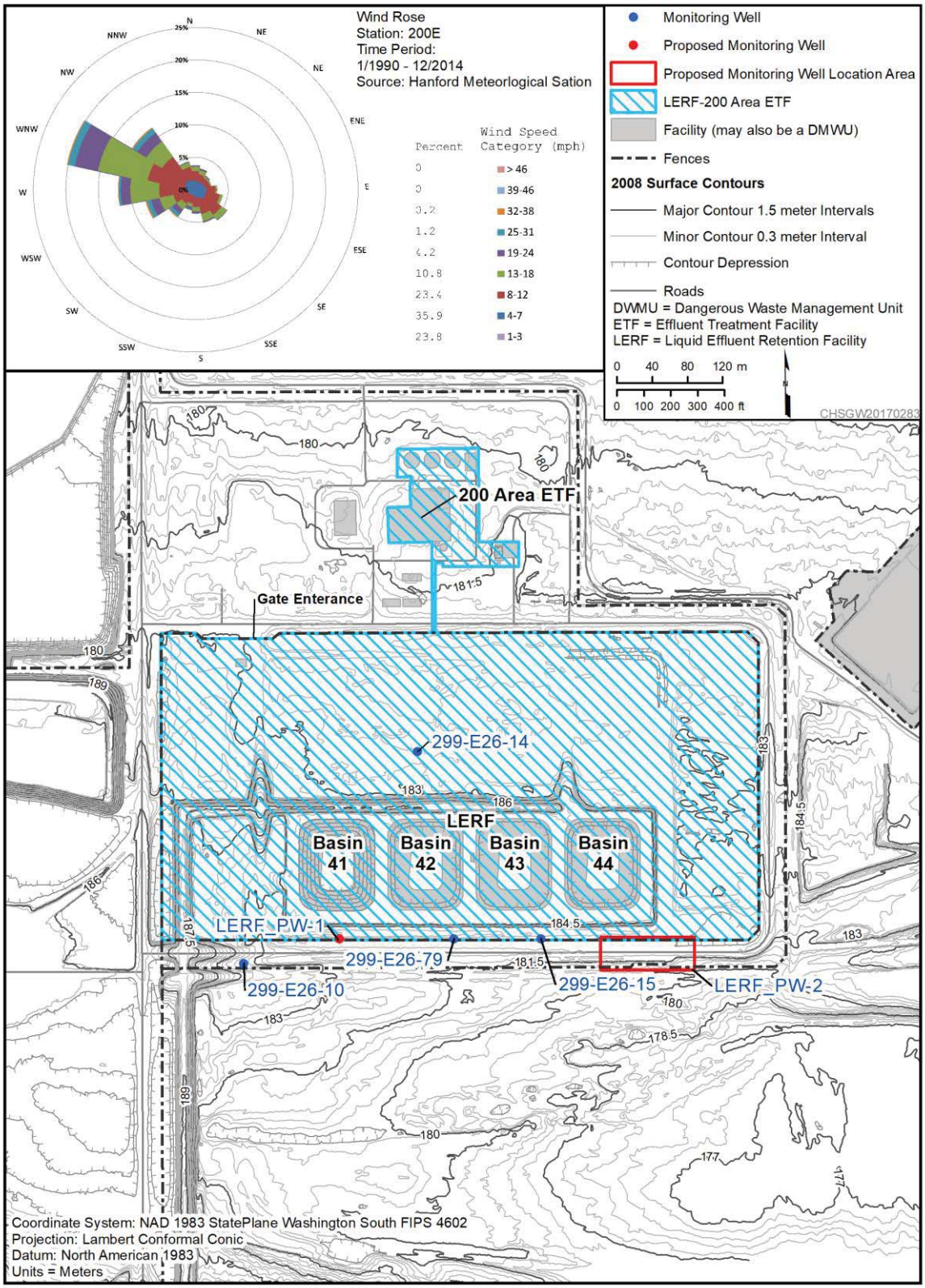


Figure B-1. Topographic Map

This page intentionally left blank.

Appendix C

Plume Maps

This page intentionally left blank.

C1 Plume Maps

This appendix presents a regional plume map in the vicinity of the Liquid Effluent Retention Facility (LERF). This plume does not originate from LERF, but is a regional plume in the area of the unit.

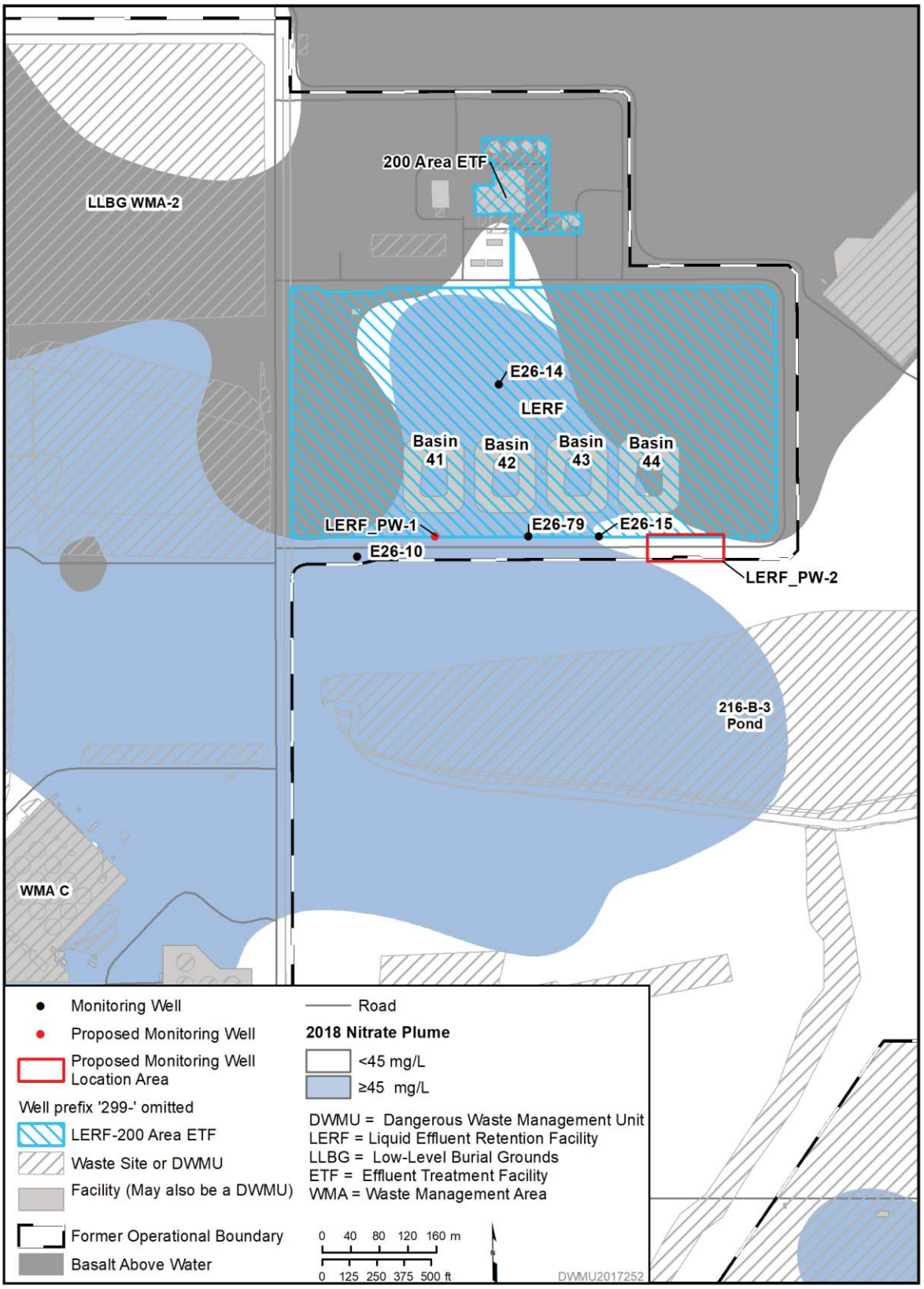


Figure C-1. Regional Nitrate Plume at LERF

Appendix D

Well As-Built Diagrams and Proposed Well Locations

This page intentionally left blank.

Contents

D1 Introduction D-1

D2 References D-12

Figures

Figure D-1. Well 299-E26-10 Construction and Completion Summary D-3

Figure D-2. Well 299-E26-14 Construction and Completion Summary D-5

Figure D-3. Well 299-E26-15 Construction and Completion Summary D-7

Figure D-4. Well 299-E26-79 Construction and Completion Summary D-10

Tables

Table D-1. Hydrogeologic Monitoring Unit Classification Scheme D-1

Table D-2. Sampling Interval Information for Wells Within the LERF Network D-1

Table D-3. Planned Locations, Surface Elevations, and Estimated Water Elevations and Depths for Proposed Wells Within the LERF Network D-2

This page intentionally left blank.

D1 Introduction

This appendix provides the following information for the existing Liquid Effluent Retention Facility (LERF) groundwater monitoring wells:

- Well name
- Hydrogeologic unit monitored (the aquifer portion at the well screen or perforation) (Table D-1)
- The following sampling interval information, as provided in Table D-2:
  - Elevation at the top of the screen or perforated interval
  - Elevation at the bottom of the screen or perforated interval
  - Open interval length (i.e., difference between the top and bottom screen or perforation elevations)
  - Drilling method

For proposed wells, the following information is provided in Table D-3:

- Well location
- Surface elevation
- Estimated water elevation
- Estimated water depth

Figures D-1 through D-4 provide construction and completion summaries for the existing network wells.

Table D-1. Hydrogeologic Monitoring Unit Classification Scheme

Unit	Description
TU	**Top of Unconfined.** Screened across the water table or the top of the open interval is within 1.5 m (5 ft) of the water table, and the bottom of the open interval is no more than 10.7 m (35 ft) below the water table.

Table D-2. Sampling Interval Information for Wells Within the LERF Network

Well Name	Hydrogeologic Unit Monitored	Elevation Top of Open Interval (m [ft] NAVD88)	Elevation Bottom of Open Interval (m [ft] NAVD88)	Open Interval Length (m [ft])	Drilling Method
299-E26-10	TU	125.4 (411.6)	120.7 (396.0)	4.8 (15.6)	Cable tool
299-E26-14	TU	122.8 (402.8)	116.7 (382.8)	6.1 (20.0)	Cable tool
299-E26-15	TU	124.2 (407.3)	119.5 (392.0)	4.7 (15.3)	Becker hammer
299-E26-79	TU	122.7 (402.6)	115.1 (377.6)	7.6 (25.0)	Cable tool and air rotary

Reference: NAVD88, *North American Vertical Datum of 1988.*

TU = Top of Unconfined, as described in Table D-1

Table D-3. Planned Locations, Surface Elevations, and Estimated Water Elevations and Depths for Proposed Wells Within the LERF Network

Well ID	Easting* (m)	Northing* (m)	Surface Elevation (m [ft] NAVD88)	Water Table Elevation (m [ft] NAVD88)	Depth to Water (m [ft] bgs)	Drill Depth (m [ft] bgs)	Final Well Diameter (cm [in.])	Screen Interval (m [ft] bgs)	Sump and End Cap Interval (m [ft] bgs)
LERF_ PW-1 (299-E26-81)	575698.0	137051.5	TBD	TBD	TBD	TBD	TBD	TBD	TBD
LERF_PW-2	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

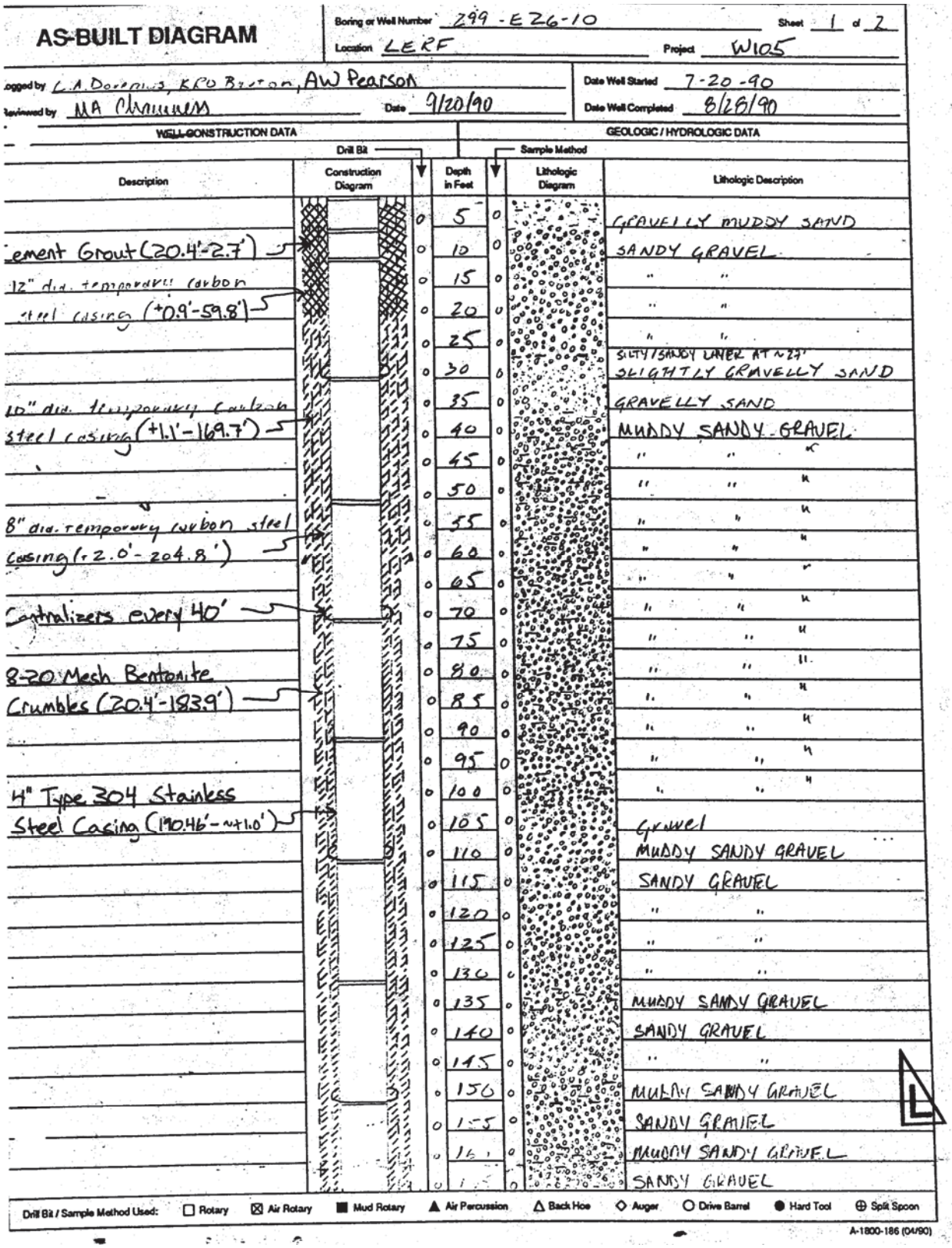
Reference: NAVD88, *North American Vertical Datum of 1988*.

Note: Proposed well coordinates, elevations, and water depths are estimates and are subject to modification based on final well location survey and conditions encountered during drilling.

*Coordinates are in Washington State Plane (south zone), NAD83, *North American Datum of 1983*; 1991 adjustment.

bgs = below ground surface

TBD = to be determined. Information will be obtained after well construction.



AS-BUILT DIAGRAM

Boring or Well Number 299-E26-10 Sheet 1 of 2
Location LERF Project W105
Logged by L.A. Dorrance, KRO Brown, AW Pearson Date Well Started 7-20-90
Reviewed by MA Chamnum Date 9/20/90 Date Well Completed 8/28/90

WELL CONSTRUCTION DATA | GEOLOGIC / HYDROLOGIC DATA

Drill Bit | Sample Method

Description	Construction Diagram	Depth in Feet	Lithologic Diagram	Lithologic Description
		5		GRAVELLY MUDDY SAND
Cement Grout (20.4'-2.7')		10		SANDY GRAVEL
12" dia. temporary carbon		15		" "
steel casing (+0.9'-59.8')		20		" "
		25		" "
		30		SILTY/SANDY LAYER AT ~27' SLIGHTLY GRAVELLY SAND
10" dia. temporary carbon		35		GRAVELLY SAND
steel casing (+1.1'-169.7')		40		MUDDY SANDY GRAVEL
		45		" " "
		50		" " "
		55		" " "
8" dia. temporary carbon steel		60		" " "
casing (+2.0'-204.8')		65		" " "
Centralizers every 40'		70		" " "
		75		" " "
8-20 Mesh Bentonite		80		" " "
Crumbles (20.4'-183.9')		85		" " "
		90		" " "
		95		" " "
4" Type 304 Stainless		100		" " "
Steel Casing (190.46'-~+1.0')		105		Gravel
		110		MUDDY SANDY GRAVEL
		115		SANDY GRAVEL
		120		" "
		125		" "
		130		" "
		135		MUDDY SANDY GRAVEL
		140		SANDY GRAVEL
		145		" "
		150		MUDDY SANDY GRAVEL
		155		SANDY GRAVEL
		160		MUDDY SANDY GRAVEL
		[illegible]		SANDY GRAVEL

Drill Bit / Sample Method Used: ☐ Rotary ☒ Air Rotary ■ Mud Rotary ▲ Air Percussion △ Back Hoe ◇ Auger ○ Drive Barrel ● Hard Tool ⊕ Split Spoon

A-1800-186 (04/90)

Figure D-1. Well 299-E26-10 Construction and Completion Summary (1 of 2)

AS-BUILT DIAGRAM

Boring or Well Number 299-E26-10 Sheet 2 of 2

Location LERF Project W105

Logged by LA Dorrius, KRO Burton, AW Bunsold

Reviewed by MA Chamness Date 9/20/90

Date Well Started 7-20-90

Date Well Completed 8-28-90

WELL CONSTRUCTION DATA — GEOLOGIC / HYDROLOGIC DATA

Drill Bit — Sample Method

Description	Construction Diagram	Depth in Feet	Lithologic Diagram	Lithologic Description
1" Type 304 stainless steel casing (190.46'-+1.0')		170		MUDDY SANDY GRAVEL
3-20 Mesh Bentonite crumbles (20.4'-183.9')		175		" " "
3" Dia. Volclay Tablets (183.9'-187.4')		180		" " "
20-40 Mesh CSST Silica Sand (187.4'-206.1')		185		" " "
10 slot channel pack stainless steel screen (206.10'-190.46')	TD = 206.6'	190		" " "
Static Water Level 193.3' - 9/4/90		195		" " "
3" temporary carbon steel casing (12.0'-204.8')		200		" " "
		205		Basalt @ 204.3'
		210		

Drill Bit / Sample Method Used: ☐ Rotary ☒ Air Rotary ■ Mud Rotary ▲ Air Percussion △ Back Hoe ◇ Auger ○ Drive Barrel ● Hard Tool ⊕ Split Spoon

A-1800-186 (04/90)

Figure D-1. Well 299-E26-10 Construction and Completion Summary (2 of 2)

WELL SUMMARY SHEET	Start Date: 9/8/11 Finish Date: 9/27/11	Page 1 of 2
Well ID: C8204	Well Name: 299-E26-14	
Location: 250 meters south of LERF Facility	Project: 2 M-24 RCRA Groundwater Wells	
Prepared By: Patrick Cabbage — Date: 10/20/11	Reviewed By: DC Weekes — Date: 10/24/11	
Signature: Patrick Cabbage	Signature: DC Weekes	

CONSTRUCTION DATA

Description

Stainless Steel Protective Casing: 2.88 ft above ground surface

Type I/II Portland Cement Grout: 0 - 9.2 ft bgs

#8 Granular Bentonite Crumbles: 9.2 - 187.3 ft bgs

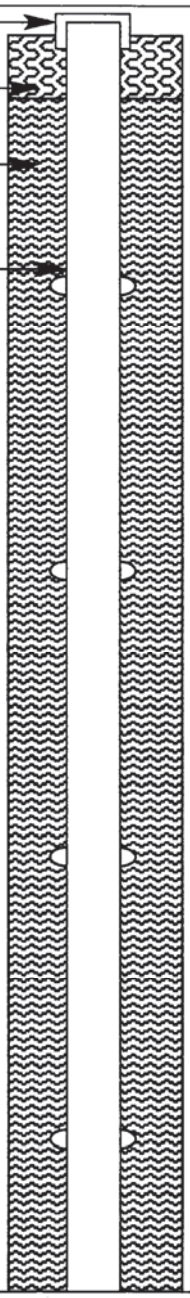
4-in I.D., Schedule 10, Type 304, Stainless Steel Permanent Casing: 1.79 ft ags - 195.90 ft bgs

All temporary drill casing was removed from the ground.

All depths are in feet below ground surface.

The borehole was drilled with 10 ¾-inch O.D. casing from 0.0 - 100.6 ft bgs, with 8 ¾-inch O.D. casing from 100.6 - 220.7 ft bgs, and with open hole from 220.7 to 240.6 ft bgs.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 20, 40, 60, 80, 100, 120, 140, 160

Graphic Log

Lithologic Description/Groundwater Sample Depths (ft bgs)

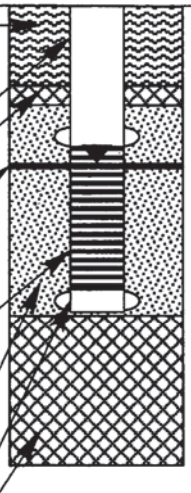
0-1 Gravel Drill Pad (G)
1-34 Silty Sandy Gravel (msG)
34-36 Sandy Gravel (sG)
36-45 Sand (S)
45-57 Gravelly Sand (gS)
57-77 Sandy Gravel (sG)
77-83 Sandy Gravel (sG)
83-98 Sandy Gravel (sG)
98-103 Gravelly Sand (gS)
103-106 Gravelly Sand (gS)
106-122 Sandy Gravel (sG)
122-177 Sandy Gravel (sG)

Figure D-2. Well 299-E26-14 Construction and Completion Summary (1 of 2)

WELL SUMMARY SHEET	Start Date: 9/8/11 Finish Date: 9/27/11	Page 2 of 2
Well ID: C8204	Well Name: 299-E26-14	
Location: 250 meters south of LERF Facility	Project: 2 M-24 RCRA Groundwater Wells	
Prepared By: Patrick Cabbage — Date: 10/21/11	Reviewed By: DC Weekes — Date: 1/24/11	
Signature: Patrick Cabbage	Signature: DC Weekes	

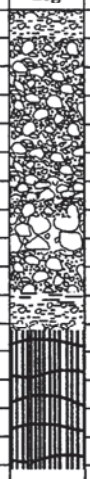
CONSTRUCTION DATA

Description	Diagram
#8 Granular Bentonite Crumbles: 9.2 - 187.3 ft bgs	
4-in I.D., Schedule 10, Type 304, Stainless Steel Permanent Casing: 1.79 ft ags - 195.90 ft bgs	
3/8-in Bentonite Pellets: 187.3 - 190.0 ft bgs	
Static Water Level: 198.4 ft bgs (9/27/11)	
4-in I.D., Schedule 10, Type 304, Stainless Steel 20-slot Screen: 195.90 - 215.90 ft bgs	
Primary Filter Pack 10-20 Mesh Colorado Silica Sand: 190.0 - 219.6 ft bgs	
4-in I.D., Schedule 10, Type 304, Stainless Steel Sump: 215.90 - 218.90 ft bgs	
3/8-in Bentonite Pellets: 219.6 - 240.6 ft bgs	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description/Groundwater Sample Depths (ft bgs)
180		177-180 Silty Gravel (mG)
		180-200 Silty Sandy Gravel (msG)
200		200-202.5 Gravel (G)
		202.5-205 Silty Sandy Gravel (msG)
		205-210 Gravel (G)
		210-215.5 Sandy Gravel (sG)
		215.5-217 Silt (M)
220		217-220 Gravelly Silt (gM)
		220-221 Silty Gravel (mG)
		221-240.6 Basalt
240		**TD = 240.6 ft bgs (09-21-2011)**
260		



All temporary drill casing was removed from the ground.

