1248415

[00662661H]

DOE/RL-2017-65
Revision 0

Hanford Site RCRA Groundwater Monitoring Report for 2017

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

attached to:
1248414

RECEIVED
MAR 01 2018
EDMC

Approved for Public Release;
Further Dissemination Unlimited

204

DOE/RL-2017-65
Revision 0

Hanford Site RCRA Groundwater Monitoring Report for 2017

Date Published
February 2018

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
P.O. Box 550
Richland, Washington 99352

APPROVED
By Julia Raymer at 3:55 pm, Feb 22, 2018

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

Executive Summary

The U.S. Department of Energy conducts groundwater monitoring at 25 dangerous waste management units (DWMUs) regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA)[1] at the Hanford Site. RCRA regulates the management of solid waste, hazardous waste, and certain underground storage tanks, and applies to active or recently active DWMUs. Groundwater monitoring is required at land disposal units, including surface impoundments, landfills, or land treatment facilities to determine if they are affecting water quality in the uppermost aquifer. The uppermost aquifer is unconfined beneath most of the Hanford Site and semiconfined in some locations. Groundwater monitoring requirements for Hanford Site RCRA DWMUs fall into one of two broad categories: interim status or final status. Final status units incorporated into the *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*[2] require groundwater monitoring under Washington State dangerous waste regulations (WAC 173-303-645[3]). Interim status regulated units require groundwater monitoring under WAC 173-303-400(3)(c)(v),[4] and by reference 40 CFR 265.[5] Annual reporting is required by March 1 each year under interim status requirements.

During 2017, U.S. Department of Energy (DOE) monitored nine DWMUs under interim status indicator evaluation programs and five under final status detection programs. New interim status groundwater monitoring plans were implemented for the 216-A-37-1 Crib, 216-B-3 Pond, and 216-S-10 Pond and Ditch in 2017. New monitoring requirements for the Liquid Effluent Retention Facility were implemented through a revision to the Hanford RCRA Permit. Also in 2017, Ecology approved a request for

---

[1] *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.

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

[3] 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.

[4] WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/wac/default.aspx?cite=173-303-400.

[5] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5.

a Class 2 Modification, which adds a clean closure option for the 1301-N and 1325-N Liquid Waste Disposal Facilities.

Nine DWMUs were monitored under groundwater quality assessment programs to evaluate the nature and extent of contamination. One of these, the Nonradioactive Dangerous Waste Landfill, began assessment in 2017 as a result of a new critical mean exceedance.

The 183-H Solar Evaporation Basins and the 300 Area Process Trenches continued to be monitored under corrective action programs in 2017. The groundwater monitoring requirements for both units were revised in 2017 with the implementation of Hanford RCRA Permit modifications.

In 2017, five new RCRA wells were installed (three for the 216-A-29 Ditch and one each for the 216-B-3 Pond and the 216-A-17-1 Crib). Two RCRA wells were decommissioned.

Contents

1 Introduction 1-1

1.1 RCRA Groundwater Monitoring Programs 1-1
1.2 Interim Status Reporting Requirements 1-6
1.3 Final Status Reporting Requirements 1-6
1.4 Specific Conductance 1-7
1.5 Other Hanford Site Groundwater Reports 1-7

2 Indicator Evaluation and Detection Monitoring 2-1

2.1 1301-N Crib and Trench 2-1
2.2 1325-N Crib and Trench 2-6
2.3 1324-N Surface Impoundment and 1324-NA Percolation Pond 2-15
2.4 216-A-36B Crib 2-20
2.5 216-A-37-1 Crib 2-29
2.6 216-B-3 Pond 2-36
2.7 216-B-63 Trench 2-44
2.8 216-S-10 Pond and Ditch 2-50
2.9 Integrated Disposal Facility 2-56
2.10 Liquid Effluent Retention Facility 2-62
2.11 Low-Level Waste Management Area 1 2-70
2.12 Low-Level Waste Management Area 2 2-76
2.13 Low-Level Waste Management Area 3 2-83
2.14 Low-Level Waste Management Area 4 2-88

3 Groundwater Quality Assessment Monitoring 3-1

3.1 Waste Management Area A-AX 3-1
3.2 Waste Management Area B-BX-BY 3-6
3.3 Waste Management Area C 3-14
3.4 Waste Management Area S-SX 3-21
3.5 Waste Management Area T 3-28
3.6 Waste Management Area TX-TY 3-33
3.7 Waste Management Area U 3-40
3.8 216-A-29 Ditch 3-45
3.9 Nonradioactive Dangerous Waste Landfill 3-52

4 Corrective Action Monitoring 4-1

4.1 183-H Solar Evaporation Basins 4-1
4.2 300 Area Process Trenches 4-6

5 References 5-1

Appendix

A 2017 Groundwater Data for Hanford Site RCRA Monitoring Wells ..... A-i

Figures

Figure 1-1. Hanford Site RCRA Units 1-2
Figure 1-2. Specific Conductance in 200 East Area, 2016 1-8
Figure 1-3. Nitrate Distribution in 200 East Area, 2016 1-9
Figure 1-4. Sulfate Distribution in 200 East Area, 2016 1-10
Figure 2-1. 1301-N Liquid Waste Disposal Facility (116-N-1 Waste Site) 2-2
Figure 2-2. 1325-N Crib and Trench (116-N-3 Waste Site) 2-9
Figure 2-3. Chloroform Comparison of 1325-N Upgradient Well to Downgradient Wells 2-14
Figure 2-4. 1324-N Surface Impoundment and 1324-NA Percolation Pond (120-N-2 and 120-N-1 Waste Sites) 2-16
Figure 2-5. 216-A-36B Crib 2-22
Figure 2-6. 200 East Water Table Based on Low-Gradient Monitoring Network 2-24
Figure 2-7. 216-A-37-1 Crib 2-31
Figure 2-8. 216-B-3 Pond (B Pond) 2-38
Figure 2-9. 216-B-63 Trench 2-45
Figure 2-10. 216-S-10 Pond and Ditch 2-52
Figure 2-11. Integrated Disposal Facility 2-58
Figure 2-12. Liquid Effluent Retention Facility 2-64
Figure 2-13. Low-Level Waste Management Area 1 2-71
Figure 2-14. Low-Level Waste Management Area 2 2-77
Figure 2-15. Low-Level Waste Management Area 3 2-84
Figure 2-16. Low-Level Waste Management Area 4 2-89
Figure 3-1. Waste Management Area A-AX 3-3
Figure 3-2. Waste Management Area B-BX-BY 3-8
Figure 3-3. Total Cyanide in WMA B-BX-BY Wells 3-12
Figure 3-4. Total and Free Cyanide Concentrations in Well 299-E33-38 3-12
Figure 3-5. Total and Free Cyanide Concentrations in Wells 299-E33-44 and 299-E33-47 3-13
Figure 3-6. Waste Management Area C 3-15
Figure 3-7. Total and Free Cyanide in Wells 299-E27-24 and 299-E27-155 3-20
Figure 3-8. Waste Management Area S-SX 3-23
Figure 3-9. Chromium Concentration in Well 299-W23-19 within WMA S-SX 3-27
Figure 3-10. Waste Management Area T 3-30
Figure 3-11. Waste Management Area TX-TY 3-35
Figure 3-12. Total and Free Cyanide in Wells 299-W10-26 and 299-W14-18 3-39

Figure 3-13. Waste Management Area U 3-42
Figure 3-14. 216-A-29 Ditch 3-47
Figure 3-15. Nonradioactive Dangerous Waste Landfill 3-53
Figure 4-1. 183-H Solar Evaporation Basins (116-H-6 Waste Site) 4-3
Figure 4-2. 300 Area Process Trenches (316-5 Waste Site) 4-9

Tables

Table 1-1. RCRA Monitoring Status, 2017 1-3
Table 1-2. Hanford Site RCRA Monitoring Reports 1-11
Table 2-1. 1301-N Groundwater Monitoring Network 2-3
Table 2-2. Groundwater Velocity at the 1301-N Crib and Trench 2-4
Table 2-3. 1301-N Sampling Summary for Contamination Indicator Parameters, 2017 2-4
Table 2-4. 1301-N Sampling Summary for Water Quality Parameters and Other Constituents, 2017 2-6
Table 2-5. 1325-N Groundwater Monitoring Network 2-10
Table 2-6. Groundwater Velocity at the 1325-N Crib and Trench 2-11
Table 2-7. 1325-N Sampling Summary for Contamination Indicator Parameters, 2017 2-11
Table 2-8. 1325-N Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2017 2-14
Table 2-9. 1324-N/NA Groundwater Monitoring Network 2-17
Table 2-10. Groundwater Velocity at 1324-N/NA Facilities 2-18
Table 2-11. 1324-N/NA Sampling Summary for Contamination Indicator Parameters, 2017 2-18
Table 2-12. 1324-N/NA Sampling Summary for Water Quality Parameters and Other Constituents, 2017 2-20
Table 2-13. 216-A-36B Groundwater Monitoring Network 2-23
Table 2-14. Groundwater Velocity at the 216-A-36B Crib 2-25
Table 2-15. 216-A-36B Sampling Summary for Contamination Indicator Parameters, 2017 2-25
Table 2-16. 216-A-36B Sampling Summary for Water Quality Parameters and Other Constituents, 2017 2-28
Table 2-17. 216-A-37-1 Groundwater Monitoring Network 2-32
Table 2-18. Groundwater Velocity at the 216-A-37-1 Crib 2-33
Table 2-19. 216-A-37-1 Sampling Summary for Contamination Indicator Parameters, 2017 2-33
Table 2-20. 216-A-37-1 Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2017 2-35
Table 2-21. 216-B-3 Pond Groundwater Monitoring Network 2-39
Table 2-22. Groundwater Velocity at the 216-B-3 Pond 2-40
Table 2-23. 216-B-3 Sampling Summary for Contamination Indicator Parameters, 2017 2-40
Table 2-24. 216-B-3 Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2017 2-42
Table 2-25. 216-B-63 Groundwater Monitoring Network 2-46

Table 2-26. Groundwater Velocity at the 216-B-63 Trench 2-46
Table 2-27. 216-B-63 Sampling Summary for Contamination Indicator Parameters, 2017 2-47
Table 2-28. 216-B-63 Sampling Summary for Water Quality Parameters and Other Constituents, 2017 2-49
Table 2-29. 216-S-10 Groundwater Monitoring Network 2-53
Table 2-30. Groundwater Velocity at the 216-S-10 Pond and Ditch 2-53
Table 2-31. 216-S-10 Sampling Summary for Contamination Indicator Parameters, 2017 2-54
Table 2-32. 216-S-10 Sampling Summary for Water Quality Parameters and Other Constituents, 2017 2-55
Table 2-33. IDF Groundwater Monitoring Network 2-59
Table 2-34. Groundwater Velocity at the IDF 2-60
Table 2-35. IDF Contamination Indicator Parameters, 2017 2-60
Table 2-36. IDF Sampling Summary for Other Constituents, 2017 2-61
Table 2-37. LERF Groundwater Monitoring Network 2-65
Table 2-38. Groundwater Velocity at LERF 2-66
Table 2-39. LERF Contamination Indicator Parameters, 2017 2-67
Table 2-40. LERF Sampling Summary for Other Constituents, 2017 2-69
Table 2-41. LLWMA-1 Groundwater Monitoring Network 2-72
Table 2-42. Groundwater Velocity at LLWMA-1 2-73
Table 2-43. LLWMA-1 Sampling Summary for Contamination Indicator Parameters, 2017 2-73
Table 2-44. LLWMA-1 Sampling Summary for Water Quality Parameters and Other Constituents, 2017 2-75
Table 2-45. LLWMA-2 Groundwater Monitoring Network 2-78
Table 2-46. Groundwater Velocity at LLWMA-2 2-79
Table 2-47. LLWMA-2 Sampling Summary for Contamination Indicator Parameters, 2017 2-79
Table 2-48. LLWMA-2 Sampling Summary for Water Quality Parameters and Other Constituents, 2017 2-82
Table 2-49. LLWMA-3 Groundwater Monitoring Network 2-85
Table 2-50. Groundwater Velocity at LLWMA-3 2-85
Table 2-51. LLWMA-3 Sampling Summary for Contamination Indicator Parameters, 2017 2-86
Table 2-52. LLWMA-3 Sampling Summary for Water Quality Parameters and Other Constituents, 2017 2-87
Table 2-53. LLWMA-4 Groundwater Monitoring Network 2-90
Table 2-54. Groundwater Velocity at LLWMA-4 2-91
Table 2-55. LLWMA-4 Sampling Summary for Contamination Indicator Parameters, 2017 2-91
Table 2-56. LLWMA-4 Sampling Summary for Water Quality Parameters and Other Constituents, 2017 2-94
Table 3-1. WMA A-AX Groundwater Monitoring Network 3-4
Table 3-2. Groundwater Velocity at WMA A-AX 3-5
Table 3-3. WMA A-AX Sampling Summary for 2017 3-5

Table 3-4. WMA B-BX-BY Groundwater Monitoring Network 3-9
Table 3-5. Groundwater Velocity at WMA B-BX-BY 3-10
Table 3-6. WMA B-BX-BY Sampling Summary for 2017 3-11
Table 3-7. WMA C Groundwater Monitoring Network 3-17
Table 3-8. Groundwater Velocity at WMA C 3-19
Table 3-9. WMA C Sampling Summary for 2017 3-19
Table 3-10. WMA S-SX Groundwater Monitoring Network 3-24
Table 3-11. Groundwater Velocity at WMA S-SX 3-26
Table 3-12. WMA S-SX Sampling Summary for 2017 3-26
Table 3-13. WMA T Groundwater Monitoring Network 3-31
Table 3-14. Groundwater Velocity at WMA T 3-32
Table 3-15. WMA T Sampling Summary for 2017 3-32
Table 3-16. WMA TX-TY Groundwater Monitoring Network 3-36
Table 3-17. Groundwater Velocity at WMA TX-TY 3-37
Table 3-18. WMA TX-TY Sampling Summary for 2017 3-37
Table 3-19. WMA U Groundwater Monitoring Network 3-43
Table 3-20. Groundwater Velocity at WMA U 3-43
Table 3-21. WMA U Sampling Summary for 2017 3-44
Table 3-22. 216-A-29 Groundwater Monitoring Network 3-48
Table 3-23. Groundwater Velocity at the 216-A-29 Ditch 3-49
Table 3-24. 216-A-29 Sampling Summary for 2017 3-50
Table 3-25. NRDWL Groundwater Monitoring Network 3-54
Table 3-26. NRDWL Groundwater Velocity 3-55
Table 3-27. NRDWL Sampling Summary for 2017 3-55
Table 4-1. 183-H Groundwater Monitoring Network 4-4
Table 4-2. Groundwater Velocity at 183-H Solar Evaporation Basins 4-5
Table 4-3. 183-H Solar Evaporation Basins Sampling Summary, 2017 4-5
Table 4-4. Statistical Evaluation of 183-H Dangerous Waste Constituents, 2017 4-6
Table 4-5. 300 Area Process Trenches Groundwater Monitoring Network 4-10
Table 4-6. Groundwater Velocity at 300 Area Process Trenches 4-11
Table 4-7. 300 Area Process Trenches Dangerous Waste Constituents, 2017 4-11
Table 4-8. Statistical Evaluation of 300 Area Process Trenches Dangerous Waste Constituents, 2017 4-13

This page intentionally left blank.

Terms

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
cis-1,2-DCE	*cis*-1,2-dichloroethene
Cr(VI)	hexavalent chromium
DOE	U.S. Department of Energy
DWMU	dangerous waste management unit
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ETF	Effluent Treatment Facility
GEL	GEL Laboratories Inc.
IDF	Integrated Disposal Facility
LERF	Liquid Effluent Retention Facility
LLWMA	Low-Level Waste Management Area
LOQ	limit of quantitation
LWDF	Liquid Waste Disposal Facility
MTCA	Model Toxic Control Act
NRDWL	Nonradioactive Dangerous Waste Landfill
OU	operable unit
P&T	pump and treat
PFP	Plutonium Finishing Plant
PUREX	Plutonium Uranium Extraction
PQL	practical quantitation limit
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	reduction-oxidation
SST	single-shell tank
SWL	Solid Waste Landfill
TADN	Test America – Denver
TASL	Test America – St. Louis

TCE	trichloroethene
TEDF	Treated Effluent Disposal Facility
TOC	total organic carbon
TOX	total organic halides
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
UCL	upper confidence limit
VOA	volatile organic analyte
VOC	volatile organic compound
WMA	waste management area

1
Introduction

1 Introduction

The U.S. Department of Energy (DOE) conducts groundwater monitoring at 25 dangerous waste management units (DWMUs) at the Hanford Site (Figure 1-1). These units are regulated under Washington State dangerous waste regulations with authorization from the *Resource Conservation and Recovery Act of 1976* (RCRA). RCRA regulates the management of solid waste, hazardous waste, and certain underground storage tanks. It applies to active or recently active treatment, storage, and disposal (TSD) units. Groundwater monitoring is required at land disposal units including surface impoundments, landfills, or land treatment facilities to determine if they are affecting water quality in the uppermost aquifer at the Hanford Site. The uppermost aquifer is unconfined beneath most of the Hanford Site but is semiconfined in some locations.

Groundwater monitoring requirements for Hanford Site RCRA DWMUs fall into two broad categories: interim status or final status. Final status units have been incorporated into the *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 RCRA Permit). A permitted RCRA unit requires final status monitoring under WAC 173-303-645, "Dangerous Waste Regulations," "Releases from Regulated Units." The RCRA units not currently incorporated into a permit require interim status monitoring under WAC 173-303-400(3)(c)(v), "Interim Status Facility Standards," as implemented by 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring." Appendix A contains all of the 2017 data for the RCRA wells, including data from other groundwater monitoring programs.

In 1989, DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology) signed Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). The agreement implemented remediation of the Hanford Site under the federal facility provisions of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), Section 120, "Federal Facilities," and brought the Hanford Site into compliance with environmental requirements under RCRA, including groundwater monitoring. In the early 1990s, certain DWMUs had ceased operations and were scheduled to close. These units included ponds, ditches, trenches, cribs, and retention basins. Tri-Party Agreement milestones were agreed upon for the submission of closure plans, and the individual closure plans were submitted for regulatory approval. While awaiting approval and implementation of these closure plans, DOE developed interim status groundwater monitoring plans to monitor the effects of these units on groundwater until closures could be implemented. Tri-Party Agreement milestones have again been established to submit closure plans for approval and eventual implementation. Until these closures have been implemented or the units are included in the Hanford RCRA Permit, interim status groundwater monitoring will continue.

1.1 RCRA Groundwater Monitoring Programs

RCRA groundwater monitoring is conducted under one of three types of programs: contamination indicator evaluation (or detection) monitoring, groundwater quality assessment (or compliance) monitoring, or corrective action monitoring. Prior to closing these units, monitoring may move between these programs as groundwater circumstances change. Table 1-1 lists the Hanford Site RCRA units and their 2017 monitoring status.

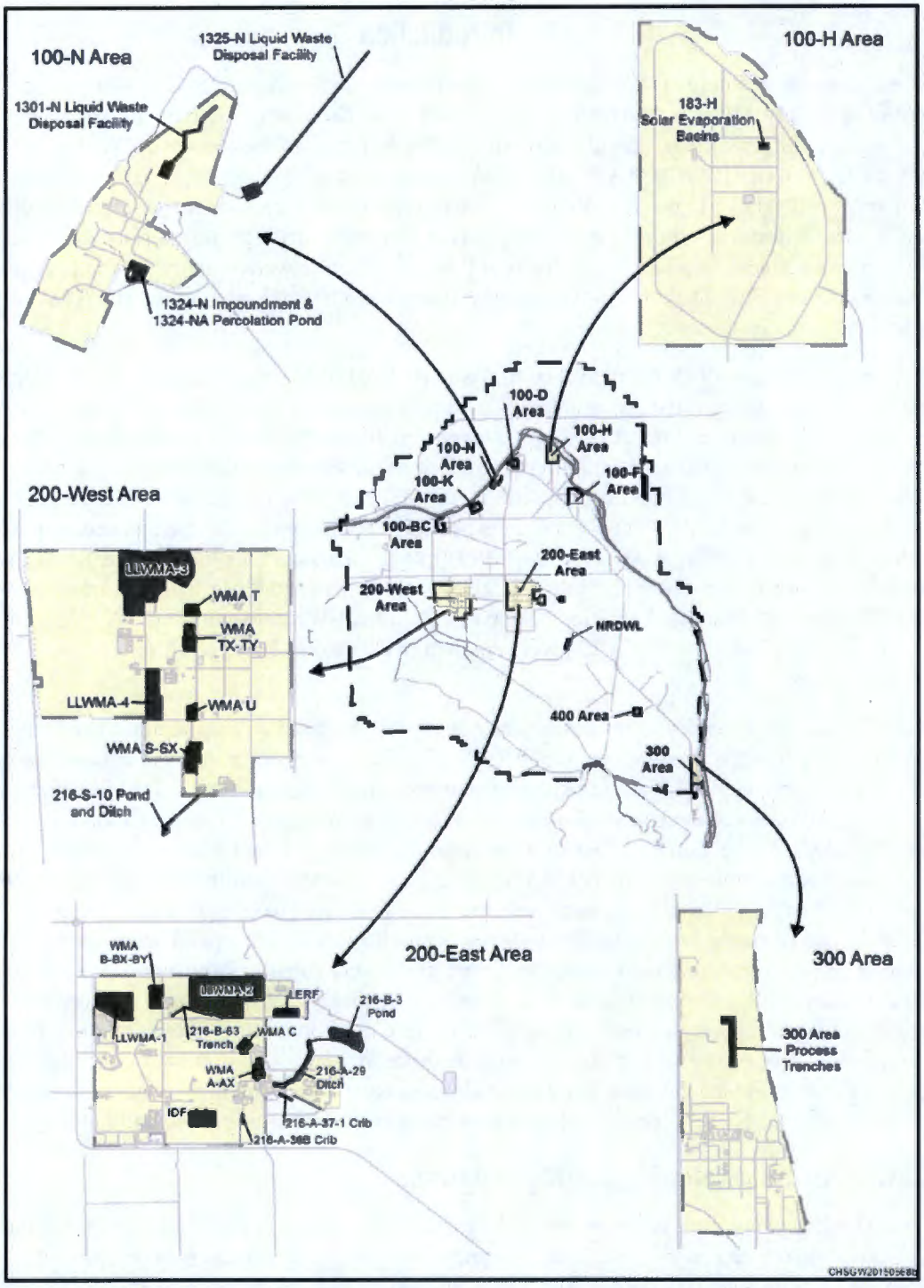


Figure 1-1. Hanford Site RCRA Units

Table 1-1. RCRA Monitoring Status, 2017

RCRA Unit	Section	Status	Engineering Evaluation[a]
1301-N LWDF	2.1	Continued indicator evaluation monitoring[b]; in 2017 Ecology approved a request for a Class 2 Modification, which adds a clean closure option.	No
1324-N and 1324-NA Ponds	2.3	Continued indicator evaluation monitoring.[b]	No
1325-N LWDF	2.2	Continued indicator evaluation monitoring[b]; in 2017 Ecology approved a request for a Class 2 Modification, which adds a clean closure option.	No
183-H Evaporation Basins	4.1	Corrective action monitoring program during interim remedial action; monitoring plan revised in Hanford RCRA Permit in 2017.	No
300 Area Process Trenches	4.2	Corrective action monitoring program during interim remedial action; monitoring plan revised in Hanford RCRA Permit in 2017.	No
216-A-29 Ditch	3.8	Assessment monitoring (elevated specific conductance); assessment plan revised in 2017.	Yes (to be prepared in 2018)
216-A-36B Crib	2.4	Continued indicator evaluation monitoring.[b]	Yes (to be prepared in 2018)
216-A-37-1 Crib	2.5	Continued indicator evaluation monitoring[b]; monitoring plan revised in 2017.	Yes (to be prepared in 2018)
216-B-3 Pond	2.6	Continued indicator evaluation monitoring[b]; monitoring plan revised in 2017.	Yes (to be prepared in 2018)
216-B-63 Trench	2.7	Continued indicator evaluation monitoring.[b]	Yes (to be prepared in 2018)
216-S-10 Pond and Ditch	2.8	Continued indicator evaluation monitoring[b]; monitoring plan revised in 2017.	Yes (draft in review)
IDF	2.9	Not yet in use; monitoring results added to baseline data set.	Yes (to be prepared in 2018)
LERF	2.10	Detection monitoring; monitoring plan revised in 2017 and incorporated into the Hanford RCRA Permit.	Yes (SGW-41072[c])
LLWMA-1	2.11	Continued indicator evaluation monitoring.[b]	Yes (to be prepared in 2018)

Table 1-1. RCRA Monitoring Status, 2017

RCRA Unit	Section	Status	Engineering Evaluation[a]
LLWMA-2	2.12	Continued indicator evaluation monitoring.[b]	Yes (to be prepared in 2018)
LLWMA-3	2.13	Continued indicator evaluation monitoring.[b]	Yes (draft in review)
LLWMA-4	2.14	Continued indicator evaluation monitoring.[b]	Yes (draft in review)
NRDWL	3.9	Began assessment monitoring (specific conductance exceedance).	Yes (to be prepared in 2018)
SST WMA A-AX	3.1	Continued assessment monitoring (elevated specific conductance).	Yes (to be prepared in 2018)
SST WMA B-BX-BY	3.2	Continued assessment monitoring (cyanide[d]).	Yes (to be prepared in 2018)
SST WMA C	3.3	Continued assessment monitoring (cyanide[d]).	Yes (to be prepared in 2018)
SST WMA S-SX	3.4	Continued assessment monitoring (chromium[d]).	Yes (draft in review)
SST WMA T	3.5	Continued assessment monitoring (chromium[d]).	Yes (draft in review)
SST WMA TX-TY	3.6	Continued assessment monitoring (chromium[d]).	Yes (draft in review)
SST WMA U	3.7	Continued assessment monitoring (chromium[d]).	Yes (draft in review)

Reference: *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended (Hanford RCRA Permit).

a. Engineering evaluations will be used to determine the need for new or replacement monitoring wells for these units.

b. Analysis of RCRA contamination indicator parameters provided no evidence of groundwater contamination with dangerous waste or dangerous waste constituents from the unit.

c. SGW-41072, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report.*

d. Primary RCRA constituent at this unit.

IDF = Integrated Disposal Facility
LERF = Liquid Effluent Retention Facility
LLWMA = Low-Level Waste Management Area
LWDF = Liquid Waste Disposal Facility
NRDWL = Nonradioactive Dangerous Waste Landfill
RCRA = *Resource Conservation and Recovery Act of 1976*
SST = single-shell tank
WMA = waste management area

Contamination indicator evaluation (interim status) or detection (final status) monitoring programs use groundwater data from specified indicator parameters to determine and monitor the impact of the unit (if any) on groundwater. Unit-specific conditions in the Hanford RCRA Permit include (or will include) requirements for final status detection monitoring programs (e.g., comparing groundwater concentrations with groundwater protection standards). Under interim status, the indicator evaluation program continues until the unit is incorporated into the permit or until monitoring indicates a statistically significant change. A statistically significant change is determined by comparing concentrations of the specified indicator parameters in downgradient wells to a statistical comparison value (critical mean) that is derived from background measurements (usually from upgradient wells). If a downgradient well exceeds a critical mean value for any of the indicator parameters, the well is resampled. If the results of the second sampling event confirm the exceedance, the detection monitoring program changes to an assessment monitoring program.

Interim status indicator parameters are specific conductance and pH (field measurements), total organic carbon (TOC), and total organic halides[1] (TOX) (40 CFR 265.92(b)(3), "Sampling and Analysis"). The critical mean values for the indicator parameters represent 99% prediction limits, calculated based on samples from upgradient wells. The methodology used to calculate the critical mean value is the Student's t-test in accordance with 40 CFR 265.93(b), "Preparation, Evaluation, and Response."

Critical mean values are recalculated annually or whenever the number of analyses changes (e.g., due to adding or removing wells). ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring*, describes the 2017 critical mean calculations. Tables in Chapter 2 provide the 2017 critical mean values and the results of statistical comparisons for each unit monitored under a detection program. Annual recalculation accounts for changing hydrologic conditions due to natural or manmade causes (e.g., pump and treat [P&T] systems). If changes occur in a monitoring well network, critical mean values are recalculated for subsequent sampling events using the new well network. When a critical mean for TOC or TOX cannot be calculated using a parametric statistical test because more than 50% of data from the upgradient well are below detection limits, DOE has decided to use the limit of quantitation (LOQ) as the upper reporting limit.

The LOQs for TOC and TOX are estimated from quality control (QC) sample results, and they vary from laboratory to laboratory and from quarter to quarter. An indicator parameter exceedance is not declared unless the downgradient concentration exceeds both the critical mean and the applicable LOQ. If an LOQ is not yet available for the current quarter, the previous quarter's LOQ is used as a comparison value. The indicator parameter tables in Chapter 2 list the applicable LOQs.

If an exceeded critical mean is verified in a downgradient well, a groundwater quality assessment plan is submitted to Ecology for approval, after which a groundwater quality assessment program begins (interim status; 40 CFR 265.93(d)). The objective of the monitoring program is to assess the nature and extent of the problem.

Assessments may also consider and test for alternative explanations for critical mean exceedances. For example, specific conductance exceedances may be caused by nondangerous waste constituents such as sulfate (Section 1.4). Because of changes in the direction of groundwater flow and multiple past-practice CERCLA release sites, some assessments require evaluation of dangerous waste from other sources. These assessments can take time to evaluate before a first determination is made, and some sites in assessment can be returned to detection monitoring in accordance with 40 CFR 265.93(d)(6).

---

[1] Total organic halides are synonymous with total organic halogens, which is the term used in 40 CFR 265.92.

For final status, if contaminant concentrations in groundwater have exceeded a permit concentration limit during compliance monitoring, groundwater remediation may be required. Corrective action groundwater monitoring would then be initiated to determine if the corrective action is effective.

Natural or anthropogenic changes in groundwater flow and water quality (e.g., those imposed by P&T systems) may affect the adequacy of RCRA groundwater monitoring networks. DOE is working with Ecology to review the monitoring networks and is evaluating the need for additional wells through the Hanford RCRA Permit (Revision 9) working group. DOE is preparing RCRA engineering evaluation reports and related final status monitoring plans (Table 1-1), which are expected to be added to the Hanford RCRA Permit through Revision 9.

1.2 Interim Status Reporting Requirements

40 CFR 265.94, "Recordkeeping and Reporting," includes reporting requirements for interim status units monitored under contamination indicator evaluation and assessment programs. For units monitored under contamination indicator parameter programs, the owner/operator must report the following information no later than March 1 each year (40 CFR 265.94):

- Concentrations of the contamination indicator parameters for each groundwater monitoring well, along with the required evaluations for these parameters (i.e., comparison to critical mean values)
- Any significant differences from initial background found in the upgradient wells
- Results of the evaluations of groundwater surface elevations and a description of the response to that evaluation, where applicable

Chapter 2 describes the 2017 results for nine sites monitored under interim status indicator evaluation and five sites monitored under final status detection programs.

For assessment sites, the owner/operator must submit an annual report with the results of the groundwater quality assessment program no later than March 1. The report should include the calculated (or measured) rate of migration of hazardous waste constituents in groundwater during the reporting period.
The assessment regulations also require quarterly determinations of concentrations, the extent of contamination, and the rate of contaminant migration, although these determinations are not specified in the reporting requirements. Chapter 3 provides the assessment results for 2017.

1.3 Final Status Reporting Requirements

Under the final status requirements of WAC 173-303-645, conditions specified in the Hanford RCRA Permit may specify reporting requirements. The following requirements apply to final status units:

- The 183-H Solar Evaporation Basins and 300 Area Process Trenches are monitored under corrective action and reported semiannually. Sections 4.1 and 4.2 summarize the monitoring results for 2017.
- The 100-N Area RCRA facilities (1301-N, 1325-N, and 1324-N/NA) and the Liquid Effluent Retention Facility (LERF) are monitored under detection programs. Sections 2.1, 2.2, 2.3, and 2.10 summarize the monitoring results for 2017.
- For the Integrated Disposal Facility (IDF), Section 5.5.4.3.3 "Groundwater Monitoring," of the Hanford RCRA Permit requires that "The results of the statistical evaluation and associated information will be submitted to Ecology quarterly in Hanford Site groundwater monitoring reports." Because the IDF is not in use, this statistical evaluation has not been prepared to date. Section 2.9 summarizes the monitoring results for 2017.

1.4 Specific Conductance

Specific conductance, one of the interim status contamination indicator parameters, is a measure of the ability of water to pass an electrical current, and it is affected by the presence of dissolved solids. The primary contributors to specific conductance in Hanford Site groundwater are bicarbonate, chloride, nitrate, sulfate, calcium, potassium, magnesium, and sodium. Many of these ions are present from natural sources, and others (notably nitrate and sulfate) were also introduced from Hanford Site waste disposal. Contaminants such as nitrate are commonly detected in concentrations of tens of mg/L and have a large effect on specific conductance. Specific conductance is not a good indicator of contaminants such as chromium that are present in concentrations of tens of μg/L (three orders of magnitude less).

Specific conductance is influenced by regional nitrate and sulfate plumes that originated at past-practice waste sites and some RCRA units. For example, specific conductance distribution in the 200 East Area (Figure 1-2) is very similar to nitrate and sulfate distribution (Figures 1-3 and 1-4). Many of the RCRA TSD units in 200 East, 200 West, and 100-N Areas are located within regional nitrate or sulfate plumes. The online, interactive groundwater monitoring report "plume tool" (http://higrv.hanford.gov/Hanford_Reports_2016/Plume_Criteria/plumes.html) allows users to view nitrate plumes as they migrated over the years 1993 to 2016.

1.5 Other Hanford Site Groundwater Reports

DOE has reported annually on RCRA groundwater monitoring since 1988. Table 1-2 lists the various forms and schedules that the reports have taken over the years. DOE combined the RCRA annual report with the annual Hanford Sitewide groundwater report from 1996 through 2014. Since calendar year 2015, DOE has provided separate reports for the RCRA units by March 1, as specified in 40 CFR 265.94.

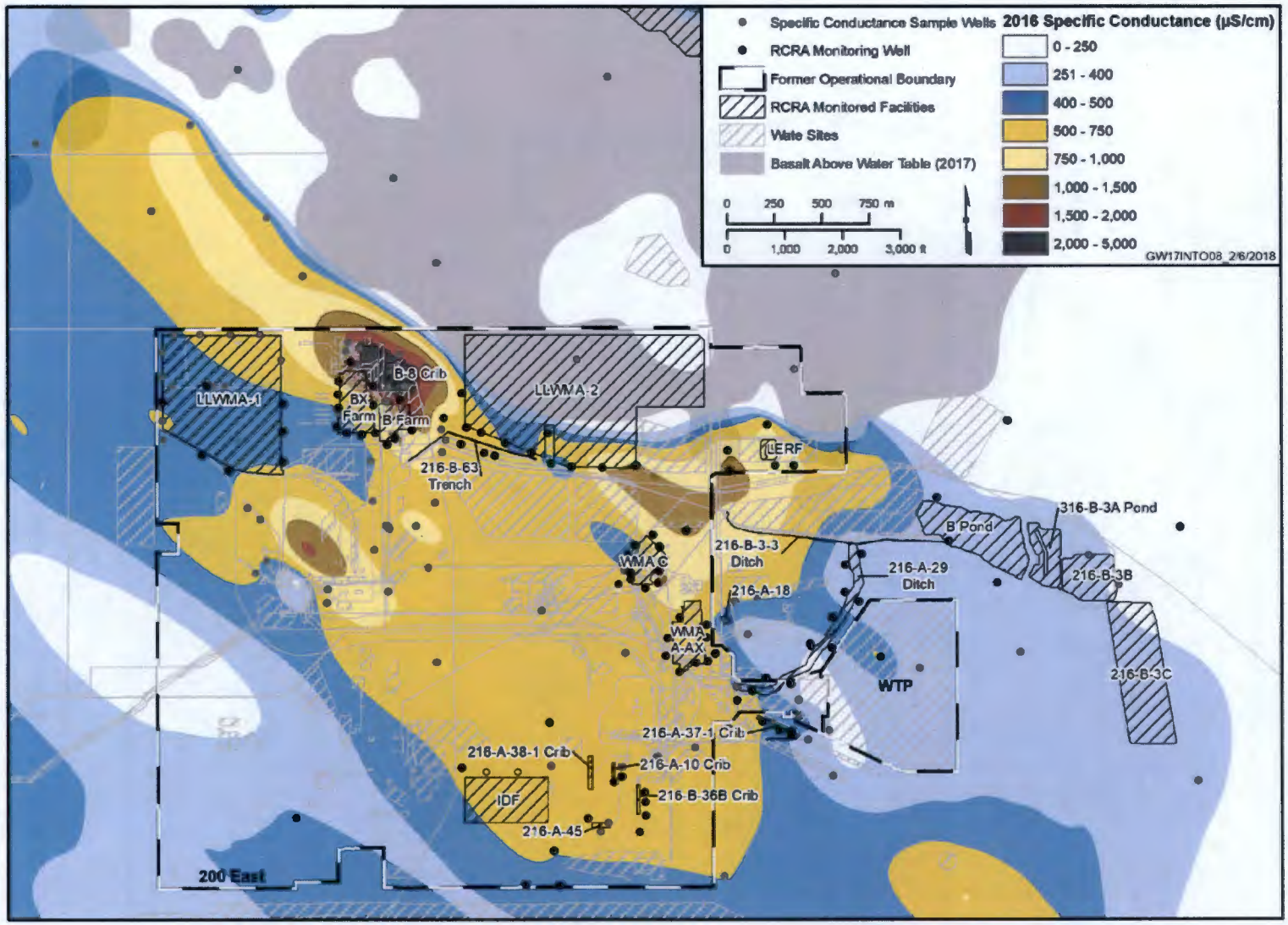


Figure 1-2. Specific Conductance in 200 East Area, 2016

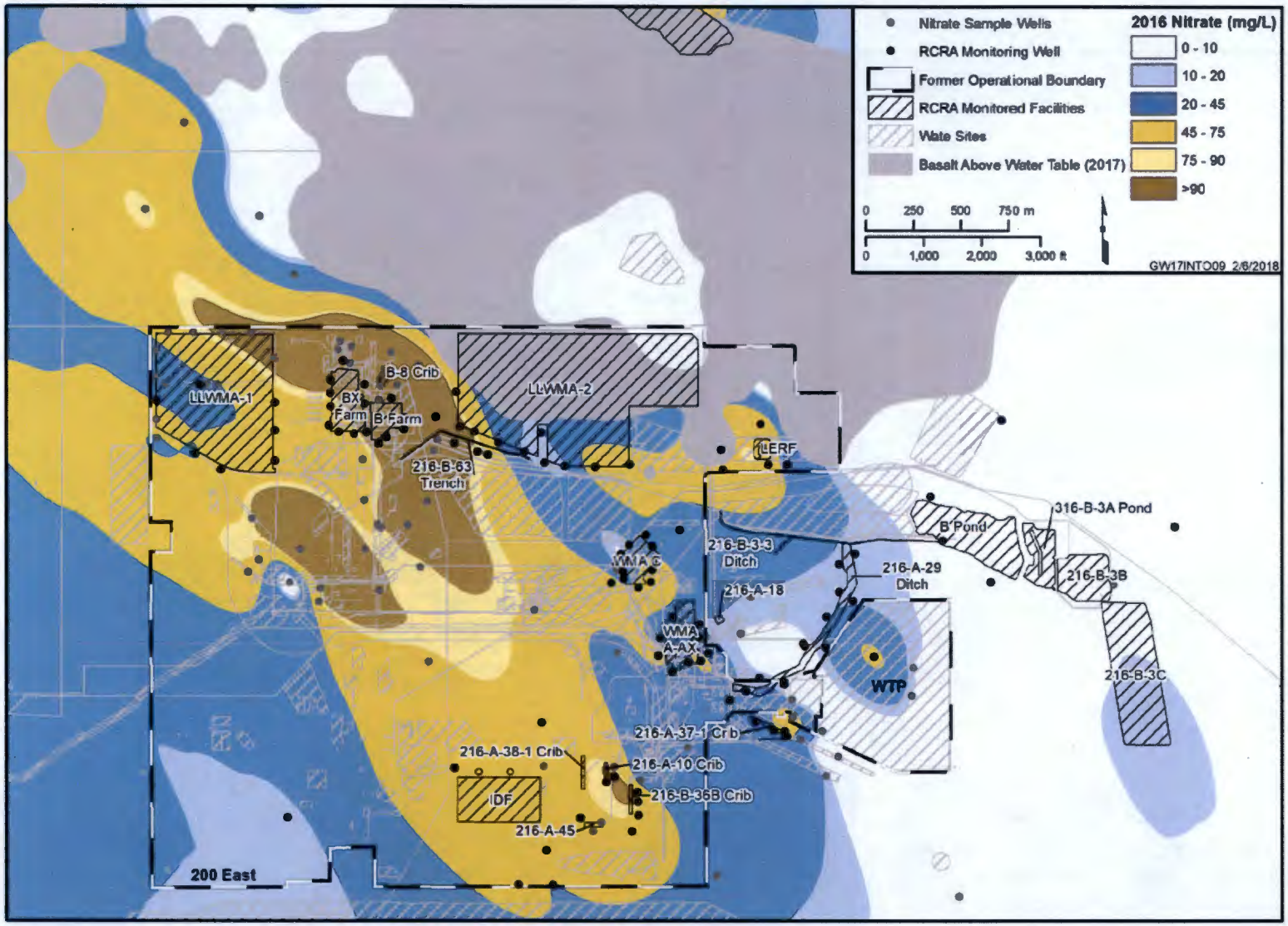


Figure 1-3. Nitrate Distribution in 200 East Area, 2016

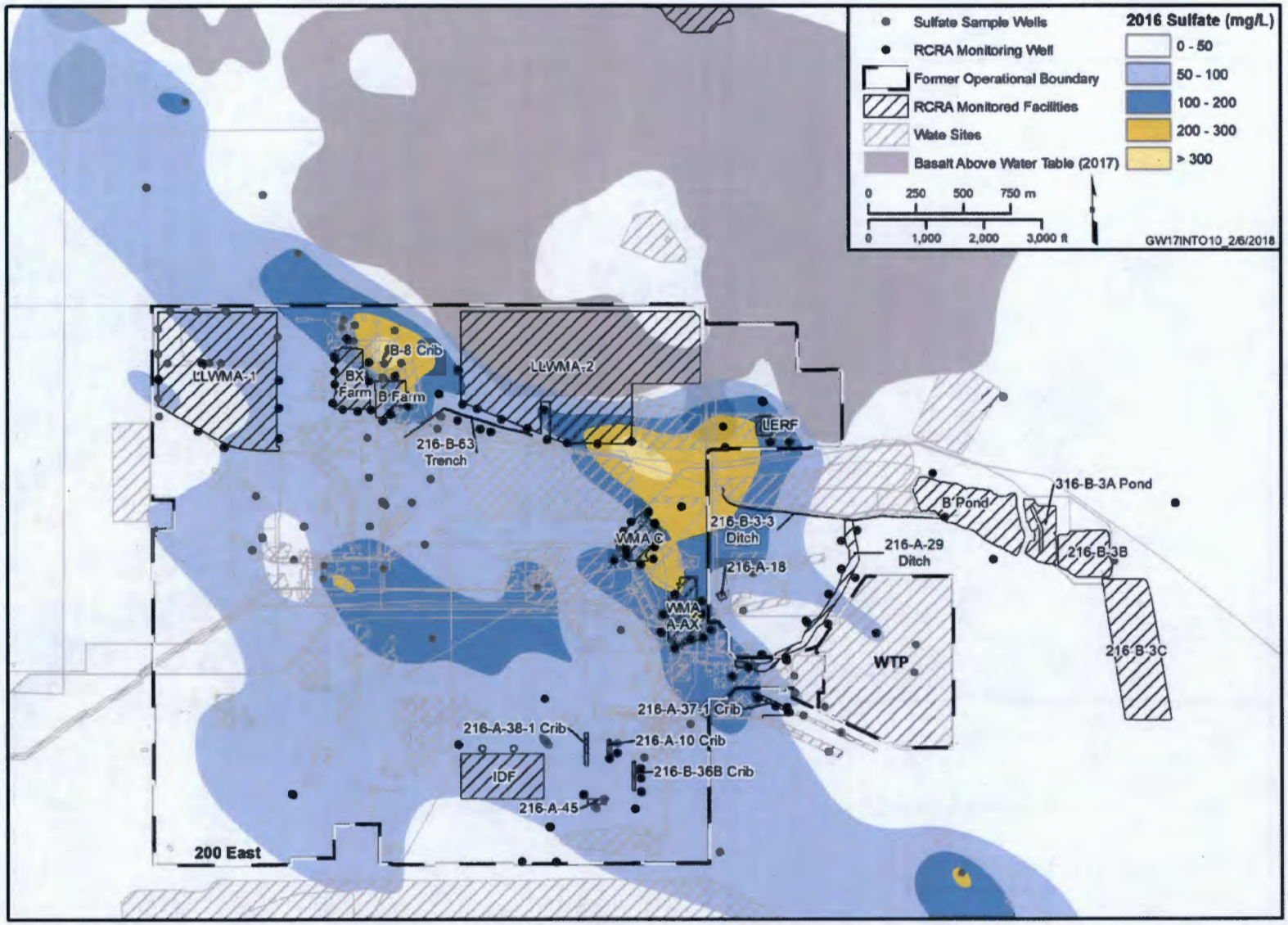


Figure 1-4. Sulfate Distribution in 200 East Area, 2016

Table 1-2. Hanford Site RCRA Monitoring Reports

Years	Publication Date	Reporting Year	Explanation
1988 to 1995	March 1	Fiscal year (October 1 to September 30)	Standalone RCRA reports. Hanford Sitewide groundwater reports published separately.
1996 to 2008	March 1	Fiscal year (October 1 to September 30)	Comprehensive report (RCRA, Hanford Sitewide, and CERCLA*).
2009 to 2014	July or August	Calendar year	Comprehensive report (RCRA, Hanford Sitewide, CERCLA*, and AEA). DOE and Ecology agreed on alternative schedules to allow the change to calendar year and extend time for reviewing the draft report.
2015 to 2017	March 1	Calendar year	Standalone RCRA report.
	August or September	Calendar year	Comprehensive report (RCRA, Hanford Sitewide, CERCLA,* and AEA). Included revisions to RCRA sections based on Ecology comments on RCRA report.