All depths are in feet below ground surface.

The borehole was drilled with 10 ¾-inch O.D. casing from 0.0 - 100.6 ft bgs, with 8 ¾-inch O.D. casing from 100.6 - 220.7 ft bgs, and with open hole from 220.7 to 240.6 ft bgs.

Figure D-2. Well 299-E26-14 Construction and Completion Summary (2 of 2)

WELL SUMMARY SHEET

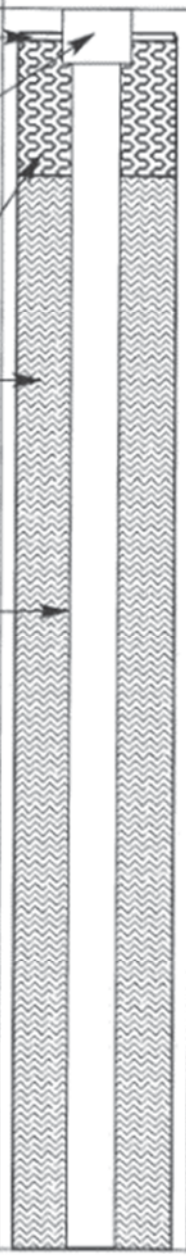
Start Date: 5/19/2015
Finish Date: ~~6/12/2015~~ 6/16/15 RSG 7/10/15

Page 1 of 3

Well ID: C8913	Well Name: 299-E26-15
Location: 20 m S of catch basin 242AL-43	Project: 8 M24 TPA GW Monitoring Wells FY2015
Prepared By: Jessa Szecsody — Date: 6/12/15	Reviewed By: J.D. WEHRER Environmental Scientist — Date: 7-2
Signature:	Signature:

CONSTRUCTION DATA

Description	Diagram
Concrete Pad: 0.5 ft above ground surface (ags)	
6-in Protective Casing: 3.1 ft ags - 1.9 ft below ground surface (bgs)	
Type I/II Portland Cement Grout: 0 - 9.6 ft bgs	
Cetco Bentonite Crumbles: 9.6 - 186.6 ft bgs	
4-in I.D. Schedule 10, Type 304/304L, Stainless Steel Blank Casing: 2.00 ft ags - 191.08 ft bgs	



Depths are in ft below ground surface.
Borehole drilled with 8 7/8-in O.D. casing from 0.0 - 206.2 ft bgs
All temporary drill casing was removed from the ground.

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
0		0 - 20 Gravel (G)
10		
20		20 - 30 Sandy Gravel (sG)
30		30 - 35 Silty Sand (mS)
		35 - 40 Sandy Gravel (sG)
40		40 - 60 Gravelly Sand (gS)
50		
60		60 - 70 Gravel (G)
70		70 - 75 Sandy Gravel (sG)
		75 - 85 Gravel (G)
80		
		85 - 95 Sandy Gravel (sG)

A-6003-643 (REV 1)

Figure D-3. Well 299-E26-15 Construction and Completion Summary (1 of 3)

WELL SUMMARY SHEET		Start Date: 5/19/2015 Finish Date: ~~6/12/2015~~ 6/16/15	Page 2 of 3
Well ID: C8913		Well Name: 299-E26-15	
Location: 20 m S of catch basin 242AL-43		Project: 8 M24 TPA GW Monitoring Wells FY2015	
Prepared By: Jessa Szecsody	Date: 6/12/15	Reviewed By: [illegible]	Date: 7-22
Signature: [signature]		Signature: [signature]	

CONSTRUCTION DATA

Description

Cetco Bentonite Crumbles: 9.6 - 186.6 ft bgs

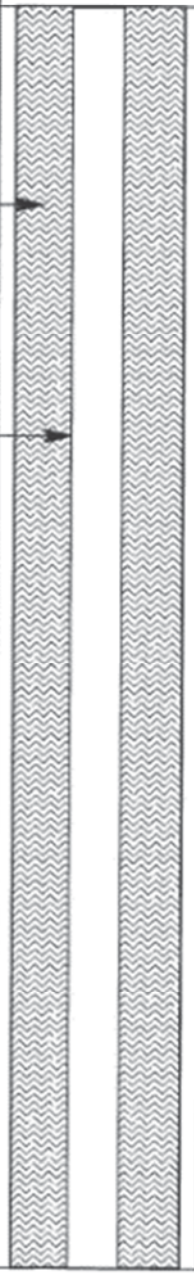
4-in I.D. Schedule 10, Type 304/304L, Stainless Steel Blank Casing: 2.00 ft ags - 191.08 ft bgs

Depths are in ft below ground surface.

Borehole drilled with 8 7/8-in O.D. casing from 0.0 - 206.2 ft bgs

All temporary drill casing was removed from the ground.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 90, 100, 110, 120, 130, 140, 150, 160, 170

Graphic Log

Lithologic Description (ft bgs)

85 - 95 Sandy Gravel (sG)

95 - 190 Gravel (G)

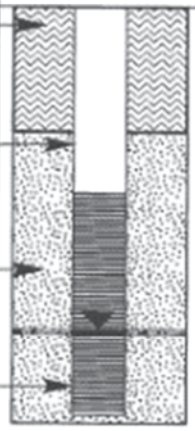
A-6003-643 (REV 1)

Figure D-3. Well 299-E26-15 Construction and Completion Summary (2 of 3)

WELL SUMMARY SHEET		Start Date: 5/19/2015 Finish Date: ~~6/12/2015~~ 6/16/15 RSG 7/16/15	Page 3 of 3
Well ID: C8913		Well Name: 299-E26-15	
Location: 20 m S of catch basin 242AL-43		Project: 8 M24 TPA GW Monitoring Wells FY2015	
Prepared By: Jessa Szecsody	Date: 6/12/15	Reviewed By: J.D. MEHRER	Date: 7-22-15
Signature:		Signature:	

CONSTRUCTION DATA

Description	Diagram
Cetco Bentonite Crumbles: 9.6 - 186.6 ft bgs	
4-in I.D. Schedule 10, Type 304/304L, Stainless Steel Blank Casing: 2.00 ft ags - 191.08 ft bgs	
10-20 mesh Premier Colorado Silica Filter Pack Sand: 186.6 - 206.9 ft bgs	
4-in I.D. Schedule 10, Type 304/304L, 30-slot (0.030 in.) Stainless Steel Screen: 191.08 - 206.43 ft bgs	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
180		95 - 190 Gravel (G)
190		190 - 208 Sandy Gravel (sG)
200		Static Water Level: 200.4 ft bgs (05/20/15) Total Depth: 206.9 ft bgs (05/20/15)
210		
220		
230		
240		
250		
260		

Depths are in ft below ground surface.
Borehole drilled with 8 7/8-in O.D. casing from 0.0 - 206.2 ft bgs
All temporary drill casing was removed from the ground.

A-6003-643 (REV 1)

Figure D-3. Well 299-E26-15 Construction and Completion Summary (3 of 3)

WELL SUMMARY SHEET

Start Date: 09/09/2008
Finish Date: 10/02/2008
Page 1 of 2

Well ID: C6826	Well Name: 299-E26-79
Location: Inside fence, LERF, 200E	Project: M-24 RCRA Wells (LERF)
Prepared By: S. Sexton — Date: 10/6/08	Reviewed By: L.D. Walker — Date: 10/13/08
Signature:	Signature:

CONSTRUCTION DATA

Description:

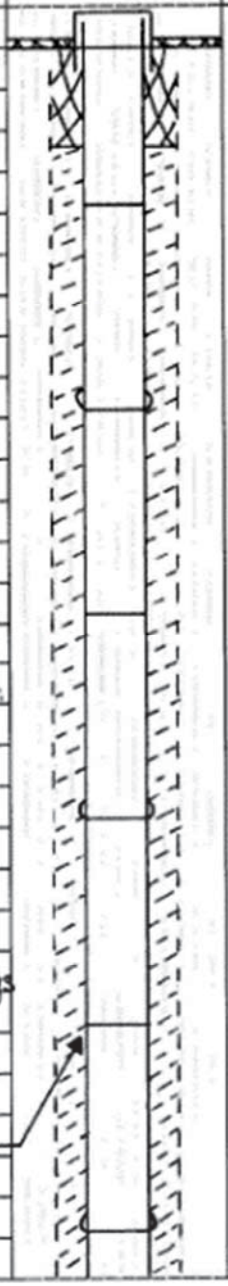
6" x 4' x 4' concrete pad
6" stainless steel protective monument: 3.0' bgs to 3.1' ags

4" stainless steel Sch. 10 casing: 2.3 ft ags to 195.2 ft bgs
4" stainless steel wire wrap screen, 0.020": 195.2 to 220.2' bgs
4" stainless steel Sch. 10 sump: 220.2 to 223.2 ft bgs

Portland cement grout: 0 to 10.3 ft bgs
Bentonite granules: 10.3 to 183.0 ft bgs
Bentonite pellets: 183.0 to 187.8 ft bgs
10-20 silica sand: 187.8 to 224.76 ft bgs

Casing Joint

Diagram:



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 20, 40, 60, 80, 100

Graphic Log:

Lithologic Description:

0-1: gravel drill pad
1-27: sandy silty Gravel (SmG)
27-27.5: sandy Silt (SM)
27.5-29: silty Gravel (mG)
29-32: sandy Silt (SM)
32-54: silty Sand (mS)
54-79: silty sandy Gravel (msG)
79-119: sandy silty Gravel (smG)

A-6003-643 (03/03)

Figure D-4. Well 299-E26-79 Construction and Completion Summary (1 of 2)

WELL SUMMARY SHEET

Start Date: 09/09/2008
Finish Date: 10/02/2008
Page 2 of 2

Well ID: C6826
Well Name: 299-E26-79
Location: Inside fence, LERF, 200C
Project: M-24 RCRA Wells (LERF)
Prepared By: S. Sexton
Date: 10/6/08
Reviewed By: L. D. Walker
Date: 10/13/08
Signature:
Signature:

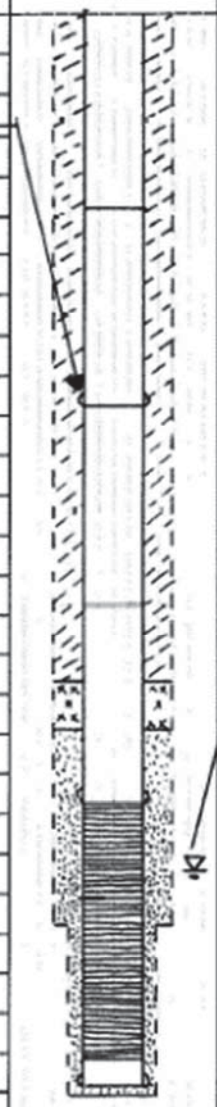
CONSTRUCTION DATA

Description

Centralizer

All temporary casing removed from borehole

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 120, 140, 160, 180, 200, 220

Graphic Log

Lithologic Description

118-135: silty sandy Gravel (ssG)
135-152: Gravel (G)
152-200: silty sandy Gravel
DTW = 201.7 ft bgs on 09/22/2008
200-203: sandy Gravel (sG)
203-206: gravelly Sand (gS)
206-207: modified clay
207-224.76: basalt
TD = 224.76 ft bgs on 09/23/2008

All depths recorded in feet "below ground surface" (bgs)

A-6003-643 (03/03)

Figure D-4. Well 299-E26-79 Construction and Completion Summary (2 of 2)

D2 References

NAD83, 1991, *North American Datum of 1983*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

NAVD88, 1988, *North American Vertical Datum of 1988*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

Appendix E

Inventory Screening for the Liquid Effluent Retention Facility Basins

This page intentionally left blank.

Contents

E1 Monitoring Program Waste Constituents E-1

E1.1 Selection Process for Waste Constituents E-1

E1.2 Composition of Waste Inventory E-2

E2 Waste Inventory E-8

E3 Inventory Evaluation E-29

E4 References E-35

Tables

Table E-1. Detected Constituents in LERF Inventory E-3

Table E-2. Mobile Constituents Exceeding Action Levels E-4

Table E-3. Dangerous Wastes Identified from Waste Codes in the LERF/ETF Part A Form E-5

Table E-4. Comparison of Potential Monitoring Constituents to Part A and Appendix 5 ..... E-7

Table E-5. Proposed Constituents for Detection Monitoring at LERF E-8

Table E-6. Waste Inventory in LERF Basins E-9

Table E-7. Evaluation of Constituent Concentrations in LERF Basins E-31

This page intentionally left blank.

Terms

ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
LERF	Liquid Effluent Retention Facility
K_d	distribution coefficient

This page intentionally left blank.

E1 Monitoring Program Waste Constituents

An evaluation of the Liquid Effluent Retention Facility (LERF) waste inventory was performed to assess the specific constituents to include in the groundwater monitoring program. This appendix also provides the selection process used for the waste constituents to be monitored at LERF.

E1.1 Selection Process for Waste Constituents

The screening process for the waste constituents associated with LERF effluent that was performed in Appendix E of SGW-41072, Rev. 1, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report*, was evaluated and modified for this revision. The modifications were intended to minimize changes to this evaluation and better align to screening elements used for the evaluation of the future effluent stream planned for LERF, the Waste Treatment and Immobilization Plant liquid effluent waste constituents (Appendix F of this document). Relative to the process used in SGW-41072, the changes to the screening process in this appendix are as follows:

- The assumption regarding the detectability of waste constituents in the LERF basins at downgradient wells (50% dilution of constituent concentration from the source [LERF basins] to point of compliance wells) was removed
- Added an evaluation to determine which of the proposed monitoring constituents are dangerous wastes

The remaining elements of the screening process identified in Appendix E of SGW-41072, Rev. 1, were retained with no further reevaluation.

The revised screening process for identifying waste constituents included the following steps:

- The detected constituents from the inventory were compared with the wastes identified in the following:
  - Appendix 5 of Ecology Publication 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*
  - HNF-3172, Rev. 8, *Liquid Waste Processing Facilities Waste Acceptance Criteria*
  - WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part III, Operating Unit Group 3, Addendum A, Part A Form
  - WA7890008967, Part III, Operating Unit Group 3, Addendum B, Waste Analysis Plan
- The detected constituents found in the identified sources were first evaluated by comparing their maximum concentration in the LERF basins to action levels based on federal and state regulations. Constituents above their respective action levels were then evaluated on their mobility to groundwater.
- The detected constituents identified above their action levels were then moved forward for further evaluation based on distribution coefficient (K_d).

  The constituents with a K_d less than or equal to 0.8 mL/g, which is the K_d for hexavalent chromium, were identified for further evaluation for use in detection monitoring. A low K_d value generally indicates that a chemical has greater potential to migrate through the vadose zone and reach

groundwater. The K_d value of 0.8 mL/g was chosen for providing a reasonable travel time to groundwater for detection of releases (approximately 20 years). The K_d value of 0.8 mL/g corresponds to a retardation factor of 11 times greater than a K_d of 0 mL/g (e.g., water). K_d values above 0.8 mL/g correspond to higher retardation factors which are not assumed to meet a reasonable time frame. Selecting a higher K_d value than 0.8 mL/g may result in releases for those constituents going undetected beyond the operating life of the site. In addition, the K_d values used for the evaluation were corrected for the estimated gravel content in the vadose zone at LERF.

- Constituents that met both criteria (greater mobility than 0.8 mL/g K_d and a concentration at the source above the action level were further evaluated. The objective of final status groundwater monitoring is to monitor for releases of dangerous wastes from a regulated unit. However, not every chemical identified in the Waste Profile Sheet is a dangerous waste. Therefore, an evaluation to determine which waste constituents are dangerous wastes was performed by comparing the LERF effluent waste constituents to the following:
  - Waste codes provided in the Part A Form for LERF and the 200 Area Effluent Treatment Facility (ETF) (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology)
  - Appendix 5 of Ecology Publication No. 97-407

E1.2 Composition of Waste Inventory

The waste inventory that was used in evaluating the waste constituent concentrations in the LERF basins is provided in Section E2. The inventory comprises the maximum concentrations from multiple waste streams and characterization samples from the basins, and include the following:

- 200-UP-1 and 200-ZP-1 groundwater, 2008 through 2011
- 242-A process condensate, 2014 through 2016
- 323 Building liquid waste, 2016
- AZ-301 catch tank waste, 2013
- 200-BP-5 perched water, 2012
- Environmental Restoration Disposal Facility (ERDF) leachate, 2000 through 2015
- Characterization data from LERF Basin 44, 2016
- Characterization data from LERF Basin 43, 2011
- Minor source leachate to LERF Basin 42, 2009 through 2011
- Mixed waste trench leachate from Trenches 31 and 34, 2012 through 2016

Table E-1 lists the detected constituents from the LERF inventory identified from step 1 of Section E1.1. Applying steps 2 and 3 identifies the mobile constituents (low K_d value) with concentrations above the minimum federal or state action level, which are presented in Table E-2. Section E3 provides the constituent concentration comparison to the minimum action levels of federal and state regulations and provides the constituent distribution coefficient.

Table E-1. Detected Constituents in LERF Inventory

Constituent	Maximum Concentration (µg/L)	Constituent	Maximum Concentration (µg/L)
1,1-Dichloroethene	0.25	Iron	579
1,2-Dichlorobenzene	0.0478	Isophorone	0.22
1-Butanol	1700	Lead	29.6
2,4-D (2,4-Dichlorophenoxyacetic acid)	0.216	Lithium	23
2-Butanone	19	Magnesium	82100
2-Butoxyethanol	330	Manganese	129.7
2-Hexanone	1.24	Mercury	6.52
2-Methylphenol (Cresol, o-)	4.3	Methyl alcohol	0
2-Pentanone	6.52	Methylene chloride	1.72
3+4 Methylphenol (Cresol, m+p)	4.3	Molybdenum	10
4-Methyl-2-pentanone	0.59	Nickel	40
Acetone	1700	Nitrate	611143
Acetonitrile	36.4	Nitrite	1288
Alkalinity	319000	n-Nitrosodimethylamine	329
Aluminum	945	Oil and grease	3213
Ammonia	170000	Pentachlorophenol	11.4
Antimony	92.2	pH measurement	10.4
Arsenic	20.9	Phenanthrene	0.27
Barium	200	Phosphate	300
Benzene	0.04	Potassium	163756
Benzyl alcohol	25.2	Selenium	14
Beryllium	10.8	Silicon	27900
Bis(2-ethylhexyl) phthalate	236	Silver	65.6
Boron	750	Sodium	397000
Bromide	3500	Specific conductivity	2780
Cadmium	4.4	Strontium	1500
Calcium	451000	Sulfate	615000
Carbon disulfide	0.023	Tetrachloroethene	0.1
Carbon tetrachloride	490.7	Tetrahydrofuran	261
Chloride	317000	Thallium	148
Chloroform	8.5	Tin	1
Chromium	143.9	Titanium	4.4
Cobalt	145	Toluene	5.86
Copper	192	Total dissolved solids	2023943
Cyanide	7.60	Total organic carbon	20000
Dimethyl phthalate	0.23	Total organic halogen	79
Di-n-octylphthalate	23.8	Total suspended solids	19400
Ethylbenzene	0.072	Tributyl phosphate	72

Table E-1. Detected Constituents in LERF Inventory

Constituent	Maximum Concentration (µg/L)	Constituent	Maximum Concentration (µg/L)
Fluoranthene	0.28	Trichloroethene	0.042
Fluoride	22000	Trichlorofluoromethane	3.2
Formaldehyde	82.1	Tungsten	0.42
Formate	0.01	Uranium	140000
Formic acid	190	Vanadium	45.1
Hexavalent chromium	120	Xylenes (total)	0.237
Iodomethane	0.57	Zinc	92.2

LERF = Liquid Effluent Treatment Facility

Table E-2. Mobile Constituents Exceeding Action Levels

Constituent	CAS Number	Maximum Value (µg/L)	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d (mL/g)
1-Butanol	71-36-3	1700	800	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.0069
Carbon tetrachloride	56-23-5	490.7	3.4	200-ZP-1 Cleanup Level (EPA et al., 2008)	Yes	0.152
Chloride	16887-00-6	317000	250000	40 CFR 143.3	Yes	0
Chloroform	67-66-3	8.5	1.41	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.053
Hexavalent chromium	18540-29-9	120	48	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.8
Nitrate	14797-55-8	611143	45000	40 CFR 141.62	Yes	0
n-Nitrosodimethylamine	62-75-9	329	0.00086	CLARC (Ecology, 2014) Groundwater Method B	Yes	0.038
Pentachlorophenol	87-86-5	11.4	0.729	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.59
Sulfate	14808-79-8	615000	250000	40 CFR 143.3	Yes	0
Tetrachloroethene	127-18-4	0.1	0.001	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.265

Note: Complete reference citations are provided in Chapter E4.

CAS = Chemical Abstracts Services

CLARC = Cleanup Levels and Risk Calculations (database)

K_d = distribution coefficient

The objective of final status groundwater monitoring is to monitor for releases of dangerous wastes from a regulated unit. However, not every mobile constituent that exceeds its action level in the LERF effluent is a dangerous waste. Therefore, an evaluation to determine which waste constituents are dangerous wastes was performed by comparing the LERF effluent waste constituents to the following:

- Waste codes provided in the Part A Form for LERF and the ETF (Table E-3) (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology)
- Appendix 5 of Ecology Publication No. 97-407

Table E-3. Dangerous Wastes Identified from Waste Codes in the LERF/ETF Part A Form

Dangerous Waste Code	Waste Constituent	CAS Number
D004	Arsenic	7440-38-2
D005	Barium	7440-39-3
D006	Cadmium	7440-43-9
D007	Chromium	7440-47-3
D008	Lead	7439-92-1
D009	Mercury	7439-97-6
D010	Selenium	7782-49-2
D011	Silver	7440-22-4
D018	Benzene	71-43-2
D019	Carbon tetrachloride	56-23-5
D022	Chloroform	67-66-3
D028	1,2-Dichloroethane	107-06-2
D029	1,1-Dichloroethylene	75-35-4
D030	2,4-Dinitrotoluene	121-14-2
D033	Hexachlorobutadiene	87-68-3
D034	Hexachloroethane	67-72-1
D035	Methyl ethyl ketone	78-93-3
D036	Nitrobenzene	98-95-3
D038	Pyridine	110-86-1
D039	Tetrachloroethylene	127-18-4
D040	Trichloroethylene	79-01-6
D041	2,4,5-Trichlorophenol	95-95-4
D043	Vinyl chloride	75-01-4
F001	1,1,1-Trichloroethane	71-55-6
F001	Methylene chloride	75-09-2

Table E-3. Dangerous Wastes Identified from Waste Codes in the LERF/ETF Part A Form

Dangerous Waste Code	Waste Constituent	CAS Number
F001	Carbon tetrachloride	56-23-5
F001	Tetrachloroethylene	127-18-4
F001	Trichloroethylene	79-01-6
F002	1,1,1-Trichloroethane	71-55-6
F002	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1
F002	1,1,2-Trichloroethane	79-00-5
F002	Chlorobenzene	108-90-7
F002	Methylene chloride	75-09-2
F002	ortho-Dichlorobenzene	95-50-1
F002	Trichlorofluoromethane	75-69-4
F002	Tetrachloroethylene	127-18-4
F002	Trichloroethylene	79-01-6
F003	Acetone	67-64-1
F003	Cyclohexanone	108-94-1
F003	Ethyl acetate	141-78-6
F003	Ethyl benzene	100-41-4
F003	Ethyl ether	60-29-7
F003	Methyl isobutyl ketone	108-10-1
F003	Methanol	67-56-1
F003	n-Butyl alcohol	71-36-3
F003	Xylene	1330-20-7
F004	Cresols	1319-77-3
F004	Cresylic acid	93-51-6
F004	Nitrobenzene	98-95-3
F005	2-Ethoxyethanol	110-80-5
F005	2-Nitropropane	79-46-9
F005	Benzene	71-43-2
F005	Carbon disulfide	75-15-0
F005	Isobutanol	78-83-1
F005	Methyl ethyl ketone	78-93-3
F005	Pyridine	110-86-1
F005	Toluene	108-88-3

Table E-3. Dangerous Wastes Identified from Waste Codes in the LERF/ETF Part A Form

Dangerous Waste Code	Waste Constituent	CAS Number
U210	Tetrachloroethylene	127-18-4

Notes: Complete reference citations are provided in Chapter E4.