* The comprehensive groundwater annual reports include the results of CERCLA monitoring. Additional details are provided in separate annual reports for operable units with active remedial actions.

AEA = *Atomic Energy Act of 1954*
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOE = U.S. Department of Energy
Ecology = Washington State Department of Ecology
RCRA = *Resource Conservation and Recovery Act of 1976*

This page intentionally left blank.

2
Indicator Evaluation and
Detection Monitoring

2 Indicator Evaluation and Detection Monitoring

This chapter presents a discussion of the monitoring results for five DWMUs monitored under final status detection and nine monitored under interim status indicator evaluation programs.

2.1 1301-N Crib and Trench

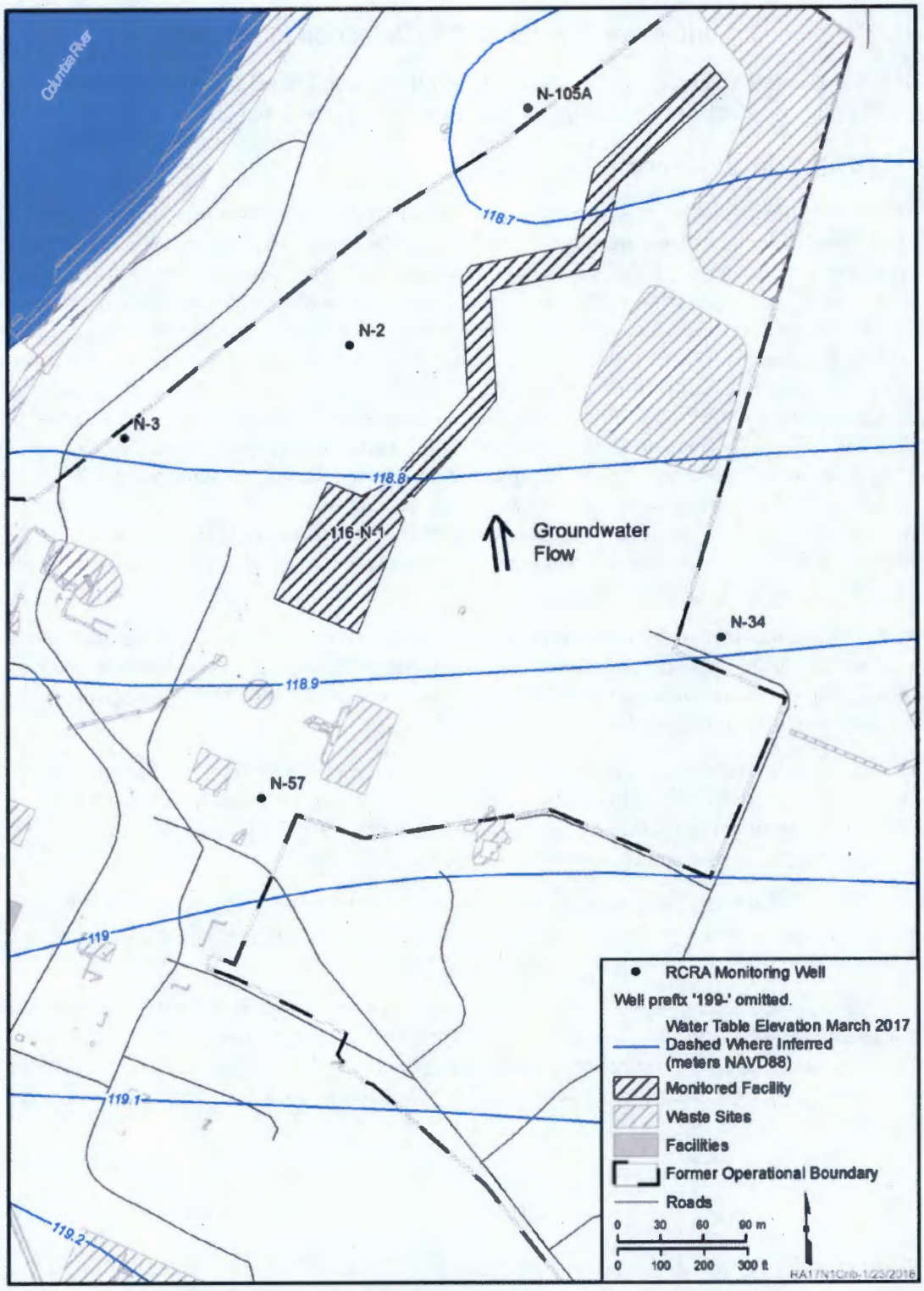
The 1301-N TSD unit, also known as the 116-N-1 waste site (Figure 2-1), was an unlined crib and trench used for disposal of liquid effluent from the 1960s through 1985. The effluent contained small quantities of dangerous waste and large volumes of radioactive waste. During remediation, the waste site was excavated from 4.6 to 6.1 m (15 to 20 ft) to remove shallow vadose zone sediment where most of the radionuclide contamination resided. The waste site was backfilled with clean soil and revegetated with native shrubs and grasses. The waste site is undergoing RCRA closure and is classified as interim closed under CERCLA (Section 1.3.2.6 of DOE/RL-2012-15, *Remedial Investigation/Feasibility Study for the 100-NR-1 and 100-NR-2 Operable Units*). Two characterization wells were drilled in 2011 as part of the 100-NR-1 and 100-NR-2 Operable Units (OUs) remedial investigation to assess groundwater protection beneath the remediated waste site. The soil characterization data indicated no remaining RCRA dangerous waste constituents above groundwater protection values. Ecology approved the request for a Class 2 Modification to the 1301-N and 1325-N Liquid Waste Disposal Facilities (LWDFs) in December 2017. The Class 2 Modification adds a clean closure option for both the 1301-N and 1325-N LWDFs. This modification is expected to become effective in 2018.

The 1301-N unit is included in the Hanford RCRA Permit, which states that groundwater monitoring during the RCRA closure period will follow the requirements of BHI-00725, *100-N Pilot Project: Proposed Consolidated Groundwater Monitoring Program*; and WHC-SD-EN-AP-038, *Groundwater Monitoring Plan for the 1301-N, 1324-N/NA, and 1325-N Sites*.

Two upgradient wells and three downgradient wells are used for RCRA monitoring (Table 2-1). The water table in the 100-N Area fluctuates in response to river stage, but it is not declining overall. The 1301-N monitoring wells produced representative samples in 2017 and are expected to do so in the future; no changes to the monitoring network were made in 2017.

The water table in March 2017 sloped to the north and northwest (Figure 2-1). Trend surface analysis of the water-level data showed a hydraulic gradient of 7.0×10^{-4} m/m. Estimates of the groundwater flow rate ranged from 0.01 to 0.26 m/d (0.05 to 0.85 ft/d) (Table 2-2).

Upgradient and downgradient wells are scheduled for sampling twice each year for RCRA contamination indicator parameters (pH, specific conductance, TOC, and TOX; Table 2-3) and turbidity, and once each year for groundwater quality and supporting parameters (chloride, iron, manganese, sodium, sulfate, and alkalinity; Table 2-4). Well sampling was conducted as scheduled in 2017 with no critical mean exceedances.



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

Figure 2-1. 1301-N Liquid Waste Disposal Facility (116-N-1 Waste Site)

Table 2-1. 1301-N Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions*
			m	ft	m	ft	m	ft		m	ft		
199-N-2	DG	1964 (P)	129.9	426.2	111.6	366.2	118.72	389.50	9/5/2017	7.1	23.3	S	None
199-N-3	DG	1964 (P)	130.2	427.1	111.6	366.1	118.48	388.72	9/6/2017	6.9	22.6	S	None
199-N-34	UG	1983 (P)	130.3	427.6	116.9	383.6	119.36	391.61	9/5/2017	2.5	8.1	S	None
199-N-57	UG	1987 (C)	122.4	401.5	117.8	386.5	119.25	391.25	9/5/2017	1.4	4.7	S	None
199-N-105A	DG	1995 (C)	118.6	389.1	111.0	364.1	118.54	388.91	9/6/2017	7.6	24.8	S	None

Note: Requirements are from WHC-SD-EN-AP-038, *Groundwater Monitoring Plan for the 1301-N, 1324-N/NA, and 1325-N Sites*, and Part V of the Hanford RCRA Permit (*Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended).

* See Table 2-3 for sample dates.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

S = semiannually

UG = upgradient

Table 2-2. Groundwater Velocity at the 1301-N Crib and Trench

Flow Direction	March 2017: north September 2017: northwest
Flow Rate (m/d)	March 2017: 0.01 to 0.26 September 2017: 0.05 to 0.87
Hydraulic Conductivity (m/d) (Source)	6.1 to 37 (PNL-8335, *Application of Three Aquifer Test Methods for Estimating Hydraulic Properties Within the 100-N Area*)
Effective Porosity	0.1 and 0.3 (assumed range)
Gradient (m/m)	March 2017: 7.0×10^{-4} September 2017: 2.4×10^{-3}
Comments	Gradient and direction determined by trend surface analysis using March and September 2017 data; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-3. 1301-N Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		**pH**		**Specific Conductance (µS/cm)**		**TOC (µg/L)**			**TOX (µg/L)**			**Lab (TOC and TOX)**	**Comment**
2017 Critical Mean[a]		**6.02**	**9.5**	**1,773**		**2,038**			**29.06**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
199-N-105A	3/3/2017	8.00	0.00	703	4	521	20.6	NC[b]	<9.0	2.2	NC[b]	TADN	TOC and TOX split
						649	34.4	640	<3.4	0.1	7.8	GEL	
	9/6/2017	8.12	0.00	664	2	550	9.5	600	<3.3	0.0	10.9	GEL	

Table 2-3. 1301-N Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
2017 Critical Mean[a]		6.02	9.5	1,773		2,038			29.06				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
199-N-2	3/3/2017	8.12	0.00	763	2	465	9.0	NC[b]	<7.7	0.0	NC[b]	TADN	TOC and TOX split
						<720	0.0	1640	<4.8	4.6	20.4	TASL	
	9/5/2017	8.19	0.01	632	1	<500	0.0	1,390	<2.4	0.4	18.2	TASL	
199-N-3	3/3/2017	7.45	0.00	878	0	<720	0.0	1,640	18.0	6.0	20.4	TASL	
	9/6/2017	7.38	0.00	950	0	<500	0.0	1,390	<5.3	2.7	18.2	TASL	
199-N-34	3/3/2017	8.15	0.00	595	1	404	34.3	NC[b]	<7.7	0.0	NC[b]	TADN	TOC and TOX split
						<720	0.0	1,640	<2.8	0.7	20.4	TASL	
	9/5/2017	8.18	0.00	704	0	<500	0.0	1,390	4.4	1.2	18.2	TASL	
199-N-57	3/6/2017	7.53	0.01	832	2	570	15.3	NC[b]	<7.7	0.0	NC[b]	TADN	TOC and TOX split
						780	23.4	640	<7.8	2.8	7.8	GEL	
	9/5/2017	7.51	0.01	1,112	2	1,088	14.8	600	12.7	3.9	10.9	GEL	

a. Critical mean values from Table 10 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring.*

b. LOQ not calculated because field blank results were not available from this laboratory.

< = one or more of the replicate values was below the detection limit

GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-4. 1301-N Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	70	232	—	
Chloride	mg/L	10	110	250*	
Iron (unfiltered)	µg/L	<30	266	300*	
Iron (filtered)	µg/L	<22.0	219.0	300*	
Manganese (unfiltered)	µg/L	0.9	33.0	50*	
Manganese (filtered)	µg/L	<1	33	50*	
Sodium (unfiltered)	µg/L	5,740	61,200	—	
Sodium (filtered)	µg/L	5,740	61,100	—	
Sulfate	mg/L	42	140	250*	
Turbidity	NTU	0.2	4.4	—	

Note: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

* Secondary drinking water standard.

< = one or more of the replicate values was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

2.2 1325-N Crib and Trench

The 1325-N TSD unit, also known as the 116-N-3 waste site (Figure 2-2), was an unlined crib and trench used to dispose liquid effluent from 1983 through 1991. The N Reactor was on cold standby beginning in 1987, but effluent was generated and disposed at a reduced rate until 1991. The effluent contained small quantities of dangerous waste and a large volume of radioactive waste. The waste site was excavated to 1.5 m (5 ft) below the engineered structure to remove vadose zone material (which contained the highest concentrations of radionuclides), backfilled with clean soil, and revegetated with native shrubs and grasses. The waste site is undergoing RCRA closure and is classified as interim closed under CERCLA (Section 1.3.2.6 of DOE/RL-2012-15). One characterization well was drilled in 2011 as part of the 100-NR-1 and 100-NR-2 OUs remedial investigation (DOE/RL-2012-15) to assess protection of groundwater beneath the remediated waste site. The soil characterization data indicated no remaining RCRA dangerous waste constituents above groundwater protection values. Ecology approved the request for a Class 2 Modification to the 1301-N and 1325-N LWDFs in December 2017. The Class 2 Modification adds a clean closure option for both the 1301-N and 1325-N LWDFs. This modification is expected to become effective in 2018.

The 1325-N unit is included in the Hanford RCRA Permit, which states that groundwater monitoring during the RCRA closure period will follow the requirements of BHI-00725 and WHC-SD-EN-AP-038.

Upgradient well 199-N-74 and downgradient wells 199-N-32, 199-N-41, and 199-N-81 monitor the site (Table 2-5). Well 199-N-28 is monitored for supporting information and previously reflected potential impacts from treated groundwater injected into a nearby well during operation of the 100-N Area P&T. Data from well 199-N-28 are not evaluated statistically. The water table in the 100-N Area fluctuates in response to river stage, but it is not declining overall. Monitoring wells produced representative samples in 2017 and are expected to do so in the future. No changes to the monitoring network were made in 2017.Groundwater flows to the north beneath the 1325-N site (Figure 2-2), turns to the northwest, and discharges to the Columbia River. The hydraulic gradient in March 2017 was 6.6×10^{-4} m/m, with the groundwater flow rate estimated from 0.01 to 0.24 m/d (0.04 to 0.80 ft/d) (Table 2-6).

In 2017, all five wells in the RCRA network were sampled twice (in March and September) for RCRA contamination indicator parameters (pH, specific conductance, TOC, and TOX; Table 2-7) and turbidity, and once (in September) for groundwater quality and supporting parameters (chloride, iron, manganese, sodium, sulfate, and alkalinity; Table 2-8). Iron exceeded the secondary drinking water standard (DWS) in samples from well 199-N-32. The presence of chromium and manganese indicates that these metals are potential corrosion products from the carbon steel well screens and casing.

The analytical laboratory did not perform TOX analyses on the September samples from wells 199-N-28 and 199-N-74. By the time this was discovered, the samples had exceeded the recommended holding times, so the network was resampled for TOX on October 15, 2017.

The TOX results from 1325-N downgradient monitoring well 199-N-41 exceeded the TOX critical mean in the September and October samples (Table 2-7). Verifications samples were collected on November 20, 2017, with split samples going to GEL Laboratory (GEL) and TestAmerica – St. Louis (TASL). The quadruplicate sample results from GEL were all above the TOX critical mean, while the TASL results were all below the critical mean; therefore, the verification splits did not confirm a TOX exceedance. Sample results from GEL had laboratory qualifiers of "C," indicating that the analyte was detected in both the associated QC blank and in the sample, and the sample concentration was less than or equal to five times the blank concentration. GEL reported 4.82 µg/L for the TOX method blank. This could be a result of inadequate column purge, and sample results may be biased high.

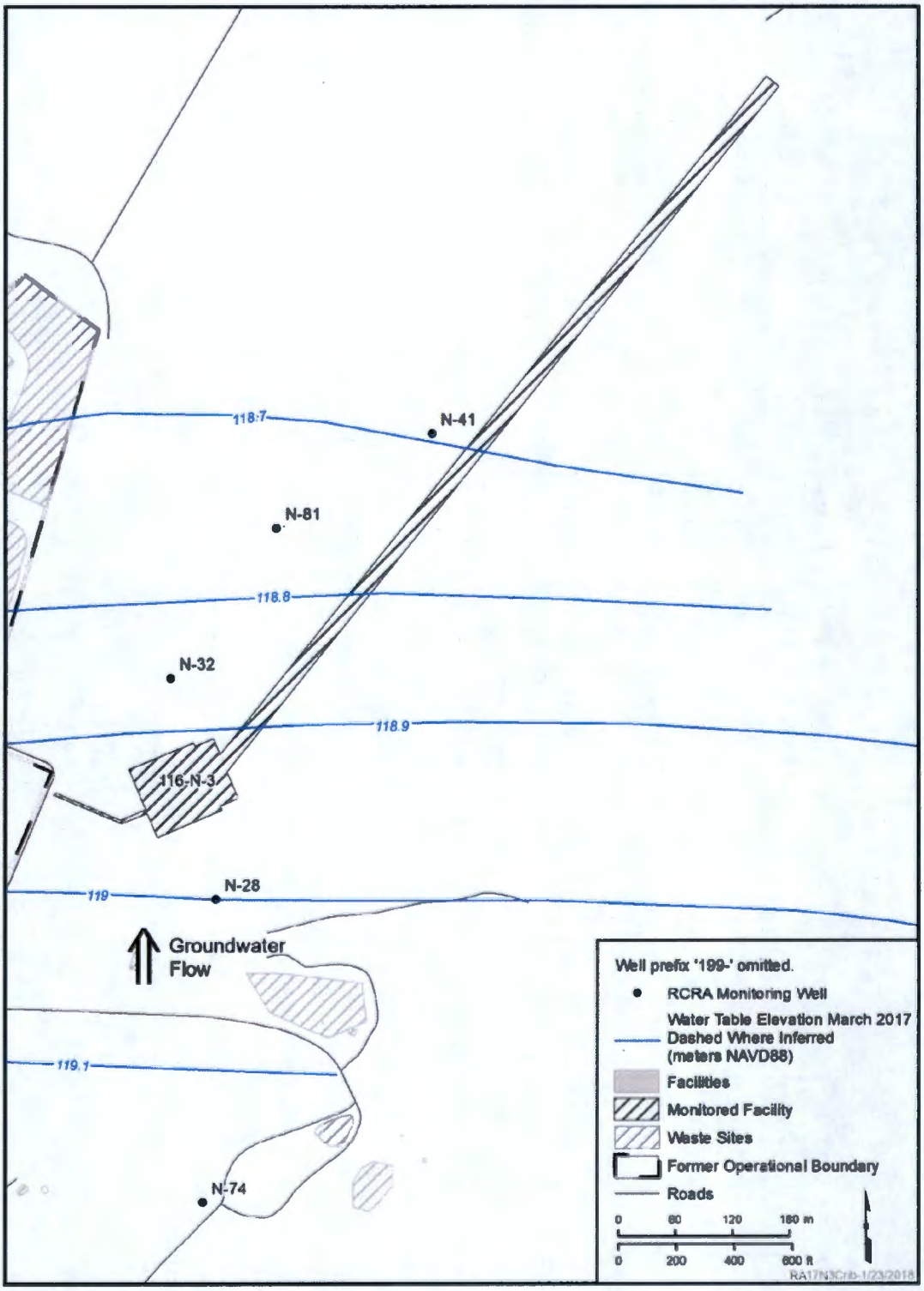
The TOX sample results from TASL had laboratory qualifiers of "N," indicating that the spike sample recovery was outside control limits. The matrix spike sample had 82% recovery, below the lower acceptable recovery range of 85% to 117%, indicating that the results may be biased low. The laboratory control sample recovery was 101% and within the acceptable recovery range of 90% to 116%; therefore, low matrix spike recovery in the sample is suspected to be from interferences in the sample matrix.

Volatile organic analysis was also performed on the well 199-N-41 verification samples because of historical chloroform detection in the area. Acetone and chloroform were the only two volatile organic analytes (VOAs) detected by both GEL and TASL. Acetone results were all either undetected or flagged as "J" (detected below the practical quantitation limit [PQL] and the reported value is an estimate). Concentrations were well below the action level (7,200 µg/L) and acetone is a common laboratory contaminant; therefore, acetone was determined not to be associated with contamination release from 1325-N. Chloroform was reported above detection limits by both GEL and TASL. The TASL results averaged 1.15 µg/L, and the GEL results averaged 1.36 µg/L (flagged as "J").

No organics were documented as having been discharged to 1325-N, and previous assessments for the 100-N Area RCRA sites identified the likely chloroform source as chlorinated water from a paint spray booth in an upgradient paint shop. Figure 2-3 shows that chloroform has historically been higher in the upgradient well for 1325-N (well 199-N-74) compared to well 199-N-41, as well as the other 1325-N downgradient monitoring wells.

The verification sample results for TOX from the splits were inconclusive in verifying an exceedance to the TOX indicator parameter. The VOA analyses indicated that the TOX is associated with chloroform. Organics were not documented as having been discharged to 1325-N, and the upgradient to downgradient well comparison indicates that the TOX exceedance at well 199-N-41 is not a release from 1325-N but rather from migration of chloroform from an upgradient source. Therefore, 1325-N remains in detection monitoring.

Statistical comparisons for specific conductance were performed in 2017 using the intrawell testing method for 1325-N, and there were no exceedances (Table 2-7). Applying intrawell testing (as identified in EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*) provides a method to account for the spatial variability in the specific conductance indicator parameter for statistical comparisons. Intrawell testing is a parametric analysis of variance method applicable for detection monitoring as provided in WAC 173-303-645(8)(h)(i). Applying the intrawell comparison for specific conductance reduces the number of false positives associated with the nonregulated sulfate present in groundwater. As discussed in previous RCRA reports (e.g., DOE/RL-2016-66, *Hanford Site RCRA Groundwater Monitoring Report for 2016*), the presence of sulfate in groundwater causes exceedances of the specific conductance critical mean in upgradient/downgradient (interwell) statistical comparisons. Sulfate is not a regulated waste constituent, but its presence results in significant spatial variability in specific conductance.



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

Figure 2-2. 1325-N Crib and Trench (116-N-3 Waste Site)

Table 2-5. 1325-N Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
199-N-28	SI	1983 (P)	127.7	419.1	116.9	383.6	119.46	391.93	9/5/2017	2.5	8.3	S	Resampled for TOX[b]
199-N-32	DG	1983 (P)	128.6	421.9	117.6	385.9	119.32	391.47	9/5/2017	1.7	5.5	S	Resampled for TOX[b]
199-N-41	DG	1984 (P)	123.7	406.0	117.6	386.0	118.63	389.19	9/11/2017	1.0	3.2	S	Resampled for TOX[b]; November verification sampling for TOX exceedance
199-N-74	UG	1991 (C)	121.5	398.5	115.3	378.2	119.58	392.33	9/5/2017	4.3	14.1	S	Resampled for TOX[b]
199-N-81	DG	1993 (C)	119.9	393.4	113.9	373.6	119.18	391.00	9/5/2017	5.3	17.4	S	Resampled for TOX[b]

Note: Requirements are from WHC-SD-EN-AP-038, *Groundwater Monitoring Plan for the 1301-N, 1324-N/NA, and 1325-N Sites*, and Part VI of the Hanford RCRA Permit (*Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended).

a. See Table 2-7 for sample dates.

b. September TOX samples exceeded recommended holding times, so wells were resampled in October for TOX (see Table 2-7).

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

S = semiannually

SI = sampled for supporting information

TOX = total organic halides

UG = upgradient

Table 2-6. Groundwater Velocity at the 1325-N Crib and Trench

Flow Direction	March 2017: north October 2017: north-northeast
Flow Rate (m/d)	March 2017: 0.01 to 0.24 October 2017: 0.04 to 0.65
Hydraulic Conductivity (m/d) (Source)	6.1 to 37 (PNL-8335, *Application of Three Aquifer Test Methods for Estimating Hydraulic Properties Within the 100-N Area*)
Effective Porosity	0.1 and 0.3 (assumed range)
Gradient (m/m)	March 2017: 6.6×10^{-4} October 2017: 1.8×10^{-3}
Comments	Gradient and direction determined by trend surface analysis using March and October 2017 data; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-7. 1325-N Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)			TOC (µg/L)			TOX (µg/L)				
2017 Critical Mean[a]		7.59	8.5	Varies by Well			1,087			11.59				
Well	**Sample Date**	**Avg**	**SD**	**Critical Mean**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**	**Lab**	**Comment**
199-N-28	3/3/2017	8.2	—	504.8	457	—	391	10	640	3.7	0.4	7.8	GEL	
	9/5/2017	8.4	—		393	—	350	—		N/A	N/A	N/A		TOX not analyzed[b]
	10/15/2017	—	—		—	—	—	—		<4.4	0.6	11.8	GEL	Resampled for TOX[b]

Table 2-7. 1325-N Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)			TOC (µg/L)			TOX (µg/L)				
2017 Critical Mean[a]		7.59	8.5	Varies by Well			1,087			11.59				
Well	Sample Date	Avg	SD	Critical Mean	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ	Lab	Comment
199-N-32	3/3/2017	7.8	0.0	588.0	468	1	457	34	640	<4.6	1.1	7.8	GEL	
	9/5/2017	8.3	0.0		431	3	390	2		<3.3	0.0	10.9	GEL	
	10/15/2017	—	—		—	—	—	—		<3.7	0.7	11.8	GEL	Resampled for TOX[b]
199-N-41	3/3/2017	8.1	0.0	731.0	594	1	543	23	640	<4.7	1.1	7.8	GEL	TOX split sample
							—	—		<7.7	0.0	NC	TADN	
	9/11/2017	8.1	0.0		597	1	563	19		17.3	0.8	10.9	GEL	
	10/15/2017	—	—		—	—	—	—		13.9	5.0	11.8	GEL	Resampled for TOX[b]
	11/20/2017	—	—		—	—	—	—		20.1	1.2	11.8	GEL	Verification for TOX (split); see text
										10.0	0.9	17.7	TASL	

Table 2-7. 1325-N Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)			TOC (µg/L)			TOX (µg/L)				
2017 Critical Mean[a]		7.59	8.5	Varies by Well			1,087			11.59				
Well	Sample Date	Avg	SD	Critical Mean	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ	Lab	Comment
199-N-74	3/3/2017	8.1	0.0	504.8	430	0	409	33	640	<5.7	3.2	7.8	GEL	
	9/5/2017	8.1	0.0		423	3	340	7		N/A	N/A			TOX not analyzed[b]
	10/15/2017	—	—		—	0	—	—		11.4	1.2		GEL	Resampled for TOX[b]
199-N-81	3/3/2017	8.1	0.0	613.0	496	0	<720	0	1,640	10.2	0.8	20.4	TASL	
	9/5/2017	8.2	0.0		519	1	<500	0		<3.8	1.2		TASL	
	10/15/2017	—	—		—	—	—	—		7.1	4.1		TASL	Resampled for TOX[b]

Note: Yellow-highlighted cell indicates exceedances of a critical mean.

a. Critical mean values from Tables 11 and 12 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring*.

b. September samples from wells 199-N-28 and 199-N-74 exceeded recommended holding times for TOX so samples were not analyzed. All wells were resampled for TOX on October 15, 2017. LOQ not calculated because field blank results were not available from this laboratory.

< = one or more of the replicate values was below the detection limit
— = no data or not applicable
GEL = GEL Laboratory
LOQ = limit of quantitation
N/A = not applicable
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-8. 1325-N Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	69	89	—	
Chloride	mg/L	13	81	250*	
Iron (unfiltered)	µg/L	<30	881	300*	199-N-32
Iron (filtered)	µg/L	<30	604	300*	199-N-32
Manganese (unfiltered)	µg/L	<1.0	42	50	
Manganese (filtered)	µg/L	<1.0	43	50	
Sodium (unfiltered)	µg/L	6,990	15,000	—	
Sodium (filtered)	µg/L	7,270	15,400	—	
Sulfate	mg/L	73	240	250*	
Turbidity	NTU	0.4	4.4	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Highlighted cells indicate concentrations greater than the comparison value.

* Secondary drinking water standard.

— = no comparison value

NTU = nephelometric turbidity unit

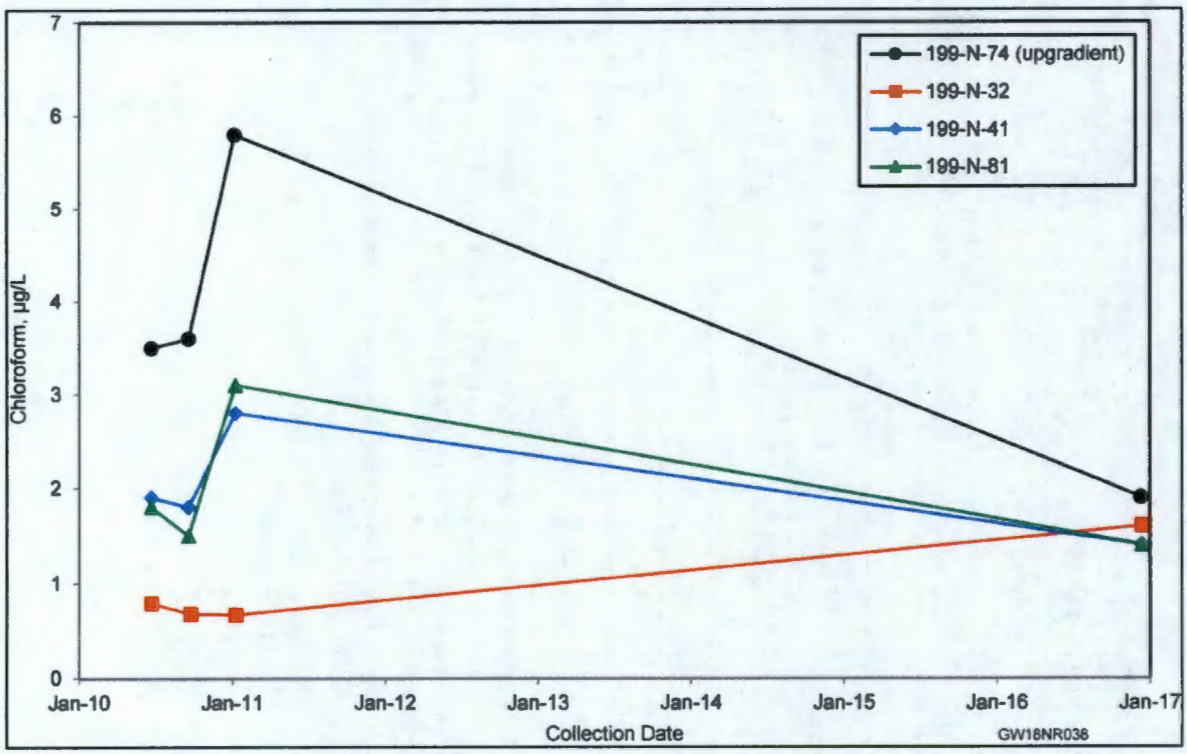


Figure 2-3. Chloroform Comparison of 1325-N Upgradient Well to Downgradient Wells

2.3 1324-N Surface Impoundment and 1324-NA Percolation Pond

The 1324-N and 1324-NA facilities, also known as the 120-N-2 and 120-N-1 waste sites (Figure 2-4), were TSD units used to treat and dispose of corrosive, nonradioactive waste from 1977 to 1990. Both units have been remediated and backfilled. The remediation consisted of removal and disposal of the site structures, which included a liner system, a small sampling shed, fencing, and other miscellaneous debris. The waste sites are undergoing RCRA closure and are classified as interim closed under CERCLA (Section 1.3.2.6 of DOE/RL-2012-15).

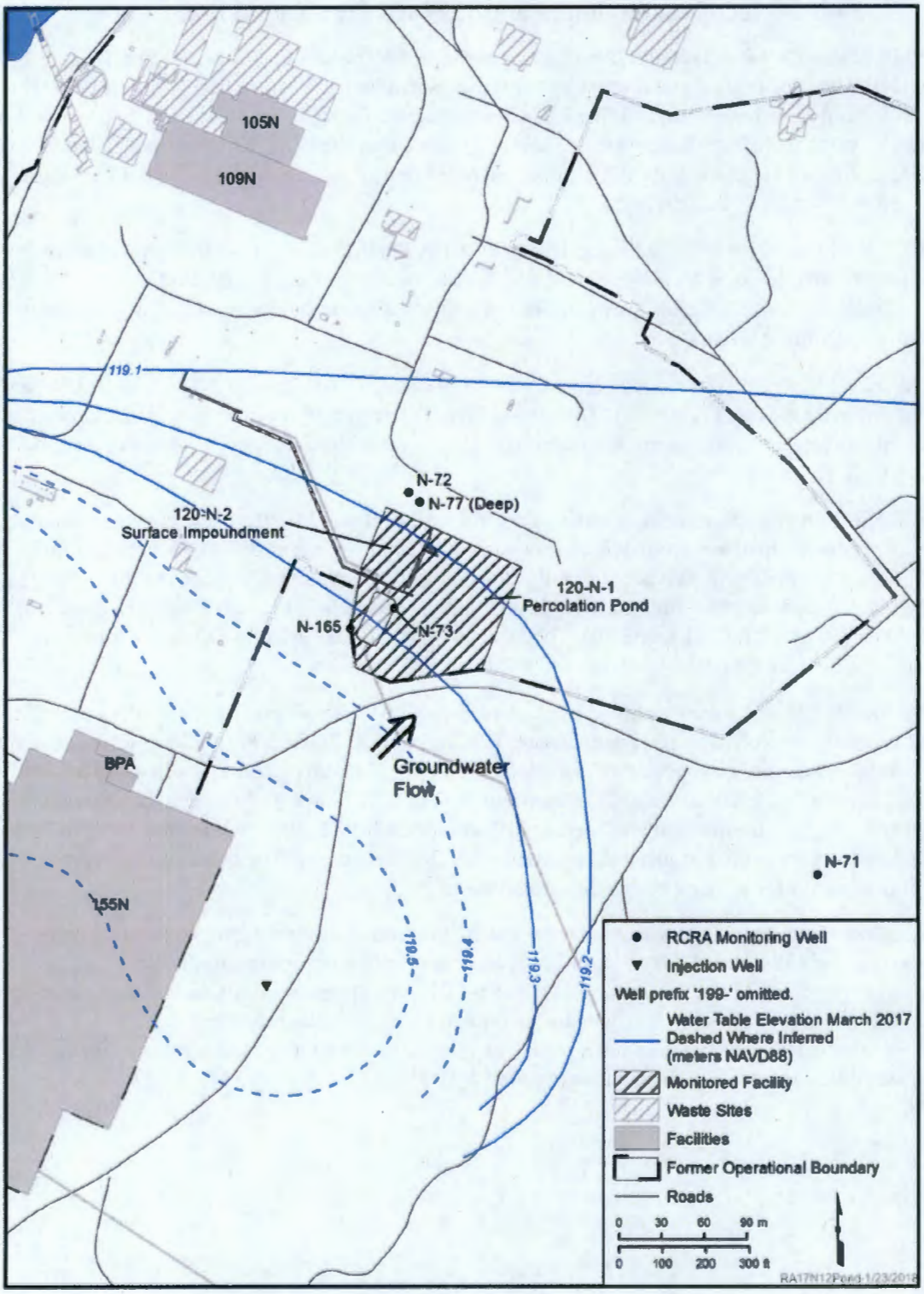
The 1324-N/NA units are included in the Hanford RCRA Permit, which states that groundwater monitoring during the RCRA closure period will follow the requirements of BHI-00725 and WHC-SD-EN-AP-038. The units are monitored as a single waste management area (WMA) due to their proximity and similar waste types.

Upgradient well 199-N-71 and downgradient wells 199-N-72, 199-N-73, 199-N-77, and 199-N-165 monitor site groundwater (Table 2-9). The 199-N-77 well screen is at the base of the unconfined aquifer, and statistical data comparisons are not performed on this well. No changes were made to the monitoring network in 2017.

The 100-KR-4 OU injection wells, located south and west of the 1324-N/NA site, have raised the water table and continued to affect groundwater flow in 2017. Trend surface analysis of March 2017 data from the 1324-N/NA monitoring well network indicated that the local water table sloped to the northeast. The hydraulic gradient was estimated to be 7.5×10^{-4} m/m in March 2017, with flow rates from 0.015 to 0.28 m/d (0.050 to 0.9 ft/d) (Table 2-10). The direction of flow has varied from northeast to north-northwest over the past 3 years.

All five monitoring wells were sampled as planned during 2017: semiannually for RCRA contamination indicator parameters (pH, specific conductance, TOC, and TOX; Table 2-11) and turbidity; and annually for groundwater quality and supporting parameters (chloride, iron, manganese, sodium, sulfate, and alkalinity; Table 2-12). The average TOC concentration in well 199-N-73 exceeded the critical mean in September. Verification split samples were collected on October 31, 2017, with splits going to GEL and TASL. Verification sample results did not confirm a TOC exceedance. The quadruplicate sample results from both laboratories were all below the critical mean.

Statistical comparisons for specific conductance were performed using the intrawell testing method (Section 2.2) for 1324-N and 1324-NA in 2017, and there were no exceedances (Table 2-11). As discussed in previous RCRA reports (e.g., DOE/RL-2016-66), the presence of sulfate in groundwater causes exceedances of the specific conductance critical mean in downgradient to upgradient (interwell) statistical comparisons. Sulfate is a not a regulated waste constituent, but its presence results in significant spatial variability in specific conductance (Section 1.4).



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

Figure 2-4. 1324-N Surface Impoundment and 1324-NA Percolation Pond (120-N-2 and 120-N-1 Waste Sites)

Table 2-9. 1324-N/NA Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions*
			m	ft	m	ft	m	ft		m	ft		
199-N-71	UG	1991 (C)	121.8	399.6	115.5	378.9	119.61	392.41	9/6/2017	4.1	13.5	S	None
199-N-72	DG	1991 (C)	121.2	397.7	114.9	376.9	119.29	391.36	9/6/2017	4.4	14.4	S	None
199-N-73	DG	1991 (C)	121.2	397.7	115.0	377.2	119.37	391.62	9/6/2017	4.4	14.4	S	October verification sample for TOC exceedance
199-N-77	DG deep	1992 (C)	114.2	374.7	111.2	364.8	119.32	391.47	9/6/2017	8.1	26.7	S	None
199-N-165	DG	2008 (C)	120.0	393.8	115.5	378.8	119.32	391.46	9/6/2017	3.9	12.7	S	None

Note: Requirements are from WHC-SD-EN-AP-038, *Groundwater Monitoring Plan for the 1301-N, 1324-N/NA, and 1325-N Sites*, and the Hanford RCRA Permit (*Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended).

* See Table 2-11 for sample dates.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

S = semiannually

TOC = total organic carbon

UG = upgradient

Table 2-10. Groundwater Velocity at 1324-N/NA Facilities

Flow Direction	March 2017: northeast September 2017: northwest
Flow Rate (m/d)	March 2017: 0.015 to 0.28 September 2017: 0.016 to 0.29
Hydraulic Conductivity (m/d) (Source)	6.1 to 37 (PNL-8335, *Application of Three Aquifer Test Methods for Estimating Hydraulic Properties Within the 100-N Area*)
Effective Porosity	0.1 and 0.3 (assumed range)
Gradient (m/m)	March 2017: 7.5×10^{-4} September 2017: 7.8×10^{-4}
Comments	Gradient is affected by groundwater mound from 100-K injection wells south and southwest of 1324-N/NA; local gradient and direction were determined by trend surface analysis using March and September 2017 water-level measurements from five wells; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradient and Velocity Calculations for RCRA Sites in 2017.*

Table 2-11. 1324-N/NA Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		**pH**		**Specific Conductance (µS/cm)**			**TOC (µg/L)**			**TOX (µg/L)**			**Lab (TOC and TOX)**	**Comment**
2017 Critical Mean[a]		**7.37**	**8.72**	**Varies by Well**			**1,061**			**31.90**				
Well	**Sample Date**	**Avg**	**SD**	**Critical Mean**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
199-N-165	3/2/2017	8.45	0.00	1,028	608	5	648	31	640	7.4	1.2	7.8	GEL	TOC and TOX split samples
	3/2/2017						449	39	NC[b]	12.1	2.2	NC[b]	TADN	
	9/6/2017	8.47	0.01		720	1	761	21	600	4.6	0.3	10.9	GEL	

Table 2-11. 1324-N/NA Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)			TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
2017 Critical Mean[a]		7.37	8.72	Varies by Well			1,061			31.90				
Well	Sample Date	Avg	SD	Critical Mean	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
199-N-71	3/2/2017	8.18	0.00	471	375	0	<720	0	1,640	<11.7	5.6	20.4	TASL	
	9/6/2017	8.26	0.00		388	0	765	114	1,390	4.0	0.7	18.2	TASL	
199-N-72	3/2/2017	8.46	0.00	1,292	853	1	681	14	640	7.3	0.7	7.8	GEL	
	9/6/2017	8.49	0.00		744	2	527	10	600	8.0	1.2	10.9	GEL	
199-N-73	3/2/2017	8.34	0.00	1,045	730	1	<720	0	1,640	<5.4	3.8	20.4	TASL	
	9/6/2017	8.31	0.00		928	5	1,600	308	1,390	4.2	0.9	18.2	TASL	
	10/31/2017	8.48	0.00		571	4	480	12	540	—	—	—	GEL	Verification sampling for TOC (split); exceedance not confirmed
							<500	0	1,540	—	—	—	TASL	
199-N-77	3/2/2017	8.57	0.00	NC[c]	598	4	<720	0	1,640	19.7	1.0	20.4	TASL	
	9/6/2017	8.64	0.00		589	2	482	54	600	3.6	0.2	10.9	GEL	

Note: Yellow-highlighted cell indicates exceedance of a critical mean.

a. Critical mean values from Tables 13 and 14 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring*.

b. LOQ not calculated because field blank results were not available from this laboratory.

c. Critical mean not calculated for well 199-N-77 (deep well); no statistical comparisons required.

< = one or more of the replicate values was below the detection limit
— = no data or not applicable
GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-12. 1324-N/NA Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	106	190	—	
Chloride	mg/L	12	35	250*	
Iron (unfiltered)	µg/L	<30	280	300*	
Iron (filtered)	µg/L	<22	41	300*	
Manganese (unfiltered)	µg/L	<0.47	7.2	50*	
Manganese (filtered)	µg/L	<0.63	1.4	50*	
Sodium (unfiltered)	µg/L	23,000	174,000	—	
Sodium (filtered)	µg/L	23,000	172,000	—	
Sulfate	mg/L	54	220	250*	
Turbidity	NTU	0.82	6.3	—	

Note: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

* Secondary drinking water standard.

— = no comparison value

NTU = nephelometric turbidity unit

2.4 216-A-36B Crib

The 216-A-36B Crib is a TSD unit located in the southeastern portion of the 200 East Area (Figures 1-1 and 2-5). The crib was 7 m (23 ft) deep, 150 m (490 ft) long, and 2.3 to 3.4 m (7.5 to 11.2 ft) wide at the base; the sides sloped at 1:1.5. The crib construction includes 7 m (23 ft) of naturally revegetated clean backfill soil. The crib was originally part of the 180 m (590 ft) long 216-A-36 Crib, which received Plutonium-Uranium Extraction (PUREX) Plant effluent from September 1965 to March 1966.
In March 1966, the northernmost 30 m (98 ft) of the crib was isolated with a grout barrier. The southern portion of the crib (now known as 216-A-36B) is the only portion regulated as a RCRA TSD.
The 216-A-36B Crib operated from March 1966 to October 1972 and was reactivated in November 1982 for the PUREX restart. It received 290 million L (76.6 million gal) of PUREX ammonia scrubber distillate and was permanently removed from service in September 1987. In May 2010, 15 cm (6 in.) of gravel was added to the surface of the 216-A-36B Crib.

The 216-A-36B, 216-A-10, and 216-A-37-1 Cribs were monitored under a RCRA interim status groundwater quality assessment program before 2011. The 216-A-10 Crib was officially closed and removed from the Hanford RCRA Permit on March 30, 2010. Since January 2011, the two remaining cribs (216-A-36B and 216-A-37-1) continue in RCRA interim status monitoring but are under indicator evaluation programs because the groundwater constituent detected (i.e., nitrate) is not a dangerous waste or dangerous waste constituent. In 2017, two upgradient wells and four downgradient wells were monitored for the 216-A-36B Crib (Figure 2-5 and Table 2-13).

In November 2016, a revised groundwater monitoring plan was issued for 216-A-36B Crib (DOE/RL-2010-93, Rev. 2, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*). The revised plan added one existing upgradient well (299-E17-1) and one existing downgradient well (299-E17-15) to the network. The two newly incorporated wells were sampled quarterly for one year for contamination indicator parameters, groundwater quality parameters, and site-specific constituents. Additional upgradient and downgradient wells are proposed for the current network when an updated monitoring plan for 216-A-36B is implemented.

The January and March herbicide results were not valid because laboratory control sample recovery limits were not met. The entire 216-A-36B network was then sampled two extra times, including events for February and March.

The low-gradient groundwater contour map for 2017 indicated groundwater flow to the east-southeast near the 216-A-36B Crib (Figure 2-6). The calculated groundwater flow rate is 0.0001 m/d (0.0004 ft/d) (Table 2-14). Table 2-13 summarizes water-level information for the 216-A-36B monitoring network. The average rate of water-level decline between 2012 and 2017 was 3.0 cm/yr (1.2 in./yr). Based on this information, the monitoring wells all have adequate water in the screened interval for continued sampling.

The 216-A-36B Crib groundwater wells were monitored in 2017 for RCRA indicator parameters (TOC, TOX, pH, and specific conductance; Table 2-15) and water quality parameters (Table 2-16). There were no exceedances of the 2017 critical mean values.