The specific dangerous wastes associated with "F"-code wastes were obtained from WAC 173-303-9904, "Dangerous Waste Regulations," "Dangerous Waste Sources List."

This table identifies specific dangerous wastes identified from the waste codes included in the LERF/EFT Part A Form. Characteristic wastes (D001, D002, and D003) and state-only wastes (WT01, and WT02) (waste codes assigned based on waste designation) are included in the LERF/ETF Part A Form but are not identified in this table.

The LERF/ETF Part A used for this evaluation is WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology.

CAS = Chemical Abstracts Service

ETF = Effluent Treatment Facility

LERF = Liquid Effluent Treatment Facility

Table E-4 provides the outcome of the evaluation. Each of the constituents is identified in either the Part A Form or Appendix 5 of Ecology Publication 97-407 with the exception of chloride, nitrate, and sulfate. Because chloride, nitrate, and sulfate are not identified from either the Part A Form or Appendix 5 of Ecology Publication 97-407, they are not included as proposed monitoring constituents.

Table E-4. Comparison of Potential Monitoring Constituents to Part A and Appendix 5

Constituent	CAS Number	Identified from Part A?	Identified in Appendix 5?	Analysis Available?	Proposed Monitoring Constituent?
1-Butanol	71-36-3	Yes	No	Yes	Yes
Carbon tetrachloride	56-23-5	Yes	Yes	Yes	Yes
Chloride	16887-00-6	No	No	Yes	No
Chloroform	67-66-3	Yes	Yes	Yes	Yes
Hexavalent chromium	18540-29-9	Yes, as chromium	Yes, as chromium	Yes	Yes
Nitrate	14797-55-8	No	No	Yes	No
n-Nitrosodimethylamine	62-75-9	No	Yes	Yes	Yes
Pentachlorophenol	87-86-5	No	Yes	Yes	Yes
Sulfate	14808-79-8	No	No	Yes	No
Tetrachloroethene	127-18-4	Yes	Yes	Yes	Yes
Tributyl phosphate	126-73-8	No	No	Yes	No

Notes: Complete reference citations are provided in Chapter E4.

The LERF/ETF Part A used for this evaluation is WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology.

Appendix 5 constituents are available in Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & 100.*

Table E-4. Comparison of Potential Monitoring Constituents to Part A and Appendix 5

Constituent	CAS Number	Identified from Part A?	Identified in Appendix 5?	Analysis Available?	Proposed Monitoring Constituent?

CAS = Chemical Abstracts Service
ETF = Effluent Treatment Facility
LERF = Liquid Effluent Treatment Facility

Table E-5 presents the waste constituents (1-butanol, carbon tetrachloride, chloroform, hexavalent chromium, n-nitrosodimethylamine, pentachlorophenol, and tetrachlorethene) proposed for detection monitoring based on the revised evaluation. Relative to the previous (Rev. 1) evaluation, three additional constituents (chloroform, pentachlorophenol, and tetrachloroethene) are added for monitoring.

Table E-5. Proposed Constituents for Detection Monitoring at LERF

Waste Constituent	CAS Number
1-Butanol	71-36-3
Carbon tetrachloride	56-23-5
Chloroform	67-66-3
Hexavalent chromium	18540-29-9
n-Nitrosodimethylamine	62-75-9
Pentachlorophenol	87-86-5
Tetrachloroethene	127-18-4

CAS = Chemical Abstracts Services
LERF = Liquid Effluent Retention Facility

E2 Waste Inventory

Table E-6 provides the maximum sample results from waste within the LERF basins. The results comprise the waste inventory and include the following influent streams:

- 200-UP-1 and 200-ZP-1 groundwater, 2008 through 2011
- 242-A process condensate, 2014 through 2016
- 323 Building liquid waste, 2016
- AZ-301 catch tank waste, 2013
- 200-BP-5 perched water, 2012
- ERDF leachate, 2000 through 2015
- Characterization data from Basin 44, 2016
- Characterization data from Basin 43, 2011
- Minor source leachate to LERF Basin 42, 2009 through 2011
- Mixed waste trench leachate from Trenches 31 and 34, 2012 through 2016

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
200-UP-1 and 200-ZP-1 to LERF Basin 43	Alkalinity	151000	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Aluminum	44	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Ammonia	77.7	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Antimony	0.3	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Arsenic	5.5	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Barium	71.1	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Beryllium	0.05	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Bromide	400	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Cadmium	0.1	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Calcium	56861.5	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Carbon tetrachloride	490.7	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Chloride	22100	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Chloroform	8.5	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Chromium	121.1	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Cobalt	4	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Copper	0.15	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Fluoride	2700	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Hexavalent chromium	113	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Iron	18	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Lead	0.1	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Magnesium	18361.5	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Manganese	4	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Mercury	0.05	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Nickel	4	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Nitrate	101000	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Nitrite	36	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	pH Measurement	7.95	unitless	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Phosphate	120	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Potassium	5536.2	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Selenium	4.8	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Silicon	21300	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Silver	5	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Sodium	161846.2	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Specific conductivity	1206.2	µS/cm	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Sulfate	57200	µg/L	--

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
200-UP-1 and 200-ZP-1 to LERF Basin 43	Tetrahydrofuran	2	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Thallium	36	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Titanium	4	µg/L	U
200-UP-1 and 200-ZP-1 to LERF Basin 43	Total dissolved solids	906800	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Total organic carbon	640	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Total suspended solids	1620	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Uranium	25.6	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Vanadium	38.5	µg/L	--
200-UP-1 and 200-ZP-1 to LERF Basin 43	Zinc	37.5	µg/L	--
323 Building to LERF Basin 44	1,1,1-Trichloroethane	5	µg/L	U
323 Building to LERF Basin 44	1,1,2-Trichloroethane	5	µg/L	U
323 Building to LERF Basin 44	1,2-Dibromoethane	5	µg/L	U
323 Building to LERF Basin 44	1.2-Dichloroethane	5	µg/L	U
323 Building to LERF Basin 44	1.4-Dichlorobenzene	10	µg/L	U
323 Building to LERF Basin 44	1-Butanol	250	µg/L	U
323 Building to LERF Basin 44	2-Butanone	10	µg/L	U
323 Building to LERF Basin 44	2-Hexanone	10	µg/L	U
323 Building to LERF Basin 44	Acetone	10	µg/L	U
323 Building to LERF Basin 44	Acetophenone	10	µg/L	U
323 Building to LERF Basin 44	Aluminum	945	µg/L	--
323 Building to LERF Basin 44	Antimony	9.72	µg/L	U
323 Building to LERF Basin 44	Arsenic	10	µg/L	--
323 Building to LERF Basin 44	Barium	25.5	µg/L	--
323 Building to LERF Basin 44	Benzene	5	µg/L	U
323 Building to LERF Basin 44	Benzyl alcohol	10	µg/L	U
323 Building to LERF Basin 44	Beryllium	4	µg/L	U
323 Building to LERF Basin 44	Cadmium	4	µg/L	U
323 Building to LERF Basin 44	Calcium	3.2	µg/L	--
323 Building to LERF Basin 44	Carbon disulfide	5	µg/L	U
323 Building to LERF Basin 44	Carbon tetrachloride	5	µg/L	U
323 Building to LERF Basin 44	Chloroform	5	µg/L	U
323 Building to LERF Basin 44	Chromium	3.79	µg/L	--
323 Building to LERF Basin 44	Copper	20	µg/L	--
323 Building to LERF Basin 44	Iron	579	µg/L	--
323 Building to LERF Basin 44	Lead	29.6	µg/L	--

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
323 Building to LERF Basin 44	Magnesium	4120	µg/L	--
323 Building to LERF Basin 44	Manganese	65.6	µg/L	--
323 Building to LERF Basin 44	Mercury	6.52	µg/L	--
323 Building to LERF Basin 44	Methyl isobutyl ketone	10	µg/L	U
323 Building to LERF Basin 44	Methylene chloride	5	µg/L	U
323 Building to LERF Basin 44	Nickel	40	µg/L	--
323 Building to LERF Basin 44	n-Nitrosodimethylamine	10	µg/L	--
323 Building to LERF Basin 44	Polychlorinated biphenyls	1.2	µg/L	U
323 Building to LERF Basin 44	pH Measurement	9.88	unitless	--
323 Building to LERF Basin 44	Potassium	13600	µg/L	--
323 Building to LERF Basin 44	Pyridine	10	µg/L	U
323 Building to LERF Basin 44	Selenium	20	µg/L	U
323 Building to LERF Basin 44	Silicon	2090	µg/L	--
323 Building to LERF Basin 44	Silver	2.88	µg/L	U
323 Building to LERF Basin 44	Sodium	397000	µg/L	--
323 Building to LERF Basin 44	Tetrachloroethene	5	µg/L	U
323 Building to LERF Basin 44	Tetrahydrofuran	5	µg/L	U
323 Building to LERF Basin 44	Toluene	5.86	µg/L	--
323 Building to LERF Basin 44	Total dissolved solids	1220000	µg/L	--
323 Building to LERF Basin 44	Total organic carbon	5920	µg/L	--
323 Building to LERF Basin 44	Total suspended solids	6000	µg/L	--
323 Building to LERF Basin 44	Tributyl phosphate	10	µg/L	U
323 Building to LERF Basin 44	Trichloroethene	6	µg/L	U
323 Building to LERF Basin 44	Uranium	140000	µg/L	--
323 Building to LERF Basin 44	Vanadium	5.99	µg/L	--
323 Building to LERF Basin 44	Vinyl chloride	10	µg/L	U
323 Building to LERF Basin 44	Xylenes (total)	5	µg/L	U
323 Building to LERF Basin 44	Zinc	39.2	µg/L	--
AZ-301 Condensate to LERF Basin 42	1,1,1-Trichloroethane	0.048	µg/L	U
AZ-301 Condensate to LERF Basin 42	1,2-Dichlorobenzene	0.0478	µg/L	--
AZ-301 Condensate to LERF Basin 42	1,2-Dichloroethane	0.03	µg/L	U
AZ-301 Condensate to LERF Basin 42	1.4-0ichlorobeozene	0.054	µg/L	U
AZ-301 Condensate to LERF Basin 42	1-Butanol	392	µg/L	--
AZ-301 Condensate to LERF Basin 42	2,4,5-T	22.9	µg/L	U
AZ-301 Condensate to LERF Basin 42	2,4,6-Trichlorophenol	24	µg/L	U

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
AZ-301 Condensate to LERF Basin 42	2,4-Dimethylphenol	57.4	µg/L	U
AZ-301 Condensate to LERF Basin 42	2-Butanone	19	µg/L	--
AZ-301 Condensate to LERF Basin 42	2-Butoxyethanol	180	µg/L	--
AZ-301 Condensate to LERF Basin 42	2-Hexanone	1.24	µg/L	--
AZ-301 Condensate to LERF Basin 42	2-Pentanone	1.96	µg/L	--
AZ-301 Condensate to LERF Basin 42	4-Methyl-2-pentanone	0.59	µg/L	--
AZ-301 Condensate to LERF Basin 42	Acetone	236	µg/L	--
AZ-301 Condensate to LERF Basin 42	Aluminum	30	µg/L	U
AZ-301 Condensate to LERF Basin 42	Ammonia	37643	µg/L	--
AZ-301 Condensate to LERF Basin 42	Antimony	30	µg/L	U
AZ-301 Condensate to LERF Basin 42	Arsenic	25	µg/L	U
AZ-301 Condensate to LERF Basin 42	Barium	5	µg/L	U
AZ-301 Condensate to LERF Basin 42	Benzene	0	µg/L	--
AZ-301 Condensate to LERF Basin 42	Beryllium	5	µg/L	U
AZ-301 Condensate to LERF Basin 42	Bromide	16	µg/L	U
AZ-301 Condensate to LERF Basin 42	cadmium	5	µg/L	U
AZ-301 Condensate to LERF Basin 42	Calcium	400	µg/L	U
AZ-301 Condensate to LERF Basin 42	Carbon disulfide	0.023	µg/L	--
AZ-301 Condensate to LERF Basin 42	Carbon tetrachloride	0.1	µg/L	U
AZ-301 Condensate to LERF Basin 42	Chloride	38	µg/L	U
AZ-301 Condensate to LERF Basin 42	Chlorobenzene	0.04	µg/L	U
AZ-301 Condensate to LERF Basin 42	Chloroform	0.2	µg/L	--
AZ-301 Condensate to LERF Basin 42	Chromium	5	µg/L	U
AZ-301 Condensate to LERF Basin 42	Copper	10	µg/L	U
AZ-301 Condensate to LERF Basin 42	Cresol (Total)	28.9	µg/L	U
AZ-301 Condensate to LERF Basin 42	Di-n-octylphthalate	23.8	µg/L	--
AZ-301 Condensate to LERF Basin 42	Ethylbenzene	0.072	µg/L	--
AZ-301 Condensate to LERF Basin 42	Fluoride	1	µg/L	U
AZ-301 Condensate to LERF Basin 42	Hexachlorobutadiene	19.6	µg/L	U
AZ-301 Condensate to LERF Basin 42	Iron	50	µg/L	U
AZ-301 Condensate to LERF Basin 42	Lead	30	µg/L	U
AZ-301 Condensate to LERF Basin 42	Magnesium	10	µg/L	U
AZ-301 Condensate to LERF Basin 42	Manganese	5	µg/L	U
AZ-301 Condensate to LERF Basin 42	Mercury	1.9	µg/L	--
AZ-301 Condensate to LERF Basin 42	Methylene chloride	0.044	µg/L	U

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
AZ-301 Condensate to LERF Basin 42	Nickel	5	µg/L	U
AZ-301 Condensate to LERF Basin 42	Nitrate	18246	µg/L	--
AZ-301 Condensate to LERF Basin 42	Nitrite	1288	µg/L	--
AZ-301 Condensate to LERF Basin 42	n-Nitrosodimethylamine	96	µg/L	U
AZ-301 Condensate to LERF Basin 42	Polychlorinated biphenyls	7.56	µg/L	U
AZ-301 Condensate to LERF Basin 42	Pentachlorophenol	11.4	µg/L	--
AZ-301 Condensate to LERF Basin 42	pH Measurement	9.9	unitless	--
AZ-301 Condensate to LERF Basin 42	Phosphate	15	µg/L	U
AZ-301 Condensate to LERF Basin 42	Potassium	100	µg/L	U
AZ-301 Condensate to LERF Basin 42	Selenium	30	µg/L	U
AZ-301 Condensate to LERF Basin 42	Silicon	68.3	µg/L	--
AZ-301 Condensate to LERF Basin 42	Silver	5	µg/L	U
AZ-301 Condensate to LERF Basin 42	Sodium	3250	µg/L	--
AZ-301 Condensate to LERF Basin 42	Sulfate	45	µg/L	--
AZ-301 Condensate to LERF Basin 42	Tetrachloroethene	0.1	µg/L	--
AZ-301 Condensate to LERF Basin 42	Tetrahydrofuran	0.306	µg/L	--
AZ-301 Condensate to LERF Basin 42	Toluene	0.1	µg/L	--
AZ-301 Condensate to LERF Basin 42	Total dissolved solids	250000	µg/L	U
AZ-301 Condensate to LERF Basin 42	Total organic carbon	20000	µg/L	U
AZ-301 Condensate to LERF Basin 42	Tributyl phosphate	8.92	µg/L	--
AZ-301 Condensate to LERF Basin 42	Trichloroethene	0.042	µg/L	--
AZ-301 Condensate to LERF Basin 42	Uranium	100	µg/L	U
AZ-301 Condensate to LERF Basin 42	Vanadium	5	µg/L	U
AZ-301 Condensate to LERF Basin 42	Xylenes (total)	0.237	µg/L	--
AZ-301 Condensate to LERF Basin 42	Zinc	20	µg/L	U
BP-5 Perched Water to LERF Basin 43	2-Butanone	9.3	µg/L	--
BP-5 Perched Water to LERF Basin 43	Acetone	25	µg/L	--
BP-5 Perched Water to LERF Basin 43	Alkalinity	231000	µg/L	--
BP-5 Perched Water to LERF Basin 43	Aluminum	125	µg/L	--
BP-5 Perched Water to LERF Basin 43	Antimony	92.2	µg/L	--
BP-5 Perched Water to LERF Basin 43	Arsenic	19.1	µg/L	--
BP-5 Perched Water to LERF Basin 43	Barium	62.1	µg/L	--
BP-5 Perched Water to LERF Basin 43	Beryllium	10.8	µg/L	--
BP-5 Perched Water to LERF Basin 43	Bis(2-ethylhexyl) phthalate	5.9	µg/L	--
BP-5 Perched Water to LERF Basin 43	Bromide	1200	µg/L	--

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
BP-5 Perched Water to LERF Basin 43	Cadmium	4.4	µg/L	--
BP-5 Perched Water to LERF Basin 43	Calcium	213000	µg/L	--
BP-5 Perched Water to LERF Basin 43	Carbon tetrachloride	3.2	µg/L	--
BP-5 Perched Water to LERF Basin 43	Chloride	83700	µg/L	--
BP-5 Perched Water to LERF Basin 43	Chloroform	1	µg/L	--
BP-5 Perched Water to LERF Basin 43	Chromium	143.9	µg/L	--
BP-5 Perched Water to LERF Basin 43	Cobalt	10.9	µg/L	--
BP-5 Perched Water to LERF Basin 43	Copper	192	µg/L	--
BP-5 Perched Water to LERF Basin 43	Fluoride	22000	µg/L	--
BP-5 Perched Water to LERF Basin 43	Iron	130.4	µg/L	--
BP-5 Perched Water to LERF Basin 43	Magnesium	82100	µg/L	--
BP-5 Perched Water to LERF Basin 43	Manganese	129.7	µg/L	--
BP-5 Perched Water to LERF Basin 43	Nickel	19.9	µg/L	U
BP-5 Perched Water to LERF Basin 43	Nitrate	611143	µg/L	--
BP-5 Perched Water to LERF Basin 43	Nitrite	200	µg/L	U
BP-5 Perched Water to LERF Basin 43	pH Measurement	7.84	unitless	--
BP-5 Perched Water to LERF Basin 43	Phosphate	300	µg/L	--
BP-5 Perched Water to LERF Basin 43	Potassium	14600	µg/L	--
BP-5 Perched Water to LERF Basin 43	Silver	65.6	µg/L	--
BP-5 Perched Water to LERF Basin 43	Sodium	391000	µg/L	--
BP-5 Perched Water to LERF Basin 43	Specific conductivity	2780	µS/cm	--
BP-5 Perched Water to LERF Basin 43	Strontium	1170	µg/L	--
BP-5 Perched Water to LERF Basin 43	Sulfate	556400	µg/L	--
BP-5 Perched Water to LERF Basin 43	Tetrahydrofuran	1	µg/L	U
BP-5 Perched Water to LERF Basin 43	Total dissolved solids	2023943	µg/L	--
BP-5 Perched Water to LERF Basin 43	Tributyl phosphate	14	µg/L	--
BP-5 Perched Water to LERF Basin 43	Uranium	111000	µg/L	--
BP-5 Perched Water to LERF Basin 43	Vanadium	24.2	µg/L	--
BP-5 Perched Water to LERF Basin 43	Zinc	92.2	µg/L	--
ERDF Leachate to LERF Basin 43	1,1-Dichloroethene	5	µg/L	U
ERDF Leachate to LERF Basin 43	1,2-Diphenylhydrazine	10	µg/L	U
ERDF Leachate to LERF Basin 43	2,4-D(2,4-Dichlorophenoxyacetic acid)	0.36	µg/L	U
ERDF Leachate to LERF Basin 43	Acetone	10	µg/L	U
ERDF Leachate to LERF Basin 43	Alkalinity	310000	µg/L	--

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
ERDF Leachate to LERF Basin 43	Aluminum	19.7	µg/L	U
ERDF Leachate to LERF Basin 43	Ammonia	121.4	µg/L	--
ERDF Leachate to LERF Basin 43	Antimony	6	µg/L	U
ERDF Leachate to LERF Basin 43	Arsenic	9.4	µg/L	B
ERDF Leachate to LERF Basin 43	Barium	200	µg/L	--
ERDF Leachate to LERF Basin 43	Beryllium	1.3	µg/L	U
ERDF Leachate to LERF Basin 43	beta-1,2,3,4,5,6-Hexachlorocyclohexane	0.05	µg/L	U
ERDF Leachate to LERF Basin 43	Bismuth	6.7	µg/L	U
ERDF Leachate to LERF Basin 43	Boron	750	µg/L	--
ERDF Leachate to LERF Basin 43	Bromide	3500	µg/L	D
ERDF Leachate to LERF Basin 43	Bromoform (Tribromomethane)	5	µg/L	U
ERDF Leachate to LERF Basin 43	Cadmium	0.58	µg/L	B
ERDF Leachate to LERF Basin 43	Calcium	451000	µg/L	--
ERDF Leachate to LERF Basin 43	Carbon tetrachloride	5	µg/L	U
ERDF Leachate to LERF Basin 43	Chloride	317000	µg/L	D
ERDF Leachate to LERF Basin 43	Chromium	98	µg/L	--
ERDF Leachate to LERF Basin 43	Cobalt	145	µg/L	--
ERDF Leachate to LERF Basin 43	Copper	145	µg/L	--
ERDF Leachate to LERF Basin 43	Cyanide	3.9	µg/L	B
ERDF Leachate to LERF Basin 43	Dibromomethane	10	µg/L	U
ERDF Leachate to LERF Basin 43	Dimethyl phthalate	10	µg/L	U
ERDF Leachate to LERF Basin 43	Ethyl acetate (Acetic acid ethyl ester)	10	µg/L	U
ERDF Leachate to LERF Basin 43	Fluoranthene	10	µg/L	U
ERDF Leachate to LERF Basin 43	Fluoride	360	µg/L	B
ERDF Leachate to LERF Basin 43	Formaldehyde	82.1	µg/L	
ERDF Leachate to LERF Basin 43	Formic acid	190	µg/L	B
ERDF Leachate to LERF Basin 43	Hexavalent chromium	120	µg/L	--
ERDF Leachate to LERF Basin 43	Iodomethane	5	µg/L	U
ERDF Leachate to LERF Basin 43	Iron	22	µg/L	U
ERDF Leachate to LERF Basin 43	Isophorone	10	µg/L	U
ERDF Leachate to LERF Basin 43	Lead	10.9	µg/L	--
ERDF Leachate to LERF Basin 43	Lithium	23	µg/L	--
ERDF Leachate to LERF Basin 43	Magnesium	78500	µg/L	--
ERDF Leachate to LERF Basin 43	Manganese	6.9	µg/L	--

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
ERDF Leachate to LERF Basin 43	Mercury	0.2	µg/L	U
ERDF Leachate to LERF Basin 43	Methyl methacrylate	5	µg/L	U
ERDF Leachate to LERF Basin 43	Molybdenum	10	µg/L	B
ERDF Leachate to LERF Basin 43	Nickel	15	µg/L	B
ERDF Leachate to LERF Basin 43	Nitrate	309557	µg/L	--
ERDF Leachate to LERF Basin 43	Nitrite	7600	µg/L	U
ERDF Leachate to LERF Basin 43	Oil and grease	1800	µg/L	B
ERDF Leachate to LERF Basin 43	pH Measurement	8.1	unitless	--
ERDF Leachate to LERF Basin 43	Phenanthrene	10	µg/L	U
ERDF Leachate to LERF Basin 43	Phosphate	300	µg/L	U
ERDF Leachate to LERF Basin 43	Potassium	20900	µg/L	--
ERDF Leachate to LERF Basin 43	Selenium	14	µg/L	B
ERDF Leachate to LERF Basin 43	Silicon	27900	µg/L	--
ERDF Leachate to LERF Basin 43	Silver	5	µg/L	--
ERDF Leachate to LERF Basin 43	Sodium	235000	µg/L	--
ERDF Leachate to LERF Basin 43	Specific conductivity	2700	µS/cm	--
ERDF Leachate to LERF Basin 43	Strontium	1500	µg/L	--
ERDF Leachate to LERF Basin 43	Sulfate	615000	µg/L	D
ERDF Leachate to LERF Basin 43	Thallium	5	µg/L	U
ERDF Leachate to LERF Basin 43	Tin	5.8	µg/L	U
ERDF Leachate to LERF Basin 43	Titanium	4	µg/L	--
ERDF Leachate to LERF Basin 43	Total organic carbon	8300	µg/L	--
ERDF Leachate to LERF Basin 43	Toluene	5	µg/L	U
ERDF Leachate to LERF Basin 43	Total dissolved solids	2000000	µg/L	--
ERDF Leachate to LERF Basin 43	Total organic carbon	6400	µg/L	--
ERDF Leachate to LERF Basin 43	Total organic halides	79	µg/L	--
ERDF Leachate to LERF Basin 43	Total suspended solids	19400	µg/L	--
ERDF Leachate to LERF Basin 43	Trichloromonofluoromethane	5	µg/L	U
ERDF Leachate to LERF Basin 43	Uranium	1350	µg/L	--
ERDF Leachate to LERF Basin 43	Vanadium	45.1	µg/L	--
ERDF Leachate to LERF Basin 43	Zinc	44	µg/L	--
ERDF Leachate to LERF Basin 44	Alkalinity	264813	µg/L	--
ERDF Leachate to LERF Basin 44	Aluminum	31	µg/L	--
ERDF Leachate to LERF Basin 44	Antimony	1	µg/L	--
ERDF Leachate to LERF Basin 44	Arsenic	9	µg/L	--

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
ERDF Leachate to LERF Basin 44	Barium	97	µg/L	--
ERDF Leachate to LERF Basin 44	Beryllium	0	µg/L	--
ERDF Leachate to LERF Basin 44	Bromide	1242	µg/L	--
ERDF Leachate to LERF Basin 44	Cadmium	0.1	µg/L	I
ERDF Leachate to LERF Basin 44	Calcium	213735	µg/L	--
ERDF Leachate to LERF Basin 44	Carbon tetrachloride	0	µg/L	--
ERDF Leachate to LERF Basin 44	Chloride	249638	µg/L	--
ERDF Leachate to LERF Basin 44	Chromium	27	µg/L	--
ERDF Leachate to LERF Basin 44	Copper	20	µg/L	--
ERDF Leachate to LERF Basin 44	Fluoride	521	µg/L	--
ERDF Leachate to LERF Basin 44	Iron	35	µg/L	--
ERDF Leachate to LERF Basin 44	Lead	2.8	µg/L	--
ERDF Leachate to LERF Basin 44	Magnesium	69580	µg/L	--
ERDF Leachate to LERF Basin 44	Mercury	0.154	µg/L	--
ERDF Leachate to LERF Basin 44	Methyl alcohol	0	µg/L	--
ERDF Leachate to LERF Basin 44	Nickel	13	µg/L	--
ERDF Leachate to LERF Basin 44	Nitrate	327241	µg/L	--
ERDF Leachate to LERF Basin 44	Nitrite	500	µg/L	U
ERDF Leachate to LERF Basin 44	Oil and grease	3213	µg/L	--
ERDF Leachate to LERF Basin 44	Potassium	20573	µg/L	--
ERDF Leachate to LERF Basin 44	Selenium	5	µg/L	--
ERDF Leachate to LERF Basin 44	Silicon	20063	µg/L	--
ERDF Leachate to LERF Basin 44	Silver	5	µg/L	U
ERDF Leachate to LERF Basin 44	Sodium	254237	µg/L	--
ERDF Leachate to LERF Basin 44	Specific conductivity	2509	µS/cm	--
ERDF Leachate to LERF Basin 44	Sulfate	473776	µg/L	--
ERDF Leachate to LERF Basin 44	Thallium	0	µg/L	--
ERDF Leachate to LERF Basin 44	Tin	1	µg/L	--
ERDF Leachate to LERF Basin 44	Total dissolved solids	1926897	µg/L	--
ERDF Leachate to LERF Basin 44	Total organic carbon	13148	µg/L	--
ERDF Leachate to LERF Basin 44	Total suspended solids	15686	µg/L	--
ERDF Leachate to LERF Basin 44	Trichloroethene	0	µg/L	--
ERDF Leachate to LERF Basin 44	Trichlorofluoromethane	3.2	µg/L	--
ERDF Leachate to LERF Basin 44	Vanadium	26	µg/L	--
ERDF Leachate to LERF Basin 44	Zinc	14	µg/L	--

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF Basin 43 Characterization	Alkalinity	224900	µg/L	--
LERF Basin 43 Characterization	Aluminum	17.5	µg/L	--
LERF Basin 43 Characterization	Ammonia	121.4	µg/L	--
LERF Basin 43 Characterization	Antimony	3.3	µg/L	U
LERF Basin 43 Characterization	Arsenic	6.9	µg/L	--
LERF Basin 43 Characterization	Barium	96.7	µg/L	--
LERF Basin 43 Characterization	Beryllium	0.8	µg/L	U
LERF Basin 43 Characterization	Bromide	1200	µg/L	--
LERF Basin 43 Characterization	Cadmium	0.5	µg/L	--
LERF Basin 43 Characterization	Calcium	181161.2	µg/L	--
LERF Basin 43 Characterization	Carbon tetrachloride	12.1	µg/L	--
LERF Basin 43 Characterization	Chloride	176900	µg/L	--
LERF Basin 43 Characterization	Chloroform	0.6	µg/L	U
LERF Basin 43 Characterization	Chromium	36.1	µg/L	--
LERF Basin 43 Characterization	Cobalt	67.7	µg/L	--
LERF Basin 43 Characterization	Copper	121.1	µg/L	--
LERF Basin 43 Characterization	Fluoride	1200	µg/L	--
LERF Basin 43 Characterization	Iron	21.2	µg/L	--
LERF Basin 43 Characterization	Lead	5.1	µg/L	--
LERF Basin 43 Characterization	Magnesium	44035.4	µg/L	--
LERF Basin 43 Characterization	Manganese	7.1	µg/L	--
LERF Basin 43 Characterization	Mercury	0.1	µg/L	--
LERF Basin 43 Characterization	Nickel	6.7	µg/L	--
LERF Basin 43 Characterization	Nitrate	63800	µg/L	--
LERF Basin 43 Characterization	Nitrite	3400	µg/L	U
LERF Basin 43 Characterization	pH Measurement	6.9	unitless	--
LERF Basin 43 Characterization	Phosphate	200	µg/L	U
LERF Basin 43 Characterization	Potassium	13579.6	µg/L	--
LERF Basin 43 Characterization	Selenium	5.7	µg/L	--
LERF Basin 43 Characterization	Silicon	17465.4	µg/L	--
LERF Basin 43 Characterization	Silver	5.5	µg/L	--
LERF Basin 43 Characterization	Sodium	187496.6	µg/L	--
LERF Basin 43 Characterization	Specific conductivity	2041.7	µS/cm	--
LERF Basin 43 Characterization	Sulfate	404400	µg/L	--
LERF Basin 43 Characterization	Tetrahydrofuran	1.1	µg/L	U

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF Basin 43 Characterization	Thallium	27.7	µg/L	--
LERF Basin 43 Characterization	Titanium	4.4	µg/L	--
LERF Basin 43 Characterization	Total dissolved solids	1351100	µg/L	--
LERF Basin 43 Characterization	Total organic carbon	6000	µg/L	--
LERF Basin 43 Characterization	Total suspended solids	9700	µg/L	--
LERF Basin 43 Characterization	Uranium	2249.2	µg/L	--
LERF Basin 43 Characterization	Vanadium	32.9	µg/L	--
LERF Basin 43 Characterization	Zinc	25.5	µg/L	--
LERF Basin 44 Characterization	2-Butoxyethanol	8.0	µg/L	--
LERF Basin 44 Characterization	Alkalinity	211973.5	µg/L	--
LERF Basin 44 Characterization	Aluminum	15.8	µg/L	--
LERF Basin 44 Characterization	Ammonia	1570.3	µg/L	--
LERF Basin 44 Characterization	Antimony	0.6	µg/L	--
LERF Basin 44 Characterization	Arsenic	7.3	µg/L	--
LERF Basin 44 Characterization	Barium	45.2	µg/L	--
LERF Basin 44 Characterization	Beryllium	1.7	µg/L	U
LERF Basin 44 Characterization	Bromide	970.7	µg/L	--
LERF Basin 44 Characterization	Cadmium	0.1	µg/L	U
LERF Basin 44 Characterization	Calcium	95702.7	µg/L	--
LERF Basin 44 Characterization	Carbon tetrachloride	21.2	µg/L	--
LERF Basin 44 Characterization	Chloride	135095.0	µg/L	--
LERF Basin 44 Characterization	Chloroform	1.8	µg/L	--
LERF Basin 44 Characterization	Chromium	18.8	µg/L	--
LERF Basin 44 Characterization	Cobalt	3.4	µg/L	U
LERF Basin 44 Characterization	Copper	4.5	µg/L	--
LERF Basin 44 Characterization	Cyanide	7.6	µg/L	--
LERF Basin 44 Characterization	Fluoride	401.1	µg/L	--
LERF Basin 44 Characterization	Iron	31.3	µg/L	--
LERF Basin 44 Characterization	Lead	0.2	µg/L	--
LERF Basin 44 Characterization	Magnesium	36525.7	µg/L	--
LERF Basin 44 Characterization	Manganese	3.9	µg/L	--
LERF Basin 44 Characterization	Mercury	0.1	µg/L	--
LERF Basin 44 Characterization	Nickel	8.6	µg/L	--
LERF Basin 44 Characterization	Nitrate	246057.1	µg/L	--
LERF Basin 44 Characterization	Nitrite	409.6	µg/L	U

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF Basin 44 Characterization	n-Nitrosodimethylamine	32.8	µg/L	--
LERF Basin 44 Characterization	pH Measurement	7.5	unitless	--
LERF Basin 44 Characterization	Phosphate	297.0	µg/L	U
LERF Basin 44 Characterization	Potassium	163755.7	µg/L	--
LERF Basin 44 Characterization	Selenium	2.9	µg/L	--
LERF Basin 44 Characterization	Silicon	14523.5	µg/L	--
LERF Basin 44 Characterization	Silver	3.4	µg/L	----
LERF Basin 44 Characterization	Sodium	208071.6	µg/L	--
LERF Basin 44 Characterization	Specific conductivity	2287.4	µS/cm	--
LERF Basin 44 Characterization	Sulfate	420107.3	µg/L	--
LERF Basin 44 Characterization	Tetrahydrofuran	1.5	µg/L	--
LERF Basin 44 Characterization	Thallium	31.5	µg/L	U
LERF Basin 44 Characterization	Titanium	3.4	µg/L	U
LERF Basin 44 Characterization	Total dissolved solids	1482272.1	µg/L	--
LERF Basin 44 Characterization	Total organic carbon	6.2	µg/L	--
LERF Basin 44 Characterization	Total suspended solids	1810.1	µg/L	U
LERF Basin 44 Characterization	Tributyl phosphate	9.9	µg/L	--
LERF Basin 44 Characterization	Uranium	1368.2	µg/L	--
LERF Basin 44 Characterization	Vanadium	18.1	µg/L	--
LERF Basin 44 Characterization	Zinc	14.9	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	1,4-Dichlorobenzene	16.7	µg/L	DU
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	1-Butanol	1700	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	2-Butanone	19	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	2-Butoxyethanol	330	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	2-Hexanone	3	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	2-Methylphenol (cresol, o-)	4.3	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	2-Pentanone	6.52	µg/L	J
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	3+4 Methylphenol (cresol, m+p)	28.9	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	4-Methyl-2-pentanone	3	µg/L	U

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	4-Nitrophenol	16.7	µg/L	DU
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Acetone	1020	µg/L	DT
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Acetonitrile	36.4	µg/L	J
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Acetophenone	16.7	µg/L	DU
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Alkalinity	319000	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Aluminum	30	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Ammonia	100786	µg/L	D
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Antimony	30	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Aroclor-1016	0.0358	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Aroclor-1221	0.0358	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Aroclor-1232	0.0358	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Aroclor-1242	0.0358	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Aroclor-1248	0.0358	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Aroclor-1254	0.0358	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Aroclor-1260	0.0358	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Arsenic	25	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Barium	5	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Benzene	1	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Benzyl alcohol	25.2	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Beryllium	5	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Bis(2-ethylhexyl) phthalate	236	µg/L	D

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Bromide	50	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Cadmium	5	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Calcium	400	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Carbon disulfide	1.6	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Carbon tetrachloride	1	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Chloride	8430	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Chlorobenzene	0.3	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Chloroform	1	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Chromium	5	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Cobalt	4	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Copper	37.4	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Cyanide	4	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Di-n-octylphthalate	16.7	µg/L	DU
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Fluoride	119	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Iron	50	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Lead	30	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Magnesium	110	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Manganese	6	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Mercury	1.9	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Methylene chloride	1.72	µg/L	BJ
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Nickel	5	µg/L	U

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Nitrate	18246	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Nitrite	1288	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	n-Nitrosodimethylamine	329	µg/L	D
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	pH Measurement	10.4	unitless	X
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Phenol	16.7	µg/L	DU
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Phosphate	70	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Potassium	100	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Selenium	30	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Silicon	388	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Silver	7	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Sodium	3250	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Specific conductivity	124	µS/cm	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Sulfate	12600	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Tetrachloroethene	0.3	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Tetrahydrofuran	261	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Thallium	49	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Titanium	4	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Toluene	0.3	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Total dissolved solids	24300	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Total organic carbon	20000	µg/L	--
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Total suspended solids	10000	µg/L	U

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Tributyl phosphate	16.7	µg/L	DU
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Trichloroethene	0.3	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Uranium	100	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Vanadium	17	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Vinyl chloride	0.3	µg/L	U
LERF/ETF 242-A Evaporator Process Condensate to LERF Basin 42	Zinc	20	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Aluminum	53.3	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Antimony	1	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Arsenic	17.3	µg/L	C
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Beryllium	0.2	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Cadmium	0.11	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Calcium	57600	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Chloride	58900	µg/L	D
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Chromium	11.3	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Cobalt	0.1	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Copper	3.5	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Fluoride	643	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Iron	101	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Lead	0.5	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Magnesium	13700	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Manganese	2.36	µg/L	B

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Mercury	0.075	µg/L	CB
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Nickel	0.5	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Nitrate	96543	µg/L	DX
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Nitrite	124.86	µg/L	UX
LERF/ETF Mixed Waste Burial Trench 31 Leachate	pH Measurement	8.34	unitless	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Phosphate	113	µg/L	BX
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Potassium	7560	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Selenium	2.77	µg/L	B
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Silicon	16700	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Silver	0.2	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Sodium	94000	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Sulfate	45400	µg/L	D
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Thallium	0.45	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Total dissolved solids	603000	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Total organic carbon	3930	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Total suspended solids	10000	µg/L	U
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Uranium	16.4	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Vanadium	21	µg/L	--
LERF/ETF Mixed Waste Burial Trench 31 Leachate	Zinc	3.5	µg/L	U
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Aluminum	75.1	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Antimony	1	µg/L	U

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Arsenic	20.9	µg/L	C
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Beryllium	0.2	µg/L	U
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Cadmium	0.11	µg/L	U
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Calcium	57700	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Chloride	16100	µg/L	D
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Chromium	28.5	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Cobalt	0.18	µg/L	CB
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Copper	8.11	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Fluoride	490	µg/L	B
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Iron	225	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Lead	0.888	µg/L	CB
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Magnesium	13100	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Manganese	3.96	µg/L	B
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Mercury	0.067	µg/L	U
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Nickel	0.537	µg/L	B
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Nitrate	62443	µg/L	DX
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Nitrite	124.86	µg/L	UX
LERF/ETF Mixed Waste Burial Trench 34 Leachate	pH Measurement	8.22	unitless	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Phosphate	70.5	µg/L	BX
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Potassium	6970	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Selenium	1.95	µg/L	B

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Silicon	15700	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Silver	0.2	µg/L	U
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Sodium	116000	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Sulfate	71600	µg/L	D
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Thallium	0.45	µg/L	U
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Total dissolved solids	706000	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Total organic carbon	4280	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Total suspended solids	10000	µg/L	U
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Uranium	38.9	µg/L	D
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Vanadium	26.6	µg/L	--
LERF/ETF Mixed Waste Burial Trench 34 Leachate	Zinc	9.05	µg/L	B
Minor Source Leachate to LERF Basin 42	1-Butanol	1700	µg/L	--
Minor Source Leachate to LERF Basin 42	2-Butanone	10	µg/L	--
Minor Source Leachate to LERF Basin 42	2-Butoxyethanol	330	µg/L	--
Minor Source Leachate to LERF Basin 42	2-Methylphenol (Cresol, o-)	4.3	µg/L	--
Minor Source Leachate to LERF Basin 42	2-Pentanone	5.7	µg/L	--
Minor Source Leachate to LERF Basin 42	3+4 Methylphenol (Cresol, m+p)	4.3	µg/L	--
Minor Source Leachate to LERF Basin 42	Acetone	1700	µg/L	--
Minor Source Leachate to LERF Basin 42	Alkalinity	500	µg/L	--
Minor Source Leachate to LERF Basin 42	Aluminum	34	µg/L	U
Minor Source Leachate to LERF Basin 42	Ammonia	170000	µg/L	--
Minor Source Leachate to LERF Basin 42	Antimony	0.3	µg/L	U
Minor Source Leachate to LERF Basin 42	Arsenic	5.2	µg/L	--
Minor Source Leachate to LERF Basin 42	Barium	12.3	µg/L	--
Minor Source Leachate to LERF Basin 42	Benzene	1	µg/L	U
Minor Source Leachate to LERF Basin 42	Benzyl alcohol	23	µg/L	--
Minor Source Leachate to LERF Basin 42	Beryllium	0.05	µg/L	U

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
Minor Source Leachate to LERF Basin 42	Bromide	90	µg/L	U
Minor Source Leachate to LERF Basin 42	Cadmium	0.1	µg/L	U
Minor Source Leachate to LERF Basin 42	Calcium	18000	µg/L	--
Minor Source Leachate to LERF Basin 42	Carbon tetrachloride	1	µg/L	U
Minor Source Leachate to LERF Basin 42	Chloride	7750	µg/L	--
Minor Source Leachate to LERF Basin 42	Chloroform	1	µg/L	U
Minor Source Leachate to LERF Basin 42	Chromium	7.9	µg/L	--
Minor Source Leachate to LERF Basin 42	Cobalt	8	µg/L	U
Minor Source Leachate to LERF Basin 42	Copper	6.96	µg/L	--
Minor Source Leachate to LERF Basin 42	Cyanide	4	µg/L	U
Minor Source Leachate to LERF Basin 42	Fluoride	60	µg/L	--
Minor Source Leachate to LERF Basin 42	Formate	0.01	µg/L	--
Minor Source Leachate to LERF Basin 42	Iron	150	µg/L	--
Minor Source Leachate to LERF Basin 42	Lead	9.01	µg/L	--
Minor Source Leachate to LERF Basin 42	Magnesium	5100	µg/L	--
Minor Source Leachate to LERF Basin 42	Manganese	8	µg/L	--
Minor Source Leachate to LERF Basin 42	Mercury	0.12	µg/L	--
Minor Source Leachate to LERF Basin 42	Methylene chloride	1.6	µg/L	--
Minor Source Leachate to LERF Basin 42	Nickel	10.6	µg/L	--
Minor Source Leachate to LERF Basin 42	Nitrate	442.86	µg/L	--
Minor Source Leachate to LERF Basin 42	Nitrite	131.4	µg/L	U
Minor Source Leachate to LERF Basin 42	n-Nitrosodimethylamine	290	µg/L	--
Minor Source Leachate to LERF Basin 42	pH Measurement	10.4	unitless	--
Minor Source Leachate to LERF Basin 42	Phosphate	270	µg/L	--
Minor Source Leachate to LERF Basin 42	Potassium	2060	µg/L	--
Minor Source Leachate to LERF Basin 42	Selenium	0.87	µg/L	--
Minor Source Leachate to LERF Basin 42	Silicon	5300	µg/L	--
Minor Source Leachate to LERF Basin 42	Silver	10	µg/L	U
Minor Source Leachate to LERF Basin 42	Sodium	26700	µg/L	--
Minor Source Leachate to LERF Basin 42	Specific conductivity	583	µS/cm	--
Minor Source Leachate to LERF Basin 42	Sulfate	80200	µg/L	--
Minor Source Leachate to LERF Basin 42	Tetrahydrofuran	84	µg/L	--
Minor Source Leachate to LERF Basin 42	Thallium	148	µg/L	--
Minor Source Leachate to LERF Basin 42	Titanium	8	µg/L	U
Minor Source Leachate to LERF Basin 42	Total dissolved solids	162	µg/L	--

Table E-6. Waste Inventory in LERF Basins

Influent Stream	Constituent	Maximum Value	Units	Lab Qualifier
Minor Source Leachate to LERF Basin 42	Total organic carbon	9590	µg/L	--
Minor Source Leachate to LERF Basin 42	Total suspended solids	10000	µg/L	--
Minor Source Leachate to LERF Basin 42	Tributyl phosphate	72	µg/L	--
Minor Source Leachate to LERF Basin 42	Uranium	13.4	µg/L	--
Minor Source Leachate to LERF Basin 42	Vanadium	24	µg/L	U
Minor Source Leachate to LERF Basin 42	Zinc	17.6	µg/L	--

B = analyte detected at less than contract required detection limit but greater than method detection limit
C = analyte was detected in both the sample and the associated quality control blank and the sample concentration was less than or equal to 5 times the blank concentration.
D = analyte reported at a secondary dilution factor
J = estimated value
T = Spike and/or spike duplicate sample recovery is outside control limits
U = undetected
X = The result-specific translation of this qualifier code is provided in the hardcopy data report and/or case narrative. Additional information may also be found in the RESULT_COMMENT field for this record (found in the Hanford Environmental Information System).
ERDF = Environmental Restoration Disposal Facility
ETF = 200 Area Effluent Treatment Facility
LERF = Liquid Effluent Retention Facility

E3 Inventory Evaluation

Table E-5 provides a comparison of the maximum concentration of detected constituents in the waste inventory to the minimum action levels of federal and state regulations and the constituent distribution coefficient. The evaluation is described in Section E1.1. Additional rationale for exclusion of specific chemicals in the monitoring program is provided, as appropriate.