Groundwater quality parameters monitored for the site include chloride, iron, manganese, nitrate, phenols, sodium, and sulfate. Samples for analyses of alkalinity, calcium, magnesium, and potassium are collected to support cation-anion balance calculations for the calcium-bicarbonate-type groundwater (Table 2-16). In 2017, nitrate continued to be above the DWS in all of the network wells, and these levels are associated with a regional nitrate plume (Figure 1-3). Nitrate is a constituent of interest at the 216-A-36B Crib because it is a breakdown product of nitric acid, which was disposed to the 216-A-10 Crib, 120 m (390 ft) to the west.

Iron and manganese concentrations exceeded the secondary DWSs in samples from several wells (Table 2-16), with the highest concentrations in wells 299-E17-1 and 299-E17-18. These wells will be scheduled for video logging in 2018 to determine the cause of the elevated metals.

Volatile organic compounds (VOCs) were monitored at the 216-A-36B Crib in 2017 to determine if previous historical, intermittent, low-level detections of trichloroethene (TCE) were still occurring. Statistical comparisons of upgradient and downgradient concentrations of TCE are not required under the current monitoring plan. During 2017, four network wells had TCE detections below the DWS of 5 µg/L:

- Upgradient well 299-E17-19 at 1.56 (J) to 1.73 (J) µg/L
- Downgradient well 299-E17-14 at 0.74 (J) to 0.86 (J) µg/L
- Downgradient well 299-E17-15 at 0.40 (J) to 0.42 (J) µg/L
- Downgradient well 299-E17-16 at 0.57 (J) to 0.76 (J) µg/L

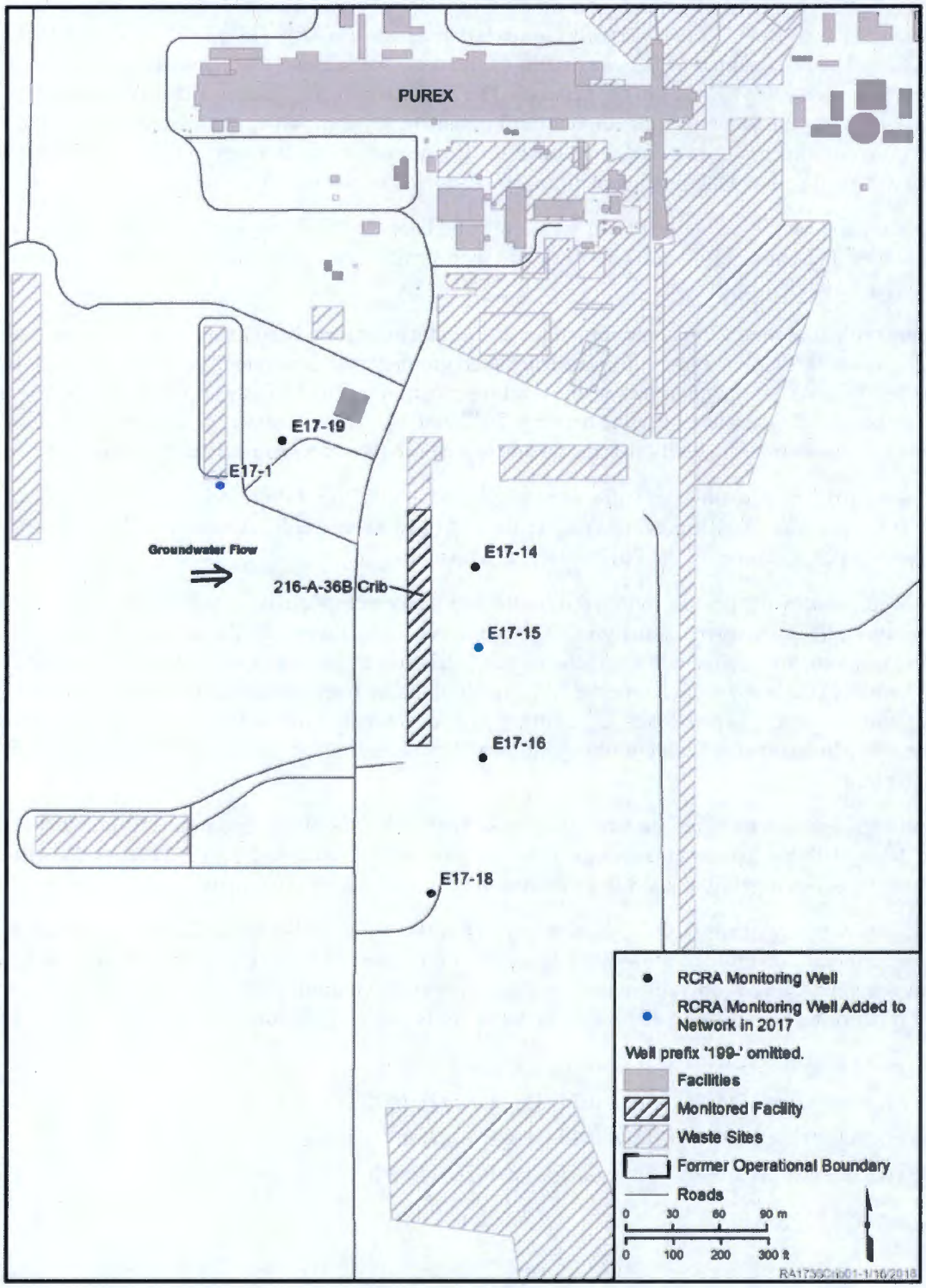


Figure 2-5. 216-A-36B Crib

Table 2-13. 216-A-36B Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
299-E17-1	UG	1955 (P)	127.2	417.4	118.1	387.4	121.5	398.7	7/25/2017	3.4	11.3	Q	Sampled with bailer; extra sampling events; see text
299-E17-14	DG	1988 (C)	126.0	413.2	119.2	391.2	124.64	408.92	7/20/2017	5.4	17.7	S	Extra sampling events; see text
299-E17-15	DG	1988 (C)	125.5	411.8	119.6	392.3	121.35	398.14	7/20/2017	1.8	5.8	Q	Extra sampling events; see text
299-E17-16	DG	1988 (C)	125.4	411.4	119.3	391.4	121.55	398.78	7/20/2017	2.2	7.4	S	Extra sampling events; see text
299-E17-18[b]	DG	1988 (C)	125.8	412.6	118.8	389.8	121.63	399.04	7/20/2017	2.8	9.3	S	Extra sampling events; see text
299-E17-19[b]	UG	1988 (C)	126.8	416.0	119.9	393.4	121.44	398.41	7/20/2017	1.5	5.0	S	Extra sampling events; see text

Note: Requirements are from DOE/RL-2010-93, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib.*

a. See Table 2-15 for sample dates.

b. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

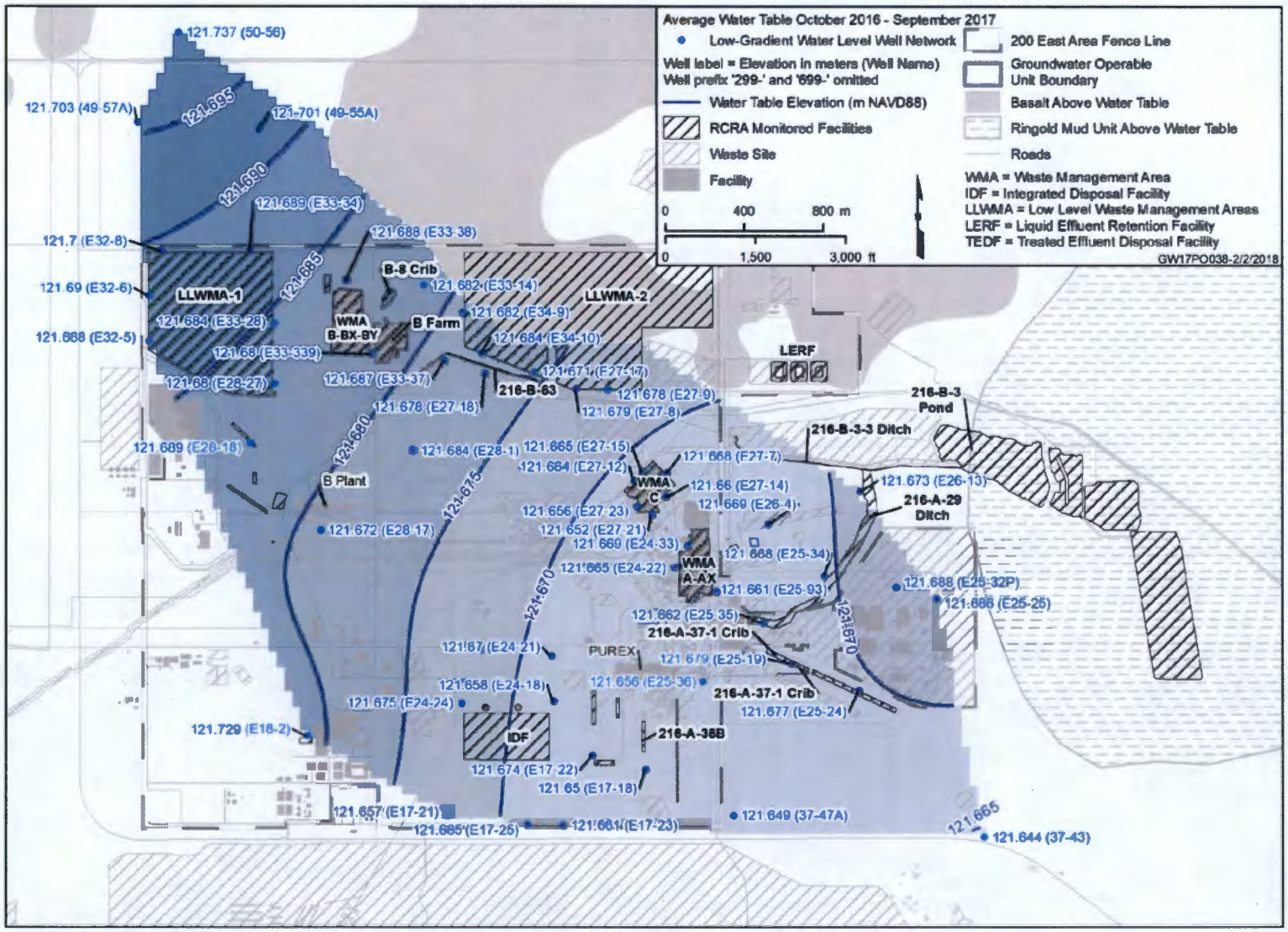
DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

Q = quarterly (for first year; semiannually thereafter)

S = semiannually

UG = upgradient



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

Figure 2-6. 200 East Water Table Based on Low-Gradient Monitoring Network

Table 2-14. Groundwater Velocity at the 216-A-36B Crib

Flow Direction	East-southeast
Flow Rate (m/d)	0.0001
Hydraulic Conductivity (m/d) (Source)	3.26 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.1 (CP-57037)
Gradient (m/m)	3.41×10^{-6}
Comments	Gradient and flow direction represent average of October 2016 through September 2017; based on trend surface analysis on low-gradient well network; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-15. 216-A-36B Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment[b]
Critical Mean[a]		7.12	8.67	1,066		804			35.75				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E17-1	1/24/2017	7.69	—	773	—	469	16	640	<3.33	0.00	7.8	GEL	No field quads
	2/24/2017	7.70	—	585	—	—	—	—	—	—	—	—	No field quads
	3/10/2017	7.86	—	669	—	425	95	640	<3.70	0.49	7.8	GEL	No field quads
	4/6/2017	7.10	—	620	—	192	39	NC	<15.65	0.43	NC	TADN	No field quads
	4/26/2017	7.56	0.35	620	11	<330	0	590	<4.19	1.49	8.3	GEL	
	7/25/2017	8.08	0.05	605	4	391	16	600	<3.33	0.00	10.9	GEL	
	10/10/2017	7.99	—	653	—	1,113	451	540	<5.14	2.98	11.8	GEL	No field quads

Table 2-15. 216-A-36B Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment[b]
Critical Mean[a]		7.12	8.67	1,066		804			35.75				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E17-14	1/23/2017	7.96	0.01	702	0	<720	0	1,640	<2.78	1.00	20.4	TASL	
	2/24/2017	7.73	0.01	744	9	<720	0	1,640	—	—	—	TASL	
	3/10/2017	7.93	0.01	715	3	<720	0	1,640	5.00	1.99	20.4	TASL	
	7/20/2017	7.82	0.00	743	11	<500	0	1,390	4.03	2.19	18.2	TASL	
299-E17-15	1/24/2017	8.04	0.02	612	7	<720	0	1,640	<3.70	2.77	20.4	TASL	
	2/24/2017	7.86	0.00	629	2	<720	0	1,640	—	—	—	TASL	
	3/10/2017	8.08	0.01	609	3	<720	0	1,640	6.38	0.89	20.4	TASL	
	4/6/2017	8.13	0.00	614	1	<720	0	1,520	<2.10	0.00	20.4	TASL	
	4/26/2017	7.89	0.02	614	1	<745	43	1,520	<2.10	0.00	20.4	TASL	
	7/20/2017	8.01	0.00	644	6	<500	0	1,390	<2.70	0.64	18.2	TASL	
	10/10/2017	7.95	0.01	644	3	<500	0	1,540	6.70	0.68	17.7	TASL	
299-E17-16	1/24/2017	7.97	0.04	587	0	367	6	640	<3.33	0.00	7.8	GEL	
	2/24/2017	7.73	0.00	561	0	—	—	—	—	—	—	—	
	3/10/2017	7.97	0.00	589	0	<349	33	640	<3.50	0.29	7.8	GEL	
	7/20/2017	7.80	0.01	621	1	<360	52	600	<3.33	0.00	10.9	GEL	

Table 2-15. 216-A-36B Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment[b]
Critical Mean[a]		7.12	8.67	1,066		804			35.75				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E17-18	1/24/2017	7.98	0.00	578	3	<720	0	1,640	<25.58	23.62	20.4	TASL	TOX flagged as "YQ"
	2/24/2017	7.70	0.00	563	1	<720	0	1,640	—	—	—	TASL	
	3/10/2017	7.93	0.00	583	0	<720	0	1,640	<3.45	2.01	20.4	TASL	
	7/20/2017	7.82	0.01	606	2	<500	0	1,390	<2.30	0.35	18.2	TASL	
299-E17-19	1/23/2017	7.91	0.00	694	1	<330	0	640	<4.16	0.60	7.8	GEL	
	2/24/2017	7.64	0.00	679	3	—	—	—	—	—	—	—	
	3/10/2017	7.86	0.00	689	2	<330	0	640	<3.66	0.58	7.8	GEL	
	7/20/2017	7.68	0.03	677	11	<333	4	600	<3.33	0.00	10.9	GEL	

Note: Highlighted cell indicates exceedance of a critical mean.

a. Critical mean values from Table 18 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring.*

b. See text for explanation of extra sampling events.

< = one or more of the replicate values was below the detection limit
— = no data or not applicable
GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
Q = associated quality control sample is out of limits
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides
Y = result suspect

Table 2-16. 216-A-36B Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity[a]	mg/L	110	137	—	
Calcium (unfiltered)	µg/L	45,700	76,300	—	
Calcium (filtered)	µg/L	50,400	77,200	—	
Chloride	mg/L	14	18	250[b]	
Dissolved oxygen	mg/L	6.0	9.6	—	
Fluoride	mg/L	0.2	0.427	4[c]	
Iron (unfiltered)	µg/L	<30	35,400	300[b]	299-E17-1, 299-E17-15
Iron (filtered)	µg/L	<22	8,070[d]	300[b]	299-E17-1, 299-E17-16
Magnesium (unfiltered)	µg/L	15,500	23,200	—	
Magnesium (filtered)	µg/L	16,900	23,300	—	
Manganese (unfiltered)	µg/L	<0.9	417	50[b]	299-E17-1, 299-E17-18
Manganese (filtered)	µg/L	<0.9	49.1	50[b]	
Nitrate	mg/L	57.5	120	45[e]	All
Nitrite	mg/L	<0.046	0.591	3.3[e]	
Phenol	µg/L	<1.9	<3	2,400[f]	
Potassium (unfiltered)	µg/L	6,710	9,190	—	
Potassium (filtered)	µg/L	6,690	8,900	—	
Sodium (unfiltered)	µg/L	23,600	31,200	—	
Sodium (filtered)	µg/L	24,700	32,700	—	
Sulfate	mg/L	64	100	250[b]	
Temperature	°C	15.3	32	—	
Turbidity	NTU	0.32	66.7	—	
Detected Volatile Organic Analytes[g]					
Chloroform	µg/L	<0.13	0.3	80[c]	
Trichloroethene	µg/L	<0.25	1.73	5[c]	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

Table 2-16. 216-A-36B Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments

a. Includes total and bicarbonate alkalinity.

b. Secondary drinking water standard.

c. Primary drinking water standard.

d. Maximum filtered iron value is under review as a suspected error.

e. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

f. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

g. The following organics were analyzed but not detected in 2017: 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, carbon tetrachloride, methylene chloride, tetrachloroethene, and vinyl chloride.

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

2.5 216-A-37-1 Crib

The 216-A-37-1 Crib TSD unit is located east of the 200 East Area (Figures 1-1 and 2-7). The crib was 5.2 m (17.1 ft) deep, 213 m (699 ft) long, and 33 m (108 ft) wide at the base, with sides sloped at 1:1. The crib operated from March 1977 through April 1989 and was used to percolate 242A evaporator process condensate to the soil column. It received spent halogenated and nonhalogenated solvents, as well as ammonia. During its operational life, this crib received 380 million L (98 million gal) of process condensate. Discharge of the evaporator process condensate to the crib continued through April 1989, when it was removed from service. In 1994, the bottom of the diversion box was filled with grout to prevent inadvertent discharges to the crib. In July 2000, vent risers from the crib were sealed to prevent potential passive radioactive emissions.

The 216-A-36B, 216-A-10, and 216-A-37-1 Cribs were monitored under a RCRA interim status groundwater quality assessment program before 2011. The 216-A-10 Crib was officially closed and removed from the Hanford RCRA Permit on March 30, 2010. Since January 2011, the two remaining cribs (216-A-36B and 216-A-37-1) continue in RCRA interim status monitoring but are under indicator evaluation programs because the groundwater constituent detected (i.e., nitrate) is not a dangerous waste or dangerous waste constituent.

In 2017, two upgradient wells and four downgradient wells were monitored for the 216-A-37-1 Crib (Table 2-17). The average rate of water-level decline between 2012 and 2017 was 3.6 cm/yr (1.4 in./yr). Based on this information, the monitoring wells all have adequate water in the screened interval for continued sampling.

Near the 216-A-37-1 Crib, the estimated groundwater flow in 2017 was toward the southeast. Flow directions are influenced by a northwest-southeast-trending paleochannel with high-permeability Hanford formation sediments near the crib, the Ringold lower mud unit at the water table east of the 200 East Area, and the higher water table elevations to the west and north. This interpretation of flow direction is supported mainly by the distribution of plumes emanating from near the crib and recent efforts to improve the accuracy of water-level measurements in the southeastern portion of the 200 East Area. The gradient magnitude for 2017 was calculated as 4.4×10^{-6} m/m. The estimated groundwater flow rate is 0.38 m/d (1.2 ft/d) (Table 2-18). Ongoing gradient network evaluation near the crib is expected to provide greater certainty in calculations of groundwater flow in this area.

Based on current groundwater flow interpretations, DOE/RL-2010-92, Rev. 2, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant,* was implemented in April 2017. The revised plan incorporates the current groundwater flow direction interpreted from the low-gradient monitoring network, presents new geologic cross sections from data added to the Hanford South Geoframework Model (ECF-Hanford-13-0029, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington, Fiscal Year 2016 Update*), reviews and summarizes historical monitoring results in relationship to changing flow directions, and updates the conceptual site model. To improve monitoring capabilities upgradient and downgradient of the crib, the updated monitoring plan added an existing upgradient well and included a new downgradient well. Although not directly downgradient, use of existing network well 299-E25-20 will continue until the new downgradient well is installed because of its proximity to the crib and its use in delineating the nitrate plume associated with 216-A-37-1.

DOE/RL-2010-92, Rev. 3 was issued on September 27, 2017. This revision incorporates new downgradient monitoring well 299-E25-95, which was proposed under Rev. 2.

The 216-A-37-1 Crib network wells are monitored for RCRA indicator parameters (TOC, TOX, pH, and specific conductance; Table 2-19), temperature, turbidity, water quality parameters, and other constituents (Table 2-20). Water-level measurements are collected semiannually. The network wells were sampled as scheduled in 2017. Analytical results for RCRA indicator parameters obtained from the 216-A-37-1 Crib network downgradient wells did not exceed the 2017 critical mean values, so the site remains in interim status indicator evaluation monitoring.

Manganese continued to exceed the 50 µg/L secondary DWS in filtered and unfiltered samples from wells 299-E25-19 and 299-E25-20 in 2017 (Table 2-20). Elevated concentrations of iron in well 299-E25-19 correspond with increased unfiltered chromium and nickel, which is associated with high turbidity and potential well casing corrosion. Chromium and nickel analyses are not monitoring plan requirements, but data were available from the required metals analyses. A video log of well 299-E25-19 in November 2016 documented significant well incrustation with iron oxide and biological material. The well was cleaned, and the post-cleaning video revealed debris from a damaged well pump within the sump. Sampling continued in 2017, but if the debris cannot be removed, the well will be evaluated for decommissioning and replacement.

Nitrate concentrations exceeded the DWS equivalent in downgradient wells 299-E25-20 and 299-E25-95. The exceedance at well 299-E25-95 was from the initial sampling event for that well. Nitrate concentrations at well 299-E25-20 have been above the DWS since March 2011. Nitrate concentrations in well 299-E25-17 are increasing and reached 35.9 mg/L in 2017.

Arsenic exceeded the 10 µg/L DWS in well 299-E25-35 in April 2017 (11.5 µg/L in filtered and unfiltered samples), but concentrations were below the standard for the remainder of the year. Gross beta was reported at 168 pCi/L in new well 299-E25-95 during the first sampling event in October 2017, which exceeded the comparison value of 50 pCi/L.

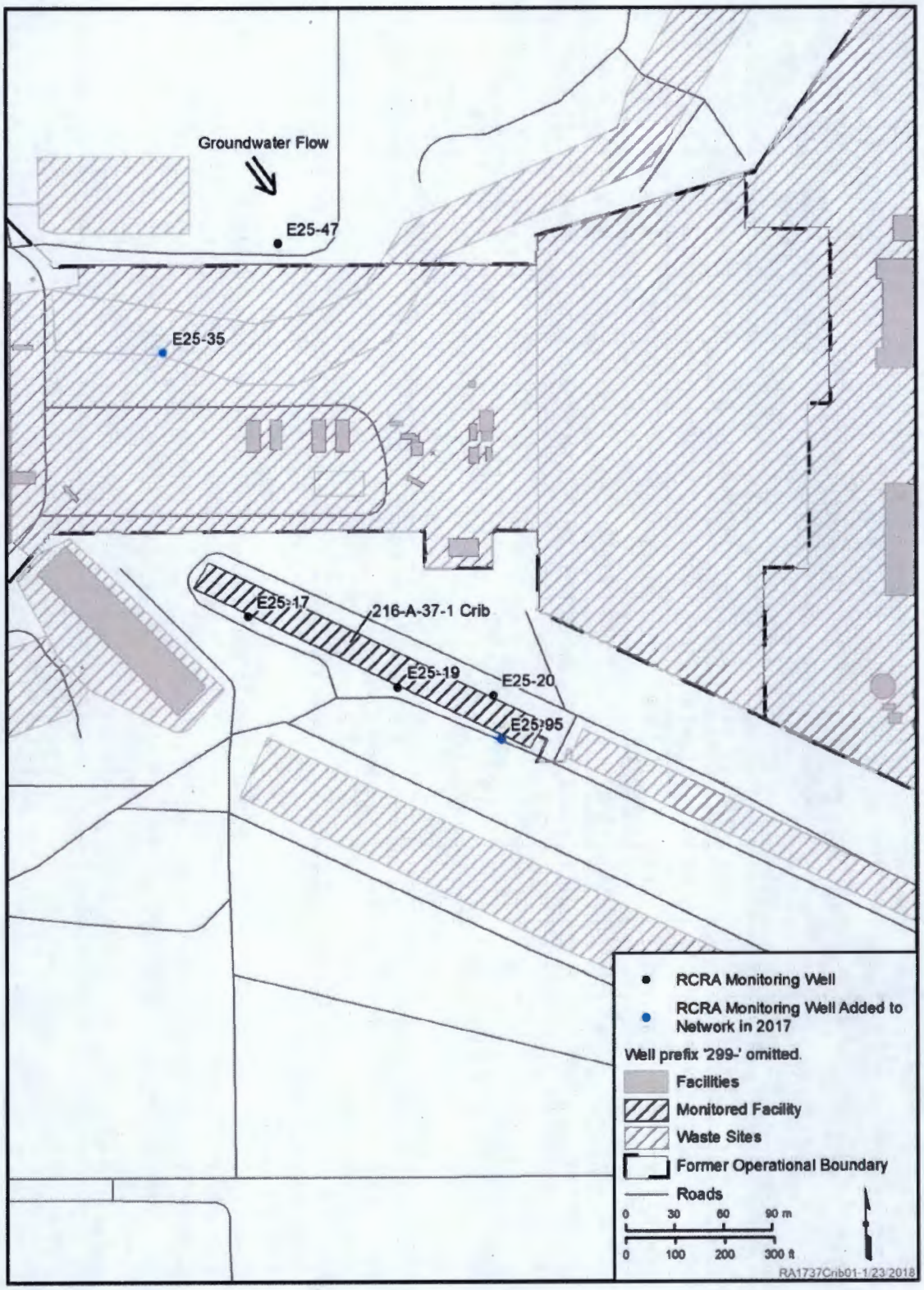


Figure 2-7. 216-A-37-1 Crib

Table 2-17. 216-A-37-1 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency Rev. 1/2/3	Comments; Sampling Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
299-E25-17	DG	1976 (P)	123.5	405.1	116.8	383.1	121.65	399.10	7/21/2017	4.9	16.0	S/S/S	None
299-E25-19	DG	1976 (P)	124.5	408.6	116.9	383.6	121.67	399.19	7/21/2017	4.8	15.6	S/S/S	None
299-E25-20	DG	1976 (P)	124.5	408.6	116.9	383.6	121.41	398.33	7/21/2017	4.5	14.7	S/S/S	None
299-E25-35[b]	UG	1988 (C)	126.2	414.0	119.9	393.5	121.65	399.12	7/21/2017	1.7	5.6	0/Q/Q	None
299-E25-47	UG	1992 (C)	125.2	410.7	119.0	390.5	121.65	399.10	7/21/2017	2.6	8.6	S/S/S	None
299-E25-95	DG	2017 (C)	122.3	401.2	113.1	371.2	122.64	402.38	8/1/2017	9.5	31.2	0/Q/Q	New well first sampled October 2017; not sampled for alkalinity

Note: Requirements are from DOE/RL-2010-92, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 1 was in effect until April 2017; Rev. 2 was in effect April through September 2017; and Rev. 3 was implemented in September 2017.

a. See Table 2-19 for sample dates.

b. Hydraulic head data for this well were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

0 = not in monitoring plan

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

Q = quarterly (for first year; semiannually thereafter)

S = semiannually

UG = upgradient

Table 2-18. Groundwater Velocity at the 216-A-37-1 Crib

Flow Direction	West-southwest (based on 2017 data); contaminant plumes in the region indicate long-term average flow to the southeast
Flow Rate (m/d)	0.38
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	4.4×10^{-6}
Comments	Gradient and flow direction represent average of October 2016 through September 2017; based on trend surface analysis on low-gradient well network; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-19. 216-A-37-1 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean (January)*		6.77	9.64	993		777			14.69				
Critical Mean (July and October)*		7.18	9.46	739		817			NC – Use LOQ				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E25-17	1/16/2017	7.88	0.02	547	1	<720	0	1,640	5.0	0.9	20.4	TASL	
	7/21/2017	7.89	0.00	565	1	<500	0	1,390	<2.1	0.0	18.2	TASL	
299-E25-19	1/24/2017	8.27	0.00	385	1	<720	0	1,640	7.8	3.4	20.4	TASL	
	7/21/2017	8.22	0.02	411	1	<500	0	1,390	8.9	2.0	18.2	TASL	

Table 2-19. 216-A-37-1 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean (January)*		6.77	9.64	993		777			14.69				
Critical Mean (July and October)*		7.18	9.46	739		817			NC – Use LOQ				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E25-20	1/16/2017	7.84	0.01	450	2	<720	0	1,640	<2.1	0.0	20.4	TASL	
	7/21/2017	7.75	0.00	458	0	<500	0	1,390	6.2	0.4	18.2	TASL	
299-E25-35	1/25/2017	8.10	0.00	514	1	<372	43	640	<10.3	0.0	7.8	GEL	
	4/18/2017	8.27	0.00	527	2	298	25	NC	<10.3	3.3	NC	TADN	
	7/21/2017	8.21	0.01	532	2	388	12	600	<3.6	0.5	10.9	GEL	
	10/24/2017	8.22	0.00	527	1	445	15	540	<3.6	0.5	11.8	GEL	
299-E25-47	1/16/2017	8.43	0.02	397	1	545	16	640	3.3	0.0	7.8	GEL	
	7/21/2017	8.36	0.01	412	1	436	48	540	<7.7	0.0	24.7	TADN	
299-E25-95	10/24/2017	7.93	0.01	508	1	<503	4	1,540	4.9	0.3	17.7	TASL	

* Critical mean values are from Tables 19 and 20 ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring.*

< = one or more of the replicate values was below the detection limit
GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-20. 216-A-37-1 Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	84	95	—	
Calcium (unfiltered)	µg/L	37,100	57,000	—	
Calcium (filtered)	µg/L	37,600	57,200	—	
Chloride	mg/L	6.8	16	250[a]	
Chromium (unfiltered)	µg/L	<0.84	296	—	
Chromium (filtered)	µg/L	<0.86	10	—	
Fluoride	mg/L	0.24	0.571	4.0[b]	
Iron (unfiltered)	µg/L	<17	1,840	300[a]	299-E25-19
Iron (filtered)	µg/L	<17	200	300[a]	
Magnesium (unfiltered)	µg/L	10,900	16,600	—	
Magnesium (filtered)	µg/L	10,500	16,100	—	
Manganese (unfiltered)	µg/L	<1.1	92.5	50[a]	299-E25-19, 299-E25-20
Manganese (filtered)	µg/L	<0.9	89.3	50[a]	299-E25-19, 299-E25-20
Nickel (unfiltered)	µg/L	<0.5	136	—	
Nickel (filtered)	µg/L	<0.3	11	—	
Nitrate	mg/L	5.8	79.7	45[c]	299-E25-20, 299-E25-95
Nitrite	mg/L	<0.046	<0.125	3.3[c]	
Phenol	µg/L	<1.9	<3	2,400[d]	
Potassium (unfiltered)	µg/L	5,710	8,910	—	
Potassium (filtered)	µg/L	5,500	8,810	—	
Sodium (unfiltered)	µg/L	14,800	26,000	—	
Sodium (filtered)	µg/L	14,200	27,800	—	
Sulfate	mg/L	47	140	250[a]	
Temperature	°C	14.4	23.3	—	
Turbidity	NTU	0.28	38.2	—	

Table 2-20. 216-A-37-1 Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Additional Constituents Detected, Wells 299-E25-35 and 299-E25-95[e]					
Arsenic (unfiltered)	µg/L	4.9	11.5	10[a]	299-E25-35
Arsenic (filtered)	µg/L	4.8	11.5	10[a]	299-E25-35
Barium (unfiltered)	µg/L	32.8	55.3	2,000[a]	
Barium (filtered)	µg/L	33.1	55.9	2,000[a]	
Chromium (unfiltered)	µg/L	<4	17	100[a]	
Chromium (filtered)	µg/L	<4	10	100[a]	
Gross beta	pCi/L	19	168	50[f]	299-E25-95
Radium-228	pCi/L	< -0.0499	0.535	—	
Selenium (unfiltered)	µg/L	<2	3.5	50[a]	
Selenium (filtered)	µg/L	<2	3.5	50[a]	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Primary drinking water standard.

b. Secondary drinking water standard.

c. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

d. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

e. Analyzed for the first year in these wells. The following constituents were analyzed but not detected in 2017: 2,4,5-TP Silvex, 2,4-D, cadmium, coliform, Endrin, Lindane, gross alpha, lead, mercury, methoxychlor, radium-226, silver, and toxaphene.

f. Concentration assumed to yield a dose equivalent of 4 mrem/yr.

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

2.6 216-B-3 Pond

The inactive 216-B-3 Pond (also known as B Pond) was located east of the 200 East Area (Figures 1-1 and 2-8) in a natural topographic depression. The TSD unit includes the main pond and an adjoining portion of the 216-B-3-3 Ditch. During operations, the pond covered about 14.2 ha (35 ac) with a depth up to 6.1 m (20 ft). The total estimated discharge to the pond since 1945 exceeded 10 billion L (2.6 billion gal) (PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*). The dangerous waste received came from three primary sources: corrosive and dangerous waste resulting from regeneration of demineralizer columns at PUREX, spills of dangerous or mixed waste from PUREX and other facilities, and off-specification chemical makeups at PUREX. The last known reportable discharge of chemical waste (sodium nitrite) occurred in 1987. In 1994, B Pond was backfilled with coarse-grained material and then covered with fine-grained material.

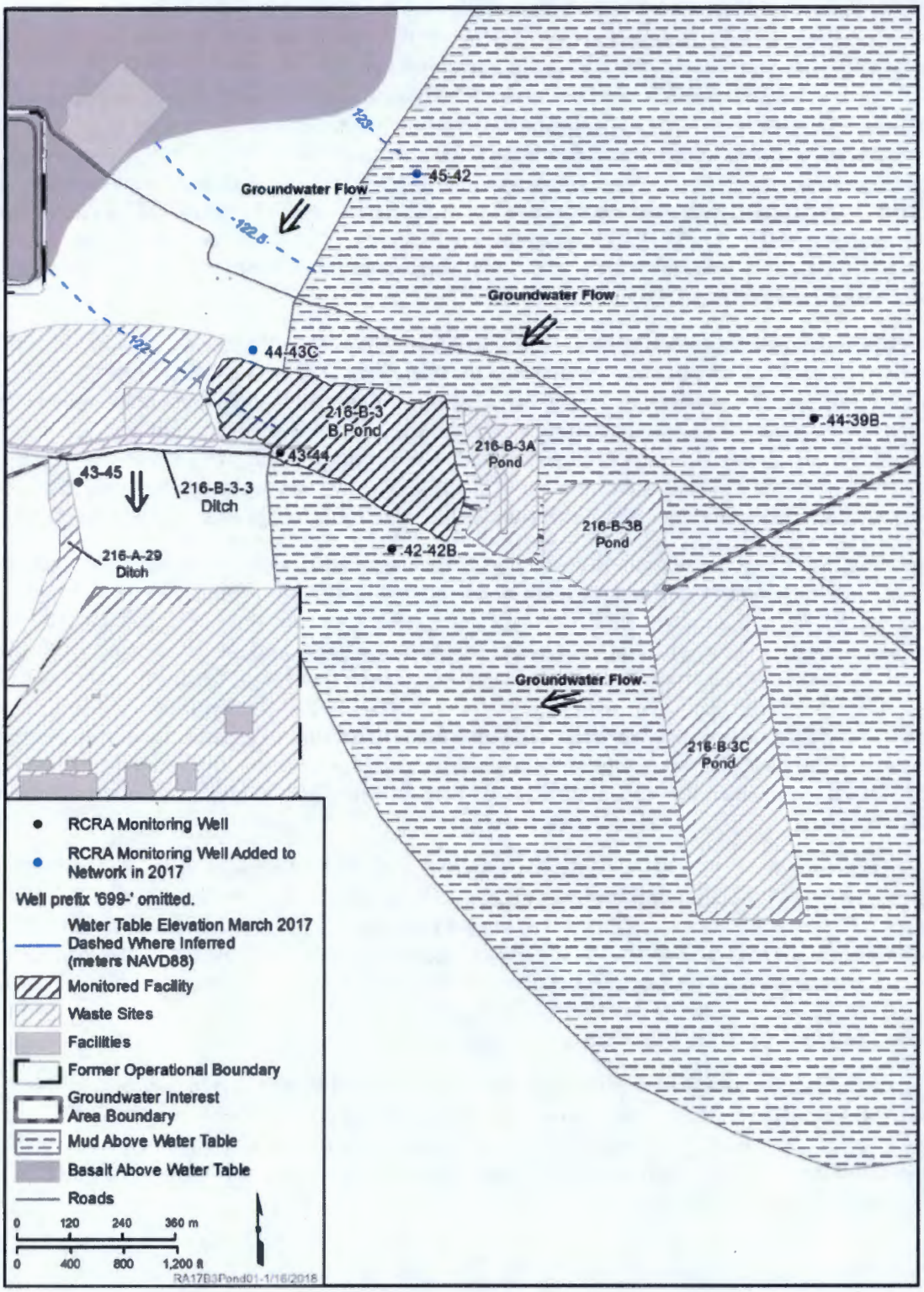
DOE/RL-2008-59, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond,* provides a detailed description of the geology and hydrogeology at B Pond. In summary, because of the dipping beds of the Ringold Formation in this area and the erosional contact with the overlying Hanford formation, groundwater beneath B Pond can occur in both confined and unconfined states, depending on the location. The uppermost aquifer is unconfined west, southwest, and northwest of the main pond where the Ringold Formation confining units 8 and 9B are absent. The aquifer is progressively more confined to the east and southeast of the main pond. Confinement of the Ringold unit 9 aquifers to the east is supported by the fact that hydrologic response to Treated Effluent Disposal Facility (TEDF) discharges has not been observed in the TEDF wells completed in Ringold unit 9A since the facility began operating in 1995 (DOE/RL-2008-59). Figure 2-8 presents the approximate boundary of the Ringold Formation mud above the water table near B Pond.

The B Pond groundwater monitoring plan (DOE/RL-2008-59) was revised twice in 2017. Rev. 1 was issued in April 2017 and proposed a new well near the upgradient facility boundary to replace well 699-45-42. Rev. 2 was issued on September 27, 2017, and incorporates changes to the well network proposed in Rev. 1 (added new well 699-44-43C and removed well 699-45-42). Additionally, due to a failure of the well casing, downgradient well 699-43-44 was removed from the network and will be replaced by a new well (scheduled for installation in 2018). The two new wells will be sampled quarterly for one year for required interim status parameters and for 40 CFR 265, Appendix III parameters.

Groundwater flow directions beneath B Pond range from southwest to west within the confined Ringold Formation and from southwest to south within the unconfined Hanford formation. The monitoring network defined in DOE/RL-2008-59 consists of one upgradient well and three downgradient wells based on a groundwater flow direction to the southwest (Table 2-21). The network wells are screened across the top 1.3 to 6.4 m (4.2 to 21.1 ft) of the aquifer. The average rate of water-level decline over the last 5 years for network wells ranged from 2 cm/yr (0.8 in./yr) for well 699-43-45 to 8 cm/yr (3 in./yr) for well 699-44-39B. The rate of decline varies across the network because of differences in hydrogeology. The network wells have adequate water in the screened interval for representative sampling over the next decade. The 2017 estimated flow rate in the Ringold Formation is 0.068 m/d (0.22 ft/d) to the southwest (Table 2-22).

In accordance with WAC 173-303-400 and 40 CFR 265.92, the B Pond network wells are monitored semiannually for RCRA indicator parameters (TOC, TOX, pH, and specific conductance). TOX, pH, and specific conductance did not exceed their critical mean values in 2017 (Table 2-23). TOC was detected above the critical mean in well 699-43-44 in January, March, and July 2017, but these exceedances did not trigger assessment because the data are not considered representative of groundwater due to casing structural failure observed during downhole videography of the well. All other individual TOC results for the network during 2017 were below the critical mean value.

Groundwater quality constituents monitored for the site include chloride, iron, manganese, phenols, sodium, and sulfate (Table 2-24). Iron and manganese concentrations exceeded secondary DWSs in well 699-44-43C in its initial sampling in October. The iron concentration also exceeded the secondary DWS in well 699-45-42 in the July sampling event. This well was replaced by 699-44-43C in Rev. 2 of the monitoring plan (DOE/RL-2008-59).



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

Figure 2-8. 216-B-3 Pond (B Pond)

Table 2-21. 216-B-3 Pond Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency Rev. 0/1/2	Comments; Sampling Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
699-42-42B	DG	1988 (C)	121.8	399.6	115.7	379.6	122.12	400.65	7/14/2017	6.4	21.1	S/S/S	None
699-43-44[b]	DG	1999 (C)	124.5	408.5	118.4	388.5	121.86	399.81	7/14/2017	3.5	11.3	S/S/0	Decommissioned in July 2017; to be replaced by 699-43-43B.
699-43-45	DG	1989 (C)	126.5	414.9	120.3	394.6	121.66	399.15	7/14/2017	1.4	4.5	S/S/S	None
699-44-39B	UG	1992 (C)	126.2	414.1	120.1	394.1	123.33	404.64	7/14/2017	3.2	10.5	S/S/S	None
699-44-43C	UG	2017 (C)	124.1	407.0	116.4	382.0	122.82	402.95	8/14/2017	6.4	20.9	0/Q/Q	New well
699-45-42	UG	1948 (P)	128.4	421.2	121.7	399.2	122.94	403.36	7/14/2017	1.3	4.2	0/S/0	Replaced by 699-44-43C
699-43-43B	DG	Planned for 2018	—	—	—	—	—	—	—	—	—	0/0/Q	Replacement for 699-43-44

Note: Requirements are from DOE/RL-2008-59, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 0 was in effect until April 2017, Rev. 1 was in effect from April through September, and Rev. 2 was implemented in late September 2017.

a. See Table 2-23 for sample dates.

b. Hydraulic head data for this well were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

0 = not in groundwater monitoring network

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

Q = quarterly

S = semiannually

UG = upgradient

Table 2-22. Groundwater Velocity at the 216-B-3 Pond

Flow Direction	Ringold semiconfined: southwest; Hanford unconfined: west-southwest
Flow Rate (m/d)	Ringold semiconfined: 0.068; Hanford unconfined: 0.34
Hydraulic Conductivity (m/d) (Source)	Ringold Formation: 5.0 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*) Hanford formation: 17,000 (CP-57037)
Effective Porosity	Ringold Formation: 0.1 (CP-57037) Hanford formation: 0.2 (CP-57037)
Gradient (m/m)	Ringold semiconfined: 1.36×10^{-3}; Hanford unconfined: 4.04×10^{-6}
Comments	Ringold gradient based on three-point analysis of data collected in March 2017; Hanford gradient is the same as 216-A-29; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-23. 216-B-3 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment[b]
Critical Mean[a]		7.09	8.98	428		2,543			NC – Use LOQ				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
699-42-42B	1/26/2017	8.1	0.0	297	0	<330	0	640	<3.8	0.9	7.8	GEL	
	7/14/2017	7.8	0.0	325	0	315	44	540	<8.1	0.6	24.7	TADN	
699-43-44	1/29/2017	8.0	0.0	279	1	3,475	249	1,640	<6.5	3.5	20.4	TASL	
	3/23/2017	8.0	0.0	284	0	4,155	646	640	—	—	—	GEL	TOC verification; split samples
						3,900	430	1,640				TASL	
	7/14/2017	7.8	0.0	302	0	7,325	130	1,390	<2.3	0.2	18.2	TASL	Assessment not triggered; see text

Table 2-23. 216-B-3 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment[b]
Critical Mean[a]		7.09	8.98	428		2,543			NC – Use LOQ				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
699-43-45	1/26/2017	8.3	0.0	275	2	<345	26	640	<3.3	0.0	7.8	GEL	
	7/14/2017	8.1	0.0	300	1	<335	6	600	<3.3	0.0	10.9	GEL	
699-44-39B	1/26/2017	8.2	0.0	252	0	<347	30	640	<3.3	0.0	7.8	GEL	
	7/14/2017	8.0	0.0	274	0	250	22	540	<7.7	0.0	24.7	TADN	
699-44-43C	10/12/2017	8.1	0.0	280	0	400	7	540	<3.3	0.0	11.8	GEL	New well
699-45-42	1/26/2017	8.0	0.0	332	1	422	7	640	<3.3	0.0	7.8	GEL	See note b
	7/14/2017	7.9	0.0	363	0	422	21	600	<3.3	0.0	10.9	GEL	
	10/12/2017	8.1	0.0	359	1	483	28	540	<3.3	0.0	11.8	GEL	See note b

Note: Yellow-highlighted cell indicates exceedance of a critical mean.

a. Critical mean values are from Tables 21 and 22 ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring*. Critical mean values did not change between revisions to the monitoring network.

b. Well 699-45-42 was sampled in January in anticipation of being added to the revised monitoring plan. It was replaced by new well 699-44-43C in October (both wells were sampled in October).

< = one or more of the replicate values was below the detection limit
-- = no data or not applicable
GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-24. 216-B-3 Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity[a]	mg/L	91.6	128	—	
Arsenic (unfiltered)	µg/L	<5	10	10[b]	
Arsenic (filtered)	µg/L	4.6	10.1	10[b]	
Cadmium (unfiltered)	µg/L	<0.062	<1.5	5[b]	
Cadmium (filtered)	µg/L	<0.062	<1.5	5[b]	
Calcium (unfiltered)	µg/L	22,000	32,000	—	
Calcium (filtered)	µg/L	22,000	32,400	—	
Chloride	mg/L	3	13	250[c]	
Fluoride	mg/L	0.23	0.46	4[b]	
Iron (unfiltered)	µg/L	<30	1,200	300[c]	699-44-43C, 699-45-42
Iron (filtered)	µg/L	<17	99.7	300[c]	
Magnesium (unfiltered)	µg/L	7,980	12,000	—	
Magnesium (filtered)	µg/L	7,910	12,000	—	
Manganese (unfiltered)	µg/L	<1.02	190	50[c]	699-44-43C
Manganese (filtered)	µg/L	<1.00	170	50[c]	699-44-43C
Nitrate	mg/L	3.32	14.2	45[d]	
Nitrite	mg/L	<0.125	0.161	3.3[d]	
Phenol	µg/L	<2.00	<3.00	2,400[e]	
Potassium (unfiltered)	µg/L	4,250	5,120	—	
Potassium (filtered)	µg/L	4,220	5,220	—	
Sodium (unfiltered)	µg/L	10,700	23,200	—	
Sodium (filtered)	µg/L	10,900	22,900	—	
Sulfate	mg/L	16	50	250[c]	
Temperature	°C	15.6	18.9	—	
Turbidity	NTU	0.99	49.2	—	

Table 2-24. 216-B-3 Sampling Summary for Groundwater Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Additional Constituents Detected, Wells 699-44-43C and 699-45-42[f]					
Barium (unfiltered)	µg/L	37.9	73.0	2,000[b]	
Barium (filtered)	µg/L	36.6	66.0	2,000[b]	
Coliform bacteria	MPN	1	65		
Gross alpha	pCi/L	<1.92	2.20	15[g]	
Gross beta	pCi/L	1.86	6.46	50[g]	
Lead (unfiltered)	µg/L	<0.18	1.00	15[h]	
Lead (filtered)	µg/L	<0.17	1.00	15[h]	
Radium-226	pCi/L	<0.030	0.173		
Selenium (unfiltered)	µg/L	0.88	2.60	50[b]	
Selenium (filtered)	µg/L	0.64	3.80	50[b]	
Silver (unfiltered)	µg/L	<0.02	1.00	100[c]	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents full the data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Includes total alkalinity and bicarbonate.

b. Primary drinking water standard.

c. Secondary drinking water standard.

d. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

e. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

f. Analyzed for first year in these wells. The following constituents were analyzed but not detected in 2017: 2,4,5-TP Silvex, 2,4-D, Endrin, Lindane, mercury, methoxychlor, radium-228, silver (filtered), and toxaphene.

g. Concentration assumed to yield a dose equivalent of 4 mrem/yr.

h. Action level.

< = one or more of the results was below the detection limit

— = no comparison value

MPN = most probably number

NTU = nephelometric turbidity unit

2.7 216-B-63 Trench

The 216-B-63 Trench TSD unit is located in the north-central portion of the 200 East Area (Figures 1-1 and 2-9). Beginning in 1970, it was used as an emergency percolation trench for chemical sewer waste from B Plant (RHO-CD-798, *Current Status of the 200 Area Ponds*). Major contributors to this waste stream were the 2902-B high tank (contains potable sanitary water), cooling water from B Plant and the 225B Waste Encapsulation and Separation Facility, some 221B steam condensate, and demineralizer effluent. Minor contributions may have included the chemical makeup overflow system (sodium hydroxide and sodium nitrite), air conditioning units, and space heaters (radiators). The effluent compositions were kept below regulated values (WHC-EP-0342, Addendum 6, *B Plant Chemical Sewer Stream-Specific Report*).

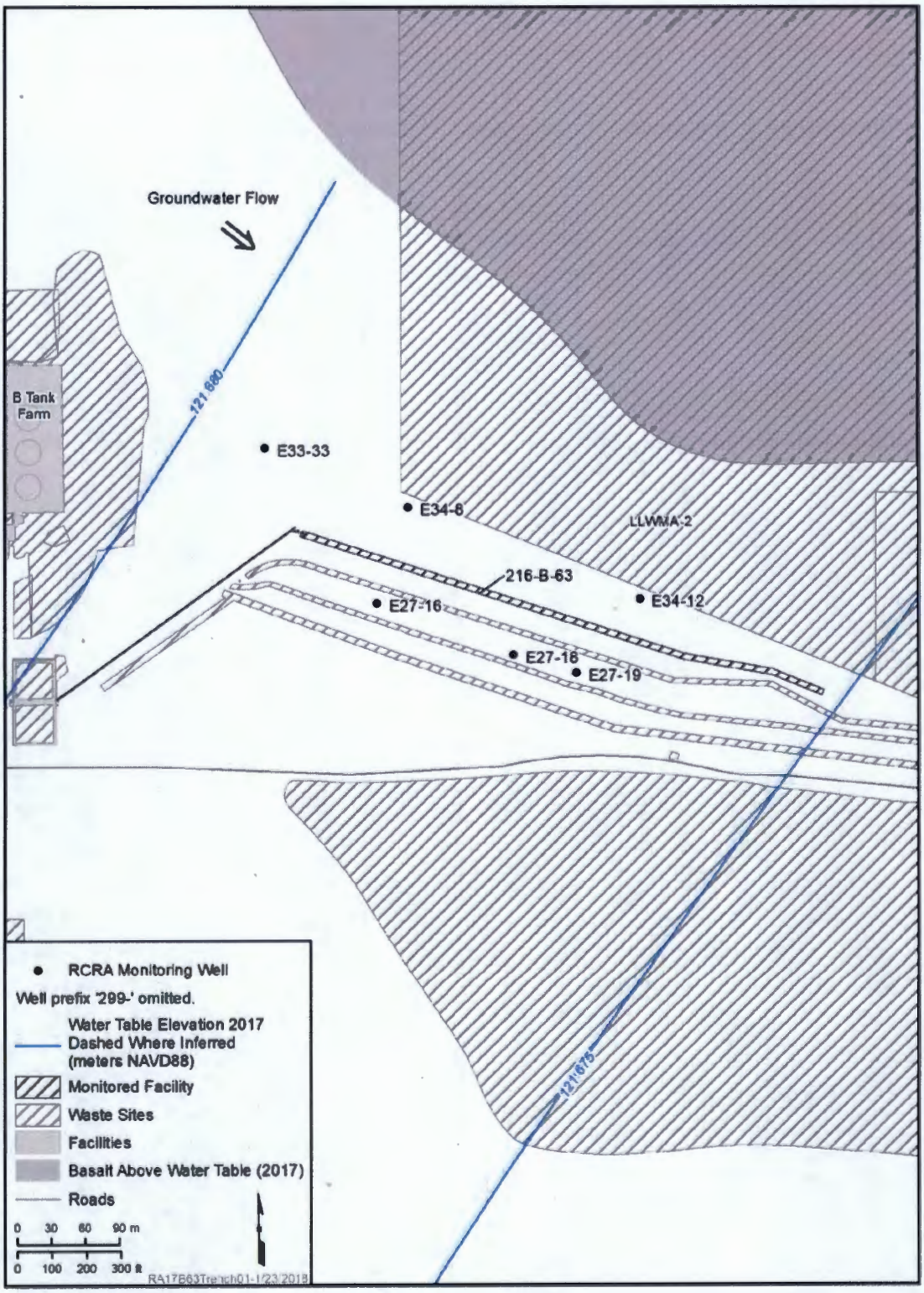
Before November 1985, acidic effluent from anion exchanger regeneration and the basic effluent from cation exchanger regeneration were discharged without neutralization (WHC-EP-0287, *Waste Stream Characterization Report*, p. A.9-2). In March and April 1987, incidental corrosive liquid waste releases were discharged to the 216-B-63 Trench. The corrosive waste discharges were regulated under RCW 70.105, "Hazardous Waste Management," and its implementing requirements in WAC 173-303. Discharges to this trench ceased in 1992.

DOE monitors the groundwater under an interim status indicator evaluation program in accordance with 40 CFR 265, Subpart F, as defined in DOE/RL-2008-60, *Interim Status Groundwater Monitoring Plan for the 216-B-63 Trench*. Table 2-25 presents construction information and water levels for the 216-B-63 wells. The monitoring network consists of three upgradient and three downgradient wells screened in the upper portion of the aquifer at the water table. Most of the well screens extend to within 1.5 m (5 ft) of the underlying basalt surface. The water table elevation at the 216-B-63 Trench declined an average of 1.8 cm/yr (0.7 in./yr) between 2012 and 2017. Based on this information, the 216-B-63 Trench monitoring wells have adequate water in the screened interval for sampling over the next two decades or longer.

Groundwater gradient magnitude and flow direction were inferred using a low-gradient monitoring network across the 200 East Area (Figure 2-6). The groundwater gradient calculated for the 216-B-63 Trench area was 8.5×10^{-6} m/m, dipping to the southeast, and the estimated groundwater flow rate was 0.73 m/d (2.4 ft/d) (Table 2-26). Groundwater extraction at WMA B-BX-BY may cause local deviations from the estimated groundwater flow direction and rate.

As required by 40 CFR 265.93(b), downgradient average indicator parameters were compared to upgradient critical mean values semiannually. The average pH in well 299-E27-19 exceeded the upper critical mean in April 2017 (Table 2-27). Verification sampling in June did not confirm the exceedance. Other indicator parameters remained below critical mean values or LOQs in 2017.

Table 2-28 summarizes the 2017 results for groundwater quality parameters (40 CFR 265.92(d)(1)) and additional constituents required by the monitoring plan (DOE/RL-2008-60). Nitrate was the only parameter with a concentration above a water quality standard. Nitrate reflects contaminant migration from sources northwest of 216-B-63 (e.g., BY Cribs) (Figure 1-3).



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

Figure 2-9. 216-B-63 Trench

Table 2-25. 216-B-63 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
299-E27-16	DG	1990 (C)	126.2	414.1	119.8	393.1	121.65	399.12	10/8/2017	1.8	6.0	S	None
299-E27-18[b]	DG	1992 (C)	124.7	409.1	118.6	389.0	121.72	399.35	10/8/2017	3.2	10.4	S	None
299-E27-19	DG	1992 (C)	124.7	409.1	118.9	390.0	121.66	399.13	10/10/2017	2.8	9.1	S	Extra sampling events; see text
299-E33-33	UG	1989 (C)	126.0	413.4	119.6	392.4	121.69	399.24	10/8/2017	2.1	6.8	S	None
299-E34-8	UG	1990 (C)	126.0	413.2	119.4	391.7	121.58	398.88	10/9/2017	2.2	7.1	S	None
299-E34-12	UG	1992 (C)	126.6	415.3	120.4	395.0	121.63	399.04	10/9/2017	1.2	4.1	S	None

Note: Requirements are from DOE/RL-2008-60, *Interim Status Groundwater Monitoring Plan for the 216-B-63 Trench.*

a. See Table 2-27 for sample dates.

b. Hydraulic head data for this well were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"
DG = downgradient
S = semiannually
UG = upgradient

Table 2-26. Groundwater Velocity at the 216-B-63 Trench

Flow Direction	Southeast
Flow Rate (m/d)	0.73
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	8.5×10^{-6}
Comments	Gradient and flow direction represent average of October 2016 through September 2017; based on trend surface analysis on low-gradient well network; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-27. 216-B-63 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
2017 Critical Mean[a]		7.68	8.56	951		659			NC – Use LOQ				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E27-16	4/4/2017	8.27	0.00	675	0	445	25	590	<5.8	2.6	8.3	GEL	
	10/8/2017	8.25	0.00	692	1	<159	6	580	<7.7	0.0	23.7	TADN	
299-E27-18	4/4/2017	8.29	0.01	612	6	413	11	590	<3.3	0.0	8.3	GEL	
	10/8/2017	8.14	0.01	664	2	420	4	540	5.5	2.0	11.8	GEL	
299-E27-19	4/4/2017	8.57	0.00	661	0	<720	0	1,520	<6.0	2.8	20.4	TASL	pH data later flagged as "Y" (suspect) based on May verification sampling; TOC less than LOQ (no exceedance)
	5/26/2017	8.14[b]	0.00	674	3	—	—	—	—	—	—	—	Verification sampling for April pH exceedances (not confirmed)
	6/14/2017	8.11	0.00	709	1	300	32	NC[c]	—	—	—	TADN	Resampled for TOC at lower detection limit; split samples for TOC
						<200	0	NC	—	—	—	SWRI	
	10/10/2017	7.96	0.00	714	0	238	15	580	<8.2	0.8	23.7	TADN	
299-E33-33	4/4/2017	8.16	0.01	660	4	<330	0	590	<3.3	0.0	8.3	GEL	
	10/8/2017	8.12	0.00	676	2	<157	3	580	<7.7	0.0	23.7	TADN	
299-E34-12	4/4/2017	8.24	0.00	470	1	404	26	590	<3.3	0.0	8.3	GEL	
	10/9/2017	7.93	0.01	620	2	211	23	580	<7.7	0.0	23.7	TADN	

Table 2-27. 216-B-63 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
2017 Critical Mean[a]		7.68	8.56	951		659			NC – Use LOQ				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E34-8	4/4/2017	8.19	0.03	671	1	412	18	590	<3.3	0.0	8.3	GEL	
	10/9/2017	8.03	0.02	704	3	453	16	540	<3.6	0.3	11.8	GEL	

Note: Yellow-highlighted cell indicates exceedance of a critical mean.

a. Critical mean values from Table 23 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring*.

b. Average field pH is listed. Samples were also analyzed for pH in the laboratory for pH (see Appendix A).

c. LOQ not calculated because field blank results were not available from this laboratory.

< = one or more of the replicate values was below the detection limit
— = no data or not applicable
GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
SWRI = Southwest Research Institute
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-28. 216-B-63 Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	94.2	104	—	
Calcium (unfiltered)	µg/L	52,000	78,200	—	
Calcium (filtered)	µg/L	52,400	77,600	—	
Chloride	mg/L	13.9	26.1	250[a]	
Dissolved oxygen	mg/L	8.01	10.34	—	
Fluoride	mg/L	0.256	0.374	4.0[b]	
Iron (unfiltered)	µg/L	<30	116	300[a]	
Iron (filtered)	µg/L	<23.1	<30	300[a]	
Magnesium (unfiltered)	µg/L	13,200	21,400	—	
Magnesium (filtered)	µg/L	13,200	21,100	—	
Manganese (unfiltered)	µg/L	<1	<4	50[a]	
Manganese (filtered)	µg/L	<1	<4	50[a]	
Nitrate	mg/L	50	146	45[c]	All
Nitrite	mg/L	<0.108	<0.125	3.3[c]	
Phenol	µg/L	<1.9	<3	2,400[d]	
Sodium (unfiltered)	µg/L	21,900	28,100	—	
Sodium (filtered)	µg/L	21,300	27,000	—	
Sulfate	mg/L	75	101	250	
Temperature	°C	14.9	19.5	—	
Turbidity	NTU	0.63	4.35	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

d. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

2.8 216-S-10 Pond and Ditch

The 216-S-10 Pond and Ditch, located outside the southwestern corner of the 200 West Area, comprised an unlined ditch, 1.2 m (3.9 ft) wide at its base and 686 m (2,250 ft) long, connected to a pond covering 0.748 ha (1.82 ac). The pond was shaped like a backward "E" with an extra leg, where each leg was a separate leaching trench. The ditch was also connected to the 216-S-11 Pond between 1954 and 1965, which was an overflow pond to accommodate excess discharges. During its active life from 1951 to 1991, the site received 6.6 billion L (1.7 billion gal) of effluent from the Reduction-Oxidation (REDOX) Plant chemical sewer. Figure 2-10 shows the major site features and monitoring well locations.

The groundwater beneath 216-S-10 is monitored under interim status regulations to determine whether dangerous waste constituents have affected groundwater (DOE/RL-2008-61, *Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*). Rev. 0 of the plan was in effect through May 2017, and Rev. 1 was implemented in June. The monitoring well network consists of an upgradient well, four downgradient wells screened in the upper portion of the aquifer at the water table, and a downgradient well screened 50 m (164 ft) below the water table (Table 2-29).

Table 2-30 summarizes groundwater flow beneath the 216-S-10 Pond and Ditch. The hydraulic gradient was determined by trend surface analysis using water-level measurements collected during March 2017 from five wells. The calculated flow direction was east (101 degrees azimuth), the hydraulic gradient magnitude was 2.8×10^{-3} m/m, and the estimated velocity was 0.14 m/d (0.46 ft/d). Water levels in the network wells declined at an average rate of 28 cm/yr (11 in./yr) from 2012 to 2017. Based on the calculated groundwater flow direction, the monitoring well network remains capable of detecting constituents migrating from 216-S-10 into the uppermost aquifer.

All of the network wells were sampled as planned in 2017. The wells completed at the water table were sampled twice for RCRA contamination indicator parameters (pH, specific conductance, TOC, and TOX; Table 2-31), and once for groundwater quality parameters (chloride, iron, manganese, phenols, sodium, and sulfate) (Table 2-32). The groundwater was also sampled for site-specific analytes (Table 2-32).

No indicator parameter critical mean exceedances occurred in 2017. Between 2007 and 2012, specific conductance generally trended upward in well 299-W26-13, from annual average values of 270 to 310 µS/cm. This increasing trend correlated to increasing chromium and nitrate concentrations. From 2012 through 2017, specific conductance has been relatively stable, consistent with a stable to slightly declining nitrate trend.

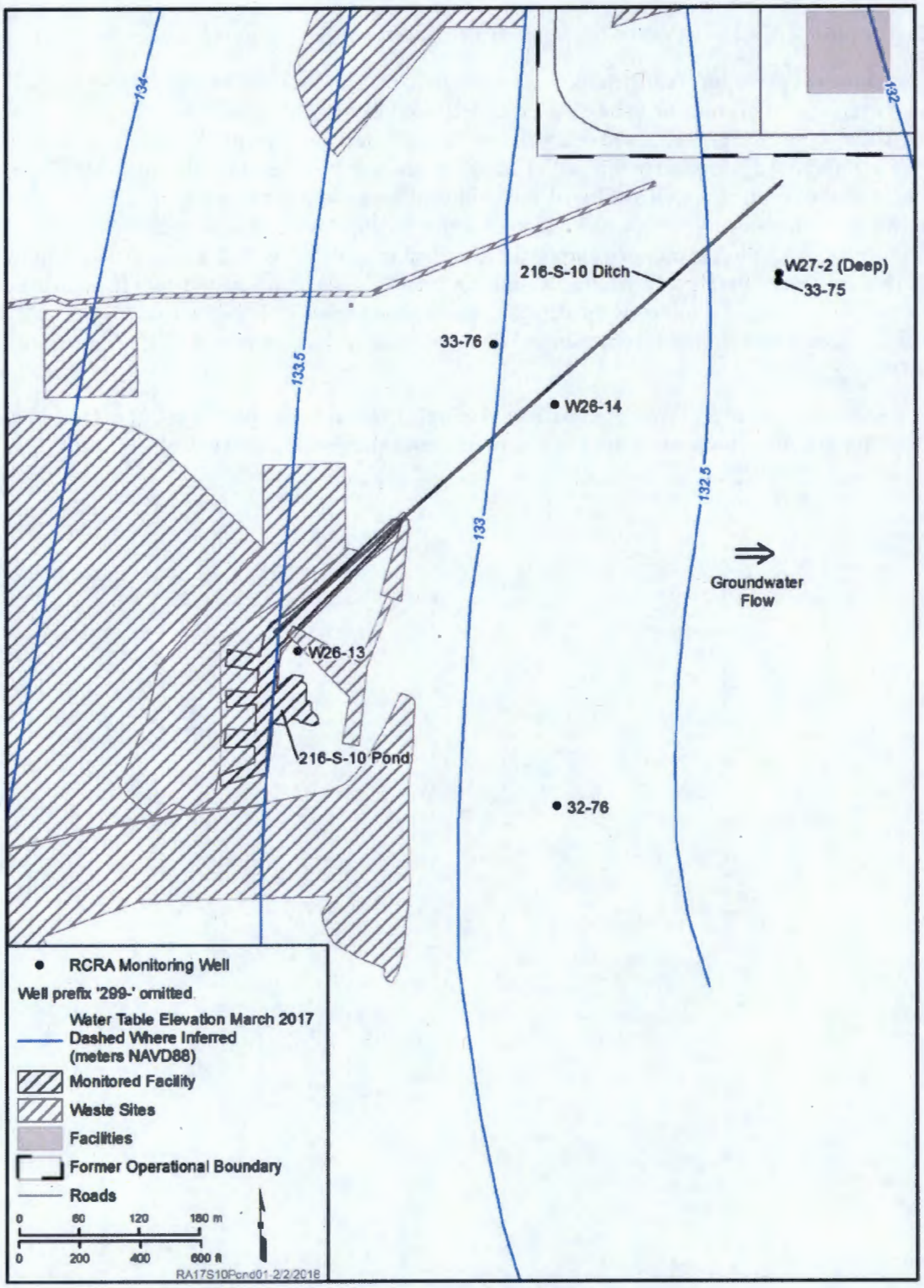
Chromium concentrations in well 299-W26-13 continued to exceed the 100 µg/L total chromium DWS in 2017 (158 µg/L maximum in May). The 216-S-10 Pond and Ditch system was the most substantial source of chromium in this area (Appendix C of RPP-26744, *Hanford Soil Inventory, Rev. 1*), but other sources of chromium (216-S-5 Crib, 216-S-6 Crib, 216-S-11, 216-S-16, and 216-S-17 Ponds, and associated ditches) also exist. In particular, the 216-S-11 overflow pond received some of the same waste as 216-S-10 but is not part of the RCRA unit.

The network monitoring wells routinely show low to nondetected levels of TOX. The highest average concentration from quadruplicate samples was in downgradient well 699-32-76 (6.88 µg/L in November 2017), below the critical mean (42.44 µg/L). The TOX detections are attributed to carbon tetrachloride in several 216-S-10 wells. Well 699-33-75 had the highest carbon tetrachloride concentration in the network (5.42 µg/L in 2017), which exceeds the 3.4 µg/L cleanup level for the 200-UP-1 OU. Carbon tetrachloride was also detected in upgradient well 699-33-76 (3.20 µg/L in 2017). This constituent does not originate from 216-S-10; carbon tetrachloride is widespread in the groundwater

beneath and near the 200 West Area and originates from waste disposal sites at Plutonium Finishing Plant (PFP) (Chapter 12 of DOE/RL-2016-09, *Hanford Site Groundwater Monitoring Report for 2015*).

Concentrations of chromium (unfiltered), iron (unfiltered), manganese (unfiltered), and nickel (filtered and unfiltered) continue to be elevated in deep well 299-W27-2. These constituents are stainless-steel corrosion products, and this well has stainless-steel components. A downhole video of the well screen confirmed corrosion in this well. Chromium analysis completed in 2017 included filtered and unfiltered total chromium, a well as filtered and unfiltered hexavalent chromium (Cr(VI)).
Total chromium analysis provides a summation of both trivalent chromium and mobile Cr(VI). Similar to the 2016 analysis results, the elevated chromium identified in well 299-W27-2 during 2017 comprised primarily undissolved trivalent chromium. Results for filtered total chromium and both filtered and unfiltered Cr(VI) were near or below the detection limits. The presence of undissolved trivalent chromium is consistent with well corrosion and does not indicate the presence of a Cr(VI) plume at 216-S-10.

Iron exceeded the secondary DWS in an unfiltered sample from well 299-W27-2 in 2017. The sample also had elevated total chromium, which is consistent with values attributable to well corrosion.



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

Figure 2-10. 216-S-10 Pond and Ditch

Table 2-29. 216-S-10 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions*
			m	ft	m	ft	m	ft		m	ft		
299-W26-13	DG	1999 (C)	137.4	450.8	126.7	415.7	133.61	438.34	11/1/2017	6.9	22.6	S	None
299-W26-14	DG	2003 (C)	136.6	448.1	125.9	413.1	132.96	436.22	11/1/2017	7.0	23.1	S	None
299-W27-2	DG/deep	1992 (C)	82.7	271.4	79.5	260.9	132.30	434.04	5/2/2017	52.8	173.2	A	None
699-32-76	DG	2008 (C)	134.8	442.2	124.1	407.2	132.61	435.07	11/1/2017	8.5	27.9	S	None
699-33-75	DG	2008 (C)	135.0	442.8	124.3	407.8	132.42	434.46	11/1/2017	8.1	26.6	S	None
699-33-76	UG	2008 (C)	135.5	444.7	124.9	409.7	133.13	436.78	11/1/2017	8.3	27.1	S	None

Note: Requirements are from DOE/RL-2008-61, *Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch.*

* See Table 2-31 for sample dates.

A = annually

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

S = semiannually

UG = upgradient

Table 2-30. Groundwater Velocity at the 216-S-10 Pond and Ditch

Flow Direction	East-southeast
Flow Rate (m/d)	0.14
Hydraulic Conductivity (m/d) (Source)	5 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	2.8×10^{-3}
Comments	Gradient and direction determined by trend surface analysis of data collected in March 2017; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-31. 216-S-10 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean*		4.31	11.04	398		NC – Use LOQ			42.44				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-W26-13	5/2/2017	7.8	0.0	305	0	<331	2	590	<3.3	0.0	8.3	GEL	
	11/1/2017	7.7	0.0	307	0	<330	0	540	<3.3	0.0	11.8	GEL	
299-W26-14	5/2/2017	7.8	0.0	285	0	<720	0	1,520	<4.0	3.2	20.4	TASL	
	11/1/2017	7.6	0.0	283	0	286	22	580	<7.7	0.0	23.7	TADN	
299-W27-2	5/2/2017	7.5	—	369	—	351	—	590	<3.3	—	8.3	GEL	
699-32-76	5/2/2017	7.7	0.0	325	0	<720	0	1,520	<2.1	0.0	20.4	TASL	
	11/1/2017	7.5	0.0	323	1	<500	0	1,540	6.9	1.4	17.7	TASL	
699-33-75	5/2/2017	7.6	0.0	292	1	<372	28	590	4.9	0.7	8.3	GEL	
	11/1/2017	7.5	0.0	286	0	<348	11	540	<3.3	0.0	11.8	GEL	
699-33-76	5/2/2017	7.5	0.0	308	0	<720	0	1,520	<2.1	0.0	20.4	TASL	
	11/1/2017	7.5	0.0	301	0	250	20	580	<7.8	0.1	23.7	TADN	

* Critical mean values from Table 24 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring.*

< = one or more of the replicate values was below the detection limit
— = no data or not applicable
GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-32. 216-S-10 Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	101	132	—	
Aroclor-1254	µg/L	<0.032	<0.21	0.0005[a]	Required for Rev. 0 only
Benzo(a)pyrene	µg/L	<0.28	<0.95	0.0002[a]	Required for Rev. 0 only
Calcium (unfiltered)	µg/L	21,100	32,500	—	
Calcium (filtered)	µg/L	21,500	46,600	—	
Carbon tetrachloride	µg/L	<0.36	5.42	5[a]	699-33-75; required for Rev. 1 only
Chloride	mg/L	6.2	19.7	250[b]	
Chromium (unfiltered)	µg/L	<1.3	165	100[a]	299-W26-13
Chromium (filtered)	µg/L	<1.3	158	100[a]	299-W26-13
Cr(VI) (unfiltered)	µg/L	<1.5	160	48[c]	299-W26-13
Cr(VI) (filtered)	µg/L	<1.5	150	48[c]	299-W26-13
Copper (unfiltered)	µg/L	<1.15	<7	1[b]	Required for Rev. 0 only
Copper (filtered)	µg/L	<1	<7	1[b]	Required for Rev. 0 only
Fluoride	mg/L	0.39	0.488	4[a]	Required for Rev. 0 only
Iron (unfiltered)	µg/L	<17	328	300[b]	299-W27-2
Iron (filtered)	µg/L	<17	64	300[b]	
Magnesium (unfiltered)	µg/L	7,130	11,800	—	
Magnesium (filtered)	µg/L	7,320	11,900	—	
Manganese (unfiltered)	µg/L	<0.29	10	50[b]	
Manganese (filtered)	µg/L	<0.27	4	50[b]	
Mercury (unfiltered)	µg/L	<0.027	<0.067	2[a]	Required for Rev. 0 only
Mercury (filtered)	µg/L	<0.027	<0.067	2[a]	Required for Rev. 0 only
Nickel (unfiltered)	µg/L	<1.5	26.1	—	Required for Rev. 1 only
Nickel (filtered)	µg/L	<1.5	23.2	—	
Nitrate	mg/L	5.75	27.9	45[d]	
Nitrite	mg/L	<0.108	0.223	3.3[d]	Required for Rev. 0 only
Oxidation-reduction potential	mV	229.9	353	—	
Phenol	µg/L	<1.9	<3	2,400[c]	Not analyzed in 699-33-75

Table 2-32. 216-S-10 Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Potassium (unfiltered)	µg/L	2,840	3,760	—	Required for Rev. 0 only
Potassium (filtered)	µg/L	2,930	5,680	—	
Sodium (unfiltered)	µg/L	14,000	23,000	—	
Sodium (filtered)	µg/L	14,000	23,000	—	
Sulfate	mg/L	17	23	250[b]	
Temperature	°C	17.4	19.4	—	
Turbidity	NTU	0.66	4.94	—	
Zinc (unfiltered)	µg/L	<2.8	6	5,000[b]	Required for Rev. 0 only
Zinc (filtered)	µg/L	<2.8	<6	5,000[b]	Required for Rev. 0 only

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Primary drinking water standard.

b. Secondary drinking water standard.

c. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

d. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

< = one or more of the results was below the detection limit

— = no comparison value

Cr(VI) = hexavalent chromium

NTU = nephelometric turbidity unit

2.9 Integrated Disposal Facility

The IDF is an expandable, double-lined landfill with 0.07 km^2 (0.027 mi^2) of liner. It includes two distinct cells: an east cell for low-level radioactive waste, and a west cell for mixed waste. The IDF is not yet in use.

Construction of the first phase for IDF was completed in April 2006. DOE submitted a Part B RCRA Permit application to Ecology, which was incorporated into the Hanford RCRA Permit on April 9, 2006. The start date for IDF operations has not been determined, but it is monitored as part of a detection monitoring program described in Section III.11.E.1.b of 10-EMD-0080, Enclosure 1, "Class 1 Modifications to the Hanford Facility Resource Conservation and Recovery Act Permit, Quarter Ending June 30, 2010."

The monitoring network for the IDF consists of two upgradient wells, one cross-gradient well, and four downgradient wells (Figure 2-11; Table 2-33). Since the IDF is not operational, the current monitoring objective is to collect baseline groundwater information. All network wells were sampled as scheduled during 2017.

Groundwater modeling was conducted in 2000 (PNNL-13400, *Groundwater Flow and Transport Calculations Supporting the Immobilized Low-Activity Waste Disposal Facility Performance Assessment*) to support an assessment of flow and transport conditions during future IDF use and to assist in positioning wells for the monitoring network. The early modeling results indicated a southeast flow direction. Beginning in 2008, data collection efforts were started to improve the accuracy of water-level measurements so flow direction beneath the PUREX cribs and IDF could be evaluated in greater detail (Section 3.2 of DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010*).

The groundwater flow direction in 2017 was east, with an estimated flow rate of up to 1.1 m/d (3.7 ft/d) (Table 2-34). In recent years, the flow direction has varied from east-northeast (2008 to 2011) to southeast (2013 to 2014). Hydraulic conductivity is markedly different between the two unconfined aquifer units beneath the site. The water table is at an elevation of 121.7 m (399 ft) in Hanford formation flood channel deposits, which have an estimated hydraulic conductivity of 17,000 m/d (56,000 ft/d). The top of Ringold unit E, which has an estimated hydraulic conductivity of 3.26 m/d (10.7 ft/d), is at an elevation of about 104.5 m (343 ft) where it is thickest in the eastern portion of the IDF site. Hanford formation saturated thickness ranges from 15 to 20 m (49 to 66 ft) from east to west. The maximum saturated thickness of Ringold unit E is about 2 m (7 ft) in the eastern portion of the IDF site. Because the Hanford formation comprises a majority of the total saturated thickness, its associated hydraulic conductivity is considered the primary driver for overall groundwater flow velocity. Based on current groundwater flow interpretations, the monitoring network is considered adequate.

The wells are monitored annually for indicator parameters chromium (filtered), pH, specific conductance, TOC, and TOX (Table 2-35). In addition, monitoring includes the supplemental constituents alkalinity, anions, metals, and turbidity (Table 2-36). Upgradient/downgradient comparisons of indicator parameters are not required because the IDF is not in use. Unfiltered chromium, nickel, and iron were detected in well 299-E18-1 but concentrations were less in 2017 than in 2016. Unfiltered iron exceeded the secondary DWS in well 299-E18-1 in the January sampling event. The well was scheduled for video logging, cleaning, and continued sampling in 2017, but these activities have not yet been performed. If indications of corrosion persist, the well will be evaluated for decommissioning and replacement. Ecology, DOE, and EPA negotiate replacement wells annually in accordance with Tri-Party Agreement Milestone M-24-00.

Nitrate concentrations in 2017 were above 45 mg/L in five IDF wells, consistent with the 2016 monitoring results. Changes in the plume configuration and trends at individual wells indicate that nitrate is slowly migrating to the southeast, consistent with the flow direction calculated from trend surface analyses of water-level measurements. The maximum 2017 nitrate concentration was 66.4 mg/L in well 299-E17-22 (Table 2-36). Wells monitoring the IDF are within the regional 200 East Area nitrate plume (Figure 1-3).

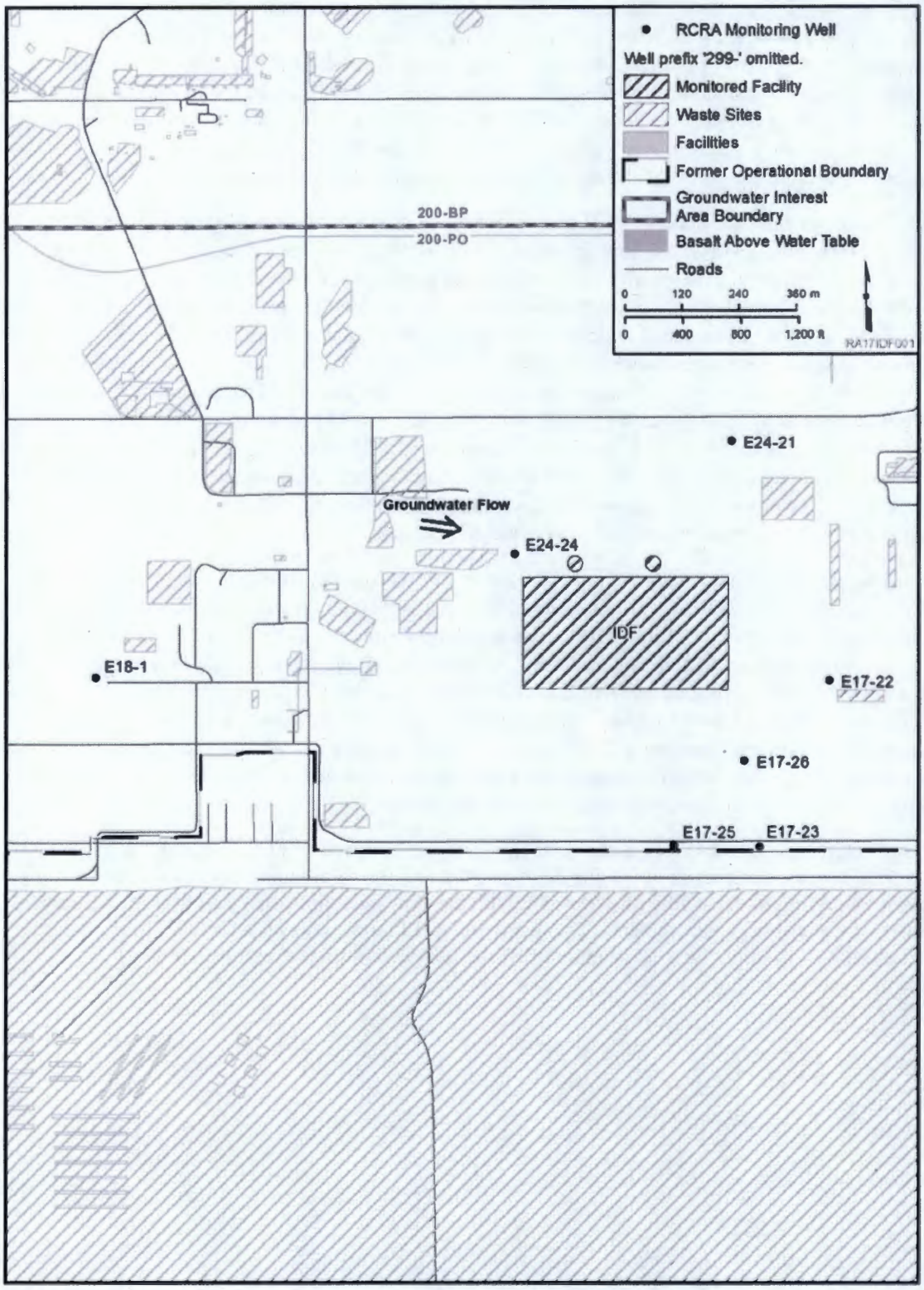


Figure 2-11. Integrated Disposal Facility

Table 2-33. IDF Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
299-E17-22	DG	2002 (C)	122.6	402.1	111.9	367.0	121.67	399.16	1/25/2017	9.8	32.2	A	None
299-E17-23	DG	2002 (C)	122.3	401.4	111.9	367.3	121.60	398.95	1/25/2017	9.7	31.7	A	None
299-E17-25	DG	2002 (C)	122.4	401.7	111.8	366.7	121.68	399.22	1/25/2017	9.9	32.5	A	None
299-E17-26	DG	2005 (C)	121.4	398.2	110.7	363.2	121.72	399.34	1/23/2017	11.0	36.1	A	None
299-E18-1[b]	UG	1988 (C)	125.5	411.6	118.4	388.6	121.75	399.45	1/17/2017	3.3	10.9	A	None
299-E24-21	CG	2001 (C)	122.7	402.5	116.6	382.5	121.67	399.17	1/25/2017	5.1	16.6	A	None
299-E24-24	UG	2005 (C)	122.5	402.0	111.9	367.0	121.67	399.17	1/25/2017	9.8	32.2	A	None

Note: Requirements are from the Hanford RCRA Permit (*Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended). In accordance with 10-EMD-0080, Enclosure 1, "Class 1 Modification to the Hanford Facility Resource Conservation and Recovery Act Permit Quarter Ending June 30, 2010," groundwater sampling under the permit will continue annually during the pre-active life of the Integrated Disposal Facility.

a. See Table 2-35 for sample dates.

b. Hydraulic head data for this well were not corrected for borehole deviation from vertical, which may cause reported head to be less than actual head.

A = annually

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

CG = cross gradient

DG = downgradient

UG = upgradient

Table 2-34. Groundwater Velocity at the IDF

Flow Direction	East
Flow Rate (m/d)	0.0001 to 1.1
Hydraulic Conductivity (m/d) (Source)	3.26 (Ringold unit E) to 17,000 (Hanford formation) (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.1 (CP-57037)
Gradient (m/m)	6.59×10^{-6}
Comments	Gradient and direction determined by trend surface analysis on low-gradient network (SGW-54165, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site*).

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-35. IDF Contamination Indicator Parameters, 2017

Well	Sample Date	Chromium (filtered)		pH	Specific Conductance	Total Organic Carbon		Total Organic Halides	
		µg/L	Flag	Standard Units	µS/cm	µg/L	Flag	µg/L	Flag
299-E17-22	1/17/2017	4.5	B	7.92	575	720	U	6.5	
299-E17-23	1/16/2017	12.1		7.87	478	401	B	3.33	U
299-E17-25	1/17/2017	10.3	D	7.77	485	720	U	5	
299-E17-26	1/23/2017	6.53		7.82	515	496	B	9.42	BC
299-E18-1	1/17/2017	6.7	BD	8.48	387	330	U	3.33	U
299-E24-21	1/24/2017	6.7		7.85	552	848	B	3.33	UQ
299-E24-24	1/23/2017	5	B	7.76	532	720	U	2.1	U

B = greater than detection limit but less than quantitation limit
C = analyte was detected both in the blank and in the associated laboratory quality control blank
D = analyte reported at a secondary dilution factor
Q = associated field quality control sample was out of limits
U = undetected

Table 2-36. IDF Sampling Summary for Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	73.6	150	—	
Antimony (unfiltered)	µg/L	<1	<5.2	6[a]	
Antimony (filtered)	µg/L	<1	<5.2	6[a]	
Arsenic (unfiltered)	µg/L	<4	5.32	10[a]	
Arsenic (filtered)	µg/L	<4	<5	10[a]	
Barium (unfiltered)	µg/L	45.2	82.3	2,000[a]	
Barium (filtered)	µg/L	45.5	77.4	2,000[a]	
Cadmium (unfiltered)	µg/L	<0.2	<1.5	5[a]	
Cadmium (filtered)	µg/L	<0.2	<1.5	5[a]	
Calcium (unfiltered)	µg/L	31,000	59,100	—	
Calcium (filtered)	µg/L	32,800	60,200	—	
Chloride	mg/L	6.7	15	250[b]	
Cobalt (unfiltered)	µg/L	<0.1	<15	—	
Cobalt (filtered)	µg/L	<0.1	<15	—	
Copper (unfiltered)	µg/L	<0.35	<7	—	
Copper (filtered)	µg/L	<0.35	<7	—	
Fluoride	mg/L	0.3	0.42	4[a]	
Iron (unfiltered)	µg/L	<30	400	300[b]	299-E18-1
Iron (filtered)	µg/L	<22.7	<30	300[b]	
Magnesium (unfiltered)	µg/L	14,100	18,100	—	
Magnesium (filtered)	µg/L	13,500	18,500	—	
Manganese (unfiltered)	µg/L	<0.9	<4	50[b]	
Manganese (filtered)	µg/L	<0.9	<4	50[b]	
Nickel (unfiltered)	µg/L	<1.48	<10	—	
Nickel (filtered)	µg/L	<0.871	26.1	—	
Nitrate	mg/L	12	66.4	45[c]	299-E17-22, 299-E17-25, 299-E17-26, 299-E24-21, 299-E24-24
Nitrite	mg/L	<0.046	<0.046	3.3[c]	
Potassium (unfiltered)	µg/L	6,030	8,070	—	

Table 2-36. IDF Sampling Summary for Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Potassium (filtered)	µg/L	6,130	8,110	—	
Silver (unfiltered)	µg/L	<0.4	<3	100[b]	
Silver (filtered)	µg/L	<0.4	4.7	100[b]	
Sodium (unfiltered)	µg/L	20,200	27,900	—	
Sodium (filtered)	µg/L	20,000	26,900	—	
Sulfate	mg/L	37	96	250[b]	
Turbidity	NTU	0.15	2.87	—	
Vanadium (unfiltered)	µg/L	<15	20.5	—	
Vanadium (filtered)	µg/L	<15	21.3	—	
Zinc (unfiltered)	µg/L	<3.3	<7.5	5,000[b]	
Zinc (filtered)	µg/L	<3.3	<7.5	5,000[b]	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Primary drinking water standard.

b. Secondary drinking water standard.

c. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

2.10 Liquid Effluent Retention Facility

Located on the eastern boundary of the 200 East Area, the LERF is a TSD unit with three lined surface impoundment basins (Figures 1-1 and 2-12). Construction of LERF 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 the basin covers also reduce possible environmental or personnel exposure. The basins are located side by side, with 18 m (60 ft) of separation between them. Each basin (cell) is 100 by 82 m (330 by 270 ft), with a maximum fluid depth of 6.7 m (22 ft).

The LERF provides aqueous waste storage and treatment prior to final treatment in the 200 Area Effluent Treatment Facility (ETF). Treatment at LERF consists of flow and pH equalization. Flow equalization allows for several smaller waste streams that are intermittently received at the LERF basins to accumulate for continuous higher volume campaign processing at the ETF. The LERF continues to receive liquid waste from a number of onsite facilities, with the largest volume from the 242A evaporator.

The LERF is incorporated into Part III of the Hanford Facility RCRA Permit. Groundwater is monitored under the permit and DOE/RL-2013-46, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*. That plan was revised in 2017, and a permit modification became effective November 26, 2017. All of the 2017 sampling events occurred before the permit modification became effective.

Table 2-37 lists wells in the LERF monitoring network. Four of the five well screens extend to the underlying basalt or within the basalt fracture zone. Well 299-E26-14 extends to within 0.9 m (3 ft) of the underlying basalt surface. The water table elevation at LERF declined an average of 1.1 cm/yr (0.4 in./yr) between 2012 and 2017. Based on this information, the LERF groundwater wells have adequate water columns in the screened interval for sampling during the next two decades.

Monthly water-level measurements were collected in 2017, and the hydraulic gradient was calculated for each data set. The average gradient was 3.0×10^{-4} m/m toward the south (Table 2-38). The estimated groundwater flow rate was 0.12 m/d (0.39 ft/d) or 44 m/yr (145 ft/yr).

In 2017, LERF monitoring wells were scheduled for semiannual sampling for indicator parameters in January and July. However, wells were sampled six to eight times due to the factors explained in Table 2-39.

Based on the July groundwater 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. DOE notified Ecology and proceeded with verification sampling activities. However, Ecology concluded that no exceedances had occurred based on the following factors:

- DOE demonstrated that longer well purging is required at well 299-E26-79 to obtain a representative pH measurement (SGW-61435, *2017 LERF Hydrogeology Investigation* [in publication]). 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. Because the exceedances were in an upgradient well, it did not trigger groundwater quality assessment.

Table 2-40 summarizes the 2017 monitoring results for other constituents. Nitrate continued to exceed its standard in upgradient well 299-E26-14 and downgradient well 299-E26-79 due to a regional plume.

Under the revised groundwater monitoring plan (DOE/RL-2013-46, Rev. 1), compliance wells will be monitored beginning in 2018 for waste constituents indicative of releases from the LERF: 1-butanol, carbon tetrachloride, Cr(VI), and n-nitrosodimethylamine.