The K_d values used for the evaluation were corrected for the estimated gravel content at LERF. Laboratory determinations of K_d typically use the <2 mm particle size fraction of the sediment. However, for materials that contain significant amounts of gravel, K_d values will be lower than those determined using the <2 mm particle size material because the surface area and corresponding quantity of adsorption sites is much lower (Section 2.4 of PNNL-17154, *Geochemical Characterization Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site*). For sediments with high gravel content, Equation 2.4 in PNNL-17154 provided the following equation (Equation 1) for gravel correction of K_d values:

$$K_d(gc) = (1-f)*Kd(<2\ mm) \qquad \textbf{(Eq. 1)}$$

where:

$K_d(gc)$ = gravel-corrected K_d value

f = % of gravel

$K_d(<2\ mm)$ = K_d value determined using <2 mm particle size material.

Section 3.1 of SGW-41072 provides the stratigraphy of the vadose zone beneath LERF, which is predominantly the Hanford formation gravel-dominated sequences Hf1 (upper gravel-dominated facies) and Hf3 (lower gravel-dominated facies) (Figures 3-2 and 3-3 of SGW-41072). According to Table 12 in ECF-HANFORD-19-0121, *Selection of Vadose Zone Flow and Transport Properties with Gravel Fraction Corrections for the Hanford Site Composite Analysis and Cumulative Impact Evaluation*, these stratigraphic units have an average gravel content of 66% (average gravel weight percent). Using Equation 1 to correct for gravel content at LERF, K_d values are multiplied by 1-0.66 or 0.34 to determine the gravel-corrected K_d values.

Table E-7. Evaluation of Constituent Concentrations in LERF Basins

Constituent	CAS Number	Maximum Value (µg/L)	Action Level (µg/L)	Exceeds Action Level	Action Level Basis	K_d (mL/g) (Reference)	Gravel Corrected K_d (mL/g)[a]	Under K_d Limit (0.8 mL/g)	Included for Monitoring?
1,1-Dichloroethene	75-35-4	0.25	7	No	40 CFR 141.61	0.065 (Ecology, 2014)	0.022	Yes	No
1,2-Dichlorobenzene	95-50-1	0.0478	600	No	40 CFR 141.61	0.38 (Ecology, 2014)	0.13	Yes	No
1-Butanol	71-36-3	1700	800	Yes	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.00692 (Ecology, 2014)	0.00235	Yes	Yes
2,4-D (2,4-Dichlorophenoxyacetic acid)	94-75-7	0.216	128	No	CLARC (Ecology, 2014) Groundwater Method B	0.0984 (EPA, 2012)	0.0335	Yes	No
2-Butanone	78-93-3	19	4800	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.0045 (EPA, 2012)	0.0015	Yes	No
2-Hexanone	591-78-6	1.24	80	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.015 (EPA, 2012)	0.0051	Yes	No
2-Methylphenol (cresol, o-)	95-48-7	4.3	400	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.0912 (Ecology, 2014)	0.0310	Yes	No
3+4 Methylphenol (cresol, m+p)	65794-96-9	4.3	--	No	--	NVR	N/A	No	No
4-Methyl-2-pentanone	108-10-1	0.59	640	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.0126 (EPA, 2012)	0.00428	Yes	No
Acetone	67-64-1	1700	7200	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.0006 (Ecology, 2014)	0.0002	Yes	No
Acetonitrile	75-05-8	36.4	--	No	--	0.0047 (EPA, 2012)	0.0016	Yes	No
Alkalinity	3812-32-6	319000	--	No	--	N/A	N/A	No	No
Aluminum	7429-90-5	945	50	Yes	40 CFR 143.3	1500 (EPA, 2012)	510	No	No
Ammonia	7664-41-7	170000	--	No	--	N/A	N/A	No	No
Antimony	7440-36-0	92.2	6	Yes	40 CFR 141.62	45 (Ecology, 2014)	15	No	No
Arsenic	7440-38-2	20.9	0.0583	Yes	WAC 173-340-720(4)(b)(iii)(A) and (B)	29 (Ecology, 2014)	9.9	No	No
Barium	7440-39-3	200	2000	No	40 CFR 141.62	41 (Ecology, 2014)	14	No	No
Benzene	71-43-2	0.04	0.795	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.062 (Ecology, 2014)	0.021	Yes	No
Benzyl alcohol	100-51-6	25.2	800	No	CLARC (Ecology, 2014) Groundwater Method B	0.021 (EPA, 2012)	0.0071	Yes	No
Beryllium	7440-41-7	10.8	4	Yes	40 CFR 141.62	790 (Ecology, 2014)	269	No	No
Bis(2-ethylhexyl) phthalate	117-81-7	236	6	Yes	40 CFR 141.61	111 (Ecology, 2014)	37.7	No	No
Boron	7440-42-8	750	3200	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	3 (EPA, 2012)	1	No	No
Bromide	24959-67-9	3500	--	No	--	NVR	N/A	No	No
Cadmium	7440-43-9	4.4	5	No	40 CFR 141.62	6.7 (Ecology, 2014)	2.3	No	No
Calcium	7440-70-2	451000	--	No	--	NVR	N/A	No	No
Carbon disulfide	75-15-0	0.023	800	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.0457 (Ecology, 2014)	0.0155	Yes	No
Carbon tetrachloride	56-23-5	490.7	3.4	Yes	200-ZP-1 Cleanup Level (EPA et al., 2008)	0.152 (Ecology, 2014)	0.0517	Yes	Yes
Chloride	16887-00-6	317000	250000	Yes	40 CFR 143.3	0 (ECF-100NR1-12-0017)	0	Yes	No[b]
Chloroform	67-66-3	8.5	1.41	Yes	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.053 (Ecology, 2014)	0.018	Yes	Yes
Chromium	7440-47-3	143.9	100	Yes	40 CFR 141.62	1000 (Ecology, 2014)	340	No	No
Cobalt	7440-48-4	145	4.8	Yes	WAC 173-340-720(4)(b)(iii)(A) and (B)	45 (EPA, 2012)	15	No	No
Copper	7440-50-8	192	640	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	22 (Ecology, 2014)	7.5	No	No
Cyanide	57-12-5	7.6034437	200	No	40 CFR 141.62	9.9 (EPA, 2012)	3.4	No	No
Dimethyl phthalate	131-11-3	0.23	--	No	--	0.0316 (ORNL, 2014)	0.0107	Yes	No

Table E-7. Evaluation of Constituent Concentrations in LERF Basins

Constituent	CAS Number	Maximum Value (µg/L)	Action Level (µg/L)	Exceeds Action Level	Action Level Basis	K_d (mL/g) (Reference)	Gravel Corrected K_d (mL/g)[a]	Under K_d Limit (0.8 mL/g)	Included for Monitoring?
Di-n-octylphthalate	117-84-0	23.8	--	No	--	83200 (Ecology, 2014)	28288	No	No
Ethylbenzene	100-41-4	0.072	3.98	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.204 (Ecology, 2014)	0.0694	Yes	No
Fluoranthene	206-44-0	0.28	640	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	49 (Ecology, 2014)	17	No	No
Fluoride	16984-48-8	22000	960	Yes	WAC 173-340-720(4)(b)(iii)(A) and (B)	150 (EPA, 2012)	51	No	No
Formaldehyde	50-00-0	82.1	1.60E+03	No	CLARC (Ecology, 2014) Groundwater Method B	0.001 (EPA, 2012)	0.0003	Yes	No
Formic Acid	64-18-6	190	7.20E+03	No	CLARC (Ecology, 2014) Groundwater Method B	0.001 (EPA, 2012)	0.0003	Yes	No
Hexavalent chromium	18540-29-9	120	48	Yes	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.8 (ECF-Hanford-11-0165)	0.3	Yes	Yes
Iodomethane	74-88-4	0.57	--	No	--	NVR	N/A	No	No
Iron	7439-89-6	579	300	Yes	40 CFR 143.3	25 (EPA, 2012)	8.5	No	No
Isophorone	78-59-1	0.22	46.1	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.0468 (Ecology, 2014)	0.0159	Yes	No
Lead	7439-92-1	29.6	15	Yes	40 CFR 141.62	10000 (Ecology, 2014)	3400	No	No
Lithium	7439-93-2	23	32	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	300 (EPA, 2012)	102	No	No
Magnesium	7439-95-4	82100	--	No	--	4.5 (EPA, 2012)	1.5	No	No
Manganese	7439-96-5	129.7	50	Yes	40 CFR 143.3	65 (EPA, 2012)	22	No	No
Mercury	7439-97-6	6.52	2	Yes	40 CFR 141.62	52 (Ecology, 2014)	18	No	No
Methylene chloride	75-09-2	1.72	5	No	40 CFR 141.61	0.01 (Ecology, 2014)	0.003	Yes	No
Molybdenum	7439-98-7	10	80	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	20 (EPA, 2012)	6.8	No	No
Nickel	7440-02-0	40	100	No	WAC 246-290-310	65 (Ecology, 2014)	22	No	No
Nitrate	14797-55-8	611142.86	45000[c]	Yes	40 CFR 141.62	0 (EPA, 2012)	0	Yes	Yes[d]
Nitrite	14797-65-0	1288	3300	No	40 CFR 141.62	0 (ECF-100NR1-12-0017)	0	Yes	No
n-Nitrosodimethylamine	62-75-9	329	0.0008578	Yes	CLARC (Ecology, 2014) Groundwater Method B	0.023 (EPA, 2012)	0.0078	Yes	Yes
Oil and grease	N/A	3213	--	No	--	N/A	N/A	No	No
Pentachlorophenol	87-86-5	11.4	0.729	Yes	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.59 (Ecology, 2014)	0.20	Yes	Yes
Phenanthrene	85-01-8	0.27	--	No	--	16.7 (ORNL, 2014)	5.68	No	No
Phosphate	14265-44-2	300	--	No	--	3.5 (ECF-100NR1-12-0017)	1.2	No	No
Potassium	2023695	163755.72	--	No	--	5.5 (EPA, 2012)	1.9	No	No
Selenium	7782-49-2	14	50	No	40 CFR 141.62	5 (Ecology, 2014)	2	No	No
Silicon	7440-21-3	27900	--	No	--	NVR	N/A	No	No
Silver	7440-22-4	65.6	80	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	8.3 (Ecology, 2014)	2.8	No	No
Sodium	7440-23-5	397000	--	No	--	100 (EPA, 2012)	34	No	No
Specific conductivity	N/A	2780	N/A	N/A	N/A	N/A	N/A	No	No
Strontium	7440-24-6	1500	9600	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	35 (EPA, 2012)	12	No	No
Sulfate	14808-79-8	615000	250000	Yes	40 CFR 143.3	0 (EPA, 2012)	0	Yes	Yes[c]
Tetrachloroethene	127-18-4	0.1	0.001	Yes	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.265 (Ecology, 2014)	0.0901	Yes	Yes
Tetrahydrofuran	109-99-9	261	--	No	--	NVR	N/A	No	No

Table E-7. Evaluation of Constituent Concentrations in LERF Basins

Constituent	CAS Number	Maximum Value (µg/L)	Action Level (µg/L)	Exceeds Action Level	Action Level Basis	K_d (mL/g) (Reference)	Gravel Corrected K_d (mL/g)[a]	Under K_d Limit (0.8 mL/g)	Included for Monitoring?
Thallium	7440-28-0	148	2	Yes	40 CFR 141.62	71 (Ecology, 2014)	24	No	No
Tin	7440-31-5	1	9600	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	250 (EPA, 2012)	85	No	No
Toluene	108-88-3	5.86	640	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.14 (Ecology, 2014)	0.048	Yes	No
Total dissolved solids	N/A	2023942.9	--	No	--	N/A	N/A	No	No
Total organic carbon	N/A	20000	--	No	--	N/A	N/A	No	No
Total organic halides	N/A	79	--	No	--	N/A	N/A	No	No
Total suspended solids	N/A	19400	N/A	N/A	N/A	N/A	N/A	No	No
Tributyl phosphate	126-73-8	72	9.51	Yes	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.35 (EPA, 2012)	0.799	Yes	Yes
Trichloroethene	79-01-6	0.042	0.492	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.094 (Ecology, 2014)	0.032	Yes	No
Trichlorofluoromethane	75-69-4	3.2	2400	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.0439 (EPA, 2012)	0.0149	Yes	No
Tungsten	7440-33-7	0.42	N/A	N/A	N/A	N/A	N/A	No	No
Uranium	7440-61-1	140000	30	Yes	40 CFR 141.62	NVR	N/A	No	No[e]
Vanadium	7440-62-2	45.1	80	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	1000 (Ecology, 2014)	340	No	No
Xylenes (total)	1330-20-7	0.237	1600	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	0.233 (Ecology, 2014)	0.0792	Yes	No
Zinc	7440-66-6	92.2	4800	No	WAC 173-340-720(4)(b)(iii)(A) and (B)	62 (Ecology, 2014)	21	No	No

Note: Complete reference citations are provided in Chapter E4.

a. K_d values used for the evaluation were corrected for the estimated gravel content at LERF as described in Section E3.

b. Chloride is not a regulated waste and is not included for detection monitoring. Nitrate and sulfate will be monitored as regional upgradient constituents and will provide information on regional background levels.

c. Nitrate may be expressed as nitrate-nitrogen (NO_3-N) or as nitrate (NO_3). The drinking water standard for NO_3-N is 10,000 µg/L, and the mathematical equivalent value for nitrate (NO_3) is 45,000 µg/L.

d. This constituent will be monitored as a regional upgradient constituent. The regional upgradient constituents are selected for monitoring based on historical groundwater information showing continued presence in groundwater from sources other than LERF. These constituents will also be used to assess potential changes in background.

e. Uranium is monitored under the *Atomic Energy Act of 1954*.

-- = no action level available
CAS = Chemical Abstracts Service
CLARC = Cleanup Levels and Risk Calculations (database)
K_d = distribution coefficient
LERF = Liquid Effluent Retention Facility
N/A = not applicable
NVR = no value reported

This page intentionally left blank.

E4 References

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr141_main_02.tpl.

40 CFR 143, "National Secondary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr143_main_02.tpl.

Atomic Energy Act of 1954, Pub. L. 83-703 as amended, 42 USC 2011 et seq., 68 Stat. 919. Available at: https://www.govinfo.gov/content/pkg/STATUTE-68/pdf/STATUTE-68-Pg919.pdf#page=30.

ECF-HANFORD-11-0165, 2012, *Evaluation of Hexavalent Chromium Leach Test Data Conducted on Vadose Zone Sediment Samples from the 100 Area*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087250.

ECF-HANFORD-19-0121, 2020, *Selection of Vadose Zone Flow and Transport Properties with Gravel Fraction Corrections for the Hanford Site Composite Analysis and Cumulative Impact Evaluation*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://www.osti.gov/biblio/1605425.

Ecology, 2014, Cleanup Levels and Risk Calculations (CLARC) database, Washington State Department of Ecology. Available at: https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx.

Ecology Publication 97-407, 2014, *Chemical Test Methods for Designating Dangerous Waste, WAC 173-303-090 & -100*, Hazardous Waste and Toxics Reduction Program, Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/97407.pdf.

EPA, 2012, "Regional Screening Levels for Chemical Contaminants at Superfund Sites," U.S. Environmental Protection Agency, Mid-Atlantic Risk Assessment. Available at: http://www.epa.gov/reg3hscd/risk/human/rb-concentration_table/.

EPA, Ecology, and DOE, 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=00098825.

HNF-3172, 2016, *Liquid Waste Processing Facilities Waste Acceptance Criteria*, Rev. 8, Washington River Protection Solutions, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071839H.

ORNL, 2014, Risk Assessment Information System, Oak Ridge National Laboratory, Oak Ridge, Tennessee. Available at: http://rais.ornl.gov/.

PNNL-17154, 2008, *Geochemical Characterization Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://pdw.hanford.gov/document/0911240119.

SGW-41072, 2017, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. https://pdw.hanford.gov/document/0068831H

WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Washington State Department of Ecology, Richland, Washington. Available at: http://www.ecy.wa.gov/programs/nwp/permitting/hdwp/rev/8c/.

WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-720.

WAC 246-290, "Group A Public Water Supplies," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=246-290.

Appendix F

Evaluation of Waste Treatment and Immobilization Plant Liquid Effluent Waste Constituents

This page intentionally left blank

Contents

F1 Introduction F-1

F2 Identification of Chemical Constituents and Concentrations in WTP Liquid Effluent F-1

F3 Evaluation of Chemical Constituents in WTP Liquid Effluent F-1

F3.1 Changes Relative to the Previous Screening Process F-5

F3.2 Screening Process for WTP Liquid Effluent F-5

F4 Waste Constituents for Monitoring of WTP Liquid Effluent F-17

F5 References F-17

Figures

Figure F-1. Inorganic Constituents In WTP Liquid Effluent F-2

Figure F-2. Organic Constituents In WTP Liquid Effluent F-4

Tables

Table F-1. Dangerous Wastes Identified from Waste Codes in the LERF/ETF Part A Form F-7

Table F-2. Evaluation of Inorganic Waste Constituents in WTP Liquid Effluent F-9

Table F-3. Evaluation of Organic Waste Constituents in WTP Liquid Effluent F-13

Table F-4. Monitoring Constituents Associated with WTP Liquid Effluent F-17

This page intentionally left blank.

Terms

ETF	Effluent Treatment Facility
LERF	Liquid Effluent Retention Facility
K_d	distribution coefficient
WTP	Waste Treatment and Immobilization Plant

This page intentionally left blank.

F1 Introduction

This appendix provides an evaluation of the waste constituents that will be present in the condensate effluent from the Waste Treatment and Immobilization Plant (WTP) (hereinafter referred to as WTP liquid effluent), which will be conveyed to Liquid Effluent Retention Facility (LERF) in the future. The waste constituents were evaluated to determine what constituents should be added to the groundwater monitoring program at LERF.

F2 Identification of Chemical Constituents and Concentrations in WTP Liquid Effluent

The chemical constituents of the WTP liquid effluent were obtained from a certified waste profile sheet for LERF and the Effluent Treatment Facility (ETF). In the waste profile document, the chemical constituents of the effluent were presented in Table 1, WTP EMF Condensate Inorganics, and Table 3, WTP EMF Organic Chemical Constituents (Figures F-1 and F-2).

For inorganics, the concentrations presented in Table 1 of the waste profile sheet (Figure F-1) represent estimated maximum concentrations. For organics, estimated concentrations are presented in Table 3 of the waste profile sheet (Figure F-2). Some constituents in these tables were provided with a concentration of “0” because they are required to be reported per the waste profile; however, such constituents are not part of the effluent and were not evaluated.

The constituents present in the effluent and their concentrations provided in the waste profile sheet were compiled into a Microsoft® Excel® spreadsheet for evaluation. Additional information related to the specified chemicals (i.e., Chemical Abstracts Service numbers, chemical names) were added where appropriate.

F3 Evaluation of Chemical Constituents in WTP Liquid Effluent

This chapter describes the screening process to evaluate the WTP liquid effluent waste constituents to identify applicable groundwater monitoring constituents for LERF. The process is based on the screening performed for LERF basin effluent in the previous engineering evaluation report described in Appendix E of SGW-41072, Rev. 1, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report*. That process was reviewed and changes were made as described in Section F3.1. The modified screening process used for the WTP liquid effluent is described in Section F3.2.

® Microsoft and Excel are registered trademarks of Microsoft Corporation in the United States and other countries.

Table 1 WTP EMF Condensate Inorganics

CAS # (per Table C-1 HNF-3172)	Cations / Anions	Chemical Constituent	Average mg/L[1]	Maximum mg/L	WAC 173-303-090 TCLP Limit mg/L	40 CFR 268.40 Waste Water Treatement Standard mg/L	Waste Code
7440-22-4	Ag+	Silver	1.30E-05	3.68E-05	5.00E+00	4.30E-01	
7429-90-5	Al+3	Aluminum	1.35E-02	2.52E-02		Not Listed	
7440-38-2	As+5	Arsenic	2.77E-03	6.40E-03	5.00E+00	1.40E+00	
	B+3		4.45E-03	7.76E-03		Not Listed	
7440-39-3	Ba+2	Barium	2.76E-06	2.41E-05	1.00E+02	1.20E+00	
7440-41-7	Be+2	Beryllium	7.45E-06	1.09E-05		Not Listed	
	Bi+3		2.80E-04	5.16E-04		Not Listed	
7440-70-2	Ca+2		1.74E-02	3.28E-02		Not Listed	
7440-43-9	Cd+2	Cadmium	3.09E-05	5.62E-05	1.00E+00	6.90E-01	
	Ce+4		3.18E-05	8.18E-05		Not Listed	
	Co+2		2.08E-06	1.81E-05		Not Listed	
7440-47-3	Cr+3	Chromium (Total)	4.68E-05	3.92E-04	5.00E+00	2.77E+00	
7440-47-3	Cr+6	Chromium (Total)	3.76E-04	7.30E-04	5.00E+00	2.77E+00	
	Cs+		0.00E+00	0.00E+00		Not Listed	
7440-50-8	Cu+2	Copper	7.77E-05	2.33E-04		Not Listed	
	Eu+3		0.00E+00	0.00E+00		Not Listed	
7439-89-6	Fe+3	Iron	1.50E-04	2.49E-04		Not Listed	
7439-97-6	Hg+2	Mercury—All Others		4.74E-03	2.00E-01	1.50E-01	
7440-09-7	K+	Potassium	2.24E-02	4.23E-02		Not Listed	
	La+3		9.84E-07	8.86E-06		Not Listed	
	Li+		5.08E-05	1.51E-04		Not Listed	
7439-95-4	Mg+2	Magnesium	1.25E-03	1.57E-03		Not Listed	
7439-96-5	Mn+4	Manganese	6.23E-04	7.59E-04		Not Listed	
	Mo+6		2.49E-04	4.13E-04		Not Listed	
7440-23-5	Na+	Sodium	9.57E+02	1.28E+03		Not Listed	
	Nd+3		3.50E-05	8.83E-05		Not Listed	
7440-02-0	Ni+2	Nickel	4.35E-05	2.99E-04		Not Listed	
7439-92-1	Pb+2	Lead	6.15E-02	1.98E-01	5.00E+00	6.90E-01	
	Pd+2		2.79E-04	1.32E-03		Not Listed	
	Pr+4		0.00E+00	0.00E+00		Not Listed	
	Rb+		1.45E-05	3.89E-05		Not Listed	
	Rh+3		4.51E-07	4.06E-06		Not Listed	
	Ru+4		6.99E-07	2.94E-06		Not Listed	
7440-36-0	Sb+3	Antimony	2.16E-03	6.40E-03		1.90E+00	
7782-49-2	Se+4	Selenium	3.86E-03	1.28E-02	1.00E+00	8.20E-01	
7440-21-3	Si+4	Silicon	8.19E-04	1.45E-03		Not Listed	
	Sr+2		4.91E-07	4.41E-06		Not Listed	
	Ta+5		1.98E-07	1.78E-06		Not Listed	
	Te+4		1.37E-04	5.48E-04		Not Listed	
	Th+4		1.02E-05	9.22E-05		Not Listed	
	Ti+4		1.91E-06	7.29E-06		Not Listed	
	Tl+5		1.60E-04	1.44E-03		Not Listed	