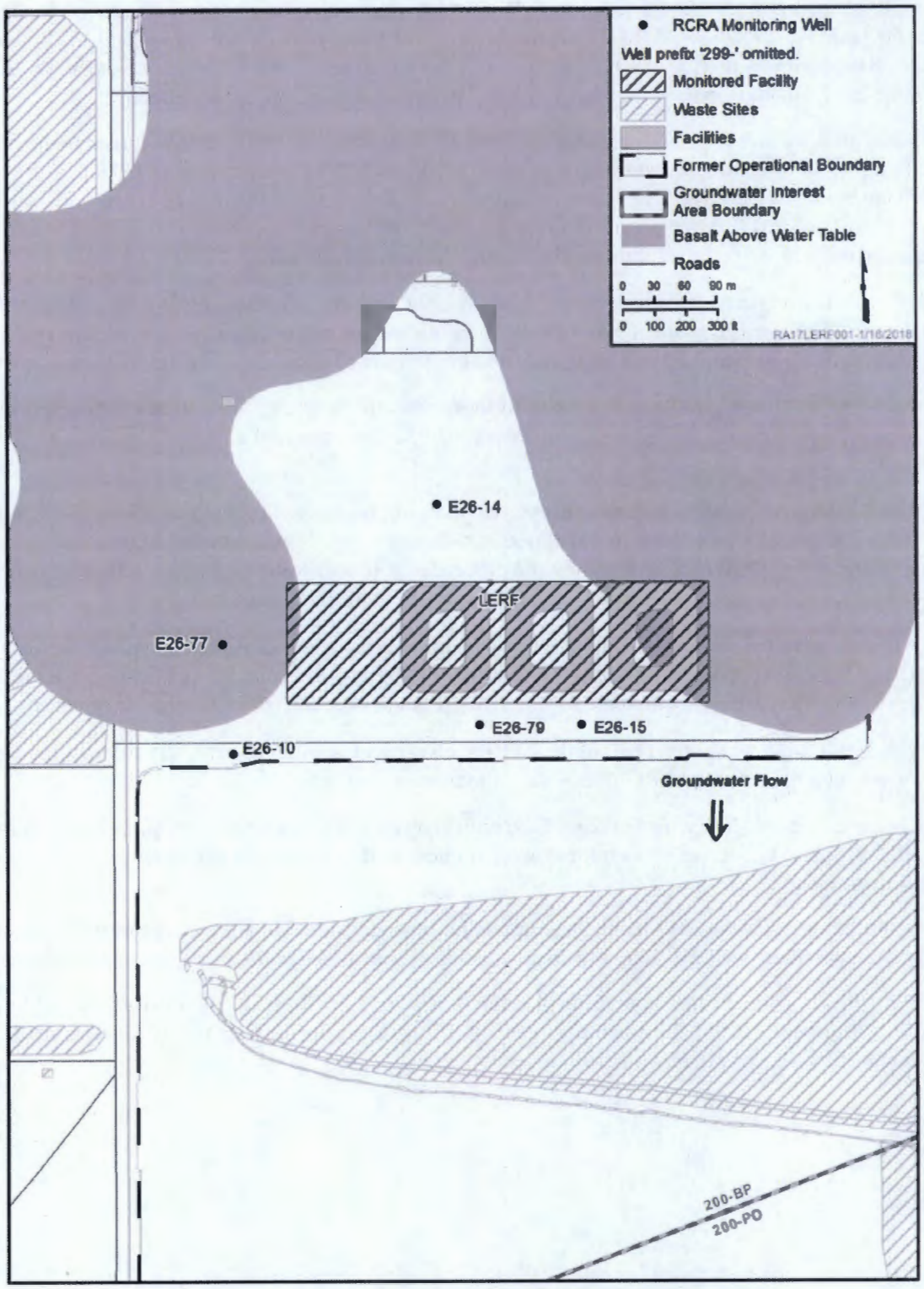


Figure 2-12. Liquid Effluent Retention Facility

Table 2-37. LERF Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head[a]		Head Date	Water Column		Sample Frequency (Rev. 0/1)[b]	Comment[c]
			m	ft	m	ft	m	ft		m	ft		
299-E26-10[d]	CG	1990 (C)	125.4	411.6	120.7	396.0	121.77	399.51	10/25/2017	1.1	3.5	0	Used for water levels only (Rev. 0 and 1)
299-E26-14	UG	2011 (C)	122.8	402.8	116.7	382.8	121.82	399.67	10/25/2017	5.1	16.8	S/S	
299-E26-15[d]	DG	2015 (C)	124.2	407.3	119.5	392.0	121.23	397.73	10/25/2017	1.7	5.7	0/S	Sampled, but not part of network in Rev. 0
299-E26-77[d]	CG	2008 (C)	122.0	400.3	114.5	375.5	121.78	399.54	10/25/2017	7.3	24.0	S/0	Water levels only in Rev. 1
299-E26-79	DG	2008 (C)	122.1	400.6	114.5	375.6	121.77	399.49	10/25/2017	7.3	23.9	S/S	

Note: Requirements are from Part III of the Hanford RCRA Permit (*Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended) and DOE/RL-2013-46, Rev. 0, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*.

a. Hydraulic head has been corrected for borehole deviation from vertical in all wells in this network.

b. Rev. 0 was in effect until the permit modification was effective on November 26, 2017. The 2017 sampling occurred under Rev. 0.

c. See Table 2-39 for sample dates and exceptions.

d. Not compliance wells under Rev. 0 (wells 299-E26-10, 299-E26-15 and 299-E26-77).

0 = no sampling required

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

CG = cross gradient

DG = downgradient

S = semiannually

UG = upgradient

Table 2-38. Groundwater Velocity at LERF

Flow Direction	South
Flow Rate (m/d)	0.12
Hydraulic Conductivity (m/d) (Source)	39.5 (DOE/RL-2013-46, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*)
Effective Porosity	0.1 (DOE/RL-2013-46)
Gradient (m/m)	3.0×10^{-4}
Comments	Based on average of February, March, May, June, July, September, October, and November 2017 gradients; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-39. LERF Contamination Indicator Parameters, 2017

Indicator Parameter		Carbon Tetrachloride		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)				
2017 Critical Mean*		Detection Limit		7.68	8.08	838		3,920			10.33				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ	Lab (TOC and TOX)	Comment
299-E26-14	1/31/2017	<0.18	0	7.85	0.01	813	1	1,100	71	1,640	6.2	0.9	20.4	TASL	
	7/27/2017	—	—	7.88	0.00	908	1	—	—	—	—	—	—	—	Sample temperature out of limits. See 8/1/2017 for carbon tetrachloride, TOC, and TOX
	8/1/2017	<0.18	0	7.63	0.01	901	1	585	51	1,390	9.1	0.8	18.2	TASL	Resampled (see 7/27/2017 comment)
	8/28/2017	<0.3	—	7.88	—	925	—	—	—	—	—	—	—	—	Sampled for Appendix IX
	9/28/2017	—	—	7.88	0.04	—	—	—	—	—	—	—	—	—	Sampled for pH investigation
	10/18/2017	—	—	7.89	—.	924	—	—	—	—	—	—	—	—	Sampled for alkalinity (missed on 8/1/2017)
299-E26-15	1/31/2017	<0.3	0	7.95	0.00	827	1	912	37	640	<4.0	0.4	7.8	GEL	
	7/27/2017	—	—	7.89	0.01	888	2	—	—	—	—	—	—	—	Sample temperature out of limits. See 8/1/2017 for carbon tetrachloride, TOC, and TOX
	8/1/2017	<0.3	0	7.75	0.00	877	0	1,270	31	600	<3.7	0.5	10.9	GEL	Resampled (see 7/27/2017 comment)
	8/28/2017	<0.3[b]	—	7.91	—	893	—	—	—	—	—	—	—	—	Sampled for Appendix IX
	9/28/2017	—	—	7.94	0.01	—	—	—	—	—	—	—	—	—	Sampled for pH investigation
	10/5/2017	—	—	7.91	0.09	861	1	—	—	—	—	—	—	—	Sampled for pH investigation
	10/12/2017	<0.3	0	7.83	0.00	853	1	990	8	540	<5.5	1.4	11.8	GEL	
	10/18/2017	—	—	7.94	—	900	—	—	—	—	—	—	—	—	Sampled for alkalinity (missed on 8/1/2017)
299-E26-79	1/31/2017	<0.3	0	8.08	0.02	755	2	755	29	640	<4.3	0.9	7.8	GEL	
	7/27/2017	<0.19	0	8.13	0.02	772	2	631	64	540	8.6	1.1	24.7	TADN	
	8/28/2017	<0.3	—	8.32	—	789	—	—	—	—	—	—	—	—	Sampled for Appendix IX
	9/28/2017	—	—	8.13	0.02	—	—	—	—	—	—	—	—	—	Sampled for pH investigation
	10/5/2017	—	—	7.99	0.09	759	0	—	—	—	—	—	—	—	Sampled for pH investigation
	10/18/2017	—	—	8.04	—	788	—	—	—	—	—	—	—	—	Sampled for alkalinity (missed on 8/28/2017)

Note: Yellow-highlighted cell indicates exceedances of a critical mean.

* Critical mean values from Table 25 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring*.

< = one or more of the replicate values was below the detection limit
— = no data or not applicable
GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

This page intentionally left blank.

Table 2-40. LERF Sampling Summary for Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	87	99	—	
Calcium (unfiltered)	µg/L	65,500	92,000	—	
Calcium (filtered)	µg/L	70,100	90,000	—	
Chloride	mg/L	45	63	250[a]	
Cr(VI) (unfiltered)	µg/L	<2	<2	48[b]	
Cr(VI) (filtered)	µg/L	<2	<2	48[b]	Filtered Cr(VI) analyzed only in 299-E26-15
Magnesium (unfiltered)	µg/L	22,400	27,900	—	
Magnesium (filtered)	µg/L	24,100	29,500	—	
Nitrate	mg/L	42	78[d]	45[c]	299-E26-14, 299-E26-79
Nitrite	mg/L	<0.11	0.27	3.3[c]	
Potassium (unfiltered)	µg/L	9,010	10,000	—	
Potassium (filtered)	µg/L	9,030	10,200	—	
Sodium (unfiltered)	µg/L	28,400	37,000	—	
Sodium (filtered)	µg/L	28,600	37,400	—	
Sulfate	mg/L	147	210[d]	250	
Appendix IX	See text for summary and Appendix A for data				

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cell indicates concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

c. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

d. Excludes "Y"-flagged data points in well 299-E26-79.

< = one or more of the results was below the detection limit

— = no comparison value

Cr(VI) = hexavalent chromium

2.11 Low-Level Waste Management Area 1

Low-Level Waste Management Area 1 (LLWMA-1) is located in the northwest corner of the 200 East Area (Figures 1-1 and 2-13). The 218-E-10 Burial Ground (14 unlined and covered trenches) received low-level radiological waste from 1955 to 2000. Low-level mixed waste was received in the north portion of Trench 9 from 1987 to 1993. Dangerous chemicals in the low-level mixed waste portion of the 218-E-10 Burial Ground are regulated under RCRA and its implementing requirements in 40 CFR 265, Subpart F, as referenced by WAC 173-303-400. The LLWMA-1 monitoring network is designed to detect indicators of dangerous waste or dangerous waste constituents affecting groundwater from the 218-E-10 Burial Ground. The monitoring network encompasses the LLWMA-1 boundary to provide coverage for potential groundwater flow direction changes. DOE monitors groundwater under an interim status indicator evaluation program in accordance with 40 CFR 265.93(b), as defined in DOE/RL-2009-75, Rev. 1, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*.

The current LLWMA-1 monitoring network consists of seven wells screened in the upper portion of the aquifer at the water table (Table 2-41). The water table elevation at LLWMA-1 declined an average 2.7 cm/yr (1.1 in./yr) between 2012 and 2017. Based on this information, the LLWMA-1 wells are expected to have adequate water columns in the screened interval for sampling. A new well is planned near the southeast corner of LLWMA-1.

Based on the low-gradient water table map (Figure 2-6), the estimated hydraulic gradient beneath LLWMA-1 in 2017 was 7.6×10^{-6} m/m, sloping to the southeast (Table 2-42). The average groundwater flow rate was estimated at 0.65 m/d (2.1 ft/d). Groundwater extraction at WMA B-BX-BY may cause local deviations from the estimated groundwater flow direction and rate.

In 2017, LLWMA-1 monitoring wells were sampled semiannually for indicator parameters as scheduled (Table 2-43). Specific conductance, pH, TOC, and TOX did not exceed critical mean values, and LLWMA-1 remains in indicator evaluation monitoring.

Table 2-44 summarizes the groundwater quality parameters and other constituents for LLWMA-1. Nitrate concentrations were greater than 45 mg/L in three wells due to a regional nitrate plume (Figure 1-3).

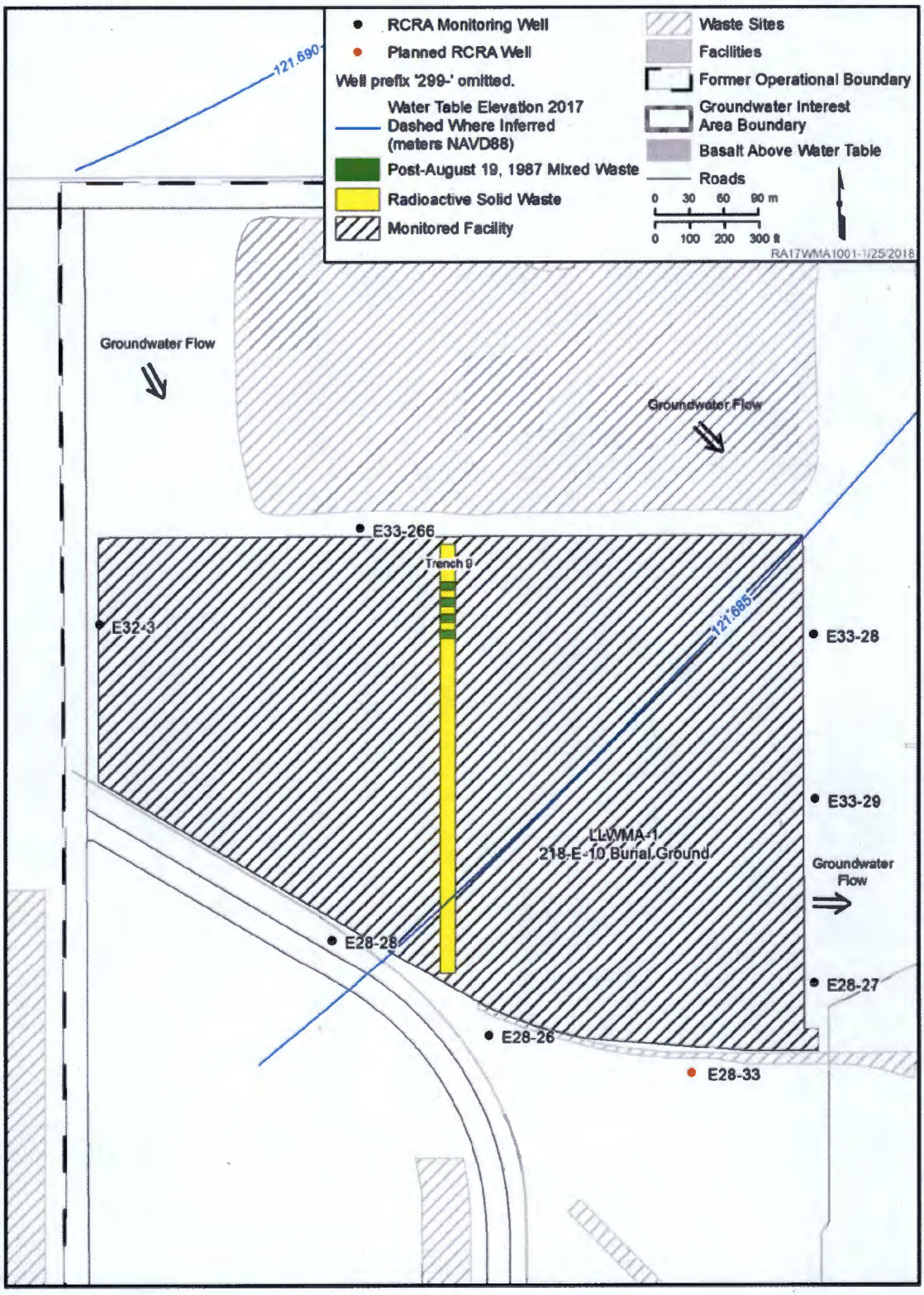


Figure 2-13. Low-Level Waste Management Area 1

Table 2-41. LLWMA-1 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
299-E28-26	DG	1987 (C)	124.9	409.6	118.7	389.5	121.68	399.21	7/27/2017	2.9	9.7	S	None
299-E28-27[b]	DG	1987 (C)	125.6	411.9	119.5	392.0	121.68	399.21	7/14/2017	2.2	7.2	S	None
299-E28-28	DG	1990 (C)	125.6	412.1	119.5	392.2	121.65	399.10	7/14/2017	2.1	6.9	S	None
299-E32-3	UG	1987 (C)	125.8	412.7	119.7	392.8	121.65	399.12	7/19/2017	1.9	6.3	S	None
299-E33-28[b]	DG	1987 (C)	125.2	410.6	119.1	390.6	121.67	399.18	7/14/2017	2.6	8.5	S	None
299-E33-29	DG	1987 (C)	120.6	395.5	117.5	385.6	121.64	399.07	7/14/2017	4.1	13.4	S	None
299-E33-266	UG	2010 (C)	123.4	404.8	117.3	384.8	121.55	398.77	7/14/2017	4.3	14.0	S	None
299-E28-33	DG	2018 (planned)	—	—	—	—	—	—	—	—	—	S	Awaiting drilling

Note: Requirements are from DOE/RL-2009-75, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*.

a. See Table 2-43 for sample dates.

b. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

UG = upgradient

S = semiannually

Table 2-42. Groundwater Velocity at LLWMA-1

Flow Direction	Southeast
Flow Rate Range (m/d)	0.65
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	7.6×10^{-6}
Comments	Gradient and flow direction represent average of October 2016 through September 2017; based on trend surface analysis on low-gradient well network; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-43. LLWMA-1 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		**pH**		**Specific Conductance (µS/cm)**		**TOC (µg/L)**			**TOX (µg/L)**			**Lab (TOC and TOX)**	**Comment**
Critical Mean*		**7.12**	**8.84**	**592**		**1,366**			**8.43**				
Well	**Sample Date**	**Avg**	**SD**	**Avg**	**SD**	**Avg**	**SD**	**LOQ**	**Avg**	**SD**	**LOQ**		
299-E28-26	1/16/2017	7.97	0.05	483	1	<720	0	1,640	4.83	1.13	20.4	TASL	
	7/14/2017	7.92	0.00	516	0	1,033	137	1,390	<3.85	2.06	18.2	TASL	
299-E28-27	1/16/2017	8.00	0.10	495	1	<334	6	640	<3.33	0.00	7.8	GEL	
	7/14/2017	8.01	0.00	514	0	<500	0	600	<4.66	2.30	10.9	GEL	
299-E28-28	1/16/2017	8.06	0.02	434	1	<720	0	1,640	4.45	0.99	20.4	TASL	
	7/14/2017	7.90	0.01	460	0	<500	0	1,390	4.18	1.38	18.2	TASL	
299-E32-3	1/16/2017	8.04	0.03	421	1	<330	0	640	<3.33	0.00	708	GEL	

Table 2-43. LLWMA-1 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean*		7.12	8.84	592		1,366			8.43				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
	7/19/2017	7.78	0.01	436	1	<344	16	600	<3.33	0.00	10.9	GEL	
299-E33-266	1/16/2017	7.87	0.04	432	4	<763	74	1,640	<7.68	3.56	708	TASL	One TOX value flagged as "Y" (suspect).
	7/14/2017	7.98	0.00	438	0	543	21	540	<8.28	1.00	24.7	TADN	
299-E33-28	1/16/2017	8.09	0.02	490	1	<342	19	640	<3.33	0.00	708	GEL	
	7/14/2017	7.98	0.00	482	0	<330	0	600	<3.33	0.00	10.9	GEL	
299-E33-29	1/16/2017	8.12	0.01	441	0	<720	0	640	<3.95	2.21	20.4	TASL	
	7/14/2017	8.04	0.00	446	1	276	29	540	<8.05	0.61	24.7	TADN	

* Critical mean values from Table 27 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring.*

< = one or more of the replicate values was below the detection limit
GEL = GEL Laboratory
LOQ = limit of quantitation
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-44. LLWMA-1 Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Calcium (unfiltered)	µg/L	36,900	52,800	—	
Calcium (filtered)	µg/L	42,700	51,500	—	
Chloride	mg/L	11	15	250[a]	
Dissolved oxygen	mg/L	7.3	9.9	—	
Fluoride	mg/L	0.4	0.6	4.0[b]	
Iron (unfiltered)	µg/L	<30	114	300[a]	
Iron (filtered)	µg/L	<26	30	300[a]	
Magnesium (unfiltered)	µg/L	11,700	16,500	—	
Magnesium (filtered)	µg/L	13,100	15,900	—	
Manganese (unfiltered)	µg/L	<1.8	<4.0	50[a]	
Manganese (filtered)	µg/L	<0.7	<4.0	50[a]	
Nitrate	mg/L	41	58	45[c]	299-E28-26, 299-E28-27, 299-E33-28
Nitrite	mg/L	<0.05	0.17	3.3[c]	
Phenol	µg/L	<1.9	2.9	2,400[d]	
Potassium (unfiltered)	µg/L	5,510	6,800	—	
Potassium (filtered)	µg/L	5,310	7,090	—	
Sodium (unfiltered)	µg/L	22,200	28,600	—	
Sodium (filtered)	µg/L	22,400	28,300	—	
Sulfate	mg/L	36	71	250[a]	
Temperature	°C	16.2	19.5	—	Excludes rejected values in well 299-E28-28, 7/14/2017
Turbidity	NTU	0.23	3.05	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cell indicates concentration greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

d. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

2.12 Low-Level Waste Management Area 2

LLWMA-2 is located in the northeast corner of the 200 East Area (Figures 1-1 and 2-14) and consists of the 218-E-12B and 200-E-304 Burial Grounds, which contain 39 inactive and covered north-south-oriented trenches (in 216-E-12B) and one active uncovered trench (Trench 94 in 200-E-304). The 218-E-12B Burial Ground received solid, low-level, radiological, and transuranic waste from 1967 to 2004 and is not subject to the requirements of WAC 173-303. LLWMA-2 continues to follow the implementing requirements in WAC 173-303-400, as defined in DOE/RL-2009-76, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-2*.

Table 2-45 lists construction information and water levels for LLWMA-2 wells. The water table elevation at LLWMA-2 declined an average of 1.5 cm/yr (0.6 in./yr) between 2012 and 2017. The wells are expected to have adequate water in the screened interval for sampling during the next two decades.

Groundwater gradient magnitudes and flow directions were determined using the 200 East Area low-gradient monitoring network from September 2016 through October 2017 (Figure 2-6). The average gradient in the western half of the monitoring network was 8.5×10^{-6} m/m, dipping to the southeast (Table 2-46). The gradient could not be calculated in the eastern portion of the LLWMA, but it likely has similar magnitude, with a flow direction more to the south. Estimates of groundwater flow rates range from 0.064 to 0.73 m/d (0.21 to 2.4 ft/d). Groundwater extraction at WMA B-BX-BY may cause local deviations from the estimated groundwater flow direction and rate.

All of the LLWMA-2 wells were sampled semiannually as required during the reporting period (Table 2-47). There were no confirmed critical mean exceedances in 2017. The average pH in well 299-E27-11 in April exceeded the upper limit, but verification sampling results did not confirm the exceedance. The site remains in interim status detection monitoring.

Table 2-48 summarizes groundwater quality parameters and other constituents required by 40 CFR 265.92(b)(2). Iron, nitrate, and sulfate concentrations exceeded DWSs but did not originate in LLWMA-2, as explained below:

- Iron exceeded the secondary DWS in unfiltered samples from well 299-E27-10. Previous video surveys of the well show moderate encrustation of apparent amorphous ferric hydroxide (orange in color). Other metals associated with stainless-steel corrosion (chromium and nickel) are also found in this well at elevated levels. It is likely that corrosion in this well affected the samples.
- Sulfate and nitrate continued to exceed applicable standards in wells 299-E27-9 and 299-E27-10. The elevated sulfate and nitrate appear to be ongoing loading from the vadose zone associated with unplanned releases to the 216-B-2 Ditches in the early 1960s and 1970s. The conceptual model for migration from the 216-B-2 Ditches includes northeast migration through the vadose zone to groundwater and southward migration within the aquifer to wells 299-E27-9 and 299-E27-10. Sulfate could also be associated with gypsum mobilized by dust-suppression water used during excavation of sediments associated with Trench 94.
- The elevated nitrate in wells 299-E34-9, 299-E34-10, and 299-E34-12 appears to be associated with southeast migration from sources to the northwest, primarily the BY Cribs (Figure 1-3).

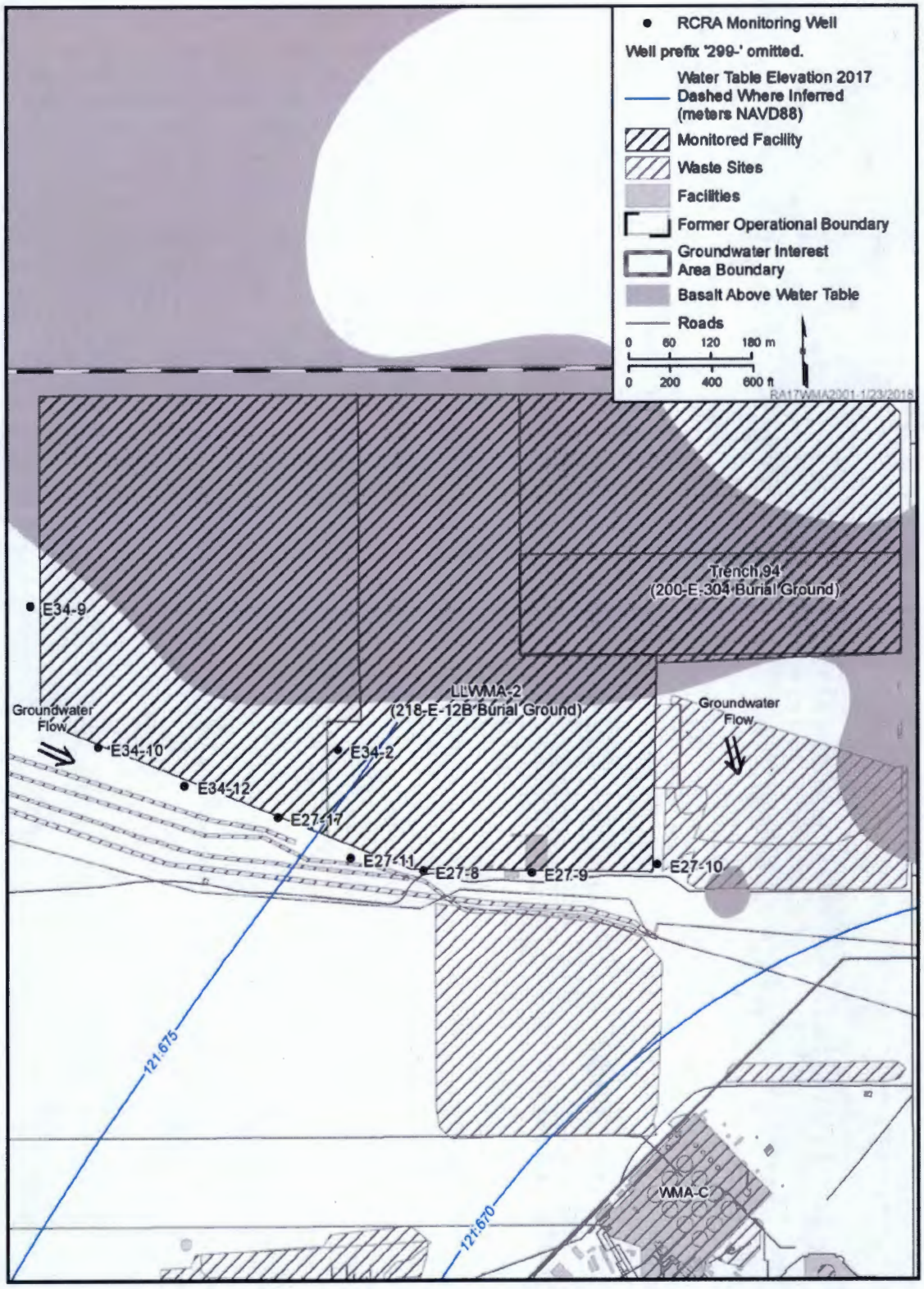


Figure 2-14. Low-Level Waste Management Area 2

Table 2-45. LLWMA-2 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampling Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
299-E27-8[b]	DG	1987 (C)	125.8	412.7	119.7	392.7	121.73	399.36	10/11/2017	2.0	6.6	S	None
299-E27-9[b]	DG	1987 (C)	125.3	411.1	119.4	391.8	121.73	399.38	10/11/2017	2.3	7.6	S	None
299-E27-10	DG	1987 (C)	126.2	413.9	120.0	393.6	121.74	399.39	10/11/2017	1.8	5.8	S	None
299-E27-11	CG	1989 (C)	126.0	413.5	119.6	392.5	121.65	399.11	10/11/2017	2.0	6.6	S	Resampled; see Table 2-47
299-E27-17[b]	CG	1991 (C)	125.5	411.9	119.1	390.9	121.72	399.34	10/1/2017	2.6	8.5	S	None
299-E34-2	UG	1987 (C)	125.2	410.9	119.2	390.9	121.74	399.39	10/11/2017	2.6	8.5	S	None
299-E34-9[b]	CG	1991 (C)	127.0	416.7	120.7	395.9	121.74	399.42	10/12/2017	1.1	3.5	S	Resampled; see Table 2-47
299-E34-10[b]	CG	1991 (C)	126.5	415.0	120.1	394.0	121.75	399.44	10/11/2017	1.6	5.4	S	None
299-E34-12	CG	1992 (C)	126.6	415.3	120.4	395.0	121.63	399.04	10/9/2017	1.2	4.1	S	None

Note: Requirements are from DOE/RL-2009-76, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-2*.

a. See Table 2-47 for sample dates.

b. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

CG = cross gradient

DG = downgradient

S = semiannually

UG = upgradient

Table 2-46. Groundwater Velocity at LLWMA-2

Flow Direction	West portion of LLWMA-2: southeast; east portion: south-southeast
Flow Rate (m/d)	0.064 to 0.73
Hydraulic Conductivity Range (m/d) (Source)	For the east portion of the WMA, 1,500 to 6,700 (pump test results, PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds—An Interim Report*). For the west portion of the WMA, 17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	8.5×10^{-6}
Comments	Gradient and flow direction represent average of October 2016 through September 2017; based on trend surface analysis on low-gradient well network; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-47. LLWMA-2 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean[a]		7.36	8.27	1,207		1,938			27.69				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E27-10	4/6/2017	7.78	0.02	1,136	2	<720	0	1520	11.08	1.97	20.4	TASL	
	10/11/2017	7.69	0.02	1,164	2	<503	4	1,540	9.35	1.08	17.7	TASL	
299-E27-11	4/6/2017	8.48	0.01	493	1	171	12	NC	<9.20	1.17	NC[b]	TADN	pH later flagged as "Y" (suspect)

Table 2-47. LLWMA-2 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean[a]		7.36	8.27	1,207		1,938			27.69				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
	5/26/2017	7.89[c]	0.01	501	0	—	—	—	—	—	—	—	Verification sampling for April pH exceedances (not confirmed)
	10/11/2017	8.07	0.02	518	0	410	49	540	10.16	2.95	11.8	GEL	
299-E27-17	4/5/2017	8.19	0.01	503	1	<720	0	1520	<2.23	0.22	20.4	TASL	
	10/11/2017	8.17	0.05	490	2	<500	0	1,540	6.73	1.06	17.7	TASL	
299-E27-8	4/4/2017	8.11	0.00	493	0	<720	0	1520	7.55	1.69	20.4	TASL	
	10/11/2017	8.01	0.00	464	0	<500	0	1,540	7.55	0.42	17.7	TASL	
299-E27-9	4/4/2017	8.13	0.01	1,056	10	961	35	590	<3.65	0.56	8.3	GEL	
	10/11/2017	8.05	0.02	1,079	6	876	3	540	8.22	3.48	11.8	GEL	
299-E34-10	4/5/2017	8.02	0.02	677	0	<720	0	1,520	7.65	3.51	20.4	TASL	
	10/11/2017	7.99	0.01	697	2	238	11	580	7.70	0.00	23.7	TADN	
299-E34-12	4/4/2017	8.24	0.00	470	1	404	26	590	<3.33	0.00	8.3	GEL	
	10/9/2017	7.93	0.01	620	1	211	23	580	<7.70	0.00	23.7	TADN	
299-E34-2	4/6/2017	8.06	0.00	578	0	<720	0	1,520	<4.95	3.69	20.4	TASL	
	10/11/2017	8.06	0.00	582	0	<500	0	1,540	5.00	1.46	17.7	TASL	

Table 2-47. LLWMA-2 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean[a]		7.36	8.27	1,207		1,938			27.69				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-E34-9	4/10/2017	7.99	0.00	703	2	<720	0	1,520	<2.10	0.00	20.4	TASL	Originally sampled 4/5/2017 but a bottle broke; resampled
	10/12/2017	7.93	0.00	1,021	3	<500	0	1,540	3.63	1.38	17.7	TASL	

Note: Yellow-highlighted cell indicates exceedance of a critical mean.

a. Critical mean values from Table 7-17 of ECF-Hanford-16-0015, *Calculation of Critical Means for Calendar Year 2016 RCRA Groundwater Monitoring.* Critical mean values for 2017 (ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring*) are not applicable because they were based on a revised monitoring plan that has not yet been implemented.

b. LOQ not calculated because field blank results were not available from this laboratory.

c. Average field pH is listed here. Samples were also analyzed for pH in the laboratory for pH (see Appendix A).

< = one or more of the replicate values was below the detection limit

— = no data or not applicable

GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-48. LLWMA-2 Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	64	112	—	
Calcium (unfiltered)	µg/L	49,900	152,000	—	
Calcium (filtered)	µg/L	45,300	148,000	—	
Chloride	mg/L	14	91	250[a]	
Chromium (unfiltered)	µg/L	6.3	64.0	—	
Chromium (filtered)	µg/L	<3.0	23.1	—	
Dissolved oxygen	mg/L	5.9	10.0	—	
Fluoride	mg/L	0.2	0.5	4.0[b]	
Iron (unfiltered)	µg/L	<30	532	300[a]	299-E27-10
Iron (filtered)	µg/L	<17	144	300[a]	
Manganese (unfiltered)	µg/L	<0.9	6.8	50[a]	
Manganese (filtered)	µg/L	<0.4	5.4	50[a]	
Nitrate	mg/L	14	235	45[c]	299-E27-10, 299-E27-9, 299-E34-10, 299-E34-12, 299-E34-9
Nitrite	mg/L	<0.1	<0.1	3.3[c]	
Phenol	µg/L	<1.9	<3.0	2,400[d]	
Potassium (unfiltered)	µg/L	4,790	12,900	—	
Potassium (filtered)	µg/L	7,280	13,400	—	
Sodium (unfiltered)	µg/L	12,200	43,000	—	
Sodium (filtered)	µg/L	15,400	41,000	—	
Sulfate	mg/L	75	394	250[a]	299-E27-10, 299-E27-9
Temperature	°C	17	19	—	
Turbidity	NTU	0.7	5.4	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

d. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

2.13 Low-Level Waste Management Area 3

LLWMA-3 (Figure 2-15) is located in the northwest quadrant of the 200 West Area and has four burial grounds (218-W-3A, 218-W-3AE, 218-W-5, and 200-W-254) within its boundary. The 218-W-3A Burial Ground (0.204 km^2 [0.079 mi^2]) has 57 unlined trenches and operated between 1970 and 1998. The 218-W-3AE Burial Ground (0.200 km^2 [0.077 mi^2]) has eight unlined trenches and operated between 1981 and July 2004. The 218-W-5 Burial Ground (0.27 km^2 [0.103 mi^2]) has 10 unlined trenches and began operating in 1986. The 200-W-254 Burial Ground (0.105 km^2 [0.041 mi^2] was originally within the 218-W-5 Burial Ground boundary.

In 2014, a new waste site code (200-W-254) was placed in the Waste Information Data System database to specifically identify the operating units (i.e., active areas) of the 218-W-5 Burial Ground containing Trenches 31 and 34 and associated waste treatment and storage pads. Constructed with double polyethylene liners, the trenches and pads are unique within LLWMA-3 and direct all surface runoff to a leachate collection and removal system. The 200-W-254 Burial Ground began operating in 1999 and continues to receive waste. Trenches 31 and 34 and associated waste treatment and storage pads are considered four separate DWMUs.

LLWMA-3 is monitored under an interim status indicator program as described in DOE/RL-2009-68, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3*. The monitoring network consists of one upgradient well and three downgradient wells that monitor Trenches 31 and 34 (Table 2-49). Each well was constructed according to WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the saturated thickness across screen intervals is expected to be adequate for future groundwater sampling.

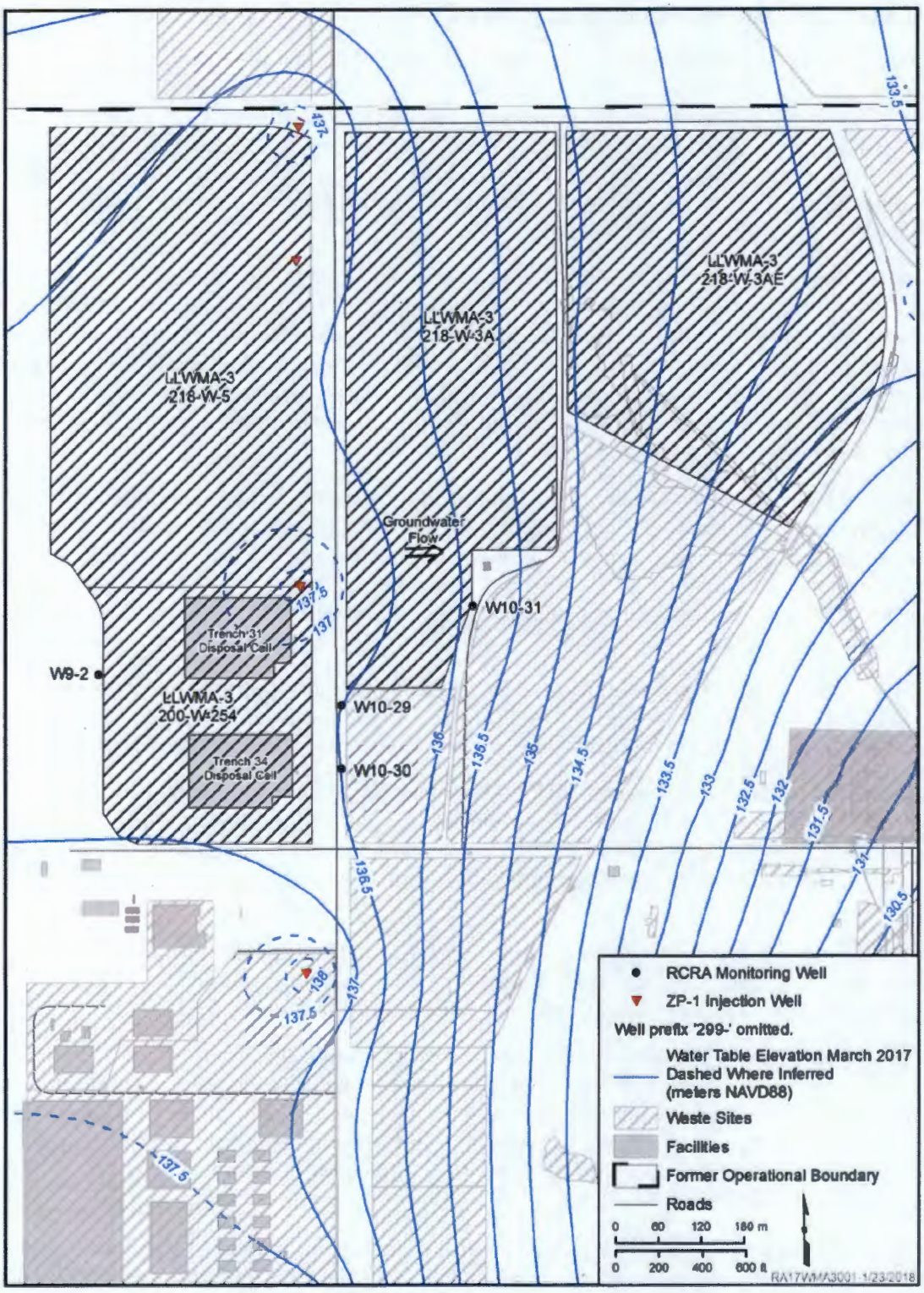
Between 2012 and 2014, water levels increased due to the injection of water from the 200 West Area P&T system in and adjacent to LLWMA-3 (Figure 2-15). Groundwater levels declined 60 to 80 cm (24 to 31 in.) between 2015 and 2016 and increased 20 to 40 cm (8 to 16 in.) between 2016 and 2017.

The water table elevation in upgradient well 299-W9-2 remains higher than downgradient wells by at least 0.24 m (0.79 ft). Groundwater flows predominately to the east beneath LLWMA-3 but is locally affected by P&T injection wells. The estimated groundwater flow rates beneath LLWMA-3 range from 0.036 m/d (0.12 ft/d) within the southern portion to 0.21 m/d (0.69 ft/d) in the northern portion of this LLWMA (Table 2-50).

Wells in the LLWMA-3 monitoring network were sampled in 2017 for indicator parameters (specific conductance, pH, TOC, and TOX; Table 2-51), water quality parameters (chloride, iron, manganese, phenol sodium, and sulfate), and other parameters (Table 2-52).

As shown in Table 2-51, the average specific conductance in downgradient well 299-W10-31 exceeded the critical mean value in March and September. The elevated specific conductance is presumed to be from increasing nitrate concentration associated with the migration of a regional nitrate plume. In 2017, the nitrate concentration in well 299-W10-31 was 44.7 mg/L. The highest nitrate concentration in a LLWMA-3 well in 2017 was 52.7 mg/L in 299-W10-30, which exceeds the 45 mg/L DWS equivalent and is an increase from 30.5 mg/L in 2016.

The TOX concentrations in well 299-W10-30 exceeded the critical mean value in March and September (Table 2-51). The TOX concentrations are consistent with observed levels of carbon tetrachloride in the area (SGW-59713-VA, *LLWMA-3 Groundwater Monitoring: 299-W10-31 Specific Conductance and TOX*; and SGW-61120, *Meeting Notes – Briefing to Ecology on LLWMA-3 RCRA Groundwater Monitoring)*. The carbon tetrachloride concentration in well 299-W10-30 was 15.1 µg/L in 2017.



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

Figure 2-15. Low-Level Waste Management Area 3

Table 2-49. LLWMA-3 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions*
			m	ft	m	ft	m	ft		m	ft		
299-W9-2	UG	2011 (C)	135.9	445.8	125.2	410.8	136.79	448.79	9/13/2017	11.6	38.0	S	None
299-W10-29	DG	2006 (C)	136.9	449.3	126.3	414.3	136.43	447.61	9/13/2017	10.2	33.3	S	None
299-W10-30	DG	2006 (C)	137.1	449.8	126.4	414.8	136.43	447.61	9/13/2017	10.0	32.8	S	None
299-W10-31	DG	2006 (C)	136.5	447.9	125.8	412.9	135.93	445.95	9/13/2017	10.1	33.1	S	None

Note: Requirements are from DOE/RL-2009-68, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3.*

* See Table 2-51 for sample dates.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

S = semiannually

UG = upgradient

Table 2-50. Groundwater Velocity at LLWMA-3

Flow Direction	East (locally disrupted by groundwater injection wells)
Flow Rate (m/d)	Northern portion (218-W-3A): 0.21 Southern portion (Trenches 31 and 34): 0.036
Hydraulic Conductivity (m/d) (Source)	5.0 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	Northern portion (218-W-3A): 4.2×10^{-3} Southern portion (Trenches 31 and 34): 7.3×10^{-4}
Comments	Gradient for northern portion estimated from water table map; gradient for southern portion calculated between wells 299-W9-2 and 299-W10-29; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-51. LLWMA-3 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)			Lab (TOC and TOX)	Comment
Critical Mean[a]		7.43	8.63	462		1,413			9.32				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-W10-29	3/20/2017	8.00	0.00	405	0	<720	0	640	5.3	0.97	20.4	TASL	
						186	19	NC[b]	<7.70	0.00	NC[b]	TADN	TOC and TOX split samples
	9/13/2017	7.91	0.01	416	0	<720	0	1,390	3.65	0.36	18.2	TASL	
299-W10-30	3/20/2017	7.94	0.01	391	1	<355	41	640	10.04	2.30	7.8	GEL	See text regarding TOX exceedances
									12.08	2.55	NC[b]	TADN	
	9/13/2017	7.83	0.01	428	1	<344	23	600	10.38	0.04	10.9	GEL	
299-W10-31	3/20/2017	7.85	0.03	499	1	<720	0	1,640	<8.45	3.72	20.4	TASL	See text regarding specific conductance exceedances
	9/13/2017	7.85	0.00	505	0	<685	142	1,390	6.95	1.38	18.5	TASL	
299-W9-2	3/20/2017	8.03	0.00	393	1	<330	0	640	<3.80	0.82	7.8	GEL	TOC and TOX split samples
						377	92	NC[b]	<9.23	1.07	NC[b]	TADN	
	9/13/2017	8.11	0.04	409	0	<350	21	600	<3.44	0.14	10.9	GEL	

Note: Yellow-highlighted cells indicate exceedances of a critical mean.

a. Critical mean values from Table 29 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring.*

b. LOQ not calculated because field blank results were not available from this laboratory.

< = one or more of the replicate values was below the detection limit
GEL = GEL Laboratory
LOQ = limit of quantitation
NC = not calculated
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-52. LLWMA-3 Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	110	116	—	
Calcium (unfiltered)	µg/L	33,600	56,800	—	
Chloride	mg/L	13.9	28.8	250[a]	
Chromium (unfiltered)	µg/L	3.34	24.2	100[b]	
Dissolved oxygen	mg/L	6.47	11.29	—	
Fluoride	mg/L	0.237	0.451	4[b]	
Iron (unfiltered)	µg/L	<28.7	214	300[a]	
Magnesium (unfiltered)	µg/L	12,400	19,300	—	
Manganese (unfiltered)	µg/L	0.53	8.53	50[a]	
Nitrate	mg/L	27.3	52.7	45[c]	299-W10-30
Nitrite	mg/L	<108	<108	3.3[c]	
Oxidation-reduction potential	mV	204	353	—	
Phenol	µg/L	<1.9	<3	2,400[d]	
Potassium (unfiltered)	µg/L	4,060	4,470	—	
Sodium (unfiltered)	µg/L	9,900	12,400	—	
Sulfate	mg/L	36.1	90.8	250[a]	
Temperature	°C	18.6	22	—	
Turbidity	NTU	0.73	5.52	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

d. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

2.14 Low-Level Waste Management Area 4

LLWMA-4 (Figure 2-16) includes the 218-W-4B and 218-W-4C Burial Grounds and contains 28 unlined trenches used for disposal of low-level radioactive waste and low-level mixed waste. The 218-W-4B Burial Ground also has 12 below-grade caissons at its southern end, which contain remote-handled, low-level waste and retrievable transuranic waste. The 218-W-4B Burial Ground was closed in 1990, and the 218-W-4C Burial Ground was closed in 2004. RCRA monitoring under DOE/RL-2009-69, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-4*, is limited to dangerous waste in the low-level mixed waste portions of Trenches NC, 14, and 58.

The LLWMA-4 network includes six downgradient wells and two upgradient wells (Table 2-53). Upgradient well 299-W18-22 is screened at the bottom of the unconfined aquifer. The water level in upgradient well 299-W18-21, screened at the top of the aquifer, varies in response to changes in operation of nearby injection wells. The well was sampled with a bailer in 2017. Between 2012 and 2017, water levels increased in most LLWMA-4 monitoring wells (up to 71 cm [28 in.] in well 299-W15-224) and declined in other wells (up to 24 cm [9 in.] in well 299-W15-152).

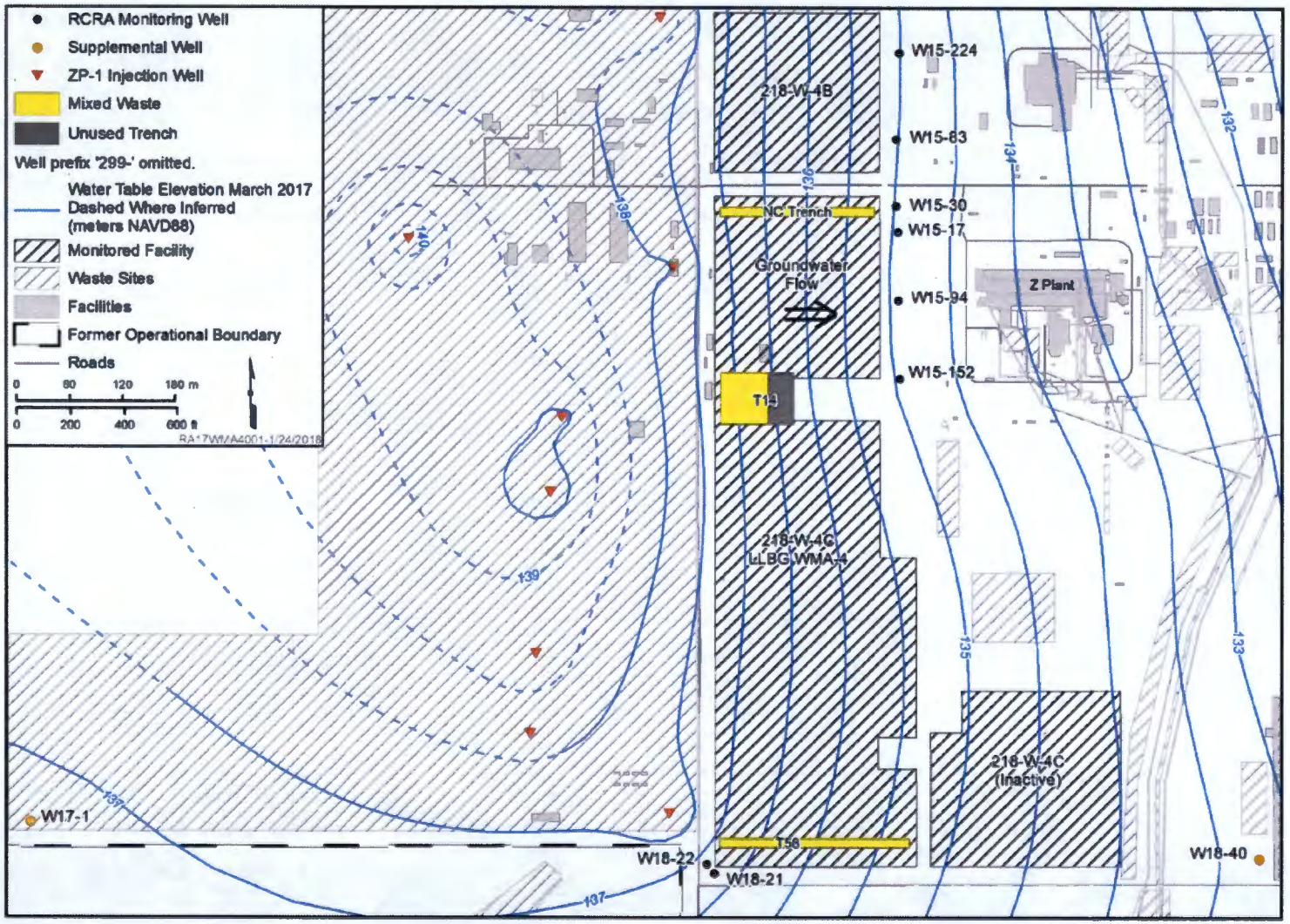
Although not formally included in the LLWMA-4 monitoring network under DOE/RL-2009-69, upgradient well 299-W17-1 and downgradient well 299-W18-40 were sampled in 2016 and 2017 to provide supplemental groundwater data. Well 299-W17-1 was sampled quarterly for indicator parameters beginning in October 2016. Well 299-W18-40 was sampled semiannually beginning in January 2017. DOE and Ecology will determine locations for additional monitoring wells during the engineering evaluation process..

The P&T injection wells upgradient of LLWMA-4 (Figure 2-16) have caused the water table to rise and increased the hydraulic gradient since injection began in 2012. The general direction of groundwater flow is east, and the estimated flow rate is 0.57 m/d (1.9 ft/d) beneath this LLWMA (Table 2-54).

The well network was sampled as scheduled in 2017 for indicator parameters pH, specific conductance, TOC, and TOX (Table 2-55). During the July 2017 event, laboratory QC criteria were not met for TOX analysis and the network wells were resampled for TOX.

Specific conductance, pH, and TOX in downgradient wells did not exceed critical mean values. The TOX results for well 299-W15-83 during the January 2017 sampling event averaged 59.30 μg/L and were below the then-published critical mean value of 86.51 μg/L established for calendar year 2016. The critical mean value for TOX was subsequently updated to 57.18 μg/L in 2017. The TOX results from well 299-W15-83 were flagged as suspect due to laboratory blank contamination.

Nitrate concentrations greater than 45 mg/L were detected in five wells (Table 2-56) as a result of a regional nitrate plume.



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

Figure 2-16. Low-Level Waste Management Area 4

Table 2-53. LLWMA-4 Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comments; Sampling Exceptions*
			m	ft	m	ft	m	ft		m	ft		
299-W15-17	Deep	1987 (C)	80.6	264.5	77.3	253.5	135.27	443.79	7/28/2017	58.0	190.3	S	None
299-W15-30	DG	1995 (C)	142.8	468.6	130.6	428.6	135.21	443.61	7/28/2017	4.6	15.0	S	None
299-W15-83	DG	2005 (C)	137.3	450.5	126.7	415.5	135.24	443.70	7/28/2017	8.6	28.2	S	None
299-W15-94	DG	2005 (C)	137.5	451.0	126.8	416.0	135.08	443.17	7/28/2017	8.3	27.1	S	None
299-W15-152	DG	2005 (C)	137.5	451.1	126.8	416.1	134.99	442.87	7/28/2017	8.2	26.8	S	None
299-W15-224	DG	2006 (C)	136.5	447.9	125.9	412.9	135.23	443.66	7/28/2017	9.4	30.7	S	None
299-W17-1	UG	2003 (C)	139.4	457.4	128.7	422.3	136.86	449.02	7/28/2017	8.1	26.7	Q	Not formally in network (see text)
299-W18-21	UG	1987 (C)	144.7	474.6	135.5	444.6	136.89	449.12	7/28/2017	1.4	4.5	S	Sampled with a bailer
299-W18-22	UG, Deep	1987 (C)	77.5	254.1	68.0	223.1	136.22	446.91	7/28/2017	68.2	223.8	S	None
299-W18-40	DG	2001 (C)	136.2	446.9	125.5	411.9	133.08	436.61	7/28/2017	7.5	24.8	S	Not formally in network (see text)

Note: Requirements are from DOE/RL-2009-69, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3*, as modified by TPA-CN-718, 2016, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-69, Interim Status Groundwater Monitoring Plan for the LLBG WMA-4, Revision 2.*

* See Table 2-55 for sample dates.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

S = semiannually

Q = quarterly

UG = upgradient

Table 2-54. Groundwater Velocity at LLWMA-4

Flow Direction	East
Flow Rate (m/d)	0.57
Hydraulic Conductivity (m/d) (Source)	5.0 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	1.2×10^{-2}
Comments	Gradient estimated from the March 2017 water table map; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 2-55. LLWMA-4 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)[a]			Lab (TOC and TOX)	Comment
Critical Mean[a]		6.94	8.83	725		1,926			57.18				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-W15-152	1/25/2017	7.73	0.00	550	1	<720	0	1,640	14.73	2.23	20.4	TASL	
	7/6/2017	7.69	0.01	562	1	<688	188	1,390	—	—	—	TASL	See 7/28/2107 for TOX
	7/28/2017	—	—	—	—	—	—	—	9.98	1.80	18.2	TASL	Resampled for TOX[b]
299-W15-17	1/24/2017	7.78	—	362	—	<330	—	640	3.64	—	7.8	GEL	
	7/6/2017	7.81	—	383	--	193	—	540	—	—	—	TADN	See 7/28/2017 for TOX
	7/28/2017	—	—	—	—	—	—	—	5.02	—	10.9	GEL	Resampled for TOX[b]

Table 2-55. LLWMA-4 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)[a]			Lab (TOC and TOX)	Comment
Critical Mean[a]		6.94	8.83	725		1,926			57.18				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-W15-224	1/25/2017	7.89	0.12	510	1	<720	0	1,640	43.50	2.49	20.4	TASL	
	7/6/2017	7.77	0.01	536	0	315	30	540	—	—	—	TADN	See 7/28/2017 for TOX
	7/28/2017	—	—	—	—	—	—	—	35.30	3.02	18.2	TASL	Resampled for TOX[b]
299-W15-30	1/24/2017	7.88	0.02	521	1	<330	0	640	17.63	2.77	7.8	GEL	
	7/6/2017	7.97	0.00	536	0	328	23	540	—	—	—	TADN	See 7/28/2017 for TOX
	7/28/2017	—	—	—	—	—	—	—	18.93	1.01	10.9	GEL	Resampled for TOX[b]
299-W15-83	1/24/2017	7.83	0.00	487	0	<720	0	1,640	59.30	12.4	20.4	TASL	All four TOX values flagged as suspect; see text
	7/7/2017	7.87	0.00	481	8	240	27	540	—	—	—	TADN	See 7/28/2017 for TOX
	7/28/2017	—	—	—	—	—	—	—	23.95	0.50	18.2	TASL	Resampled for TOX[b]
299-W15-94	1/24/2017	7.85	0.00	534	0	<330	0	640	8.09	1.31	7.8	GEL	
	7/6/2017	7.83	0.00	570	0	433	31		—	—	—	GEL	See 7/28/2017 for TOX
	7/28/2017	—	—	—	—	—	—	—	8.01	0.34	10.9	GEL	Resampled for TOX[b]

Table 2-55. LLWMA-4 Sampling Summary for Contamination Indicator Parameters, 2017

Indicator Parameter		pH		Specific Conductance (µS/cm)		TOC (µg/L)			TOX (µg/L)[a]			Lab (TOC and TOX)	Comment
Critical Mean[a]		6.94	8.83	725		1,926			57.18				
Well	Sample Date	Avg	SD	Avg	SD	Avg	SD	LOQ	Avg	SD	LOQ		
299-W18-21	1/24/2017	8.04	—	589	—	<720	0	1,640	4.6	2.14	20.4	TASL	No field quads in January due to bailed sample
	7/6/2017	8.21	—	618	—	359	67	540	—	—	—	TADN	No field quads in July due to bailed sample; see 7/28/2017 for TOX
	7/28/2017	—	—	—	—	—	—	—	16.5	3.31	18.2	TASL	Resampled for TOX[b]
299-W18-22	1/24/2015	8.11	—	400	—	<720	—	1,640	13.4	—	20.4	TASL	Deep upgradient well; no statistics
	7/12/2017	7.77	0.01	432	1	1,005	226	1,390	—	—	—	TASL	See 7/28/2017 for TOX
	7/28/2017	—	—	—	—	—	—	—	7.05	1.13	18.2	TASL	Resampled for TOX[b]

Note: Yellow-highlighted cell indicates exceedance of a critical mean.

a. Critical mean values from Table 31 of ECF-Hanford-17-0009, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring.*

b. Laboratory quality control criteria were not met for TOX analysis during the initial July sampling event; wells were resampled for TOX.

< = one or more of the replicate values was below the detection limit
-- = no data or not applicable
GEL = GEL Laboratory
LOQ = limit of quantitation
SD = standard deviation
TADN = TestAmerica – Denver
TASL = TestAmerica – St. Louis
TOC = total organic carbon
TOX = total organic halides

Table 2-56. LLWMA-4 Sampling Summary for Water Quality Parameters and Other Constituents, 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	106	132	—	
Calcium (unfiltered)	µg/L	38,400	54,800	—	Excluded "Y"-flagged value[a]
Chloride	mg/L	11	41	250[b]	
Chromium (unfiltered)	µg/L	5	51.9	100[c]	Excluded "Y"-flagged value[a]
Dissolved oxygen	mg/L	6.24	10.51	—	
Fluoride	mg/L	0.25	0.49	4[c]	
Iron (unfiltered)	µg/L	<22	199	300[b]	Excluded "Y"-flagged value[a]
Magnesium (unfiltered)	µg/L	13,600	17,700	—	Excluded "Y"-flagged value[a]
Manganese (unfiltered)	µg/L	<1.6	4.4	50[b]	Excluded "Y"-flagged value[a]
Nitrate	mg/L	21.2	96.1	45[d]	299-W15-152, 299-W15-224, 299-W15-30, 299-W15-83, 299-W15-94
Nitrite	mg/L	<0.046	<0.125	3.3[d]	
Phenol	µg/L	<1.9	<2.86	2,400[e]	
Potassium (unfiltered)	µg/L	4,460	5,310	—	Excluded "Y"-flagged value[a]
Sodium (unfiltered)	µg/L	14,400	27,800	—	Excluded "Y"-flagged value[a]
Sulfate	mg/L	21	75	250[b]	
Temperature	°C	16.8	24	—	
Turbidity	NTU	0.38	1,000	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents full data set for 2017.

Yellow-highlighted cell indicates concentration greater than the comparison value.

a. Metals data from 299-W18-21 on 1/24/2017 were anomalously high as a result of excessive turbidity in the bailed sample and were flagged as "Y" (suspect).

b. Secondary drinking water standard.

c. Primary drinking water standard.

d. The federal drinking water standards for nitrate and nitrite are 10 mg/L and 1 mg/L, expressed as nitrogen. These equate to 45 mg/L and 3.3 mg/L when expressed as NO_3 and NO_2.

e. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

3 Groundwater Quality Assessment Monitoring

This chapter presents the groundwater monitoring results for units monitored under interim status groundwater quality assessment programs: seven single-shell tank (SST) WMAs, the 216-A-29 Ditch, and the Nonradioactive Dangerous Waste Landfill (NRDWL).

3.1 Waste Management Area A-AX

WMA A-AX is located in the southeast quarter of the 200 East Area (Figures 1-1 and 3-1) and consists of 10 underground storage tanks, 2 of which are confirmed or assumed leakers (HNF-EP-0182, *Waste Tank Summary Report for Month Ending November 30, 2017*). Leaks were reassessed in the 2014 revision of RPP-ENV-37956, *Hanford A and AX-Farm Leak Assessments Report*. To minimize the probability and severity of future leaks, most of the drainable liquid in each tank has been removed and transferred to double-shell tanks. The extent of vadose zone contaminant migration from the tanks is uncertain. Although no dangerous waste groundwater contamination has been attributed to the tank releases, the WMA is in an interim status assessment program because specific conductance exceeded the critical mean value in 2005. Specific conductance of groundwater in the 200 East Area is elevated regionally (Figure 1-2).

WMA A-AX remained in assessment monitoring in accordance with 40 CFR 265.93(d) (as referenced by WAC 173-303-400) during 2017 and is monitored under DOE/RL-2015-49, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX*. The plan is a continuation of the first determination process of a previous plan (PNNL-15315, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area A-AX at the Hanford Site*) and includes a comprehensive list of dangerous waste constituents for assessment.

The monitoring network includes three upgradient and six downgradient wells (Table 3-1). The average rate of water-level decline between 2012 and 2017 was 1.2 cm/yr (0.5 in./yr), and the wells all have adequate water in the screened interval for continued sampling. Wells are screened across the water table and monitor the upper portion of the unconfined aquifer. The estimated thickness of the unconfined aquifer is from 15 to 24 m (50 to 80 ft) near WMA A-AX.

Indications of corrosion were identified in well 299-E25-41 in 2016 and were confirmed with an inspection video log. Sampling of this well will continue as a portion of the monitoring network, with elevated unfiltered chromium, iron, and nickel attributed to corrosion. Well cleaning has been scheduled in an attempt to improve sample quality in the interim until the well can be replaced.

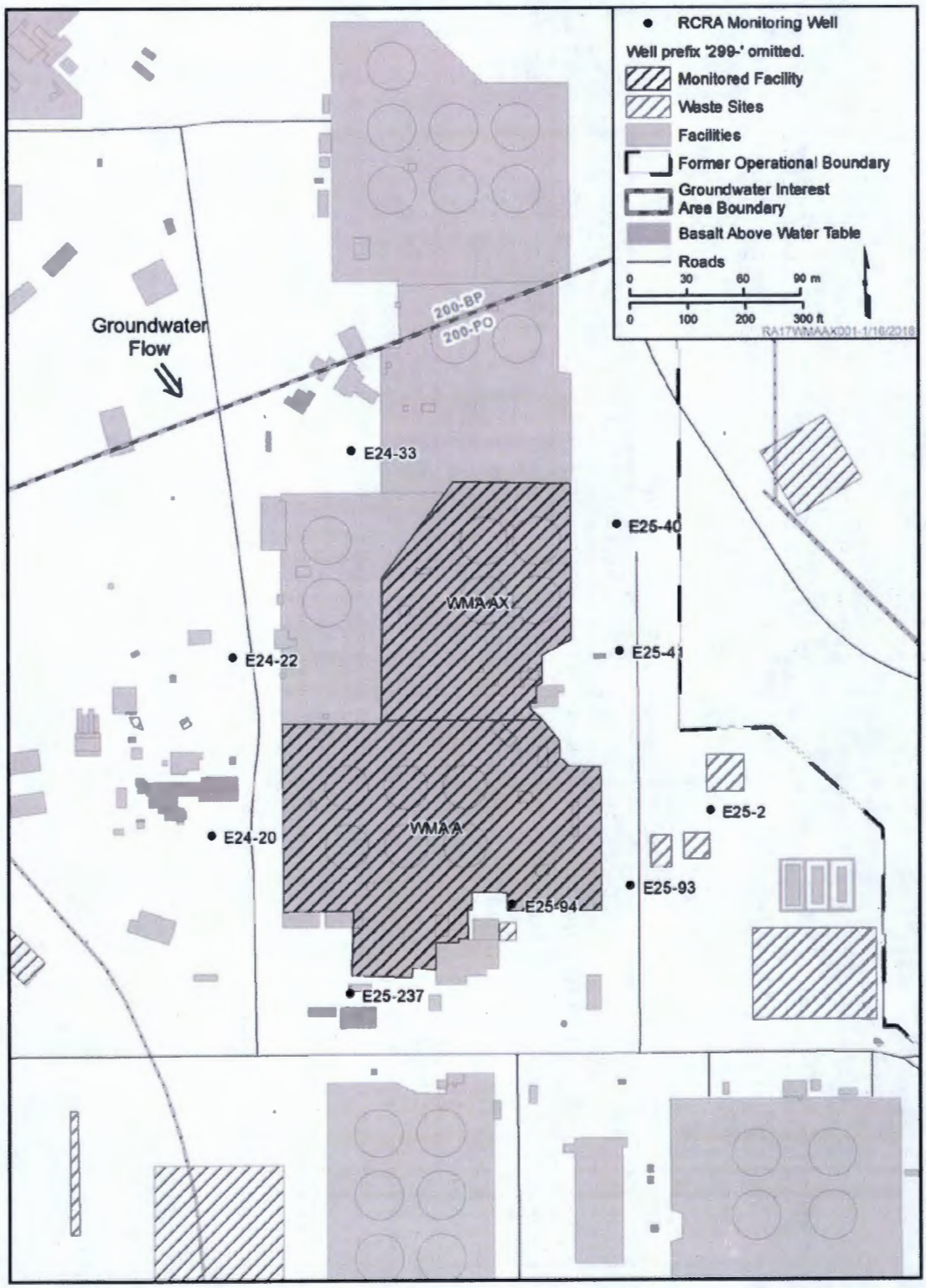
In 2017, groundwater near WMA A-AX was interpreted to flow to the south-southeast based on trend surface analysis results. Supporting evidence for the flow orientation included water-level measurements with slightly higher hydraulic heads to the northwest, as well as the distribution and migration of the nitrate plume in this area. This flow direction also corresponds to the orientation of a southeast-trending paleochannel in the area (Appendix E of DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*). Based on the 2017 trend surface analysis and low-gradient groundwater contour map for this area (Figure 2-6), the estimated hydraulic gradient is 1.4×10^{-6} m/m, with an estimated groundwater flow rate of 0.12 m/d (0.39 ft/d) (Table 3-2).

The monitoring network was sampled quarterly in 2017 to assess whether dangerous waste or dangerous waste constituents are present in the groundwater and to determine their extent and rate of migration. The assessment has not been completed. Assessment data will be evaluated in detail in a first determination report (40 CFR 265.94 (d)(4)).

Table 3-3 summarizes the monitoring results for 2017. Nitrate continued to exceed the DWS equivalent in wells 299-E24-20 and 299-E25-93. Chromium exceeded the DWS in one unfiltered sample from well 299-E25-40 in June, but the filtered sample had no detectable chromium. Iron and nickel were also elevated in the June unfiltered sample, suggesting the presence of particulate matter from the stainless-steel casing or screen. The well is scheduled for cleaning and inspection via video logging to evaluate the casing condition.

The June samples for herbicide analysis and were not reported because laboratory calibration verification standards did not meet acceptance criteria. Samples for herbicides were re-collected in July and August 2017. Low-level detections of pesticides, VOAs, semivolatile organic compounds, and dioxins were noted in 2017. All detected constituent concentrations were "J" qualified by the analytical laboratories, except for the tentatively identified compound 2-propanol (in well 299-E25-2). The laboratory "J" flag indicates that the value is estimated, the detection is uncertain, and the value reported is less than the PQL but greater than or equal to the method detection limit. Detailed evaluation and discussion of the groundwater quality assessment results will be presented in a first determination report.

Cyanide is detected in WMA C monitoring wells, located upgradient from WMA A-AX. Total cyanide was analyzed in WMA A-AX wells in 2017, though it is not required by the monitoring plan. The highest total cyanide concentration in 2017 was 5.5 µg/L in upgradient well 299-E24-33. Cyanide also was detected in upgradient well 299-E24-22 and downgradient wells 299-E25-93 and 299-E25-94.



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

Figure 3-1. Waste Management Area A-AX

Table 3-1. WMA A-AX Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions[a]
			m	ft	m	ft	m	ft		m	ft		
299-E24-20	UG	1991 (C)	125.01	410.15	118.86	389.95	121.74	399.42	9/20/2017	2.9	9.5	Q	1, 3, 6, 7, 8, 9, 12
299-E24-22[b]	UG	2003 (C)	122.32	401.32	111.62	366.22	121.72	399.33	9/18/2017	10.1	33.1	Q	1, 3, 6, 7, 8, 9, 12
299-E24-33[b]	UG	2004 (C)	121.27	397.86	111.51	365.86	121.72	399.33	9/18/2017	10.2	33.5	Q	1, 3, 6, 7, 8, 9, 12
299-E25-2	DG	1955 (P)	122.10	400.58	109.91	360.58	121.67	399.19	9/15/2017	11.8	38.6	Q	1, 3, 6, 7, 8, 9, 12
299-E25-40	DG	1989 (C)	126.30	414.37	119.90	393.37	121.67	399.17	9/15/2017	1.8	5.8	Q	1, 3, 6, 7, 8, 9, 12
299-E25-41	DG	1989 (C)	126.91	416.38	120.51	395.38	121.68	399.21	9/15/2017	1.2	3.8	Q	1, 3, 6, 7, 8, 9, 12
299-E25-93[b]	DG	2003 (C)	122.47	401.81	111.77	366.71	121.69	399.24	9/15/2017	9.9	32.5	Q	1, 3, 6, 7, 8, 9, 12
299-E25-94[b]	DG	2004 (C)	121.36	398.17	110.69	363.17	121.93	400.02	9/18/2017	11.2	36.8	Q	1, 3, 6, 7, 8, 9, 12
299-E25-237	DG	2015 (C)	123.18	404.12	112.51	369.12	121.64	399.08	9/20/2017	9.1	30.0	Q	1, 3, 6, 7, 8, 9, 12

Note: Requirements are from DOE/RL-2015-49, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX.*

a. Extra sampling events were due to missed hold times. See text for additional discussion.

b. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

Q = quarterly

UG = upgradient

Table 3-2. Groundwater Velocity at WMA A-AX

Flow Direction	South-southeast
Flow Rate (m/d)	0.12
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	1.4×10^{-6}
Comments	Gradient and flow direction represent average of October 2016 through September 2017; based on trend surface analysis on low-gradient well network; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 3-3. WMA A-AX Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	84	0	—	
Calcium (unfiltered)	µg/L	51,900	94,000	—	
Calcium (filtered)	µg/L	50,000	92,000	—	
Chloride	mg/L	11	35	250[a]	
Chromium (unfiltered)	µg/L	<1.1	128	100[b]	299-E25-40
Chromium (filtered)	µg/L	1.1	6.2	100[b]	
Cyanide[c]	µg/L	<1.67	5.5	—	
Iron (unfiltered)	µg/L	<22	300	300[a]	
Iron (filtered)	µg/L	<16	140	300[a]	
Magnesium (unfiltered)	µg/L	14,600	26,100	—	
Magnesium (filtered)	µg/L	14,500	26,700	—	
Manganese (unfiltered)	µg/L	<0.31	11.9	50[a]	
Manganese (filtered)	µg/L	<0.31	7.19	50[a]	
Nickel (unfiltered)	µg/L	<0.3	73.5	—	
Nickel (filtered)	µg/L	<0.3	20.7	—	
Nitrate	mg/L	10.2	57.5	45[d]	299-E24-20, 299-E25-93
pH Measurement	--	7.54	8.29	—	
Potassium (unfiltered)	µg/L	6,930	9,730	—	
Potassium (filtered)	µg/L	7,030	9,000	—	
Sodium (unfiltered)	µg/L	17,100	29,000	—	
Sodium (filtered)	µg/L	17,300	30,000	—	
Specific conductance	µS/cm	517	835	—	

Table 3-3. WMA A-AX Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Sulfate	mg/L	102	226	250[a]	
Temperature	°C	14.8	21	—	
Turbidity	NTU	0.1	230	—	
Dangerous waste constituents					See text

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. This anslyte is not required under the groundwater monitoring plan but was analyzed in 2017.

d. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen. This equates to 45 mg/L when expressed as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

3.2 Waste Management Area B-BX-BY

WMA B-BX-BY is located in northwestern 200 East Area (Figures 1-1 and 3-2). It was constructed in stages: B Tank Farm between 1943 and 1944, BX Tank Farm between 1946 and 1947, and BY Tank Farm between 1948 and 1949. All three tank farms provided interim storage of radioactive mixed waste, primarily from the bismuth phosphate, PUREX, and uranium extraction processes. However, no self-boiling waste from PUREX or REDOX was sent to the B-BX-BY Tank Farms prior to removal of high heat-generating fission products. All of the 24 SSTs in the B and BX Tank Farms were built to store up to 2.0 million L (530,000 gal) of liquid waste. In the B Tank Farm, four additional tanks each had a capacity of 208,000 L (55,000 gal). Each of the 12 SSTs in the BY Tank Farm had a 2.9 million L (770,000 gal) capacity. Ancillary equipment at WMA B-BX-BY includes 13 diversion boxes, the 244-BXR waste transfer vault, 5 catch tanks, and several connecting underground lines.

Of the 40 tanks in WMA B-BX-BY, 20 are known or assumed leakers (Table 4-1 of HNF-EP-0182). To minimize the probability and severity of future leaks, most of the drainable liquid in each tank has been removed and transferred to double-shell tanks. Additional sources of unplanned releases within WMA B-BX-BY include tank overfills, waste loss from spare inlet nozzles or cascade lines, pipeline leaks, and surface releases.

DOE monitors groundwater beneath WMA B-BX-BY under an interim status assessment program in accordance with 40 CFR 265.93(d)(4), as defined in DOE/RL-2012-53, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area B-BX-BY*. While developing DOE/RL-2012-53, an assessment of historical process chemistry, leak assessment reports, and groundwater contaminants concluded that cyanide had affected groundwater quality beneath the B Tank Farm. The probable cyanide source and a conceptual model for transport were provided as part of the determination. Although other releases from WMA B-BX-BY have affected groundwater, there is currently no evidence of additional dangerous waste or dangerous waste constituents.

The WMA B-BX-BY well network consists of six upgradient and nine downgradient wells (Table 3-4). Most of the well screens extend across the entire unconfined aquifer to the underlying basalt surface. The water table elevation at WMA B-BX-BY declined an average of 1.4 cm/yr (0.6 in./yr) between 2012 and 2017. The wells have adequate water columns in the screened interval for sampling during the next decade.

Groundwater gradient magnitudes and flow directions were determined using the 200 East Area low-gradient monitoring network for the period of October 2016 through September 2017 (Figure 2-6). The estimated gradient average is 7.0×10^{-6} m/m, dipping to the southeast (Table 3-5). The estimated groundwater flow rate ranged from 0.59 to 0.66 m/d (2.0 to 2.2 ft/d). In 2017, groundwater was pumped from two extraction wells near WMA B-BX-BY as part of a CERCLA removal action for the B Complex technetium-99 and uranium plumes (DOE/RL-2016-41, *Action Memorandum for the 200-BP-5 Operable Unit Groundwater Extraction*). Figure 3-2 illustrates the extraction well locations. Because the hydraulic conductivity of the aquifer is so high, they do not create a discernible cone of depression, but it can be assumed that groundwater extraction affects flow directions locally. Groundwater extraction will continue in 2018.

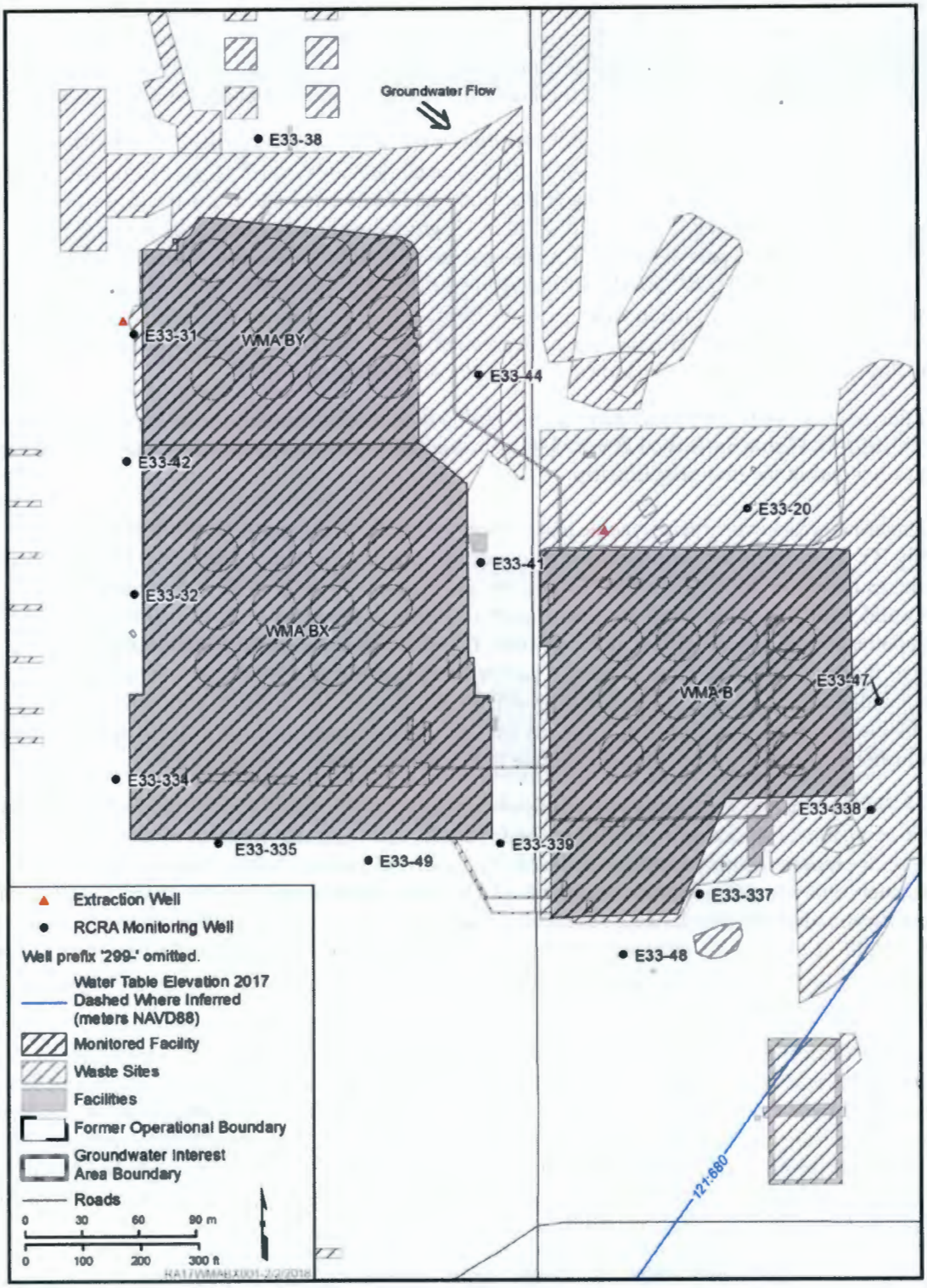
All of the network wells were sampled quarterly during the reporting period, except for decommissioned well 299-E33-18 (Table 3-4). Well 299-E33-41 was sampled twice in May because of incorrect cyanide preservation during the first sampling trip.

The dangerous waste constituent cyanide had sources in the BY Cribs and in WMA B-BX-BY (B, BX, and possibly BY Tank Farms). The monitoring plan requires analysis for total cyanide, and five wells had total cyanide results above 200 µg/L in 2017 (Table 3-6 and Figure 3-3). A 2016 EPA document clarifies that total cyanide methods are allowed for screening, but cyanide is regulated as free cyanide, and the 200 µg/L DWS applies to free cyanide (EPA, 2016, *Cyanide Clarification of Free and Total Cyanide Analysis for Safe Drinking Water Act (SDWA) Compliance*). Cyanide forms complexes with various metals, and only a portion is bioavailable as free cyanide. Chlorinating water for municipal water supplies may increase the amount of bioavailable cyanide, so EPA defines "free" as amenable to chlorination. Total cyanide concentrations in groundwater are typically much higher than free or amenable cyanide concentrations.

In 2017, WMA B-BX-BY groundwater samples were analyzed by methods to determine free cyanide and cyanide amenable to chlorination, as well as total cyanide, and Table 3-6 summarizes the results. None of the free cyanide results, and only sporadic amenable cyanide results, exceeded the 200 µg/L DWS. Inconsistencies in amenable cyanide results raised questions regarding data quality. Some results have QC qualifiers, indicating a lack of consistency between parent and duplicate results. Filtered and unfiltered sample results also varied much more than expected, and results were inconsistent between one sample event and the next (Figure 3-4). Similar inconsistences were also noted for free and total cyanide in some wells but to a lesser extent (Figure 3-5).

The extent of free cyanide concentrations above the 4.8 µg/L "Model Toxic Control Act—Cleanup" (WAC 173-340) (MTCA) standard at WMA B-BX-BY is uncertain because analytical detection limits for free cyanide ranged from 3 to 5 µg/L in 2017. Nearly all of the detections were flagged as "B," indicating that the results were less than the required detection limit but greater than or equal to the method detection limit. Reported results ranged from nondetect to 7.8 µg/L with one exception: 57.3 µg/L in a November 2017 filtered sample from well 299-E33-48. However, the corresponding unfiltered sample did not have detectable free cyanide (<5 µg/L), and other 2017 results were near or below detection limits.

Nitrate exceeds the DWS in all WMA B-BX-BY wells, with the highest concentrations at downgradient wells 299-E33-44 and 299-E33-47. Well 299-E33-44 also had sulfate concentrations above the secondary DWS.



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

Figure 3-2. Waste Management Area B-BX-BY

Table 3-4. WMA B-BX-BY Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E33-20[a]	UG	1956 (P)	125.9	413.1	118.6	389.1	121.75	399.44	11/9/2017	3.1	10.3	Q	2, 5, 8, 11
299-E33-31	UG	1989 (C)	125.8	412.8	119.4	391.8	121.74	399.41	11/10/2017	2.3	7.6	Q	2, 5, 8, 11
299-E33-32	UG	1989 (C)	126.1	413.8	119.7	392.8	121.74	399.40	11/10/2017	2.0	6.6	Q	2, 5, 8, 11
299-E33-38	UG	1991 (C)	126.4	414.7	120.0	393.7	121.74	399.40	11/6/2017	1.7	5.7	Q	2, 5, 8, 11
299-E33-41	DG	1991 (C)	124.9	409.9	119.7	392.8	121.73	399.38	11/9/2017	2.0	6.6	Q	2, 5[b], 8, 11
299-E33-42	UG	1991 (C)	126.7	415.7	120.4	395.0	121.74	399.41	11/10/2017	1.4	4.4	Q	2, 5, 8, 11
299-E33-44	DG	1998 (C)	123.5	405.1	118.9	390.1	121.75	399.43	11/9/2017	2.8	9.3	Q	2, 5, 8, 11
299-E33-47	DG	2004 (C)	123.3	404.7	117.3	384.7	121.74	399.41	11/9/2017	4.5	14.7	Q	2, 5, 8, 11
299-E33-48	DG	2004 (C)	123.3	404.5	115.7	379.5	121.74	399.40	11/9/2017	6.1	19.9	Q	2, 5, 8, 11
299-E33-49	DG	2004 (C)	122.9	403.3	116.8	383.3	121.75	399.44	11/10/2017	4.9	16.2	Q	2, 5, 8, 11
299-E33-334	UG	2000 (C)	124.7	409.3	117.1	384.3	121.74	399.42	11/10/2017	4.6	15.2	Q	2, 5, 8, 11
299-E33-335[a]	DG	2000 (C)	124.2	407.4	118.1	387.4	121.73	399.36	11/10/2017	3.7	12.0	Q	2, 5, 8, 11
299-E33-337	DG	2001 (C)	124.1	407.3	116.5	382.3	121.73	399.37	11/9/2017	5.2	17.1	Q	2, 5, 8, 11
299-E33-338	DG	2001 (C)	123.8	406.1	117.7	386.1	121.74	399.42	11/6/2017	4.1	13.3	Q	2, 5, 8, 11

Table 3-4. WMA B-BX-BY Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-E33-339	DG	2001 (C)	123.2	404.3	117.2	384.4	121.73	399.39	11/10/2017	4.6	15.0	Q	2, 5, 8, 11

Note: Requirements are from DOE/RL-2012-53, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area B-BX-BY*. That document also lists well 299-E33-18 as an upgradient well, but it was decommissioned in 2013 because it was a potential conduit for migration of contaminated perched water into the underlying aquifer.

a. Hydraulic head data for these wells were not corrected for borehole deviation from vertical, which may cause reported head to be less than actual head.

b. Sampled twice in May because of cyanide preservation error.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

P = constructed prior to *Washington Administrative Code* requirements

DG = downgradient

Q = quarterly

UG = upgradient

Table 3-5. Groundwater Velocity at WMA B-BX-BY

Flow Direction	Southeast
Flow Rate Range (m/d)	0.59 to 0.66
Hydraulic Conductivity Range (m/d) (Source)	17,000 to 18,800 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model, Version 7.1*, and 200-BP-5 Operable Unit treatability test results, respectively
Effective Porosity	0.2
Gradient Range (m/m)	7.0×10^{-6}
Comments	Gradient and flow direction represent average of October 2016 through September 2017; based on trend surface analysis on low-gradient well network; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017*.