Figure F-1. Inorganic Constituents In WTP Liquid Effluent (1 of 2)

Table 1 WTP EMF Condensate Inorganics

CAS # (per Table C-1 HNF-3172)	Cations / Anions	Chemical Constituent	Average mg/L[1]	Maximum mg/L	WAC 173-303-090 TCLP Limit mg/L	40 CFR 268.40 Waste Water Treatement Standard mg/L	Waste Code
7440-62-2	V+3	Vanadium	5.89E-06	5.26E-05		Not Listed	
	W+6		7.01E-04	3.30E-03		Not Listed	
	Y+3		1.45E-06	5.87E-06		Not Listed	
7440-66-6	Zn+2	Zinc	7.04E-05	1.67E-04		Not Listed	
	Zr+4		1.81E-05	1.63E-04		Not Listed	
	B(OH)4-		3.27E-05	5.74E-05		Not Listed	
	C2O4-2		2.48E-01	3.76E-01		Not Listed	
16887-00-6	Cl-	Chloride	1.94E+00	3.06E+00		Not Listed	
57-12-5	CN-	Cyanide	5.00E-06	2.36E-05		Not Listed	
	CO3-2		1.25E+03	1.67E+03		Not Listed	
16984-48-8	F-	Fluoride	2.48E-02	5.75E-02		Not Listed	
	H2PO4-		0.00E+00	0.00E+00		Not Listed	
	H2SiO4-2		1.58E-02	2.81E-02		Not Listed	
	H3SiO4-		0.00E+00	0.00E+00		Not Listed	
	HPO4-2		0.00E+00	0.00E+00		Not Listed	
	HSO3-		0.00E+00	0.00E+00		Not Listed	
	HSO4-		0.00E+00	0.00E+00		Not Listed	
7664-41-7	NH4+	Ammonia	4.48E+01	6.75E+01		Not Listed	
14797-65-0	NO2-	Nitrite	1.80E-01	2.26E-01		Not Listed	
14797-55-8	NO3-	Nitrate	1.06E+01	1.65E+01		Not Listed	
	O-2		5.19E-02	7.36E-02		Not Listed	
	O2-2		0.00E+00	0.00E+00		Not Listed	
	OH(aq)-		1.90E-01	3.97E-01		Not Listed	
	OH(s)-		1.82E-04	4.74E-04		Not Listed	
14265-44-2	PO4-3	Phosphate	3.42E-02	6.19E-02		Not Listed	
	SO3-2		6.53E-03	2.37E-02		Not Listed	
14808-79-8	SO4-2	Sulfate	1.87E-02	2.89E-02		Not Listed	

[1] EMF Concentrations are from 24590-BOF-M4C-DEP-00002, Rev B Direct Feed LAW Effluent Management Facility Process System (DEP) Condensate Composition Estimate

Figure F-1. Inorganic Constituents In WTP Liquid Effluent (2 of 2)

Table 3 WTP EMF Organic Chemical Constituents

CAS #	Chemical Constituent	Feed, PIC, Feed/PIC, NA[1]	Effluent Concentration (mg/L)	Effluent Concentration (ug/L)[2]	WAC 173-303-090 TCLP Limit mg/L	40 CFR 268.40 Waste Water Treatement Standard mg/L	Exceeds standard Y/N	Waste Code
106-47-8	p-Chloroaniline	NA	0.00E+00	0.00E+00	NA	4.60E-01	NA	
71-43-2	Benzene	NA	0.00E+00	0.00E+00	5.00E-01	1.40E-01	NA	
107-12-0	Propionitrile	Feed	6.07E-04	6.07E-01	NA	2.40E-01	N	
107-13-1	Acrylonitrile	PIC	2.03E-01	2.03E+02	NA	2.40E-01	N	
108-10-1	Methyl isobutyl ketone	NA	0.00E+00	0.00E+00	NA	1.40E-01	NA	F003
108-60-1	Dichloroisopropyl ether	NA	0.00E+00	0.00E+00	NA	Not Listed	NA	
109-99-9	Tetrahydrofuran	NA	0.00E+00	0.00E+00	NA	Not Listed	NA	
110-86-1	Pyridine	NA	0.00E+00	0.00E+00	5.00E+00	1.40E-02	NA	
111-76-2	2-Butoxyethanol	Feed	8.38E-01	8.38E+02	NA	Not Listed	N	
112-39-4	Diphenylamine	NA	0.00E+00	0.00E+00	NA	Not Listed	NA	
117-84-0	Di-n-octylphthalate	NA	0.00E+00	0.00E+00	NA	1.70E-02	NA	
118-74-1	Hexachlorobenzene	NA	0.00E+00	0.00E+00	1.30E-01	5.50E-02	NA	
123-91-1	1,4-Dioxane	Feed	2.15E-04	2.15E-01	NA	1.20E+01	N	
126-73-8	Tributyl phosphate	Feed	8.07E-01	8.07E+02	NA	Not Listed	N	
127-18-4	Tetrachloroethylene	NA	0.00E+00	0.00E+00	7.00E-01	5.60E-02	NA	
1319-77-3	Cresol (m,o,p)	Feed	5.07E+00	5.07E+03	2.00E+02	8.80E-01	Y	F004
1336-36-3	Aroclors (Total PCB)	Feed	6.39E-04	6.39E-01	NA	1.00E-01	N	
218-01-9	Chrysene	NA	0.00E+00	0.00E+00	NA	5.90E-02	NA	
56-23-5	Carbon tetrachloride	NA	0.00E+00	0.00E+00	5.00E-01	5.70E-02	NA	
58-89-9	gamma-BHC (g-Lindane)	NA	0.00E+00	0.00E+00	4.00E-01	1.70E-03	NA	
591-78-6	2-Hexanone	Feed	9.78E-05	9.78E-02	NA	Not Listed	N	
59-89-2	N-Nitrosomorpholine	Feed	5.78E+00	5.78E+03	NA	4.00E-01	Y	
62-75-9	N-Nitroso-N,N-dimethylamine	Feed	1.23E-02	1.23E+01	NA	4.00E-01	N	
67-64-1	2-Propanone (Acetone)	Feed	2.97E-03	2.97E+00	NA	2.80E-01	N	F003
67-66-3	Chloroform	NA	0.00E+00	0.00E+00	6.00E+00	4.60E-02	NA	
71-36-3	n-Butyl alcohol (1-Butanol)	Feed	1.34E-02	1.34E+01	NA	5.60E+00	N	
71-55-6	1,1,1 Trichloroethane	NA	0.00E+00	0.00E+00	NA	5.40E-02	NA	F001
75-05-8	Acetonitrile	PIC	3.21E+01	3.21E+04	NA	5.60E+00	Y	
75-09-2	Dichloromethane (Methylene Chloride)	NA	0.00E+00	0.00E+00	NA	8.90E-02	NA	F002
75-15-0	Carbon disulfide	NA	0.00E+00	0.00E+00	NA	3.80E+00	NA	
77-47-4	Hexachlorocyclopentadiene	NA	0.00E+00	0.00E+00	NA	5.70E-02	NA	
78-59-1	Isophorone	NA	0.00E+00	0.00E+00	NA	Not Listed	NA	
78-93-3	2-Butanone (MEK)	Feed/PIC	1.01E+00	1.01E+03	2.00E+02	2.80E-01	Y	F005
86-74-8	Carbazole	NA	0.00E+00	0.00E+00	NA	Not Listed	NA	
88-06-2	2,4,6-Trichlorophenol	NA	0.00E+00	0.00E+00	2.00E+00	3.50E-02	NA	
98-86-2	Acetophenone	Feed/PIC	9.46E-04	9.46E-01	NA	1.00E-02	N	
	Non-COPC							
71-47-6	Formate	Feed	2.52E+00	2.52E+03	NA	Not Listed	N	
71-50-1	Acetate	Feed	5.94E-01	5.94E+02	NA	Not Listed	N	
Glycolate	Glycolate	Feed	8.96E-01	8.96E+02	NA	Not Listed	N	
Oxolate	Oxalate (C2O4-2)	Feed	3.76E-04	3.76E-01	NA	Not Listed	N	
			Total (ug/L)	4.98E+04				

[1] Items listed as NA are from Table C-1 HNF-3172 and are not in WTP effluent as either a feed or PIC

[2] EMF Concentrations are from 24590-BOF-M4C-DEP-00002, Rev B Direct Feed LAW Effluent Management Facility Process System (DEP) Condensate Composition Estimate

Figure F-2. Organic Constituents In WTP Liquid Effluent

F3.1 Changes Relative to the Previous Screening Process

The screening process used to identify monitoring constituents for LERF in the previous engineering evaluation report (Appendix E in SGW-41072, Rev. 1) was evaluated for use with the WTP liquid effluent. Relative to the previous screening described in Section E1.1 of SGW-41072, Rev. 1, the process to identify monitoring constituents associated with WTP liquid effluent incorporated the following modifications:

- The step that identified detected waste constituents based on effluent sample data was not performed. No sample data are used for the WTP liquid effluent evaluation; therefore, the step is not relevant.
- The assumption regarding the detectability of waste constituents in the LERF basins at downgradient wells (50% dilution of constituent concentration from the source [LERF basins] to point of compliance wells) was removed.
- The qualitative evaluation to exclude constituents already detected in groundwater that originate from another source (regional upgradient constituents) was removed.
- The objective of final status groundwater monitoring is to monitor for releases of dangerous wastes from a regulated unit. However, not every chemical identified in the waste profile sheet is a dangerous waste. Therefore, an evaluation to determine which waste constituents are dangerous wastes was performed by comparing the WTP liquid effluent waste constituents to the following:
  - Waste codes provided in the Part A Form for LERF and the ETF (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology).
  - Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & 100.*

F3.2 Screening Process for WTP Liquid Effluent

The first steps of the screening process for WTP liquid effluent waste constituents are the same as performed for the waste constituents in the LERF basin effluents in the previous engineering evaluation report (Section E1.1 in SGW-41072, Rev. 1) and comprise the following:

- Constituents were first evaluated by comparing their expected maximum (inorganics) or estimated (organics) concentrations in the WTP liquid effluent to federal and state action levels for groundwater. The action levels were obtained from Table 1 and Table 5 in ECF-HANFORD-12-0023, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological and Radiological Analytes in the 100 Areas and 300 Area*. Constituents above their respective action levels were further evaluated for use in detection monitoring.
- The constituents were then evaluated based on distribution coefficient (K_d). A K_d of less than or equal to 0.8 mL/g was used in the previous evaluation as an indicator for mobility (Section E1.1 in SGW-41072, Rev. 1). The K_d values used in the evaluation were obtained from Table 5 in ECF-HANFORD-12-0023. The constituents with a K_d less than or equal to 0.8 mL/g were further evaluated for use in detection monitoring.

The K_d values used for the evaluation were corrected for the estimated gravel content in the vadose zone at LERF. Laboratory determinations of K_d typically use the <2 mm particle size fraction of the sediment. However, for materials that contain significant amounts of gravel, K_d values will be lower than those determined using the <2 mm particle size material because the surface area and corresponding quantity of adsorption sites is much lower (Section 2.4 of PNNL-17154, *Geochemical Characterization Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site*). For sediments with high gravel content, PNNL-17154 provided the following equation (Equation 1) for gravel correction of K_d values (Equation 2.4 in PNNL-17154):

$$K_d(gc) = (1-f)*K_d(<2\text{ mm}) \qquad \textbf{(Eq. 1)}$$

where:

$K_d(gc)$	=	gravel-corrected K_d value
f	=	% of gravel
$K_d(<2\text{ mm})$	=	K_d value determined using <2 mm particle size material

Section 3.1 of SGW-41072 provides the stratigraphy of the vadose zone beneath LERF, which is predominantly the Hanford formation gravel-dominated sequences Hf1 (upper gravel-dominated facies) and Hf3 (lower gravel-dominated facies) (Figures 3-2 and 3-3 of SGW-41072). According to Table 12 in ECF-HANFORD-19-0121, *Selection of Vadose Zone Flow and Transport Properties with Gravel Fraction Corrections for the Hanford Site Composite Analysis and Cumulative Impact Evaluation*, these stratigraphic units have an average gravel content of 66% (average gravel weight percent). Using Equation 1 to correct for gravel content at LERF, K_d values are multiplied by 1-0.66 or 0.34 to determine the gravel-corrected Kd values.

Additional screening information was compiled for the waste constituents as follows:

- Constituents that are dangerous wastes were identified by comparing to the (1) dangerous wastes identified from the LERF/ETF Part A Form (Table F-1) and (2) Appendix 5 of Ecology Publication 97-407. WTP liquid effluent waste constituents that are not identified in either the Part A Form or Appendix 5 are not included as monitoring constituents.
- The analytical availability of constituents at commercial laboratories was evaluated. It is necessary to have a backup laboratory available for monitoring constituents required in the Hanford Facility RCRA Permit; therefore, constituents that are available for analysis at only one commercial laboratory (or at no commercial laboratory) are not included as monitoring constituents.

Constituents that met the following criteria are identified as WTP liquid effluent monitoring constituents for LERF (Tables F-2 and F-3):

- Concentration in the WTP liquid effluent above the action level
- K_d at or less than 0.8 mL/g
- Identified from the LERF/ETF Part A Form waste codes or in Appendix 5 of Ecology Publication 97-407
- Available for analysis at commercial laboratories

Table F-1. Dangerous Wastes Identified from Waste Codes in the LERF/ETF Part A Form

Dangerous Waste Code	Waste Constituent	CAS Number
D004	Arsenic	7440-38-2
D005	Barium	7440-39-3
D006	Cadmium	7440-43-9
D007	Chromium	7440-47-3
D008	Lead	7439-92-1
D009	Mercury	7439-97-6
D010	Selenium	7782-49-2
D011	Silver	7440-22-4
D018	Benzene	71-43-2
D019	Carbon tetrachloride	56-23-5
D022	Chloroform	67-66-3
D028	1,2-Dichloroethane	107-06-2
D029	1,1-Dichloroethylene	75-35-4
D030	2,4-Dinitrotoluene	121-14-2
D033	Hexachlorobutadiene	87-68-3
D034	Hexachloroethane	67-72-1
D035	Methyl ethyl ketone	78-93-3
D036	Nitrobenzene	98-95-3
D038	Pyridine	110-86-1
D039	Tetrachloroethylene	127-18-4
D040	Trichloroethylene	79-01-6
D041	2,4,5-Trichlorophenol	95-95-4
D043	Vinyl chloride	75-01-4
F001	1,1,1-Trichloroethane	71-55-6
F001	Methylene chloride	75-09-2
F001	Carbon tetrachloride	56-23-5
F001	Tetrachloroethylene	127-18-4
F001	Trichloroethylene	79-01-6
F002	1,1,1-Trichloroethane	71-55-6
F002	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1
F002	1,1,2-Trichloroethane	79-00-5
F002	Chlorobenzene	108-90-7
F002	Methylene chloride	75-09-2
F002	ortho-Dichlorobenzene	95-50-1

Table F-1. Dangerous Wastes Identified from Waste Codes in the LERF/ETF Part A Form

Dangerous Waste Code	Waste Constituent	CAS Number
F002	Trichlorofluoromethane	75-69-4
F002	Tetrachloroethylene	127-18-4
F002	Trichloroethylene	79-01-6
F003	Acetone	67-64-1
F003	Cyclohexanone	108-94-1
F003	Ethyl acetate	141-78-6
F003	Ethyl benzene	100-41-4
F003	Ethyl ether	60-29-7
F003	Methyl isobutyl ketone	108-10-1
F003	Methanol	67-56-1
F003	n-Butyl alcohol	71-36-3
F003	Xylene	1330-20-7
F004	Cresols	1319-77-3
F004	Cresylic acid	93-51-6
F004	Nitrobenzene	98-95-3
F005	2-Ethoxyethanol	110-80-5
F005	2-Nitropropane	79-46-9
F005	Benzene	71-43-2
F005	Carbon disulfide	75-15-0
F005	Isobutanol	78-83-1
F005	Methyl ethyl ketone	78-93-3
F005	Pyridine	110-86-1
F005	Toluene	108-88-3
U210	Tetrachloroethylene	127-18-4

Notes: Complete reference citations are provided in Chapter F5.

The LERF/ETF Part A dangerous waste codes were obtained from WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology.

The specific dangerous wastes associated with "F"-code wastes were obtained from WAC 173-303-9904, "Dangerous Waste Regulations," "Dangerous Waste Sources List."

This table identifies specific dangerous wastes identified from the waste codes included in the LERF/ETF Part A Form. Characteristic wastes (D001, D002, and D003) and state-only wastes (WP01, WP02, WT01, and WT02) (waste codes assigned based on waste designation) are included in the LERF/ETF Part A Form but are not identified in this table.

CAS = Chemical Abstracts Service

ETF = Effluent Treatment Facility

LERF = Liquid Effluent Treatment Facility

Table F-2. Evaluation of Inorganic Waste Constituents in WTP Liquid Effluent

CAS Number	Cations	Chemical Constituent	Average (mg/L)	Maximum (mg/L)	Maximum (µg/L)	Comment	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d (mL/g)	Source[a]	Gravel Corrected K_d (mL/g)[b]	Under K_d Limit (0.8 mL/g)?	Identified from Part A?	Identified in Appendix 5?	Analysis Available?	Proposed Monitoring Constituent?
7429-90-5	Al+3	Aluminum	0.0135	0.0252	25.2		16000	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	1500	EPA	510	No	No	No	Yes	No
7440-36-0	Sb+3	Antimony	0.00216	0.00640	6.40		6.0	40 CFR 141 - Federal MCL	Yes	45	CLARC	15	No	No	Yes	Yes	No
7440-38-2	As+5	Arsenic	0.00277	0.0064	6.40		10[c]	40 CFR 141 - Federal MCL	No	29	CLARC	9.9	No	Yes	Yes	Yes	No
7440-39-3	Ba+2	Barium	0.00000276	0.0000241	0.0241		2000	40 CFR 141 - Federal MCL	No	41	CLARC	14	No	Yes	Yes	Yes	No
7440-41-7	Be+2	Beryllium	0.00000745	0.0000109	0.0109		4.0	40 CFR 141 - Federal MCL	No	790	CLARC	269	No	No	Yes	Yes	No
7440-69-9	Bi+3	Bismuth	0.000280	0.000516	0.516		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
7440-42-8	B+3	Boron	0.00445	0.00776	7.76		3200	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	3.0	EPA	1	No	No	No	Yes	No
7440-43-9	Cd+2	Cadmium	0.0000309	0.0000562	0.0562		5.0	40 CFR 141 - Federal MCL	No	6.7	CLARC	2.3	No	Yes	Yes	Yes	No
7440-70-2	Ca+2	Calcium	0.0174	0.0328	32.8		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
7440-45-1	Ce+4	Cerium	0.0000318	0.0000818	0.0818		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
7440-46-2	Cs+	Cesium	0	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7440-47-3	Cr+6	Chromium (total)[d]	0.000376	0.000730	0.730		48	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	NVR	N/A	N/A	No	Yes (as chromium)	Yes (as chromium)	Yes	No
7440-47-3	Cr+3	Chromium (total)[e]	0.0000468	0.000392	0.392		100	40 CFR 141 - Federal MCL	No	1000	CLARC	340	No	Yes (as chromium)	Yes (as chromium)	No	No
7440-48-4	Co+2	Cobalt	0.00000208	0.0000181	0.0181		4.8	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	45	EPA	15	No	No	Yes	Yes	No
7440-50-8	Cu+2	Copper	0.0000777	0.000233	0.233		640	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	22	CLARC	7.5	No	No	Yes	Yes	No
7440-53-1	Eu+3	Europium	0	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7439-89-6	Fe+3	Iron	0.000150	0.000249	0.249		11200	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	25	EPA	8.5	No	No	No	Yes	No
7439-91-0	La+3	Lanthanum	0.000000984	0.00000886	0.00886		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
7439-92-1	Pb+2	Lead	0.0615	0.198	198		15.0	40 CFR 141 - Federal MCL	Yes	10000	CLARC	3400	No	Yes	Yes	Yes	No

Table F-2. Evaluation of Inorganic Waste Constituents in WTP Liquid Effluent

CAS Number	Cations	Chemical Constituent	Average (mg/L)	Maximum (mg/L)	Maximum (µg/L)	Comment	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d (mL/g)	Source[a]	Gravel Corrected K_d (mL/g)[b]	Under K_d Limit (0.8 mL/g)?	Identified from Part A?	Identified in Appendix 5?	Analysis Available?	Proposed Monitoring Constituent?
7439-93-2	Li+	Lithium	0.0000508	0.000151	0.151		32	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	300	EPA	102	No	No	No	Yes	No
7439-95-4	Mg+2	Magnesium	0.00125	0.00157	1.569		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
7439-96-5	Mn+4	Manganese	0.000623	0.000759	0.759		384	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	65	EPA	22	No	No	No	Yes	No
7439-97-6	Hg+2	Mercury—all others	Not provided	0.00474	4.74		2.0	40 CFR 141 - Federal MCL	Yes	52	CLARC	18	No	Yes	Yes	Yes	No
7439-98-7	Mo+6	Molybdenum	0.000249	0.000413	0.413		80	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	20	EPA	6.8	No	No	No	Yes	No
7440-00-8	Nd+3	Neodymium	0.0000350	0.0000883	0.0883		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
7440-02-0	Ni+2	Nickel	0.0000435	0.000299	0.299		100	WAC 246-290-310	No	65	CLARC	22	No	No	Yes	Yes	No
7440-05-3	Pd+2	Palladium	0.000279	0.00132	1.32		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
7440-09-7	K+	Potassium	0.0224	0.0423	42.3		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
7440-10-0	Pr+4	Praseodymium	0	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7440-16-6	Rh+3	Rhodium	0.000000451	0.00000406	0.00406		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
7440-17-7	Rb+	Rubidium	0.0000145	0.0000389	0.0389		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
7440-18-8	Ru+4	Ruthenium	0.00000070	0.00000294	0.00294		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
7782-49-2	Se+4	Selenium	0.00386	0.0128	12.8		50	40 CFR 141 - Federal MCL	No	5.0	CLARC	1.7	No	Yes	Yes	Yes	No
7440-21-3	Si+4	Silicon	0.000819	0.00145	1.45		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
7440-22-4	Ag+	Silver	0.0000130	0.0000368	0.0368		80	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	8.3	CLARC	2.8	No	Yes	Yes	Yes	No
7440-23-5	Na+	Sodium	957	1283	1283455		--	N/A	No	100	EPA	34	No	No	No	Yes	No
7440-24-6	Sr+2	Strontium	0.000000491	0.00000441	0.00441		9600	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	35	EPA	12	No	No	No	Yes	No
7440-25-7	Ta+5	Tantalum	0.000000198	0.00000178	0.00178		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
13494-80-9	Te+4	Tellurium	0.000137	0.000548	0.548		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
7440-28-0	Tl+5	Thallium	0.000160	0.00144	1.44		0.50	40 CFR 141 - Federal MCL	Yes	71	CLARC	24	No	No	Yes	Yes	No
7440-29-1	Th+4	Thorium	0.0000102	0.0000922	0.092		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
7440-32-6	Ti+4	Titanium	0.00000191	0.0000073	0.00729		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
7440-33-7	W+6	Tungsten	0.000701	0.00330	3.30		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No

Table F-2. Evaluation of Inorganic Waste Constituents in WTP Liquid Effluent

CAS Number	Cations	Chemical Constituent	Average (mg/L)	Maximum (mg/L)	Maximum (µg/L)	Comment	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d (mL/g)	Source[a]	Gravel Corrected K_d (mL/g)[b]	Under K_d Limit (0.8 mL/g)?	Identified from Part A?	Identified in Appendix 5?	Analysis Available?	Proposed Monitoring Constituent?
7440-62-2	V+3	Vanadium	0.00000589	0.0000526	0.0526		80	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	1000	CLARC	340	No	No	Yes	Yes	No
7440-65-5	Y+3	Yttrium	0.00000145	0.00000587	0.00587		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
7440-66-6	Zn+2	Zinc	0.0000704	0.000167	0.167		4800	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	62	CLARC	21	No	No	Yes	Yes	No
7440-67-7	Zr+4	Zirconium	0.0000181	0.000163	0.163		1.3	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	3000	EPA	1020	No	No	No	Yes	No
14798-03-9	NH4+	Ammonium	44.8	67.5	67483		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes, as ammonia	No
3812-32-6	CO3-2	Carbonate	1245	1672	1672055		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
16887-00-6	Cl-	Chloride	1.94	3.06	3063		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
57-12-5	CN-	Cyanide	0.00000500	0.0000236	0.0236		4.8 (free) 200 (total)	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	9.9	EPA	3.4	No	No	No	Yes	No
16984-48-8	F-	Fluoride	0.0248	0.0575	57.5		960	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	150	EPA	51	No	No	No	Yes	No
14066-20-7	H2PO4-	Dihydrogen phosphate	0	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	HPO4-2	Hydrogen phosphate	0	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14280-30-9	OH(aq)-	Hydroxide	0.190	0.397	397		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
14280-30-9	OH(s)-	Hydroxide	0.000182	0.000474	0.474		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
14797-55-8	NO3-	Nitrate	10.6	16.5	16499		45000	40 CFR 141 - Federal MCL	No	NVR	N/A	N/A	No	No	No	Yes	No
14797-65-0	NO2-	Nitrite	0.180	0.226	226		3300	40 CFR 141 - Federal MCL	No	NVR	N/A	N/A	No	No	No	Yes	No
10193-36-9	H2SiO4-2	Orthosilicic acid	0.0158	0.0281	28.1		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
338-70-5	C2O4-2	Oxalate	0.248	0.376	376		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
N/A	O2-2	Peroxide	0	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14265-44-2	PO4-3	Phosphate	0.0342	0.0619	61.9		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
14808-79-8	SO4-2	Sulfate	0.0187	0.0289	28.9		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
14265-45-3	SO3-2	Sulfite	0.00653	0.0237	23.7		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No

Table F-2. Evaluation of Inorganic Waste Constituents in WTP Liquid Effluent

CAS Number	Cations	Chemical Constituent	Average (mg/L)	Maximum (mg/L)	Maximum (µg/L)	Comment	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d (mL/g)	Source[a]	Gravel Corrected K_d (mL/g)[b]	Under K_d Limit (0.8 mL/g)?	Identified from Part A?	Identified in Appendix 5?	Analysis Available?	Proposed Monitoring Constituent?
7664-93-9	HSO4-	Sulfuric acid	0	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7782-99-2	HSO3-	Sulfurous acid	0	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15390-83-7	B(OH)4-	Tetrahydroxyborate	0.0000327	0.0000574	0.0574		--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
N/A	H3SiO4-	Trihydrogen orthosilicate	0	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7782-44-7	O-2	Oxygen	0.0519	0.0736	73.6		--	N/A	No	NVR	N/A	N/A	No	No	No	Yes, as dissolved oxygen - field measurement	No

Notes: Complete reference citations are provided in Chapter F5.