Table 3-6. WMA B-BX-BY Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	88.4	124	—	
Calcium (unfiltered)	µg/L	36,100	247,000	—	
Calcium (filtered)	µg/L	39,900	246,000	—	
Chloride	mg/L	11	55.2	250[a]	
Cyanide (total; unfiltered and filtered)	µg/L	<1.86	1,440	—	
Cyanide (amenable; unfiltered and filtered)[d]	µg/L	<1.67	380	200[b,c]	299-E33-38, 299-E33-44, 299-E33-47
Cyanide (free; unfiltered and filtered)[d]	µg/L	<3	57.3	200[b,c]	
Magnesium (unfiltered)	µg/L	10,400	70,600	—	
Magnesium (filtered)	µg/L	11,900	71,000	—	
Nitrate	mg/L	41.1	1,400	45[e]	All wells
pH		7.37	8.22	—	
Potassium (unfiltered)	µg/L	5,530	18,700	—	
Potassium (filtered)	µg/L	5,940	18,900	—	
Sodium (unfiltered)	µg/L	23,000	275,000	—	
Sodium (filtered)	µg/L	22,600	282,000	—	
Specific conductance	µS/cm	449	2,967	—	
Sulfate	mg/L	48.1	260	250[a]	299-E33-44
Total organic carbon	µg/L	<223	8,100	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. Applies to free cyanide. Note that the WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B," standard is 4.8 µg/L.

d. These analyses are not required under the groundwater monitoring plan but were performed in 2017.

e. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen. This equates to 45 mg/L when expressed as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

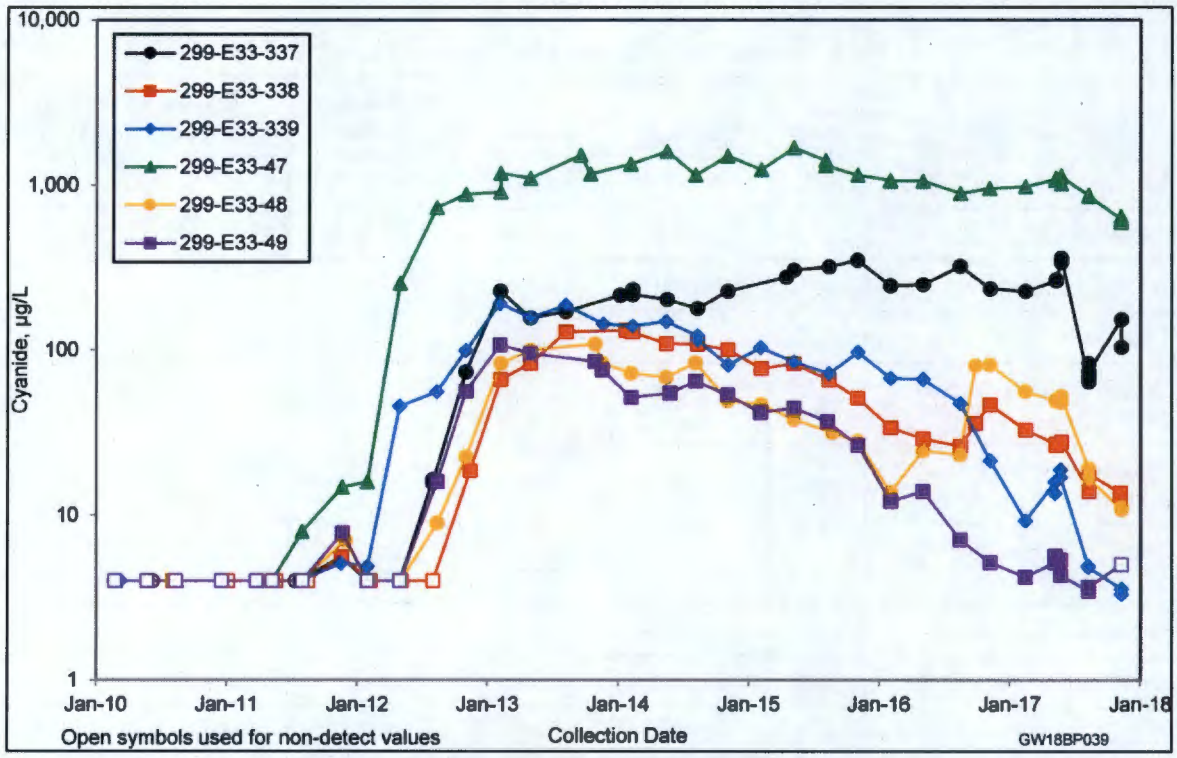


Figure 3-3. Total Cyanide in WMA B-BX-BY Wells

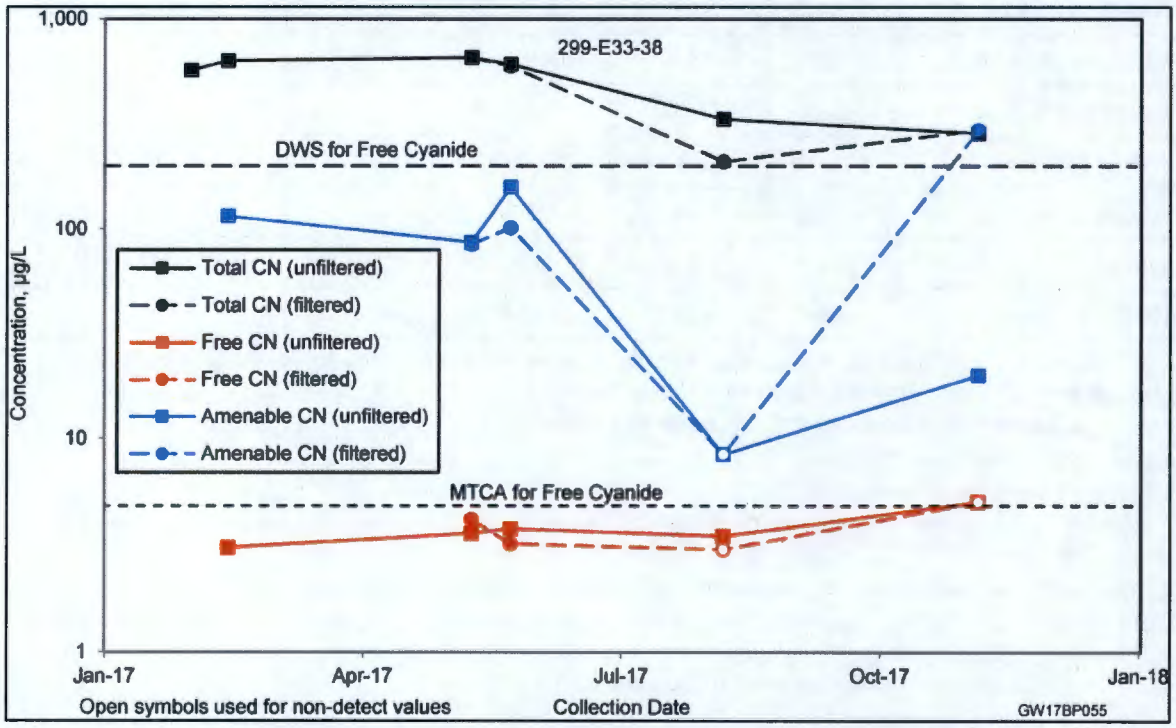


Figure 3-4. Total and Free Cyanide Concentrations in Well 299-E33-38

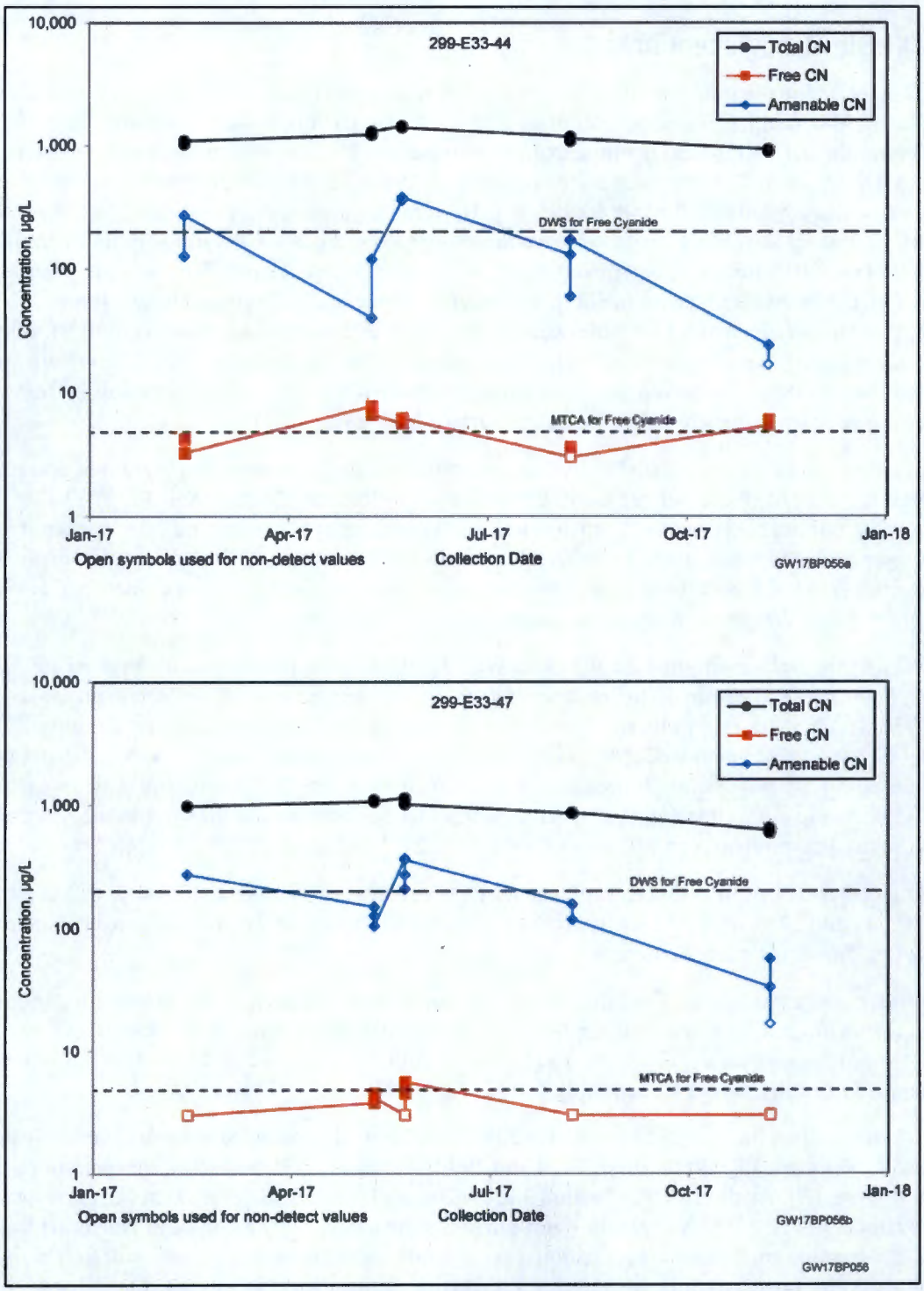


Figure 3-5. Total and Free Cyanide Concentrations in Wells 299-E33-44 and 299-E33-47

3.3 Waste Management Area C

WMA C is located in the east-central portion of the 200 East Area (Figures 1-1 and 3-6). Constructed in 1943 and 1944, WMA C provided interim storage of radioactive mixed waste, primarily from the bismuth phosphate, PUREX, and uranium extraction processes. High-level liquid waste from these processes was stored in 12 SSTs, each with a capacity of 2.01 million L (530,000 gal). Four additional SSTs, each with a capacity of 208,000 L (55,000 gal), were also used to store high-level liquid waste. Ancillary equipment at WMA C includes seven diversion boxes, the 244-CR vault with four permitted tanks, the 241-C-301 catch tank, one french drain, two dry wells (liquid waste disposal units associated with the 241-C-801 cesium loadout facility), and several connecting underground lines. Of the 16 underground tanks in WMA C, 7 tanks were confirmed or assumed to have leaked (DOE/RL-2009-77, *Groundwater Quality Assessment Plan for the Single-Shell Waste Management Area C*) and retrieval processes since 1998 have removed the liquid waste. Additional sources include waste losses from spare inlet nozzles or cascade lines, pipeline leaks, and surface releases.

DOE monitors groundwater beneath WMA C under an interim status assessment program in accordance with 40 CFR 265.93(d)(4), as defined in DOE/RL-2009-77. While developing DOE/RL-2009-77, an assessment of historical process chemistry, leak assessment reports, and groundwater contaminant distribution concluded that cyanide had affected groundwater beneath the C Tank Farm. Although other releases from WMA C have affected groundwater, there is currently no significant evidence of additional dangerous waste or dangerous waste constituents.

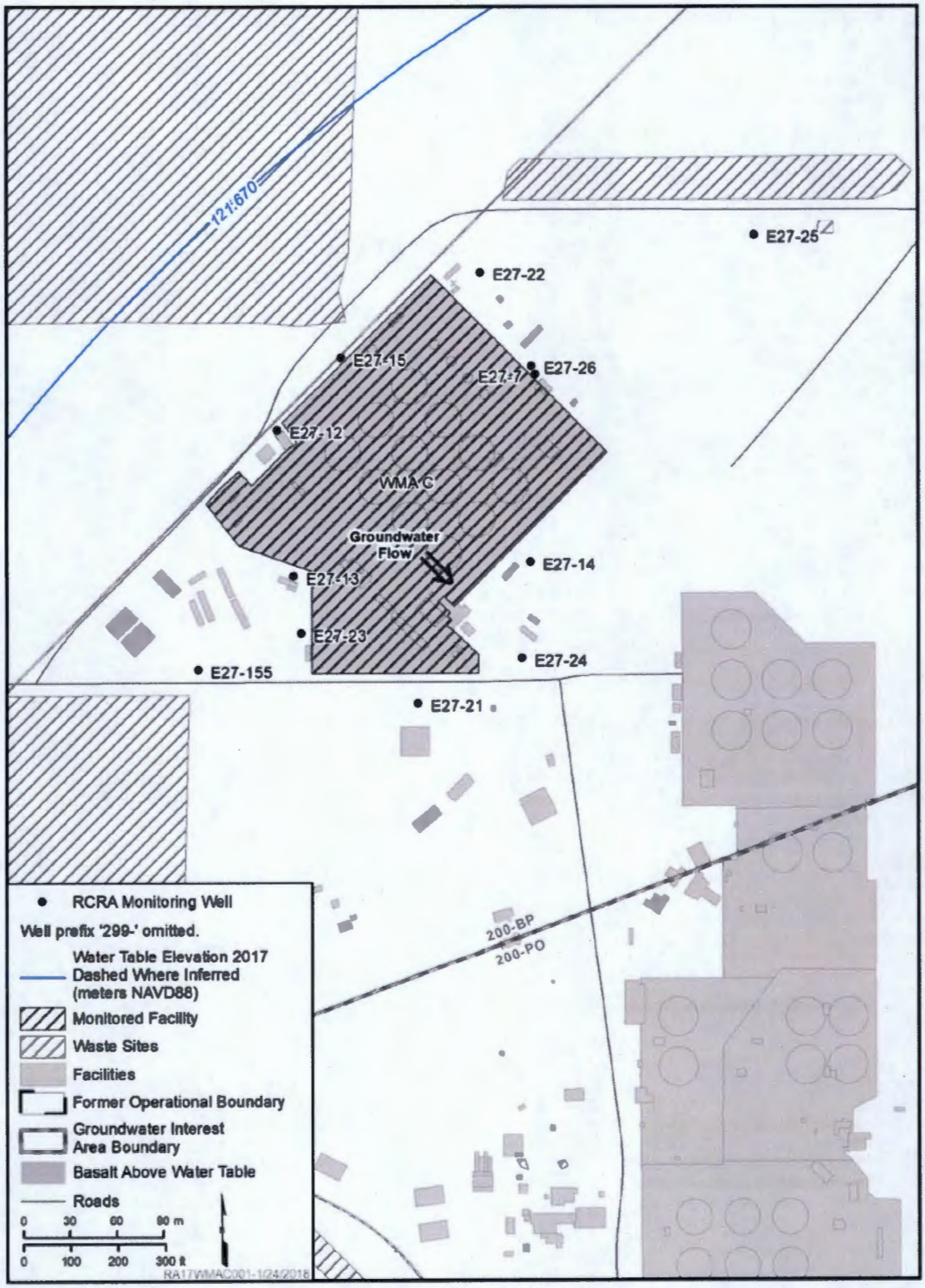
Table 3-7 lists the wells monitored for WMA C. Well 299-E27-4 was formerly in the monitoring network, but because of casing corrosion it was removed from service in 2016 and decommissioned in 2017. WMA C monitoring wells are *Washington Administrative Code* compliant, except for well 299-E27-7. Replacement well 299-E27-26 was installed in 2016, and samples were collected from both wells in 2017. Total cyanide concentrations are somewhat higher in the new well (9 to 14 μg/L in 2017) than in the old well (<8 μg/L). Specific conductance and nitrate are the same in the new and old wells. A revised assessment plan will remove well 299-E27-7 and add well 299-E27-26.

Excluding outliers, the water table elevation at WMA C declined an average of 1.2 cm/yr (0.5 in./yr) between 2012 and 2016. The WMA C groundwater wells have adequate water in the screened intervals for sampling during the next two decades.

Groundwater gradient magnitude and flow direction were determined using a low-gradient monitoring network across the 200 East Area (Figure 2-6). The estimated average gradient was 4.9×10^{-6} m/m, dipping toward the southeast (Table 3-8). The estimated flow rate was 0.41 m/d (1.4 ft/d). All of the wells were sampled quarterly during the reporting period (Table 3-7).

Table 3-9 summarizes the analytical results for 2017. Total cyanide continued to be detected in some of the WMA C wells in 2017. Wells 299-E27-24 and 299-E27-155 showed increasing concentrations of total cyanide (Figure 3-7). As discussed in Section 3.2, the 200 μg/L DWS and 4.8 μg/L MTCA standard apply to free cyanide. In 2017, WMA C groundwater samples were analyzed by methods to determine free cyanide and cyanide amenable to chlorination. Free cyanide results were near or below detection limits. Amenable cyanide concentrations were also near detection limits, except in sporadic cases that appear to be related to data quality issues (discussed in Section 3.2).

Iron exceeded the secondary DWS in unfiltered samples from six wells (Table 3-9) and filtered samples from well 299-E27-13. Well 299-E27-13 also exceeded the secondary DWS for manganese in filtered and unfiltered samples. Nitrate and sulfate also exceeded DWSs in 2017.



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

Figure 3-6. Waste Management Area C

This page intentionally left blank.

Table 3-7. WMA C Groundwater Monitoring Network

Well Name	Location[a]	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Comment	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft			
299-E27-7[a]	DG	1982 (P)	120.8	396.2	108.6	356.2	121.74	399.42	9/29/2017	13.2	43.2	Q	To be replaced by 299-E27-7 when assessment plan revised.	3, 6, 9, 12
299-E27-12[a]	UG	1989 (C)	126.4	414.7	120.0	393.6	121.68	399.20	8/1/2017	1.7	5.6	Q		3, 6, 9, 12
299-E27-13	DG	1989 (C)	126.8	416.0	120.4	394.9	121.68	399.21	9/29/2017	1.3	4.3	Q		3, 6, 9, 12
299-E27-14[b]	DG	1989 (C)	125.9	413.1	119.5	392.1	121.74	399.40	9/28/2017	2.2	7.3	Q		3, 6, 9, 12
299-E27-15[b]	UG	1989 (C)	126.6	415.4	120.2	394.4	121.74	399.42	9/29/2017	1.5	5.0	Q		3, 6, 9, 12
299-E27-21[b]	DG	2003 (C)	122.3	401.1	111.6	366.1	121.73	399.38	9/29/2017	10.1	33.2	Q		3, 6, 9, 12
299-E27-22[b]	UG	2003 (C)	123.1	403.8	110.9	363.9	121.76	399.48	9/28/2017	10.8	35.6	Q		3, 6, 9, 12
299-E27-23[b]	DG	2003 (C)	122.3	401.2	111.6	366.2	121.72	399.35	9/29/2017	10.1	33.1	Q		3, 6, 9, 12
299-E27-24	DG	2010 (C)	113.0	370.9	107.0	350.9	121.68	399.22	9/28/2017	14.7	48.3	Q		3, 6, 9, 12
299-E27-25	CG	2010 (C)	123.1	404.0	117.0	383.9	121.57	398.85	9/29/2017	4.6	15.0	Q		3, 6, 9, 12
299-E27-26	DG	2016 (C)	122.9	403.2	110.7	363.2	121.07[c]	397.22	6/5/2017	10.4	34.0	Q	Installed as replacement for 299-E27-7. Both wells sampled in 2017.	3, 6, 9, 12
299-E27-155	CG (deep)	2007 (C)	116.1	380.9	105.4	345.9	121.62	399.01	9/29/2017	16.2	53.1	Q	Not in monitoring plan but sampled in 2017.	3, 6, 9, 12

Note: Requirements are from DOE/RL-2009-77, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area C.* The plan also includes downgradient well 299-E27-4, which was removed from service in 2016 and decommissioned in 2017 because of casing corrosion.

a. Designations as upgradient, downgradient, and cross gradient have been modified from DOE/RL-2009-77 due to a change in flow direction.

b. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

c. Head in this well is consistently much lower than other wells in the network, suggesting that the well is deviated from vertical.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

CG = cross gradient

DG = downgradient

P = constructed prior to *Washington Administrative Code* requirements

Q = quarterly

UG = upgradient

This page intentionally left blank.

Table 3-8. Groundwater Velocity at WMA C

Flow Direction	Southeast
Flow Rate Range (m/d)	0.41
Hydraulic Conductivity (m/d) (Source)	17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	4.9×10^{-6}
Comments	Gradient and flow direction represent average of October 2016 through September 2017; based on trend surface analysis on low-gradient well network; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 3-9. WMA C Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	56	133	—	
Chloride	mg/L	13	74	250[a]	
Cyanide (total; unfiltered and filtered)	µg/L	<1.67	47.2	—	
Cyanide (amenable, unfiltered and filtered)[d]	µg/L	<1.67	37.1	200[b,c]	
Cyanide (free; unfiltered and filtered)[d]	µg/L	<3	7.36	200[b,c]	
Iron (unfiltered)	µg/L	<17	11,800	300[a]	299-E27-7, 299-E27-12, 299-E27-13, 299-E27-14, 299-E27-15, 299-E27-23
Iron (filtered)	µg/L	<16	9,510	300[a]	299-E27-13
Manganese (unfiltered)	µg/L	<0.31	282	50[a]	299-E27-13
Manganese (filtered)	µg/L	<0.3	213	50[a]	299-E27-13
Nitrate	mg/L	9.74	159	45[e]	299-E27-14, 299-E27-21, 299-E27-22, 299-E27-23, 299-E27-24, 299-E27-25, 299-E27-155
pH		6.19	8.87	—	
Sodium (unfiltered)	µg/L	12,000	30,000	—	
Sodium (filtered)	µg/L	12,500	30,000	—	

Table 3-9. WMA C Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Specific conductance	µS/cm	413	1,151	—	
Sulfate	mg/L	64	350	250[a]	299-E27-14, 299-E27-22, 299-E27-24, 299-E27-25

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. Applies to free cyanide. Note that the WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B," standard is 4.8 µg/L.

d. These analyses are not required under the groundwater monitoring plan but were performed in 2017.

e. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen. This equates to 45 mg/L when expressed as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

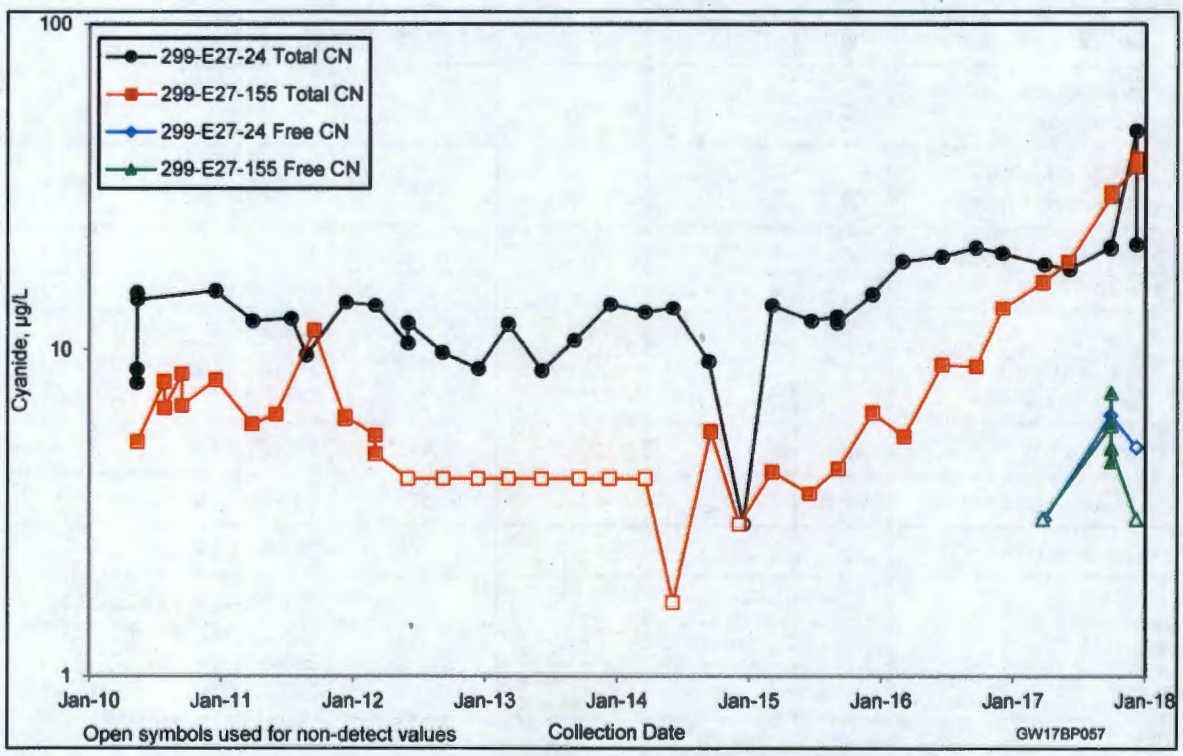


Figure 3-7. Total and Free Cyanide in Wells 299-E27-24 and 299-E27-155

3.4 Waste Management Area S-SX

WMA S-SX (Figure 3-8) consists of the S and the SX Tank Farms. The S Tank Farm contains 12 SSTs, each with a capacity of 2.9 million L (758,000 gal). The SX Tank Farm contains 15 SSTs, each with a capacity of 3.8 million L (1,000,000 gal) (Section 1.2 of RPP-7884, *Field Investigation Report for Waste Management Area S-SX*). The WMA also includes the following ancillary equipment: three catch tanks; one receiver tank; six diversion boxes; and associated piping, valve pits, and pumps (Section 1.2 of RPP-7884). Both tank farms received waste from REDOX in the 1950s and 1960s. To minimize the probability and severity of future leaks, most of the drainable liquid in each tank has been removed and transferred to double-shell tanks.

In 1996, at the direction of Ecology, WMA S-SX was placed into assessment status because of elevated specific conductance in downgradient monitoring wells. The first determination assessment found that multiple sources within the WMA had affected groundwater quality with elevated chromium (Chapter 5.0 of PNNL-11810, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas S-SX at the Hanford Site*). Monitoring is currently performed under DOE/RL-2009-73, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area S-SX*. The objective of RCRA monitoring at WMA S-SX is to assess the extent and concentration of the dangerous waste constituent chromium in the groundwater and determine its rate of movement.

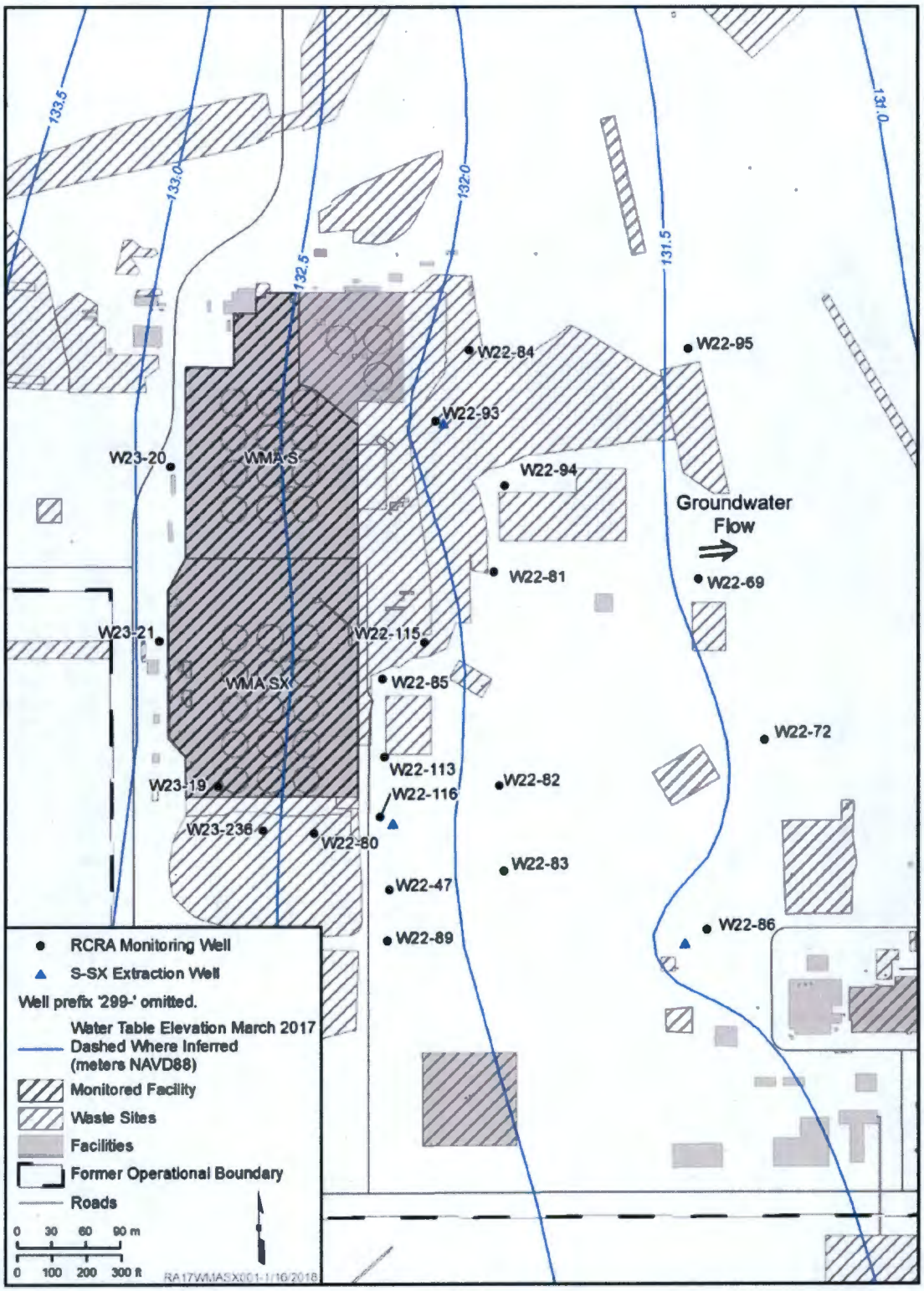
Table 3-10 lists the monitoring wells for WMA S-SX. Based on the well distribution compared to the extent of contamination, the current well network is capable of monitoring the distribution of contamination at WMA S-SX. All wells were sampled as required in 2017, and the WMA will remain in interim status groundwater quality assessment monitoring for 2018.

Water levels in the wells declined an average of 22 cm (8.7 in.) during 2017. This was greater than in 2016, when the decline was 18 cm (7.1 in.). The groundwater extraction system operating at WMA S-SX and the 200 West Area P&T system operated at a higher average rates during 2017, which may have contributed to the higher average decline in the local water level. Trend surface analyses performed on water-level measurements collected during March 2017 resulted in an estimated hydraulic gradient of 3.0×10^{-3} m/m toward the east (91 degrees azimuth). The estimated groundwater flow rate in 2017 was 0.15 m/d (0.49 ft/d) (Table 3-11), consistent with the 2016 value of 0.18 m/d (0.59 ft/d).

Table 3-12 summarizes the assessment data. Groundwater beneath WMA S-SX is contaminated with the dangerous waste constituent chromium at levels above the DWS. The chromium is attributed to a 91,000 L (24,000 gal) overfill event from tank S-104 in the S Tank Farm (Sections 3.7.2 and 4.6 in RPP-RPT-48589, *Hanford 241-S Farm Leak Assessment Report*) and a 190,000 L (51,000 gal) leak from tank SX-115 during 1965 in the SX Tank Farm (Section 4.3 of RPP-ENV-39658, *Hanford SX-Farm Leak Assessments Report*). Cr(VI) analysis is not required by the monitoring plan, but available data show concentrations about the same as total chromium. Because dissolved chromium is highly mobile in the aquifer, it migrates to the east at the same average flow rate as groundwater (0.15 m/d [0.49 ft/d]). Depth-discrete sampling while drilling well 299-W22-47 indicated that chromium was present within the upper 20 m (65 ft) of the aquifer.

Groundwater extraction wells (Figure 3-8) have altered chromium plume migration. Instead of moving eastward, some of the chromium is drawn into the extraction wells. The groundwater extraction system has caused chromium concentrations to decline in several network wells. Of the six wells that had baseline chromium concentrations above the 48 µg/L 200-UP-1 OU cleanup level prior to P&T, concentrations decreased in wells 299-W22-47, 299-W22-83, 299-W22-86, 299-W22-93, and 299-W22-116. The chromium concentration in well 299-W22-95 increased between 2013 and 2016 and then leveled off in 2017 (54.7 and 52 µg/L in filtered and unfiltered samples). The increase in concentrations is consistent with downgradient migration of the S Tank Farm portion of the plume. At well 299-W23-19 inside the SX Tank Farm, the chromium concentration increased from 168 µg/L in December 2016 to 190 µg/L in December 2017 (Figure 3-9). The increase in well 299-W23-19 indicates that chromium is migrating downward through the vadose zone as a continuing source. At well 299-W22-93, directly downgradient of the S Tank Farm, the chromium concentration has been steady over the past few years (145 µg/L in December 2017), consistent with a continuing source.

Manganese concentrations exceeded the secondary DWS in wells 299-W22-81 and 299-W23-21. Samples had high turbidity and elevated iron concentrations, and the wells will be cleaned in 2018. Five wells had nitrate concentrations above the DWS equivalent due to a regional contaminant plume.



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

Figure 3-8. Waste Management Area S-SX

Table 3-10. WMA S-SX Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency[a]	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W22-47	DG	2005 (C)	135.8	445.6	125.2	410.6	132.09	433.38	6/28/2017	6.9	22.8	Q	6, 12
299-W22-69	DG	2006 (C)	134.7	442.0	124.0	406.9	131.44	431.23	6/28/2017	7.4	24.3	A	6, 12
299-W22-72	DG	2006 (C)	135.1	443.3	124.4	408.3	131.44	431.23	6/28/2017	7.0	23.0	A	6, 12
299-W22-80	DG	2000 (C)	137.5	451.1	126.8	416.0	132.27	433.94	6/29/2017	5.5	18.0	A	6, 12
299-W22-81	DG	2001 (C)	136.8	448.8	126.1	413.9	131.86	432.62	6/28/2017	5.7	18.8	A	6, 12
299-W22-82	DG	2001 (C)	137.2	450.2	126.5	415.1	131.93	432.84	6/28/2017	5.4	17.8	A	6, 12
299-W22-83	DG	2001 (C)	137.4	450.7	126.7	415.7	131.90	432.75	6/28/2017	5.2	17.1	A	6, 12
299-W22-84	DG	2001 (C)	137.1	449.7	126.4	414.7	131.76	432.28	6/29/2017	5.3	17.5	A	6, 12
299-W22-85	DG	2001 (C)	137.5	451.1	126.9	416.2	132.18	433.66	6/29/2017	5.3	17.4	A	6, 12
299-W22-86	DG	2006 (C)	135.2	443.5	124.5	408.4	131.39	431.07	6/28/2017	6.9	22.7	A	6, 12
299-W22-89	DG	2006 (C)	135.1	443.3	124.4	408.2	132.15	433.57	6/28/2017	7.7	25.4	A	6, 12
299-W22-93	DG	2015 (C)	132.3	434.1	121.6	399.1	131.57	431.65	6/29/2017	9.9	32.6	Q	3, 6, 9, 12
299-W22-94	DG	2013 (C)	133.2	436.9	122.5	401.9	131.77	432.30	6/28/2017	9.3	30.4	S	6, 12
299-W22-95	DG	2013 (C)	132.1	433.3	119.9	393.3	131.46	431.29	6/28/2017	11.6	38.0	S	6, 12
299-W22-113	DG	2014 (C)	132.7	435.5	123.6	405.4	132.05	433.23	6/29/2017	8.5	27.8	S	6, 12
299-W22-115	DG	2015 (C)	133.3	437.2	122.6	402.1	132.04	433.19	6/29/2017	9.5	31.1	S	6, 12
299-W22-116	DG	2015 (C)	132.5	434.8	121.9	399.8	132.05	433.22	6/29/2017	10.2	33.4	A	6, 12
299-W23-19[b]	DG	1999 (C)	138.3	453.6	128.9	423.0	132.71	435.39	6/29/2017	3.8	12.3	Q	3, 6, 9, 12
299-W23-20	UG	2000 (C)	138.3	453.8	126.7	415.8	132.77	435.61	6/29/2017	6.0	19.8	A	6, 12

Table 3-10. WMA S-SX Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency[a]	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W23-21	UG	2000 (C)	137.8	452.0	126.5	414.9	132.90	436.03	6/29/2017	6.4	21.1	A	6, 12; sampled with bailer in December
299-W23-236	DG	2015 (C)	132.9	436.0	122.2	401.0	132.51	434.73	6/29/2017	10.3	33.7	A	6, 12

Note: Requirements are from DOE/RL-2009-73, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area S-SX.*

a. Listed frequency is as required under the monitoring plan. Quarterly sampling was initiated in all wells in December 2017 in anticipation of a monitoring plan revision.

b. Water-level measurements are not possible from well 299-W23-19 because it is located within the tank farm fence line and sampled remotely from outside the fence. The water level was estimated as 0.2 m higher than at nearby well 299-W23-236.

A = annually

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

Q = quarterly

S = semiannually

UG = upgradient

Table 3-11. Groundwater Velocity at WMA S-SX

Flow Direction	East
Flow Rate (m/d)	0.15
Hydraulic Conductivity (m/d) (Source)	5 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	3.0×10^{-3}
Comments	Gradient and direction determined by trend surface analysis of data collected in March 2017; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 3-12. WMA S-SX Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	70	301	—	
Calcium (unfiltered)	µg/L	18,400	51,400	—	
Calcium (filtered)	µg/L	17,300	51,200	—	
Chloride	mg/L	3.99	19.9	250[a]	
Chromium (unfiltered)	µg/L	<0.72	216	100[b]	299-W22-116, 299-W22-93, 299-W23-19, 299-W23-21
Chromium (filtered)	µg/L	<1.5	224	100[b]	299-W22-116, 299-W22-93, 299-W23-19
Cr(VI) (unfiltered)[c]	µg/L	<1.5	180	48[d]	299-W22-116, 299-W22-93, 299-W23-95, 299-W23-19
Magnesium (unfiltered)	µg/L	6,320	16,800	—	
Magnesium (filtered)	µg/L	6,310	16,900	—	
Manganese (unfiltered)	µg/L	<0.69	94.6	50[a]	299-W22-81, 299-W23-21
Manganese (filtered)	µg/L	<0.31	71.5	50[a]	299-W22-81
Nitrate	mg/L	5.58	149	45[e]	299-W22-115, 299-W22-116, 299-W22-93, 299-W22-95, 299-W23-19
pH Measurement		6.69	8.36	—	
Potassium (unfiltered)	µg/L	2,480	4,270	—	
Potassium (filtered)	µg/L	2,300	4,290	—	
Sodium (unfiltered)	µg/L	13,900	32,600	—	

Table 3-12. WMA S-SX Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Sodium (filtered)	µg/L	12,200	33,000	—	
Specific conductance	µS/cm	238	630	—	
Sulfate	mg/L	14.8	70	250[a]	
Temperature	°C	13.7	24.4	—	
Turbidity	NTU	0.26	388	—	
Dangerous waste constituents					See text

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. Not required by current monitoring plan. Data summarized for information.

d. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

e. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen. This equates to 45 mg/L when expressed as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

Cr(VI) = hexavalent chromium

NTU = nephelometric turbidity unit

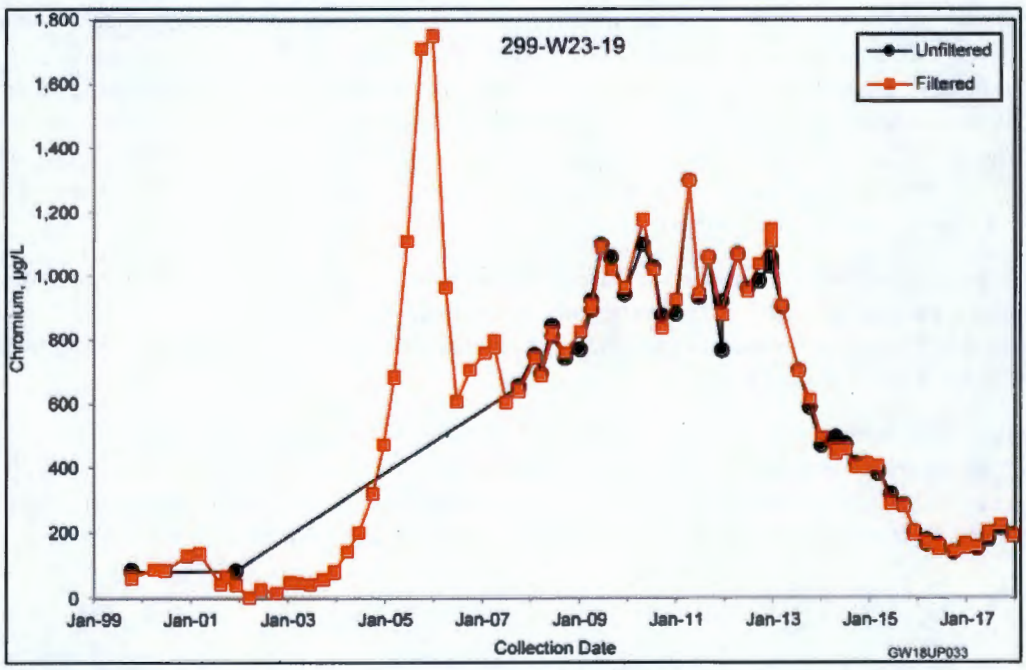


Figure 3-9. Chromium Concentration in Well 299-W23-19 within WMA S-SX

3.5 Waste Management Area T

WMA T (Figure 3-10), which includes the T Tank Farm, is located in the northern portion of the 200 West Area and was used for interim storage of radioactive waste from reactor fuel chemical processing for plutonium production. WMA T contains 16 underground SSTs constructed in 1943 and 1944. Tanks T-101 through T-112 have capacities of 2,000,000 L (528,000 gal), and tanks T-201 through T-204 have capacities of 208,000 L (55,000 gal). In addition to the tanks, six diversion boxes and ancillary pumps, valves, and pipes are included in the Hanford RCRA Permit Part A Form for the T Tank Farm SST system.

The tanks in WMA T began receiving waste in 1944 and were in almost continual use until 1980, when all tanks in this WMA were removed from service. The SSTs received transuranic, high-level metal, and first-cycle waste from chemical processing of uranium-bearing, irradiated reactor fuel rods. Lesser amounts of other waste also were stored in the WMA T tanks. WHC-MR-0132, *A History of the 200 Area Tank Farms*; WRPS-55779-FP, *Hanford Tank Waste to WIPP – Maximizing the Value of our National Repository Asset - 14230;* and RPP-7218, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*, provide more detailed information on WMA T waste inventory. Most of the drainable liquid in each tank has been removed, and the tanks have been interim stabilized. As interim corrective actions, berms were constructed around the tank farms in 2001 to stop run-on of natural precipitation, and all known water lines were tested or cut off. Interim surface barriers were placed over tanks in WMA T in 2008 to inhibit infiltration of precipitation.

The WMA T was placed in assessment in 1993 due to elevated specific conductance. Cr(VI) is a dangerous waste constituent monitored under the RCRA assessment program. From 1944 to 1980, the WMA received metal and first-cycle waste from chemical processing, including the bismuth phosphate, tributyl phosphate, and REDOX processes. Past leaks from SSTs and waste pipelines within the WMA are the sources of Cr(VI) contamination.

The monitoring network described in DOE/RL-2009-66, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area T*, includes two upgradient, one assessment, one far-field, and six downgradient wells (Table 3-13). Assessment well 299-W10-23 is not directly upgradient or downgradient and is used to help distinguish other contaminant plumes impinging on WMA T. Wells are screened across the water table and monitor the upper portion of the unconfined aquifer. The 200 West Area P&T system caused water levels in WMA T wells to decline from the 1990s until 2016, when the decline ceased. The WMA monitoring wells have sufficient water for sampling (Table 3-13) and are not expected to go dry.

Extraction wells east of the WMA affect local groundwater flow (Figure 3-10). Groundwater flows to the east-southeast, and the estimated groundwater and contaminant flow rate beneath WMA T is 0.34 m/d (1.1 ft/d) (Table 3-14). The direction of groundwater flow is not expected to change with continued operation of the 200 West Area P&T.

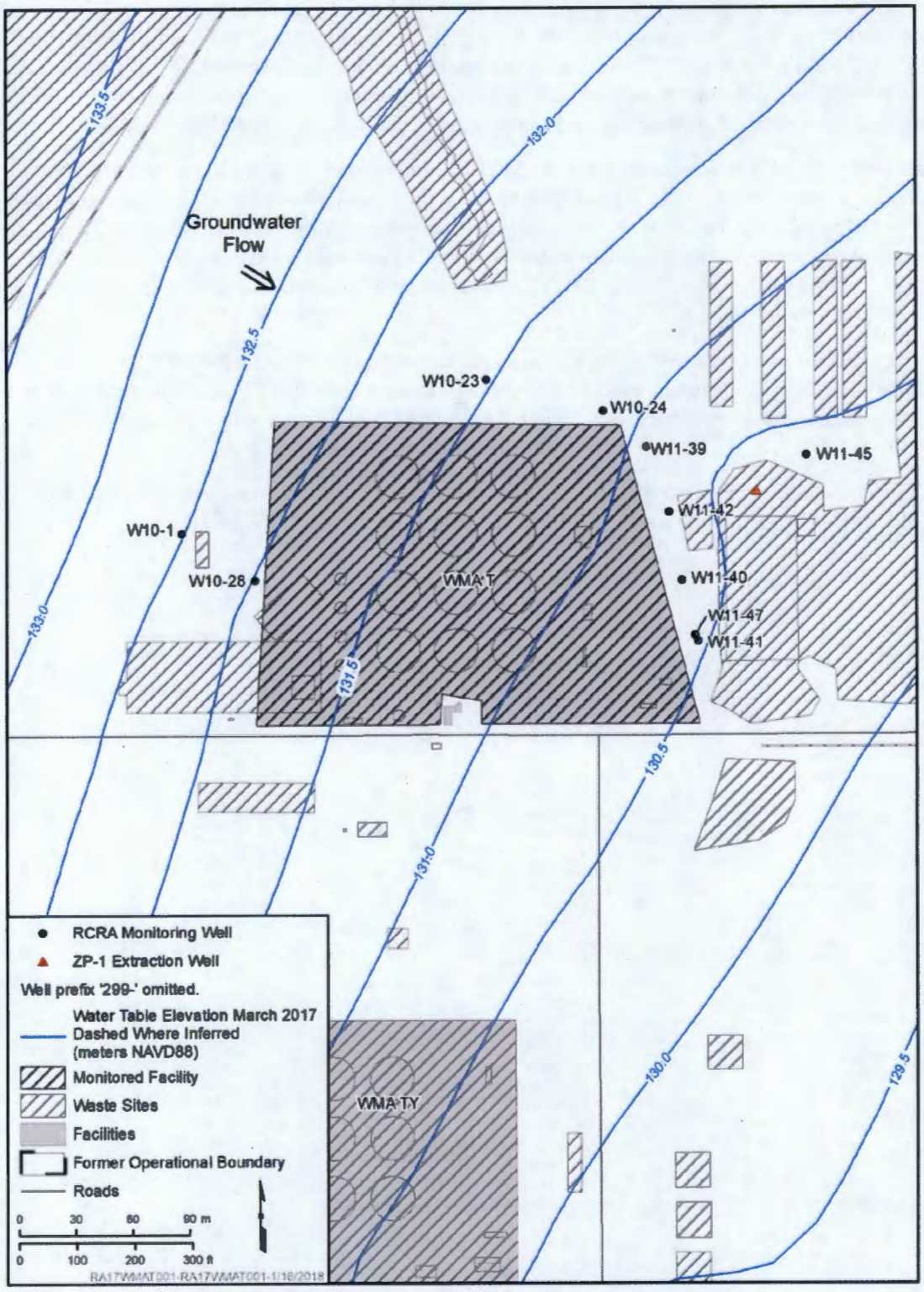
The WMA T wells were sampled as required in 2017 (Table 3-13). During November 2017, recommended holding times for nitrate were exceeded prior to analysis. The network was resampled for the analyte later the same month. Well 299-W11-41 was sampled more than required in 2017 to provide information on cyanide contamination, which is not currently required under DOE/RL-2009-66.

Table 3-15 summarizes the monitoring results for 2017. The concentration of the dangerous waste constituent Cr(VI) was 120 µg/L in well 299-W10-28 in 2017, an increase from 18 µg/L in 2016 and exceeding the MTCA standard. Concentrations of total chromium were about the same. Based on depth-discrete sample data from wells drilled in the vicinity, Cr(VI) is found in the top 45 m (150 ft) of the aquifer. The estimated unconfined aquifer thickness is about 52 m (170 ft) beneath WMA T.