The source of CAS numbers, cations/anions, chemical constituents, and chemical concentrations in this table is the waste profile sheet for the WTP liquid effluent (referred to as WTP EMF Condensate Inorganics in Figure F-1). Not all CAS numbers and chemical constituents entries were provided in the waste profile sheet (Figure F-1). CAS numbers and chemical constituent names were added as appropriate in this table to complete the information.

The values presented for Action Level, Action Level Basis, K_d, and K_d Source were obtained from Tables 1 and 5 in ECF-HANFORD-12-0023, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological and Radiological Analytes in the 100 Areas and 300 Area*.

The LERF/ETF Part A Form used for this evaluation is WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology.

Appendix 5 constituents are available in Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & 100*.

a. As presented in ECF-HANFORD-12-0023, EPA refers to EPA, 2017, "Regional Screening Levels for Chemical Contaminants at Superfund Sites," and CLARC refers to Ecology, 2015, Cleanup Levels and Risk Calculations (CLARC) database. The 2020 revision of CLARC was reviewed to confirm the values presented in this table.

b. K_d values used for the evaluation were corrected for the estimated gravel content at LERF as described in Section F3.2.

c. The federal MCL was selected as the groundwater action level for arsenic because the Method B groundwater cleanup level is less than the Hanford Site 90th percentile background value of 7.85 µg/L, as presented in Table 1 in ECF-HANFORD-12-0023.

d. Identified as "Chromium (Total)" and "Cr+6" in Figure F-1; evaluated as hexavalent chromium.

e. Identified as "Chromium (Total)" and "Cr+3" in Figure F-1; evaluated as chromium (total).

-- = no action level available
CAS = Chemical Abstracts Service
ETF = Effluent Treatment Facility
K_d = distribution coefficient
LERF = Liquid Effluent Treatment Facility
MCL = maximum contaminant level
N/A = not applicable
NVR = no value reported
WTP = Waste Treatment and Immobilization Plant

Table F-3. Evaluation of Organic Waste Constituents in WTP Liquid Effluent

CAS Number	Chemical Constituent	Effluent Concentration (mg/L)	Effluent Concentration (µg/L)	Comment	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d	Source[a]	Gravel Corrected K_d (mL/g)[b]	Under K_d Limit (0.8 mL/g)?	Identified from Part A?	Identified in Appendix 5?	Analysis Available?	Proposed Monitoring Constituent?
71-55-6	1,1,1-Trichloroethane	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
123-91-1	1,4-Dioxane	0.000215	0.215		0.44	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	0.0026	EPA	0.00088	Yes	No	Yes	Yes	No
88-06-2	2,4,6-Trichlorophenol	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
78-93-3	2-Butanone (MEK)	1.01	1010		4800	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	0.0045	EPA	0.0015	Yes	Yes	Yes	Yes	No
111-76-2	2-Butoxyethanol	0.838	838		800	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.0028	EPA	0.00095	Yes	No	No	No	No
591-78-6	2-Hexanone (Methyl butyl ketone [MBK])	0.0000978	0.0978		40	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	0.015	EPA	0.0051	Yes	No	Yes	Yes	No
67-64-1	2-Propanone (Acetone)	0.00297	2.97		7200	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	0.000575	CLARC	0.000196	Yes	Yes	Yes	Yes	No
75-05-8	Acetonitrile (Methyl cyanide)	32.1	32100		--	N/A	No	0.0047	EPA	0.0016	Yes	No	Yes	Yes	No
98-86-2	Acetophenone	0.000946	0.946		800	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	0.052	EPA	0.018	Yes	No	Yes	Yes	No
107-13-1	Acrylonitrile	0.203	203		0.081	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.0085	EPA	0.0029	Yes	No	Yes	Yes	Yes
1336-36-3	Aroclors (Total PCB)[b]	0.000639	0.639		0.044	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	309	CLARC	105	No	No	Yes (as isomers)	Yes (as isomers)	No
71-43-2	Benzene	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
86-74-8	Carbazole	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
75-15-0	Carbon disulfide	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
56-23-5	Carbon tetrachloride	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
67-66-3	Chloroform	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
218-01-9	Chrysene	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1319-77-3	Cresol (m-, o-, p-) (Total cresols)	5.07	5070	Replaced cresol isomers in revised sheet	1600	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.31	EPA	0.11	Yes	Yes	Yes	Yes	Yes
108-60-1	Dichloroisopropyl ether; Bis(2-chloro-1-methylethyl)ether (2,2'-Oxybis[1-chloropropane])	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table F-3. Evaluation of Organic Waste Constituents in WTP Liquid Effluent

CAS Number	Chemical Constituent	Effluent Concentration (mg/L)	Effluent Concentration (µg/L)	Comment	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d	Source[a]	Gravel Corrected K_d (mL/g)[b]	Under K_d Limit (0.8 mL/g)?	Identified from Part A?	Identified in Appendix 5?	Analysis Available?	Proposed Monitoring Constituent?
75-09-2	Dichloromethane (Methylene chloride)	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
117-84-0	Di-n-octylphthalate	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
112-39-4	Diphenylamine	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
58-89-9	gamma-BHC (g-Lindane)	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
118-74-1	Hexachlorobenzene	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
77-47-4	Hexachlorocyclopenta-diene	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
78-59-1	Isophorone	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
108-10-1	Methyl isobutyl ketone (4-Methyl-2-pentanone)	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
71-36-3	n-Butyl alcohol (1-Butanol)	0.0134	13.4		800	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	0.0069	CLARC	0.0023	Yes	Yes	No	Yes	No
59-89-2	n-Nitrosomorpholine	5.78	5780		0.013	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.023	EPA	0.0078	Yes	No	Yes	Yes	Yes
62-75-9	n-Nitroso-n,n-dimethylamine (n-Nitrosodimethylamine)	0.0123	12.3		0.00086	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.023	EPA	0.0078	Yes	No	Yes	Yes	Yes
106-47-8	p-Chloroaniline (4-Chloroaniline)	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
107-12-0	Propionitrile	0.000607	0.607		--	N/A	No	NVR	N/A	N/A	N/A	No	Yes	Yes	No
110-86-1	Pyridine	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
127-18-4	Tetrachloroethylene	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
109-99-9	Tetrahydrofuran	0	0	Not part of effluent - not further evaluated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
126-73-8	Tributyl phosphate	0.807	807		9.7	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	2.35	EPA	0.799	Yes	No	No	Yes	No
Non-Contaminant of Potential Concern															
71-47-6	Formate	2.52	2520		N/A	N/A	N/A	--	N/A	N/A	N/A	No	No	No	No
71-50-1	Acetate	0.594	594		N/A	N/A	N/A	--	N/A	N/A	N/A	No	No	No	No
666-14-8	Glycolate	0.896	896		N/A	N/A	N/A	--	N/A	N/A	N/A	No	No	No	No
Oxolate	Oxalate (C2O4-2)	0.000376	0.376		N/A	N/A	N/A	--	N/A	N/A	N/A	No	No	No	No

Table F-3. Evaluation of Organic Waste Constituents in WTP Liquid Effluent

CAS Number	Chemical Constituent	Effluent Concentration (mg/L)	Effluent Concentration (µg/L)	Comment	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d	Source[a]	Gravel Corrected K_d (mL/g)[b]	Under K_d Limit (0.8 mL/g)?	Identified from Part A?	Identified in Appendix 5?	Analysis Available?	Proposed Monitoring Constituent?

Notes: Complete reference citations are provided in Chapter F5.

The source of CAS numbers, chemical constituents, and chemical concentrations in this table is the waste profile sheet for the WTP liquid effluent (referred to as WTP EMF Organic Chemical Constituents in Figure F-2). Not all CAS number entries were provided in the waste profile sheet (Figure F-2). Where needed, CAS numbers and additional information on the chemical constituent names were added as appropriate in this table to complete the information.

The values presented for Action Level, Action Level Basis, K_d, and K_d Source were obtained from Tables 1 and 5 in ECF-HANFORD-12-0023, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological and Radiological Analytes in the 100 Areas and 300 Area.*

The LERF/ETF Part A used for this evaluation is WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste,* Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology.

Appendix 5 constituents are available in Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & 100.*

a. As presented in ECF-HANFORD-12-0023, EPA refers to EPA, 2017, "Regional Screening Levels for Chemical Contaminants at Superfund Sites," and CLARC refers to Ecology, 2015, Cleanup Levels and Risk Calculations (CLARC) database. The 2020 revision of CLARC was reviewed to confirm the values presented in this table.

b. K_d values used for the evaluation were corrected for the estimated gravel content at LERF as described in Section F3.2.

c. The action level and distribution coefficient reported for "Aroclors (Total PCB)" used the valued for "TOTALPCB" in ECF-HANFORD-12-00123. The identified PQL is the lowest PQL amongst the individual Aroclors-1016, -1221, -1232, -1242, -1248, -1254, and -1260.

-- = no action value available
CAS = Chemical Abstracts Service
CLARC = Cleanup Levels and Risk Calculation
EPA = U.S. Environmental Protection Agency
ETF = Effluent Treatment Facility
K_d = distribution coefficient
LERF = Liquid Effluent Treatment Facility
N/A = not applicable
NVR = no value reported
PQL = practical quantitation limit
WTP = Waste Treatment and Immobilization Plant

This page intentionally left blank.

F4 Waste Constituents for Monitoring of WTP Liquid Effluent

Based on the evaluation of the chemical constituents identified in the WTP liquid effluent, the waste constituents in Table F-4 are identified for groundwater monitoring at LERF due to the WTP liquid effluent waste stream.

Table F-4. Monitoring Constituents Associated with WTP Liquid Effluent

Waste Constituent	CAS Number
2-Methylphenol (o-Cresol)[a]	95-48-7
4-Methylphenol + 3-methylphenol (m- + p-Cresol)[a]	65794-96-9
Acrylonitrile	107-13-1
n-Nitrosodimethylamine[b] (n-Nitroso-n,n-dimethylamine)	62-75-9
n-Nitrosomorpholine	59-89-2

a. Total cresols was identified as a monitoring constituent for the WTP liquid effluent. Monitoring for total cresols will be performed using the isomers of cresol.

b. n-Nitrosodimethylamine (CAS 62-75-9) is included as a monitoring constituent under the current LERF final status groundwater monitoring plan.

CAS = Chemical Abstracts Service

WTP = Waste Treatment and Immobilization Plant

F5 References

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr141_main_02.tpl.

ECF-HANFORD-12-0023, 2018, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological and Radiological Analytes in the 100 Areas and 300 Area*, Rev. 4, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0065283H.

ECF-HANFORD-19-0121, 2020, *Selection of Vadose Zone Flow and Transport Properties with Gravel Fraction Corrections for the Hanford Site Composite Analysis and Cumulative Impact Evaluation*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://www.osti.gov/biblio/1605425.

EPA, 2017, "Regional Screening Levels for Chemical Contaminants at Superfund Sites," June 2017, U.S. Environmental Protection Agency. Available at: https://www.epa.gov/risk/regional-screening-levels-rsls.

Ecology, 2020, Cleanup Levels and Risk Calculations (CLARC) database, Washington State Department of Ecology, Olympia, Washington. Available at: https://fortress.wa.gov/ecy/clarc/.

Ecology Publication No. 97-407, 2014, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*, Hazardous Waste and Toxics Reduction Program, Washington State Department of Ecology, Olympia, Washington. Available at: https://fortress.wa.gov/ecy/publications/publications/97407.pdf.

PNNL-17154, 2008, *Geochemical Characterization Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://pdw.hanford.gov/document/0911240119.

SGW-41702, 2017, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report*, Rev. 1 CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0068831H.

WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Washington State Department of Ecology. Available at: https://fortress.wa.gov/ecy/nwp/permitting/hdwp/rev/8c/.

WAC 173-303-9904, "Dangerous Waste Regulations," "Dangerous Waste Sources List," *Washington Administrative Code*, Olympia, Washington. Available at: https://apps.leg.wa.gov/WAC/default.aspx?cite=173-303.

WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-720.

WAC 246-290-310, "Group A Public Water Supplies," "Maximum Contaminant Levels (MCLs) and Maximum Residual Disinfectant Levels (MRDLs)," *Washington Administrative Code*, Olympia, Washington. Available at: https://apps.leg.wa.gov/WAC/default.aspx?cite=246-290.

Appendix G

Updated Inventory Screening for the Liquid Effluent Retention Facility Basins, 2016 to 2019

This page intentionally left blank

Contents

G1 Introduction G-1

G2 Previous Liquid Effluent Retention Facility Inventory Evaluation G-1

G3 Update to Liquid Effluent Rentention Facility Inventory Evaluation G-2

G3.1 Composition of Waste Inventory G-2

G3.2 Evaluation Process for Waste Constituents G-3

G3.3 Evaluation Results G-5

G4 Waste Constituents for Groundwater Monitoring G-15

G5 References G-15

Tables

Table G-1. Evaluation of Constituents Detected in Previous LERF Inventory Versus Calendar Year 2016 to 2019 Dataset G-7

Table G-2. Evaluation of Newly Detected Constituents in Calendar Year 2016 to 2019 LERF Dataset G-11

Table G-3. Evaluation of Detected Constituent Concentrations in LERF Inventory G-13

Table G-4. Proposed Constituents for Detection Monitoring at LERF Based on Evaluation of Calendar Year 2016 Through 2019 Effluent G-15

This page intentionally left blank.

Terms

CY	calendar year
ETF	Effluent Treatment Facility
K_d	distribution coefficient
LERF	Liquid Effluent Retention Facility
PQL	practical quantitation limit
WTP	Waste Treatment and Immobilization Plant

This page intentionally left blank.

G1 Introduction

This appendix provides an update to the previous evaluation of the Liquid Effluent Retention Facility (LERF) waste inventory to assess if additional groundwater monitoring constituents should be included for detection monitoring.

The waste inventory for LERF is determined from sample data associated with effluent that has been received at the basins and characterization samples of waste effluent in the basins. The previous report evaluated such data as recent as 2016 (Appendix E in SGW-41072, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report*, Rev. 1).

This revision of the engineering evaluation report for LERF (Rev. 2) was prepared to support the planned completion and operation of a fourth basin at the facility (Basin 41) and future receipt of a new waste effluent from the Waste Treatment and Immobilization Plant (WTP) (hereinafter referred to as WTP liquid effluent). Evaluation of the waste constituents in the WTP liquid effluent for groundwater monitoring is provided in Appendix F of this document (Rev. 2).

To support this revision (Rev. 2), sample data of waste effluent received at LERF and associated characterization samples for calendar years (CY) 2016 through 2019 were screened to determine if additional constituents should be included for detection monitoring. This appendix provides the screening process and outcome.

G2 Previous Liquid Effluent Retention Facility Inventory Evaluation

In SGW-41072, Rev. 1, the waste inventory for LERF was evaluated to identify constituents for detection monitoring. The inventory comprised sample data from the various effluents that had been accepted in the LERF basins and characterization samples associated with the combined effluent in the basins as recently as 2016 (Appendix E in SGW-41072, Rev. 1).

As part of this Rev. 2 update, the inventory evaluation process used for Rev. 1 was reviewed and modifications were made. Appendix E of this document (Rev. 2) presents the previous waste inventory evaluation, with these modifications. As detailed in Section E1.1 of this document, the evaluation process in Rev. 2 was modified from that in Rev. 1 as follows:

- Removed the assumption regarding the detectability of waste constituents in the LERF basins at downgradient wells (50% dilution of constituent concentration from the source [LERF basins] to point of compliance wells)
- Added an evaluation to determine which of the proposed monitoring constituents are dangerous wastes
- Removed the qualitative evaluation to exclude constituents already detected in groundwater that originate from another source (regional upgradient constituents)

As a result of the modified process, additional monitoring constituents were identified for LERF (Section E1.2 and Table E-5 of Appendix E).

The update to the LERF inventory to assess the effluent accepted at LERF in CYs 2016 through 2019 detailed in this appendix incorporates these modifications of the evaluation process to identify if additional constituents are needed for the detection monitoring program.

G3 Update to Liquid Effluent Retention Facility Inventory Evaluation

For this Rev. 2 update, the analytical data for effluent wastes that were received into the LERF basins and effluent that was sent from LERF to the 200 Area Effluent Treatment Facility (ETF) in CYs 2016 through 2019 were evaluated for the following:

- Identify any waste constituents that are detected in the CYs 2016 through 2019 dataset but were not detected in the previous inventory evaluation (Appendix E).
- Determine if any of the detected waste constituents from the previous inventory evaluation (Appendix E, which includes effluent data as recent as 2016) have a maximum concentration in the CYs 2016 through 2019 dataset that is greater than the previous maximum concentration and would trigger additional screening. The maximum concentrations from the previous evaluation are presented in Table E-1 of this document.

Waste constituents that were detected in the CY2016 through CY2019 dataset that were not detected in the previous evaluation (hereinafter referred to as newly-detected constituents), plus the waste constituents that were detected at higher maximum concentrations in the CY2016 through CY2019 dataset in comparison to the previous evaluation, were then evaluated to determine if any constituents should be added for detection monitoring at LERF.

G3.1 Composition of Waste Inventory

Sample results for waste effluent that was received into LERF basins and effluent transferred from LERF basins to ETF in CYs 2016 through 2019 were obtained from facility engineering staff in a Microsoft® Excel® workbook. The sample data from this workbook is contained in electronic files to accompany this report.

Non-radiological sample results of the following are included in the inventory:

1. Effluent within the LERF basins upon transfer to ETF
    a. Basin 42 and 44, sampled at ETF in 2019
    b. Basin 43, sampled at ETF 2017 and 2018
2. Effluent wastes accepted at LERF
    a. 242-A process condensate, 2016 through 2019
    b. Mixed waste trench leachate from Trenches 31 and 34, 2016 through 2019
    c. AZ-301 catch tank condensate, 2016 through 2019
    d. 325 RPS Tanks, 2018
    e. Solid Waste Landfill lysimeter leachate, 2017 through 2019
    f. Modu tank annual purgewater sampling, 2017
    g. WESF tank 100 wastewater, 2018 and 2019
    h. 3420 sump wastewater, 2017
    i. C Farm raw water, 2016 - 2017
3. Basin cover water: Basin 42, 43, and 44 cover water, 2016 through 2019

® Microsoft and Excel are registered trademarks of Microsoft Corporation in the United States and other countries.

Sample data from sources above were screened to identify any additional monitoring constituents for LERF using the process described in Section G3.2.

G3.2 Evaluation Process for Waste Constituents

The screening process in this appendix is applied to the waste constituents in the CY2016 through CY2019 effluent data and is based on the process used in the previous LERF inventory evaluation (Appendix E) and the new WTP liquid effluent waste stream evaluation (Appendix F) and includes the following steps:

1. The waste constituents included in the previous LERF inventory screening and their maximum concentrations (Table E-1) were compiled. These waste constituents are rescreened in step 4 using results from the CY2016 through CY2019 dataset as available.

2. The CY2016 through CY2019 effluent dataset was screened to identify nondetected and rejected data. Results with a "U" laboratory qualifier (nondetected) or an "R" review qualifier (rejected results) were not considered in the screening.

3. The remaining results in the CY2016 through CY2019 dataset were evaluated to determine the maximum concentration for each waste constituent and if the maximum concentration represents a detection. A constituent is considered "detected" when its concentration exceeds its respective practical quantitation limit (PQL) (obtained from ECF-HANFORD-18-0058, *Practical Quantitation Limits for Groundwater Environmental Samples*).

4. The resulting detected constituents and their corresponding maximum concentrations for the CY2016 through CY2019 effluent dataset were compared to the results from the previous evaluation (compiled in step 1) to identify the following:

    a. Constituents detected above the PQL and with a maximum concentration in the CY2016 through CY2019 dataset that were greater than the maximum concentration determined in the previous evaluation (compiled in step 1)

    b. Constituents detected above the PQL in the CY2016 through CY2019 dataset but were not included in the previous evaluation (Table E-1) (i.e., newly-detected constituents)

The constituents with new maximum concentrations (from step 4a) and the newly-detected constituents (from step 4b) were compiled and further evaluated as monitoring constituents as follows:

5. Comparison of maximum concentration in the LERF basins to action levels based on federal and state regulations. Constituents with concentrations above their respective action levels were further evaluated for use in detection monitoring.

6. Comparison of mobility to groundwater based on distribution coefficient (K_d). A low K_d value generally indicates that a chemical has greater potential to migrate through the vadose zone and reach groundwater. Constituents with a K_d less than or equal to 0.8 mL/g were identified for further evaluation for use in detection monitoring. K_d values were obtained from either the Cleanup Levels and Risk Calculation (CLARC) database (Ecology, 2020) or ECF-HANFORD-12-0023, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological and Radiological Analytes in the 100 Areas and 300 Area*.

    In addition, the K_d values used for the evaluation were corrected for the estimated gravel content in the vadose zone at LERF. Laboratory determinations of K_d typically use the <2 mm particle size fraction of the sediment. However, for materials that contain significant amounts of gravel, K_d values

will be lower than those determined using the <2 mm particle size material because the surface area and corresponding quantity of adsorption sites is much lower (Section 2.4 of PNNL-17154, *Geochemical Characterization Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site*). For sediments with high gravel content, PNNL-17154 provided the following equation for gravel correction of K_d values (Equation 2.4 in PNNL-17154):

$$K_d(gc) = (1-f) * K_d(<2\ mm) \qquad \textbf{(Eq. 1)}$$

where:

$K_d(gc)$	=	gravel-corrected K_d value
f	=	% of gravel
$K_d(<2\ mm)$	=	K_d value determined using <2 mm particle size material.

Section 3.1 of SGW-41072 provides the stratigraphy of the vadose zone beneath LERF, which is predominantly the Hanford formation gravel-dominated sequences Hf1 (upper gravel-dominated facies) and Hf3 (lower gravel-dominated facies) (Figures 3-2 and 3-3 of SGW-41072). According to Table 12 in ECF-HANFORD-19-0121, *Selection of Vadose Zone Flow and Transport Properties with Gravel Fraction Corrections for the Hanford Site Composite Analysis and Cumulative Impact Evaluation*, these stratigraphic units have an average gravel content of 66% (average gravel weight percent). Using Equation 1 to correct for gravel content at LERF, K_d values are multiplied by 1-0.66 or 0.34 to determine the gravel-corrected K_d values.

7. Identification of dangerous waste. The objective of final status groundwater monitoring is to monitor for releases of dangerous wastes from a regulated unit. However, not every chemical present in the LERF effluent is a dangerous waste. Therefore, an evaluation to determine which constituents are dangerous wastes was performed by comparing the LERF effluent constituents to the following:

   a. Dangerous wastes associated with the waste codes provided in the Part A Form for LERF and ETF (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, Part 3, OUG-3, Addendum A, Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility Part A Form, dated October 25, 2017, Washington State Department of Ecology).

   b. Constituents identified in Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods for Designating Dangerous Waste, WAC 173-303-090 & -100*.

8. Analytical availability for monitoring constituents at commercial laboratories. It is necessary to have a backup laboratory available for monitoring constituents required in the WA7890008967; therefore, constituents that are available for analysis at only one commercial laboratory (or at no commercial laboratory) are not included as monitoring constituents.

G3.3 Evaluation Results

This section provides the results of the LERF effluent evaluation.

An evaluation of the 90 waste constituents from the previous inventory screening (Table E-1) is presented in Table G-1. Of these 90 constituents, 75 have sample results in the CY2016 through CY2019 dataset for comparison. The maximum concentrations of these 75 constituents is presented, along with PQLs, and the maximum concentrations from the previous inventory screening for comparison. The sample results for each of the 75 constituents were compared against the PQLs to identify detections. The new detections were compared to the previous concentrations to identify any new maximum concentrations. Of these, 21 constituents had new maximum concentrations and moved forward for further screening.

A total of 13 constituents in the CY2016 through CY2019 dataset were not included within the 90 constituents from the previous inventory screening (i.e., newly detected constituents), and were evaluated to identify "detections" (Table G-2). Of these, six newly detected constituents moved forward for further screening. In cases where a PQL value was not available for comparison, constituents were conservatively carried forward for further screening.

Evaluation of the 21 constituents with new maximum concentrations and the six newly detected constituents was performed using steps 5 through 8 in Section G.3.2 to identify any new potential monitoring constituents (Table G-3), as follows:

- Concentration in the LERF effluent that is above the applicable federal or state action level
- K_d at or less than 0.8 mL/g
- Identified from the LERF/ETF Part A Form waste codes or in Appendix 5 of Ecology Publication 97-407
- Available for analysis at commercial laboratories

Of the 29 constituents, three constituents (1,4-dichlorobenzene, methylene chloride, and n-nitrosodimethylamine) met the four screening criteria above for potential inclusion as monitoring constituents for LERF. However, methylene chloride may be present in analytical data as an artifact of sampling, analysis, or laboratory operations but has not been attributed to environmental contamination at the Hanford Site. Therefore, methylene chloride is excluded as a monitoring constituent. The remaining constituents (1,4-dichlorobenzene and n-nitrosodimethylamine) are identified as detection-monitoring constituents.

This page intentionally left blank.

Table G-1. Evaluation of Constituents Detected in Previous LERF Inventory Versus Calendar Year 2016 to 2019 Dataset

Constituent	CAS Number	Maximum Value in 2016 – 2019 Dataset (µg/L)	Qualifier	PQL (µg/L)[a]	Detected above PQL?	Previous Maximum Concentration (µg/L)[b]	If Detected Above PQL, is 2016 - 2019 a New Maximum?	Evaluate Further?
1,1-Dichloroethene	75-35-4	0.83	J	10	No	0.25	N/A	No
1,2-Dichlorobenzene	95-50-1	ND	--	10.5	N/A	0.0478	N/A	No
1-Butanol	71-36-3	1630	--	262.5	Yes	1700	No	No
2,4-D (2,4-Dichlorophenoxyacetic acid)	94-75-7	ND	--	20	N/A	0.216	N/A	No
2-Butanone	78-93-3	24.9	--	10	Yes	19	Yes	Yes
2-Butoxyethanol	111-76-2	220	D	5000	No	330	N/A	No
2-Hexanone	591-78-6	4.07	JT	20	No	1.24	N/A	No
2-Methylphenol (Cresol, o-)	95-48-7	ND	--	10.5	N/A	4.3	N/A	No
2-Pentanone	107-87-9	17.2	--	10.5	Yes	6.52	Yes	Yes
3+4 Methylphenol (Cresol, m+p)	65794-96-9	ND	--	20	N/A	4.3	N/A	No
4-Methyl-2-pentanone	108-10-1	3.71	--	10	No	0.59	N/A	No
Acetone	67-64-1	1020	DT	20	Yes	1700	No	No
Acetonitrile	75-05-8	36.9	J	100	No	36.4	N/A	No
Alkalinity	3812-32-6	975000	--	10000	Yes	319000	Yes	Yes
Aluminum	7429-90-5	899	--	105	Yes	945	No	No
Ammonia	7664-41-7	126000 (as nitrogen)	D	105	Yes	170000	No	No
Antimony	7440-36-0	5.32	B	5.25	Yes	92.2	No	No
Arsenic	7440-38-2	50.4	--	10	Yes	20.9	Yes	Yes
Barium	7440-39-3	540	D	100	Yes	200	Yes	Yes
Benzene	71-43-2	0.0352	--	5	No	0.04	N/A	No
Benzyl alcohol	100-51-6	21.8	--	10.5	Yes	25.2	No	No
Beryllium	7440-41-7	ND	--	1.05	N/A	10.8	N/A	No
Bis(2-ethylhexyl) phthalate	117-81-7	32.1	--	10.5	Yes	236	No	No
Boron	7440-42-8	750	--	105	Yes	750	No	No
Bromide	24959-67-9	3500	--	262.5	Yes	3500	No	No
Cadmium	7440-43-9	0.58	B	2.1	No	4.4	N/A	No
Calcium	7440-70-2	451000	--	1050	Yes	451000	No	No
Carbon disulfide	75-15-0	23.9	--	5	Yes	0.023	Yes	Yes

Table G-1. Evaluation of Constituents Detected in Previous LERF Inventory Versus Calendar Year 2016 to 2019 Dataset

Constituent	CAS Number	Maximum Value in 2016 – 2019 Dataset (µg/L)	Qualifier	PQL (µg/L)[a]	Detected above PQL?	Previous Maximum Concentration (µg/L)[b]	If Detected Above PQL, is 2016 - 2019 a New Maximum?	Evaluate Further?
Carbon tetrachloride	56-23-5	8.87	--	3	Yes	490.7	No	No
Chloride	16887-00-6	317000	D	400	Yes	317000	No	No
Chloroform	67-66-3	0.95	J	5	No	8.5	N/A	No
Chromium	7440-47-3	98	--	10.5	Yes	143.9	No	No
Cobalt	7440-48-4	61.2	--	5.25	Yes	145	No	No
Copper	7440-50-8	568	--	25	Yes	192	Yes	Yes
Cyanide	57-12-5	3.9	B	10.5	No	7.6	N/A	No
Dimethyl phthalate	131-11-3	0.23	J	10.5	No	0.23	No	No
Di-n-octylphthalate	117-84-0	ND	--	10.5	N/A	23.8	N/A	No
Ethylbenzene	100-41-4	1.91	--	4	No	0.072	N/A	No
Fluoranthene	206-44-0	0.28	J	10.5	No	0.28	No	No
Fluoride	16984-48-8	1400	BD	525	Yes	22000	No	No
Formaldehyde	50-00-0	Not in dataset	--	50	N/A	82.1	N/A	No
Formate	71-47-6	Not in dataset	--	N/A	N/A	0.01	N/A	No
Formic acid	64-18-6	Not in dataset	--	N/A	N/A	190	N/A	No
Hexavalent chromium	18540-29-9	120		10.5	Yes	120	No	No
Iodomethane	74-88-4	0.57	JB	10.5	N/A	0.57	N/A	No
Iron	7439-89-6	12900	--	100	Yes	579	Yes	Yes
Isophorone	78-59-1	0.22	J	10.5	N/A	0.22	N/A	No
Lead	7439-92-1	20.2	--	3.15	Yes	29.6	No	No
Lithium	7439-93-2	23	--	52.5	N/A	23	N/A	No
Magnesium	7439-95-4	131000	--	1000	Yes	82100	Yes	Yes
Manganese	7439-96-5	6320	--	10	Yes	129.7	Yes	Yes
Mercury	7439-97-6	35.4	--	0.5	Yes	6.52	Yes	Yes
Methyl alcohol	67-56-1	Not in dataset	--	5250	N/A	0	N/A	No
Methylene chloride	75-09-2	6.82	--	5	Yes	1.72	Yes	Yes
Molybdenum	7439-98-7	28.9	--	5	Yes	10	Yes	Yes
Nickel	7440-02-0	90.2	D	40	Yes	40	Yes	Yes

Table G-1. Evaluation of Constituents Detected in Previous LERF Inventory Versus Calendar Year 2016 to 2019 Dataset

Constituent	CAS Number	Maximum Value in 2016 – 2019 Dataset (µg/L)	Qualifier	PQL (µg/L)[a]	Detected above PQL?	Previous Maximum Concentration (µg/L)[b]	If Detected Above PQL, is 2016 - 2019 a New Maximum?	Evaluate Further?
Nitrate	14797-55-8	69900 (as nitrogen in nitrate)	D	250	Yes	611143	No	No
Nitrite	14797-65-0	1990 (as nitrogen in nitrite)	X	250	Yes	1288	No	No
n-Nitrosodimethylamine	62-75-9	905	--	10	Yes	329	Yes	Yes
Oil and grease	N/A	1800	BC	5250	N/A	3213	N/A	No
Pentachlorophenol	87-86-5	ND	--	52.5	N/A	11.4	N/A	No
pH measurement	N/A	11.1	X	N/A	N/A	10.4	N/A	No
Phenanthrene	85-01-8	0.27	J	10.5	N/A	0.27	N/A	No
Phosphate	14265-44-2	28254.8	--	491	Yes	300	Yes	Yes
Potassium	7440-09-7	73100	--	5250	Yes	163756	No	No
Selenium	7782-49-2	14		10.5	Yes	14	No	No
Silicon	7440-21-3	27900	--	525	Yes	27900	No	No
Silver	7440-22-4	18.1	--	5.25	Yes	65.6	No	No
Sodium	7440-23-5	235000	--	1050	Yes	397000	No	No
Specific conductivity	N/A	20200	--	N/A	Yes	2780	No	No
Strontium	7440-24-6	1930	D	10	Yes	1500	Yes	Yes
Sulfate	14808-79-8	615000	D	1050	Yes	615000	No	No
Tetrachloroethene	127-18-4	ND	--	5	N/A	0.1	N/A	No
Tetrahydrofuran	109-99-9	261	--	50	Yes	261	No	No
Thallium	7440-28-0	0.602	B	2.1	Yes	148	No	No
Tin	7440-31-5	24.8	C	100	No	1	N/A	No
Titanium	7440-32-6	ND	--	21	N/A	4.4	N/A	No
Toluene	108-88-3	0.61	J	5	No	5.86	No	No
Total dissolved solids	N/A	2000000	--	21000	Yes	2023943	No	No
Total organic carbon	N/A	175000	--	1000	Yes	20000	Yes	Yes
Total organic halides	59473-04-0	510	D	31.5	Yes	79	Yes	Yes
Total suspended solids	N/A	334000	--	21000	No	19400	No	No
Tributyl phosphate	126-73-8	ND	--	10.5	N/A	72	N/A	No
Trichloroethene	79-01-6	0.47	J	1	No	0.042	N/A	No

Table G-1. Evaluation of Constituents Detected in Previous LERF Inventory Versus Calendar Year 2016 to 2019 Dataset

Constituent	CAS Number	Maximum Value in 2016 – 2019 Dataset (µg/L)	Qualifier	PQL (µg/L)[a]	Detected above PQL?	Previous Maximum Concentration (µg/L)[b]	If Detected Above PQL, is 2016 - 2019 a New Maximum?	Evaluate Further?
Trichlorofluoromethane	75-69-4	ND	--	10	N/A	3.2	N/A	No
Tungsten	7440-33-7	0.42	B	N/A	N/A	0.42	N/A	No
Uranium	7440-61-1	2120	C	1.05	Yes	140000	No	No
Vanadium	7440-62-2	37	--	52.5	No	45.1	No	No
Xylenes (total)	1330-20-7	21.23	--	10	Yes	0.237	Yes	Yes
Zinc	7440-66-6	2270	*	20	Yes	92.2	Yes	Yes

a. PQL values were obtained from ECF-HANFORD-18-0058, *Practical Quantitation Limits for Groundwater Environmental Samples*.

b. Previous maximum concentration in LERF effluent is from Table E-5.

-- = no qualifier

LERF = Liquid Effluent Retention Facility

N/A = not applicable

ND = not detected

PQL = practical quantitation limit

Qualifiers:

B = analyte detected at less than contract required detection limit but greater than method detection limit.

C = analyte was detected in both the sample and the associated quality control blank, and the sample concentration was less than or equal to 5 times the blank concentration.

D = analyte reported at a secondary dilution factor.

J = estimated value.

X = result-specific translation of this qualifier code is provided in the hardcopy data report and/or case narrative. Additional information may also be found in the RESULT_COMMENT field for this record (found in the Hanford Environmental Information System).

* = analysis not within control limits

Table G-2. Evaluation of Newly Detected Constituents in Calendar Year 2016 to 2019 LERF Dataset

Constituent	CAS Number	2016 - 2019 Maximum Value (µg/L)	Qualifier	PQL (µg/L)*	Detected Above PQL?	Evaluate Further?
1,1,2-Trichloroethane	79-00-5	1.03	J	5	No	No
1,2-Dichloroethane	107-06-2	0.249	--	5	No	No
1,2-Diphenylhydrazine	122-66-7	0.25	J	10.5	No	No
1,4-Dichlorobenzene	106-46-7	9.44	--	4	Yes	Yes
1,4-Dioxane	123-91-1	15.8	J	21	No	No
2-Heptanone	110-43-0	32000	--	--	N/A	Yes
Aroclor-1248	12672-29-6	0.155	--	1.05	No	No
Aroclor-1254	11097-69-1	0.0948	J	1.05	No	No
Hydroxylion	84625-61-6	1450	--	--	N/A	Yes
Phosphorus	7723-14-0	20900	D	262.5	Yes	Yes
Phosphorus in phosphate	PO4-P	974	X	525	Yes	Yes
Silica	7631-86-9	4400	--	--	N/A	Yes
Thorium	7440-29-1	0.966	B	5.25	No	No

* PQL values obtained from ECF-HANFORD-18-0058, *Practical Quantitation Limits for Groundwater Environmental Samples*.

CAS = Chemical Abstracts Service

-- = no qualifier

N/A = not applicable

ND = not detected

PQL = practical quantitation limit

Qualifiers:

B = analyte detected at < contract required detection limit but greater than method detection limit.

C = analyte was detected in both the sample and the associated quality control blank and the sample concentration was ≤5 times the blank concentration.

D = analyte reported at a secondary dilution factor.

J = estimated value.

X = Result-specific translation of this qualifier code is provided in the hardcopy data report and/or case narrative. Additional information may also be found in the RESULT_COMMENT field for this record (found in the Hanford Environmental Information System).

* = analysis not within control limits.

This page intentionally left blank.

Table G-3. Evaluation of Detected Constituent Concentrations in LERF Inventory

Constituent	CAS Number	Maximum Value (µg/L)	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d (mL/g)	Source	Gravel Corrected K_d (mL/g)[a]	Under K_d Limit (0.8 mL/g)?	Identified from Part A?	Identified from Appendix 5?	Laboratory Analysis Available?	Include for Monitoring?
1,4-Dichlorobenzene	106-46-7	9.44	8.1	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.616	CLARC	0.209	Yes	No	Yes	Yes	Yes
2-Butanone	78-93-3	24.9	4800	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	0.0045	EPA	0.0015	Yes	Yes	Yes	Yes	No
2-Heptanone	110-43-0	32000	--	N/A	No	NVR	N/A	N/A	No	No	No	No	No
2-Pentanone	107-87-9	17.2	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
Alkalinity	3812-32-6	975000	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
Arsenic	7440-38-2	50.4	10	40 CFR 141 - Federal MCL	Yes	29	CLARC	9.9	No	Yes	Yes	Yes	No
Barium	7440-39-3	540	2000	40 CFR 141 - Federal MCL	No	41	CLARC	14	No	Yes	Yes	Yes	No
Carbon disulfide	75-15-0	23.9	800	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	0.0457	CLARC	0.0155	Yes	Yes	Yes	Yes	No
Copper	7440-50-8	568	640	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	22	CLARC	7.5	No	No	Yes	Yes	No
Hydroxylion	110-43-0	32000	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
Iron	7439-89-6	12900	11200	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	25	EPA	8.5	No	No	No	Yes	No
Magnesium	7439-95-4	131000	--	N/A	No	4.5	EPA	1.5	No	No	No	Yes	No
Manganese	7439-96-5	6320	384	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	65	EPA	22	No	No	No	Yes	No
Mercury	7439-97-6	35.4	2	40 CFR 141 - Federal MCL	Yes	52	CLARC	18	No	Yes	Yes	Yes	No
Methylene chloride	75-09-2	6.82	5	40 CFR 141 - Federal MCL	Yes	0.01	CLARC	0.003	Yes	Yes	Yes	Yes	No[b]
Molybdenum	7439-98-7	28.9	80	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	20	EPA	6.8	No	No	No	Yes	No
Nickel	7440-02-0	90.2	100	WAC 246-290-310	No	65	CLARC	22	No	No	Yes	Yes	No
n-Nitrosodimethylamine	62-75-9	905	0.000858	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	0.023	EPA	0.0078	Yes	No	Yes	Yes	Yes
pH measurement	N/A	11.1	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
Phosphate	14265-44-2	28254.8	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
Phosphorus	7723-14-0	20900	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
Phosphorus in phosphate	N/A	974	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
Silica	N/A	4400	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
Strontium	7440-24-6	1930	9600	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	35	EPA	12	No	No	No	Yes	No
Total organic carbon	N/A	175000	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No

Table G-3. Evaluation of Detected Constituent Concentrations in LERF Inventory

Constituent	CAS Number	Maximum Value (µg/L)	Action Level (µg/L)	Action Level Basis	Exceeds Action Level?	K_d (mL/g)	Source	Gravel Corrected K_d (mL/g)[a]	Under K_d Limit (0.8 mL/g)?	Identified from Part A?	Identified from Appendix 5?	Laboratory Analysis Available?	Include for Monitoring?
Total organic halides	59473-04-0	510	--	N/A	No	NVR	N/A	N/A	No	No	No	Yes	No
Xylenes (total)	1330-20-7	21.23	1600	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	0.233	CLARC	0.0792	Yes	Yes	Yes	Yes	No
Zinc	7440-66-6	2270	4800	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	62	CLARC	21	No	No	Yes	Yes	No

Note: Complete references are provided in Chapter G5.

a. K_d values used for the evaluation were corrected for the estimated gravel content at LERF as described in Section G3.2.

b. Methylene chloride may be present in analytical data as an artifact of sampling, analysis, or laboratory operations but has not been attributed to environmental contamination at the Hanford Site. Therefore, it is excluded as a monitoring constituent for the unit.

-- = no action value available
CAS = Chemical Abstracts Service
CLARC = Cleanup Levels and Risk Calculations (Ecology, 2020)
EPA = U.S. Environmental Protection Agency
K_d = distribution coefficient
LERF = Liquid Effluent Retention Facility
MCL = maximum contaminant level
N/A = not applicable
NVR = no value reported
PQL = practical quantitation limit

G4 Waste Constituents for Groundwater Monitoring

Based on the results of the CY2016 through CY2019 LERF effluent evaluation, two waste constituents (1,4-dichlorobenzene and n-nitrosodimethylamine) are proposed for detection monitoring at LERF (Table G-4).

Table G-4. Proposed Constituents for Detection Monitoring at LERF Based on Evaluation of Calendar Year 2016 Through 2019 Effluent

Waste Constituent	CAS Number
1,4-Dichlorobenzene	106-46-7
n-Nitrosodimethylamine*	62-75-9

* n-Nitrosodimethylamine (CAS Number 62-75-9) is included as a monitoring constituent under the previous LERF final status groundwater monitoring plan.

CAS = Chemical Abstracts Service LERF = Liquid Effluent Retention Facility

G5 References

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr141_main_02.tpl.

ECF-HANFORD-12-0023, 2018, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological and Radiological Analytes in the 100 Areas and 300 Area*, Rev. 4, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0065283H.

ECF-HANFORD-18-0058, 2019, *Practical Quantitation Limits for Groundwater Environmental Samples*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/AR-03420.

ECF-HANFORD-19-0121, 2020, *Selection of Vadose Zone Flow and Transport Properties with Gravel Fraction Corrections for the Hanford Site Composite Analysis and Cumulative Impact Evaluation*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://www.osti.gov/biblio/1605425.

Ecology, 2020, Cleanup Levels and Risk Calculation (CLARC) database, Washington State Department of Ecology, Olympia, Washington. Available at: https://fortress.wa.gov/ecy/clarc/.

Ecology Publication 97-407, 2014, *Chemical Test Methods for Designating Dangerous Waste, WAC 173-303-090 & -100*, Hazardous Waste and Toxics Reduction Program, Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/97407.pdf.

PNNL-17154, 2008, *Geochemical Characterization Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://pdw.hanford.gov/document/0911240119.

SGW-41702, 2017, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report*, Rev. 1 CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0068831H.

WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Washington State Department of Ecology, Richland, Washington. Available at: http://www.ecy.wa.gov/programs/nwp/permitting/hdwp/rev/8c/.

WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-720.

WAC 246-290, "Group A Public Water Supplies," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=246-290.