Nitrate is also found in groundwater beneath the WMA and is from the same source as the Cr(VI). The nitrate plume beneath WMA T is within a regional nitrate plume and did not change significantly between 2016 and 2017; however, the maximum concentrations for the network increased. The highest nitrate levels in 2017 were in upgradient well 299-W10-28 (575 mg/L) and downgradient well 299-W11-41 (221 mg/L). While WMA T is a source of nitrate, other upgradient sources are larger contributors.

Fluoride concentrations were above the primary DWS in wells 299-W10-23, 299-W10-24, and 299-W11-39, which is consistent with previous results. Carbon tetrachloride and TCE are also present beneath WMA T; however, this contamination is associated with liquid disposal processes at PFP and not WMA T.

Monthly sampling for total cyanide, free cyanide, and cyanide amenable to chloride was initiated at well 299-W11-41 in February 2017. There were no detections during 2017.



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

Figure 3-10. Waste Management Area T

Table 3-13. WMA T Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W10-1	UG	1947 (P)	148.6	487.6	124.2	407.6	132.62	435.12	11/6/2017	8.4	27.5	A	11
299-W10-23	ASMT	1998 (C)	137.8	452.1	127.1	417.1	131.61	431.80	11/2/2017	4.5	14.7	B	11
299-W10-24	DG	1998 (C)	138.0	452.6	127.3	417.6	131.28	430.71	11/2/2017	4.0	13.1	A	11
299-W10-28	UG	2001 (C)	137.5	451.2	126.9	416.2	131.98	432.99	11/2/2017	5.1	16.8	A	11
299-W11-39	DG	2000 (C)	137.0	449.6	126.4	414.6	131.02	429.84	11/3/2017	4.6	15.2	A	11
299-W11-40	DG	2000 (C)	137.2	450.0	126.5	415.0	130.78	429.07	11/3/2017	4.3	14.1	Q	2, 5, 8, 11
299-W11-41	DG	2000 (C)	137.4	450.9	126.8	415.9	130.56	428.35	11/6/2017	3.8	12.5	Q	Monthly 2 through 12*
299-W11-42	DG	2000 (C)	137.9	452.6	127.3	417.6	130.99	429.75	11/3/2017	3.7	12.2	Q	2, 5, 8, 11
299-W11-45	Far-field	2006 (C)	127.2	417.4	122.7	402.4	130.45	427.98	11/8/2017	7.8	25.5	S	5, 11
299-W11-47	Deep	2006 (C)	126.1	413.8	116.7	382.8	130.65	428.65	11/2/2017	14.0	45.8	Q	2, 5, 8, 11

Note: Requirements are from DOE/RL-2009-66, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area T.*

* Well 299-W11-41 was sampled monthly for cyanide beginning in February 2017.

A = annually
ASMT = assessment of plume
B = biennial (every other year)
C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"
DG = downgradient
P = constructed prior to *Washington Administrative Code* requirements
Q = quarterly
S = semiannual
UG = upgradient

Table 3-14. Groundwater Velocity at WMA T

Flow Direction	East-southeast
Flow Rate (m/d)	0.34
Hydraulic Conductivity (m/d) (Source)	5 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	6.7×10^{-3}
Comments	Gradient and direction determined by trend surface analysis of data collected in March 2017; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 3-15. WMA T Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	114	139	—	
Calcium (unfiltered)	µg/L	5,560	140,000	—	
Chloride	mg/L	13	24	250[a]	
Chromium (unfiltered)	µg/L	18.5	150	100[b]	299-W10-28
Cr(VI) (unfiltered)	µg/L	<1.5	120	48[e]	299-W10-28
Cyanide (total)[c]	µg/L	<1.67	<5	—	
Cyanide (free)[c]	µg/L	<1.67	<5	200[b,d]	
Cyanide (amenable)[c]	µg/L	<1.67	<5	200[b,d]	
Dissolved oxygen	mg/L	4.58	9.76	—	
Fluoride	mg/L	0.3	5	4[b]	299-W10-23, 299-W10-24, 299-W11-39
Magnesium (unfiltered)	µg/L	1,670	43,000	—	
Nitrate	mg/L	36.7	575	45[f]	All except 299-W10-23
pH		7.28	9.27	—	
Potassium (unfiltered)	µg/L	2,240	6,800	—	
Sodium (unfiltered)	µg/L	11,100	142,000	—	
Specific conductance	µS/cm	403	1,361	—	

Table 3-15. WMA T Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Sulfate	mg/L	35	57	250[a]	
Temperature	°C	12.6	21	—	
Turbidity	NTU	0.5	74	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. These analyses are not required under the groundwater monitoring plan but were performed in 2017.

d. Applies to free cyanide. Note that the WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B," standard is 4.8 µg/L.

e. WAC 173-340-705.

f. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen. This equates to 45 mg/L when expressed as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

Cr(VI) = hexavalent chromium

NTU = nephelometric turbidity unit

3.6 Waste Management Area TX-TY

WMA TX-TY (Figure 3-11), which includes the TX and TY Tank Farms, is located in the northern portion of the 200 West Area and was used for interim storage of radioactive waste from reactor fuel chemical processing for plutonium production. The WMA contains 24 underground SSTs constructed in 1947 and 1948 for the TX Tank Farm and in 1951 and 1952 for the TY Tank Farm. Each tank has a capacity of 2.84 million L (750,000 gal). In addition to the tanks, six diversion boxes and ancillary pumps, valves, and pipes are included in the Hanford RCRA Permit Part A Form for the SSTs in the TX-TY Tank Farms system.

The tanks in WMA TX-TY began receiving waste in 1949, with the tanks in both farms used to support the bismuth phosphate process and the uranium-recovery program. Some of the tanks also received waste from REDOX and PUREX operations. Detailed information on WMA TX-TY is in DOE/RL-2009-67, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY*. Most of the drainable liquid in the tanks has been removed, and all tanks have been interim stabilized. As interim corrective actions, berms were constructed around the tank farms in 2001 to stop run-on of natural precipitation. Water lines were pressure tested and, if needed, were repaired. Lines no longer needed were cut and capped. Interim surface barriers were placed over tanks in the TY Tank Farm in 2011 to inhibit infiltration of precipitation.

The WMA is regulated under RCRA and its implementing requirements as described in DOE/RL-2009-67. WMA TX-TY is monitored under an interim status assessment program because of elevated specific conductance in two downgradient wells in 1993. The dangerous waste constituent Cr(VI) was monitored under the WMA TX-TY RCRA assessment program during the reporting period.

Other dangerous waste constituents detected include carbon tetrachloride and TCE, which are from PFP sources. Table 3-16 lists the current monitoring network for WMA TX-TY, consisting of 1 upgradient, 2 far-field, and 10 downgradient monitoring wells. Wells are screened across the water table and monitor the upper portion of the unconfined aquifer.

The 200 West Area P&T extraction wells on the east, west, and south sides of the WMA alter the groundwater flow direction and hydraulic gradients (Figure 3-11). Based on March 2017 water-level data, the flow direction is generally southeast within the northern portion and east-northeast within the southern portion of the WMA. Estimates of groundwater and contaminant flow rates beneath WMA TX-TY range from 0.19 to 35 m/d (0.62 to 1.2 ft/d) (Table 3-17). Between 2016 and 2017, monitoring well water levels increased 2 to 50 cm (0.8 to 10 in.) in wells in the northern portion and decreased 1 to 31 cm (0.4 to 12 in.) in wells in the southern portion of the WMA.

In 2017, wells were sampled quarterly to annually as planned (Table 3-16). Five wells were sampled more than required in 2017 to provide information on cyanide contamination. In 2018, the sampling frequency for Cr(VI) and supporting parameters will be increased to quarterly.

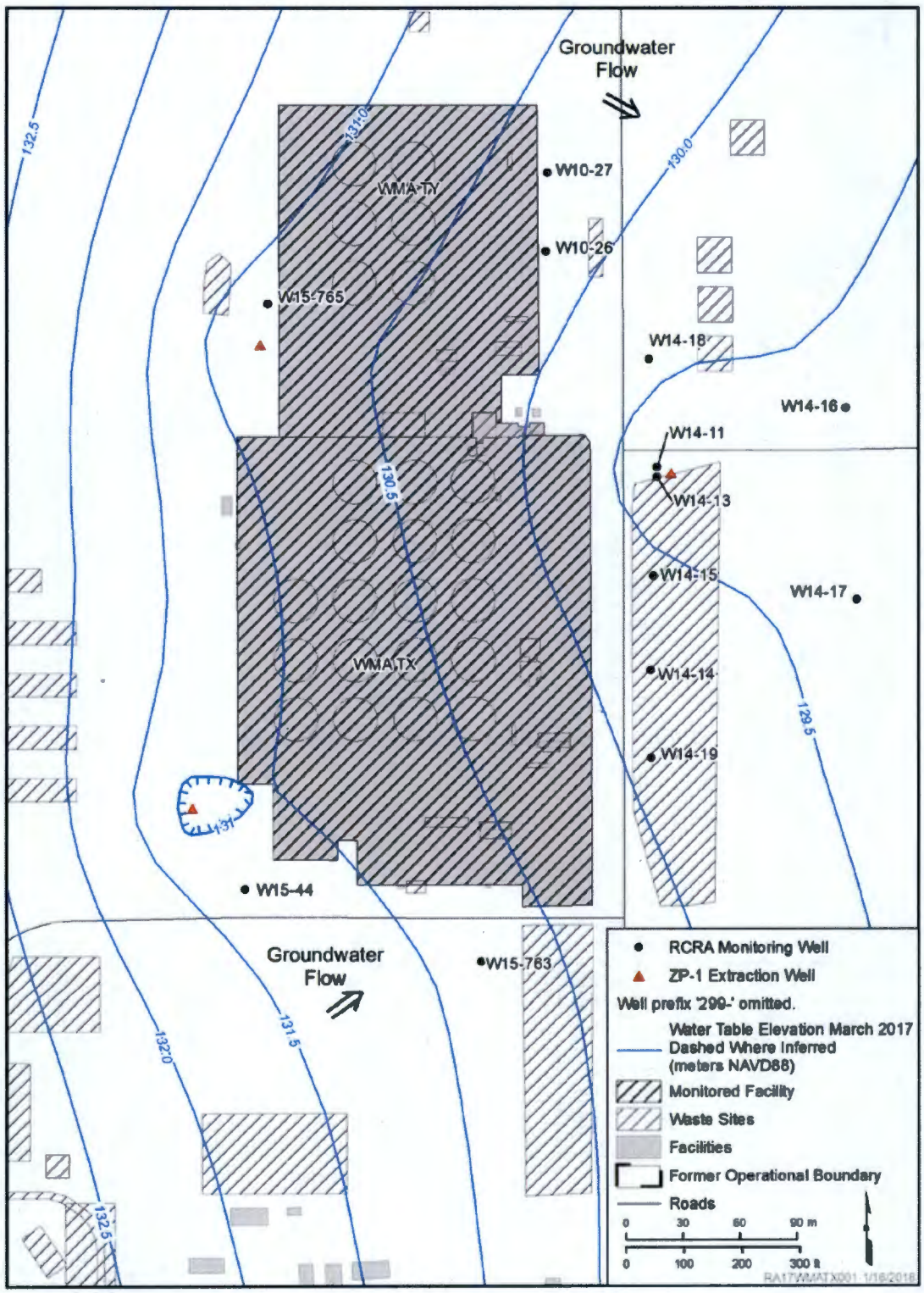
Table 3-18 summarizes the monitoring results for 2017. The 2017 maximum Cr(VI) (97.0 µg/L in well 299-W14-16) was higher than the 2016 maximum (75.0 µg/L in well 299-W14-11). This increase is consistent with a general increasing trend in Cr(VI) in well 299-W14-16. The source for the Cr(VI) was past leaks from tanks and pipelines at WMA TX-TY. Based on depth-discrete sample data from wells drilled in the vicinity, Cr(VI) is found in the top 30 m (100 ft) of the aquifer. The estimated thickness of the unconfined aquifer is about 55 m (180 ft) beneath the WMA.

Total chromium is analyzed only in unfiltered samples. The maximum concentration in 2017 was 463 µg/L in well 299-W14-16. This was much higher than the Cr(VI) concentration, indicating the presence of undissolved trivalent Cr(VI). Aluminum is elevated in unfiltered samples from nine wells, most likely due to particulate matter from aquifer sediments.

During 2017, nitrate exceeded the DWS in all network wells. Nitrate concentrations have declined in WMA TX-TY monitoring wells from a maximum of 3,600 mg/L at 299-W14-11 in 2005 to 620 mg/L at 299-W14-16 in 2017. Most of the nitrate contamination is attributed to PFP operations, as well as past-practice disposal to cribs and trenches in the area.

Monthly sampling for total cyanide, free cyanide, and cyanide amenable to chlorination was initiated at wells 299-W10-26, 299-W10-27, 299-W14-11, 299-W14-13, and 299-W14-18 in February 2017. Filtered samples were added to the suite of cyanide analysis beginning in May 2017. As discussed in Section 3.2, cyanide is regulated as free cyanide, and total cyanide concentrations in groundwater are typically much higher than free cyanide concentrations.

Total cyanide concentrations exceeded 200 µg/L in wells 299-W10-26 and 299-W14-18 (Figure 3-12). Free and amenable cyanide concentrations were much lower, and the highest free cyanide concentrations (greater than 60 µg/L in well 299-W10-26) were out of trend with the remainder of the data set. The highest concentration of cyanide amenable to chlorination was 348 µg/L in a filtered sample from well 299-W14-18, but the result was inconsistent with the unfiltered sample and the free cyanide results (less than 5 µg/L)



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

Figure 3-11. Waste Management Area TX-TY.

Table 3-16. WMA TX-TY Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W10-26	DG	1998 (C)	138.53	454.50	127.86	419.50	130.33	427.59	11/13/2017	2.5	8.1	Q	2 through 12*
299-W10-27	DG	2001 (C)	137.54	451.24	126.87	416.24	130.39	427.79	11/13/2017	3.5	11.5	Q	2 through 12*
299-W14-11	Deep	2005 (C)	124.53	408.55	121.48	398.55	128.89	422.88	11/14/2017	7.4	24.3	S	2 through 12*
299-W14-13	DG	1998 (C)	138.20	453.43	127.54	418.43	129.13	423.65	11/15/2017	1.6	5.2	Q	2 through 12*
299-W14-14	DG	1998 (C)	138.48	454.33	127.81	419.33	129.86	426.05	11/13/2017	2.0	6.7	S	5, 11
299-W14-15	DG	2000 (C)	137.53	451.21	126.86	416.21	128.27	420.84	11/16/2017	1.4	4.6	Q	2, 5, 8, 11
299-W14-16	FF	2000 (C)	137.40	450.78	126.73	415.78	129.50	424.87	11/16/2017	2.8	9.1	A	11
299-W14-17	FF	2000 (C)	137.41	450.83	126.75	415.83	129.25	424.04	11/14/2017	2.5	8.2	A	11
299-W14-18	DG	2000 (C)	137.82	452.15	127.15	417.15	128.25	420.76	11/16/2017	1.1	3.6	A	2 through 12*
299-W14-19	DG	2002 (C)	136.62	448.24	125.96	413.24	129.74	425.66	11/1/2017	3.8	12.4	S	5, 11
299-W15-44	DG	2002 (C)	138.33	453.84	127.66	418.84	131.33	430.86	11/15/2017	3.7	12.0	S	5,11
299-W15-763	DG	2001 (C)	137.56	451.30	126.89	416.30	130.76	429.00	11/15/2017	3.9	12.7	S	5, 11
299-W15-765	UG	2001 (C)	137.45	450.95	126.78	415.95	130.81	429.16	11/15/2017	4.0	13.2	S	5, 11

Note: Requirements are from DOE/RL-20009-67, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY.*

* Sampled monthly for cyanide (not required under monitoring plan).

A = annually
C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"
DG = downgradient
FF = far-field
Q = quarterly
S = semiannual
UG = upgradient

Table 3-17. Groundwater Velocity at WMA TX-TY

Flow Direction	North portion: southeast South portion: east-northeast
Flow Rate (m/d)	North portion: 0.19 to 0.34 South portion: 0.20 to 0.35
Hydraulic Conductivity (m/d) (Source)	5 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	North portion: 6.9×10^{-3} South portion: 7.1×10^{-3}
Comments	Gradient and direction estimated from March 2017 water table map; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 3-18. WMA TX-TY Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	108	128	—	
Aluminum (unfiltered)	µg/L	<15	3,150	50[a]	299-W10-26, 299-W10-27, 299-W14-13, 299-W14-14, 299-W14-16, 299-W14-18, 299-W14-19, 299-W15-44, 299-W15-763
Calcium (unfiltered)	µg/L	35,600	159,000	—	
Chloride	mg/L	18	36	250[a]	
Chromium (unfiltered)	µg/L	6.58	463	100[b]	299-W14-16
Cr(VI) (unfiltered)	µg/L	<3.3	97	48[c]	299-W14-11, 299-W14-16
Cyanide (total; filtered and unfiltered)[d]	µg/L	<1.67	688	—	
Cyanide (amenable; filtered and unfiltered)[d]	µg/L	<1.67	348	200[b,e]	299-W14-18 (filtered sample; unfiltered sample had 84 µg/L)
Cyanide (free; filtered and unfiltered)[d]	µg/L	<3	66	200[b,e]	
Dissolved oxygen	mg/L	3.65	9.69	—	
Fluoride	mg/L	0.208	1.57	4[b]	
Magnesium (unfiltered)	µg/L	11,600	53,200	—	

Table 3-18. WMA TX-TY Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Nitrate	mg/L	32.3	620	45[f]	All
pH	—	7.4	8.28	—	
Potassium (unfiltered)	µg/L	4,350	8,560	—	
Sodium (unfiltered)	µg/L	13,000	106,000	—	
Specific conductance	µS/cm	492	1,473	—	
Sulfate	mg/L	31.6	63.9	250[a]	
Temperature	°C	10	21.9	—	
Turbidity	NTU	0.13	71.9	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

d. Cyanide analyses are not required under the groundwater monitoring plan but were added to the sampling schedule in 2017. e. Applies to free cyanide. Note that the WAC 173-340-705 standard is 4.8 µg/L.

f. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen. This equates to 45 mg/L when expressed as NO_3.

< = one or more of the results was below the detection limit

— = no comparison value

Cr(VI) = hexavalent chromium

NTU = nephelometric turbidity unit

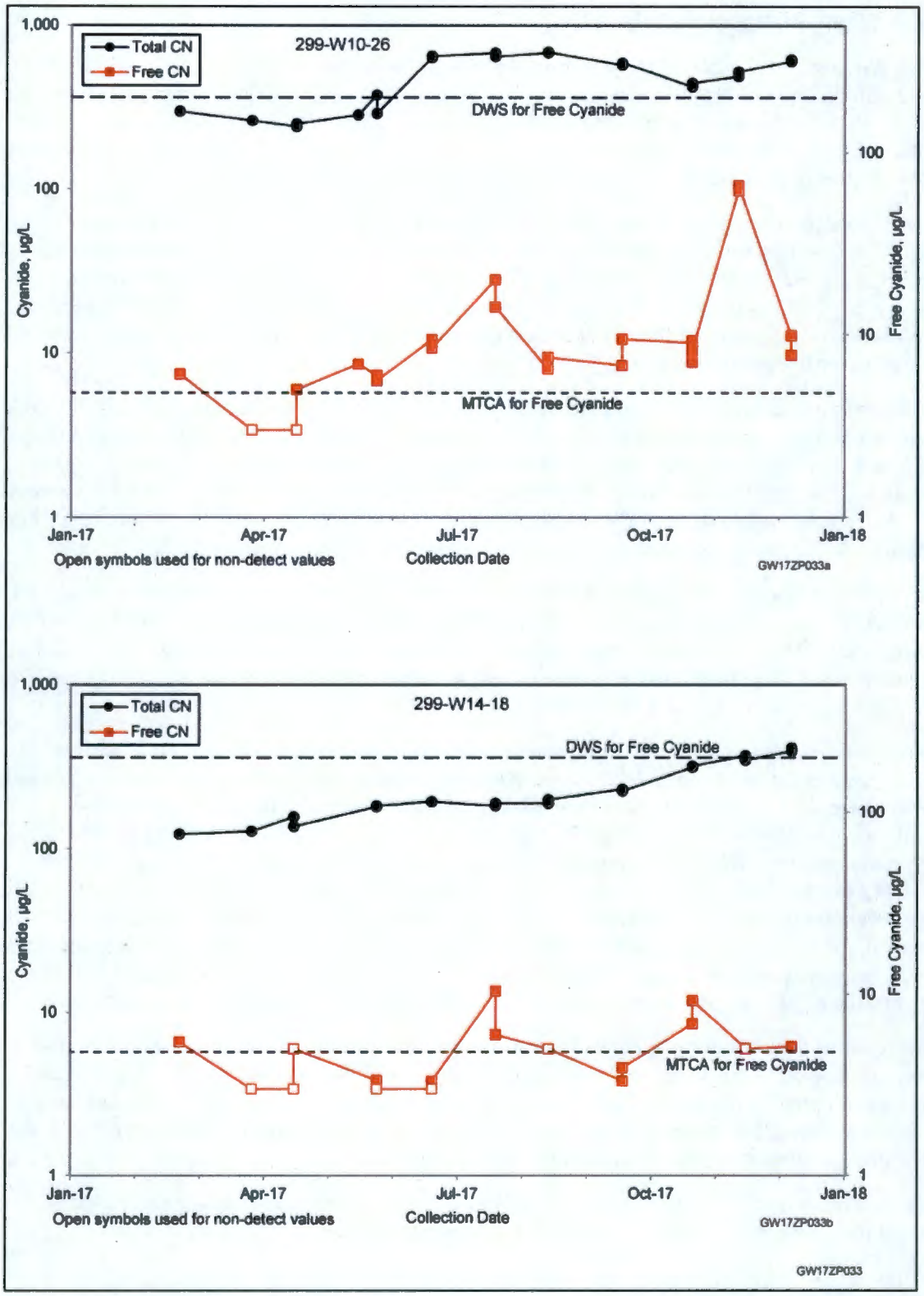


Figure 3-12. Total and Free Cyanide in Wells 299-W10-26 and 299-W14-18

3.7 Waste Management Area U

WMA U (Figure 3-13) contains 16 underground SSTs constructed between 1943 and 1944. Twelve SSTs have 2 million L (535,000 gal) capacities, and four have 210,000 L (55,000 gal) capacities (Section 1.2 of RPP-35485, *Field Investigation Report for Waste Management Area U*). The WMA also has a variety of ancillary equipment, including six diversion boxes; the 271-UR control house; the 244-UR process vault; the 244-U double-contained receiver tank; and waste transfer lines, pits, and junction boxes.

WMA U received waste from the bismuth phosphate process between 1946 and 1948 and from the REDOX process between 1954 and 1957 (WHC-MR-0132). In 1952, some waste was retrieved and pumped to the 242T evaporator and, between 1952 and 1957, the metal waste stored in nine of the 2 million L (535,000 gal) capacity tanks was transferred to U Plant for uranium recovery. To minimize the probability and severity of future leaks, most of the drainable liquid in each tank has been removed and transferred to double-shell tanks.

WMA U was placed into assessment status in 2000 when specific conductance in downgradient WMA monitoring wells exceeded upgradient levels. An assessment of that finding in 2000 determined that the WMA had affected groundwater quality based on elevated nitrate and possibly chromium in downgradient wells (Chapter 6.0 of PNNL-13282, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U: First Determination*). However, these contaminants were below their respective DWSs, and the affected area was limited to the southeastern corner of the WMA.

Groundwater at WMA U is currently monitored under DOE/RL-2009-74, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area U*. The objective of RCRA monitoring at WMA U is to assess the extent and concentrations of the dangerous waste constituent chromium in the groundwater and determine its rate of migration. Table 3-19 lists the network wells, as well as the screen intervals and water-level information.

Groundwater flow beneath WMA U is affected by the 200 West Area P&T system. Trend surface analysis was performed on water-level measurements at WMA U during March 2017, and the hydraulic gradient magnitude was 7.1×10^{-3} m/m (Table 3-20), which is higher than the 2016 average of 5.0×10^{-3} m/m and the 2015 average of 5.2×10^{-3} m/m. Extraction well 299-W17-3 is 150 m (490 ft) north-northeast of the WMA. Flow rates in this well increased from an average of 320 to 424 L/min (85 to 112 gal/min) during the four months prior to March 2017, and the resulting increase in drawdown may account for the increased gradient at WMA U. In response to pumping in this well, the flow direction beneath the WMA was expected to turn toward the northeast, but the average 2017 direction was similar to previous years (east at 82 degrees azimuth). The estimated 2017 flow rate of 0.35 m/d (1.2 ft/d) is higher than the 2016 rate of 0.18 m/d (0.58 ft/d) due to the increased hydraulic gradient magnitude.

Water levels in the monitoring wells declined an average of 21 cm (8.3 in.) in 2017. This is less than the average decline of 37 cm (15 in.) in 2016. The reduced rate of decline is due to normal water-level responses to operation of the 200 West Area P&T system during 2017. Based on the well distribution at the WMA and the groundwater flow direction, the well network is currently capable of monitoring the distribution of dangerous waste contamination from the WMA.

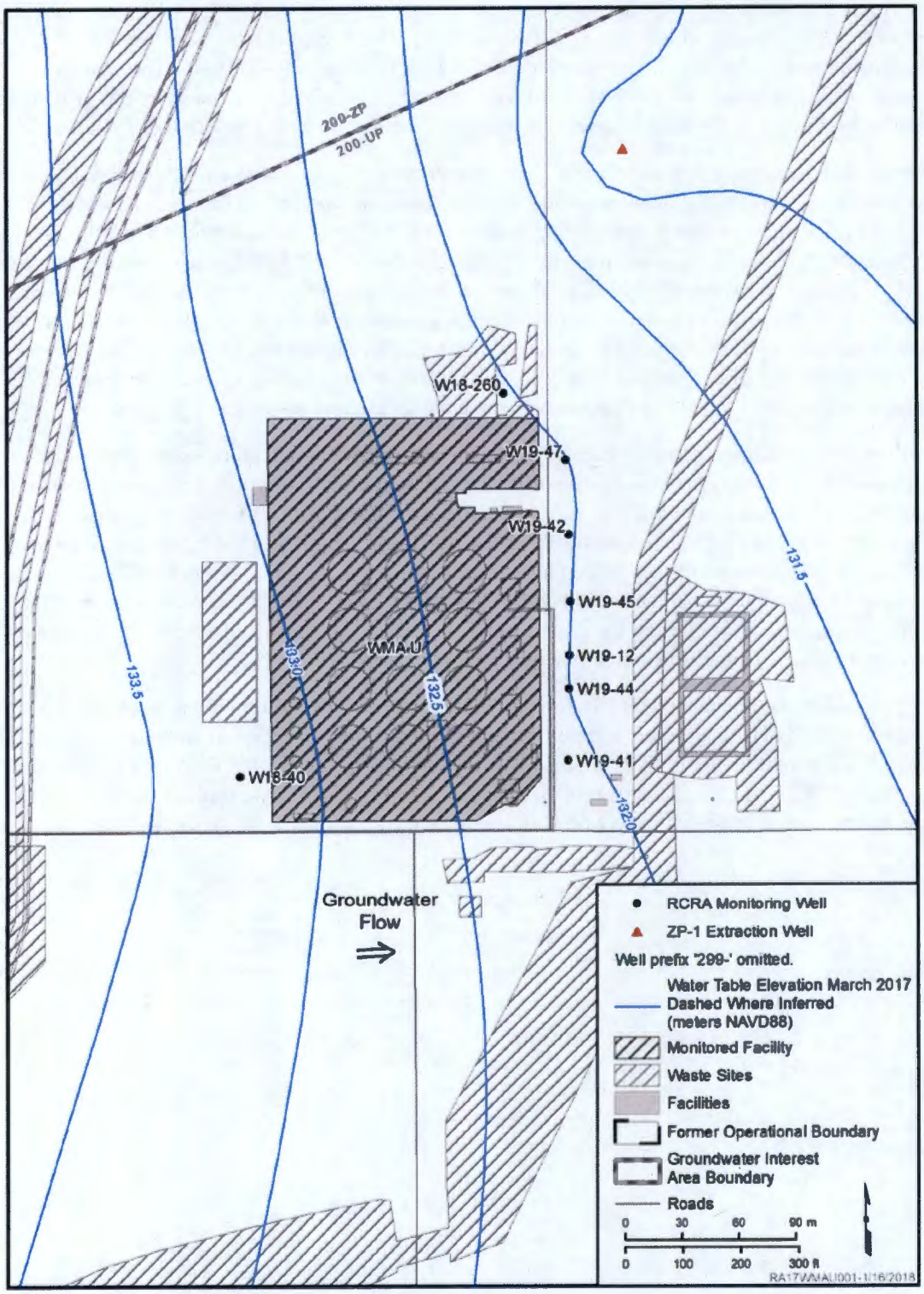
Table 3-19 provides a list of wells monitored at WMA U. All required sampling was performed successfully during 2017. Table 3-21 summarizes the sampling results.

The dangerous waste constituent chromium is present in the groundwater at WMA U. During 2017, the highest chromium concentration (98.4 µg/L) was in an unfiltered sample from well 299-W19-12. The highest concentration in a filtered sample was 20.4 µg/L in well 299-W19-45. The filtered concentration in upgradient well 299-W18-40 was 7.5 µg/L. The WMA U is the source of groundwater contamination limited to the downgradient (east) side of the tank farm (Chapter 6.0 of PNNL-13282).

Chromium may be present at WMA U as a groundwater contaminant and as a result of stainless-steel well screen corrosion. Many of the network wells have elevated iron, manganese, and nickel, which (along with chromium) are the primary components of 304 stainless steel used to construct the network wells. In particular, nickel is a good indicator of stainless-steel corrosion because its natural concentration in Hanford Site groundwater is very low (90th percentile background is 1.56 µg/L [DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*]). In wells 299-W19-45 and 299-W19-47, nickel is not routinely detected, and chromium concentrations ranged from 14.9 to 21.1 µg/L in well 299-W19-45 and from 5.06 to 7.6 µg/L in well 299-W19-47. The lack of nickel in these wells indicates that the chromium is from groundwater contamination and not screen corrosion.

While dissolved chromium is highly mobile in the aquifer, it can migrate more slowly than the movement of moisture in the vadose zone beneath the tank farms at least initially following release from a tank. This has been attributed to a reduction process where tank fluids dissolve divalent iron minerals in the sediment. The iron then reacts with the soluble Cr(VI), reducing it to trivalent chromium, which precipitates as an insoluble iron chromium hydroxide (Zachara et al., 2007, "Geochemical Processes Controlling Migration of Tank Wastes in Hanford's Vadose Zone"). This reaction may explain the current low concentrations of chromium in the groundwater. In the aquifer, dissolved chromium migrates to the east at the calculated groundwater flow rate of 0.35 m/d (1.2 ft/d).

Concentrations of the nondangerous constituent nitrate are above 45 mg/L in all network wells, including the upgradient well. The upgradient nitrate source is treated water injected into wells formerly used for the 200-ZP-1 OU interim action P&T system. The injected water was treated for VOCs but still contained nitrate (Section 3.3.5 of DOE/RL-2011-118). Because nitrate in some downgradient wells is higher than the upgradient well, it is likely that WMA U is also a source of nitrate to the groundwater.



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

Figure 3-13. Waste Management Area U

Table 3-19. WMA U Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
299-W18-40	UG	2001 (C)	136.2	446.8	125.5	411.8	133.07	436.59	10/15/2017	7.5	24.8	A	1, 10[a]
299-W18-260	DG	2014 (C)	132.0	432.9	122.8	402.9	132.06	433.26	10/15/2017	9.2	30.3	S	4, 10
299-W19-12	DG	1983 (P)	141.7	464.8	130.4	427.8	131.99	433.03	10/15/2017	1.6	5.2	S	4, 10
299-W19-41	DG	1998 (C)	138.7	455.0	128.0	420.0	132.07	433.28	10/15/2017	4.0	13.2	S	4, 10
299-W19-42	DG	1998 (C)	138.4	453.9	127.7	418.8	132.03	433.18	10/15/2017	4.4	14.3	S	4, 10
299-W19-44	DG	2001 (C)	136.4	447.7	125.8	412.7	131.98	433.02	10/15/2017	6.2	20.4	S	1, 7, 10*
299-W19-45	DG	2001 (C)	137.4	450.6	126.7	415.7	132.08	433.32	10/16/2017	5.4	17.6	S	1, 7, 10*
299-W19-47	DG	2004 (C)	136.3	447.3	125.7	412.4	132.04	433.21	10/15/2017	6.3	20.8	S	1, 7, 10*

Note: Requirements are from DOE/RL-2009-74, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area U.*

* Listed frequency is as required under the monitoring plan. Quarterly sampling was initiated in all wells in October 2017 in anticipation of a monitoring plan revision.

A = annually
DG = downgradient
C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"
P = constructed prior to *Washington Administrative Code* requirements
S = semiannual
UG = upgradient

Table 3-20. Groundwater Velocity at WMA U

Flow Direction	East
Flow Rate (m/d)	0.35
Hydraulic Conductivity (m/d) (Source)	6.12 (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*)
Effective Porosity	0.1 (CP-47631)
Gradient (m/m)	7.1×10^{-3}
Comments	Gradient and direction determined by trend surface analysis of data collected in March 2017; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 3-21. WMA U Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	79.6	98.8	—	
Calcium (unfiltered)	µg/L	29,800	59,400	—	
Calcium (filtered)	µg/L	29,500	59,200	—	
Chloride	mg/L	11.5	23	250[a]	
Chromium (unfiltered)	µg/L	5.06	98.4	100[b]	
Chromium (filtered)	µg/L	4.5	20.4	100[b]	
Magnesium (unfiltered)	µg/L	10,600	19,000	—	
Magnesium (filtered)	µg/L	10,300	19,500	—	
Nitrate	mg/L	40.1	186	45[c]	All
pH Measurement	—	7.76	8.72	—	
Potassium (unfiltered)	µg/L	3,400	5,120	—	
Potassium (filtered)	µg/L	3,260	5,040	—	
Sodium (unfiltered)	µg/L	17,400	27,000	—	
Sodium (filtered)	µg/L	18,100	27,000	—	
Specific conductance	µS/cm	362	646	—	
Sulfate	mg/L	23	33	250[a]	
Temperature	°C	15.7	22.5	—	
Turbidity	NTU	0.92	116	—	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Highlighted cell indicates concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. The federal drinking water standard for nitrate is 10 mg/L expressed as nitrogen. This equates to 45 mg/L when expressed as NO_3.

— = no comparison value

NTU = nephelometric turbidity unit

3.8 216-A-29 Ditch

The 216-A-29 Ditch TSD unit is just east of the 200 East Area fence line (Figures 1-1 and 3-14) and is planned for closure. DOE submitted an updated closure plan (DOE/RL-2008-53, *216-A-29 Ditch Closure Plan (D-2-3)*) to Ecology in 2014. The site is designated as a surface impoundment in accordance with WAC 173-303-040, "Definitions." It was placed into service in November 1955 to convey liquid effluent from the PUREX Plant chemical sewer to B Pond. Flow from the chemical sewer (low-level contaminants) was continuous, with an average volume of 3,700 L/min (970 gal/min).

The 216-A-29 Ditch received continuous discharge of corrosive waste and potentially hazardous spilled chemical materials from PUREX. The most significant chemical discharges included acidic and caustic effluents from backwashing during demineralizer column regeneration. From 1955 to 1986, daily discharges of sodium hydroxide and sulfuric acid solutions occurred. Treatment of this waste involved the successive addition of acidic and caustic waste, which neutralized waste in the ditch. The ditch also received spills from the PUREX chemical sewer (low-level contamination). After 1986, dangerous waste was no longer discharged to the chemical sewer. A complete estimated inventory of materials discharged to the 216-A-29 Ditch is provided in Appendix A of WHC-SD-EN-AP-045, *Ground Water Monitoring Plan for the 216-A-29 Ditch*.

The 216-A-29 Ditch was removed from service in 1991, partly backfilled with material from the ditch sides, and the portion of the ditch inside the 200 East Area security fence was brought to grade with clean fill material. The ditch outside of the 200 East Area security fence was topped with clean fill material in a series of 11 terraces progressing down the length of the ditch. Both areas were revegetated and posted as underground radioactive material areas.

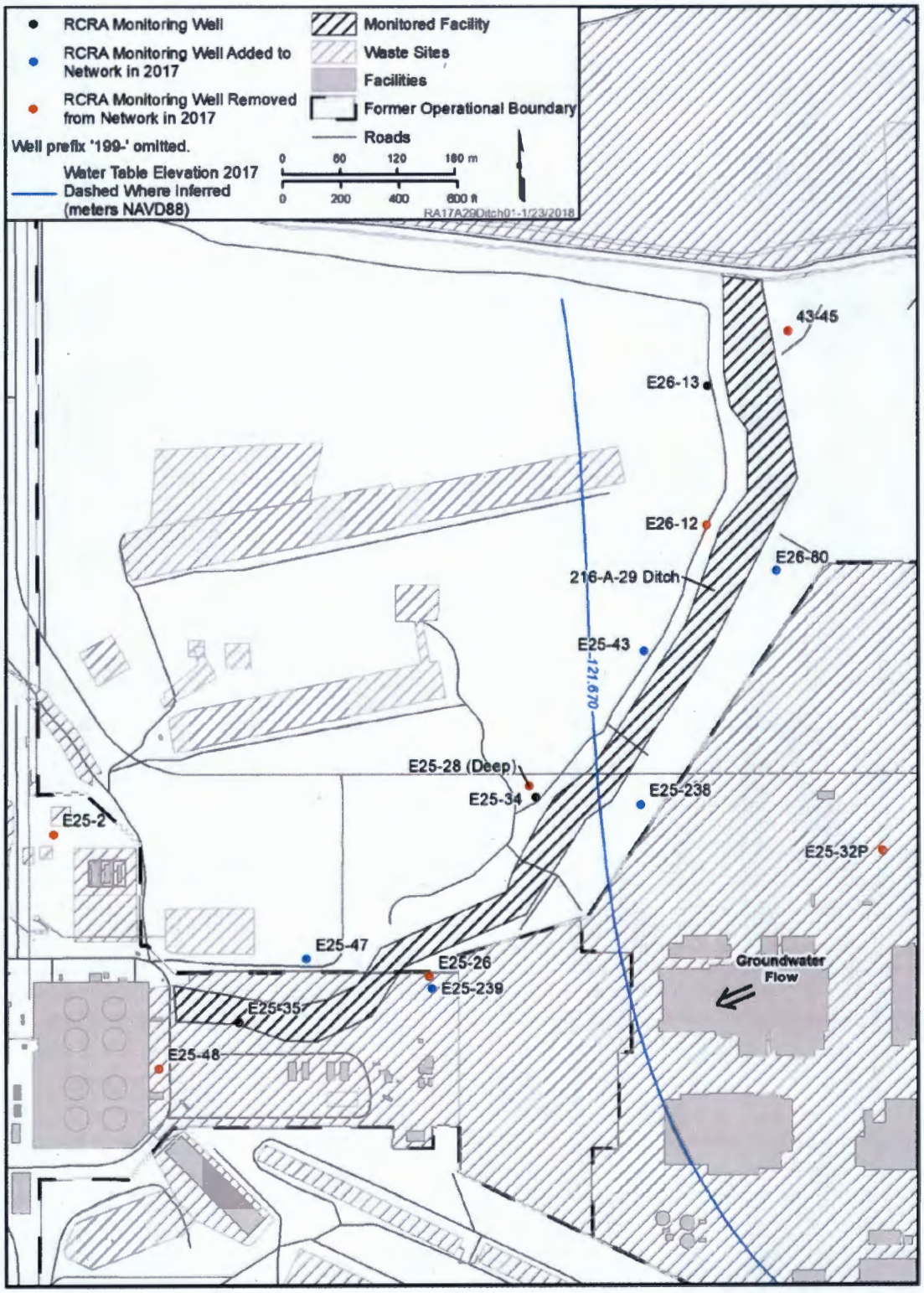
In January 2016, the 216-A-29 Ditch was placed into a groundwater assessment program because specific conductance in wells 299-E25-32P, 299-E25-35, and 299-E25-48 exceeded the critical mean value in 2015. Three versions of the groundwater quality assessment monitoring plan (DOE/RL-2016-23, *Interim Status Groundwater Quality Assessment Monitoring Plan*) were used in 2017: Rev. 0 from January until May, Rev. 1 from May until September, and Rev. 2 beginning on September 27. Rev. 2 incorporated changes to the well network proposed in Rev. 1, including installing new wells and removing older wells. Table 3-22 summarizes the changes to the network. Network groundwater wells all have adequate water columns in the screened interval for representative sampling over the next decade.

The current 216-A-29 Ditch groundwater monitoring network was based on groundwater flow directions estimated from evaluating low-gradient water table maps, comparing upgradient and downgradient well water chemistry along different ditch segments, using fate and transport modeling (including particle tracking), and reviewing historical migration patterns of 200 East Area nitrate and sulfate plumes (specifically near the ditch from 2000 to 2015). This analysis showed that near the north end of the ditch, flow in the unconfined aquifer is to the south. At the south end of the 216-A-29 Ditch, groundwater flows to the south-southeast.

Large-volume effluent discharges at TEDF influence the gradient near the 216-A-29 Ditch and other 200 East Area locations. In 2017, the gradient dipped to the west-southwest (Figure 2-6; Table 3-23). The gradient magnitude was 4.04×10^{-6} m/m, and the calculated average flow velocity was 0.34 m/d (1.1 ft/d).

The network was sampled quarterly as required in 2017 (Table 3-22). The full network was sampled quarterly for assessment parameters to assess whether dangerous waste or dangerous waste constituents are present in the groundwater and their extent and rate of migration. After additional data have been collected and evaluated, results will be included in a first determination report (40 CFR 265.93 (d)(4)). Table 3-24 summarizes the results for 2017.

Nitrate exceeded the DWS in well 299-E25-32P in all of sampling events in 2017. However, the nitrate concentration in new well 299-E25-238, which replaced 299-E25-32P, was less than the DWS at 11.1 mg/L. Iron exceeded the secondary DWS in an unfiltered sample from well 299-E25-34 in July; the filtered result was much lower, and subsequent concentrations were well below the secondary DWS. Manganese exceeded the secondary DWS in a filtered sample from well 299-E25-34 in July. The result (88.5 µg/L) was atypical for this well and did not agree with the unfiltered manganese result (6.7 µg/L).



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

Figure 3-14. 216-A-29 Ditch

Table 3-22. 216-A-29 Groundwater Monitoring Network

Well Name	Location Rev. 0[a]	Location Rev. 1 and 2[a]	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency Rev. 0/1/2[a]	Sampled Months and Exceptions
				m	ft	m	ft	m	ft		m	ft		
299-E25-2	UG	N/A	1955 (P)	122.3	401.1	110.1	361.1	121.71	399.30	10/9/2017	11.6	38.2	S/0/0	1, 4
299-E25-238	N/A	DG	2017 (C)	122.3	401.3	113.2	371.3	121.70	399.29	10/25/2017	8.5	28.0	0/Q/Q	10; new well
299-E25-239	N/A	DG	2017 (C)	122.8	402.7	113.6	372.7	121.71	399.31	10/25/2017	8.1	26.6	0/Q/Q	10; new well
299-E25-26	DG	N/A	1985 (P)	122.5	402.0	116.4	382.0	121.61	398.99	7/21/2017	5.2	17.0	S/Q/0	1, 4, 7; replaced by 299-E25-239
299-E25-28	DG	N/A	1986 (C)	104.8	343.9	98.7	323.9	121.70	399.27	10/9/2017	23.0	75.4	S/0/0	1, 4
299-E25-32P[b]	DG	N/A	1988 (C)	125.4	411.3	119.3	391.3	121.70	399.27	9/28/2017	2.4	8.0	S/Q/0	1, 4, 7; replaced by 299-E25-238
299-E25-34[b]	DG	UG	1988 (C)	125.8	412.6	119.7	392.6	121.72	399.33	10/1/2017	2.1	6.7	S/Q/Q	1, 4, 7, 10
299-E25-35[b]	DG	DG	1988 (C)	126.2	414.0	119.9	393.5	121.70	399.27	10/24/2017	1.7	5.7	S/Q/Q	1, 4, 7, 10
299-E25-43	DG	UG	1991 (C)	125.5	411.6	119.1	390.6	121.68	399.22	10/25/2017	2.6	8.6	0/Q/Q	1, 4, 7, 10
299-E25-47	DG	UG	1992 (C)	125.2	410.7	119.1	390.8	121.71	399.31	10/24/2017	2.6	8.5	0/Q/Q	4, 7, 10
299-E25-48	DG	N/A	1992 (C)	124.6	408.7	118.4	388.4	121.64	399.08	4/19/2017	3.3	10.7	S/0/0	1, 4
299-E26-12	UG	N/A	1991 (C)	125.9	413.1	119.5	392.1	121.74	399.41	10/13/2017	2.2	7.3	S/0/0	1, 4
299-E26-13[b]	UG	UG	1991 (C)	126.0	413.2	119.7	392.6	121.71	399.31	10/24/2017	2.0	6.7	S/Q/Q	1, 4, 7, 10
299-E26-80	N/A	DG	2017 (C)	122.5	402.0	113.4	372.0	121.70	399.26	10/24/2017	8.3	27.3	0/Q/Q	10; new well
699-43-45	DG	N/A	1989 (C)	126.5	414.9	120.3	394.6	121.66	399.15	7/14/2017	1.4	4.5	S/0/0	1, 4

Note: Requirements are from DOE/RL-2016-23, *216-A-29 Ditch Interim Status Groundwater Quality Assessment Monitoring Plan.*

Table 3-22. 216-A-29 Groundwater Monitoring Network

Well Name	Location Rev. 0[a]	Location Rev. 1 and 2[a]	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency Rev. 0/1/2[a]	Sampled Months and Exceptions
				m	ft	m	ft	m	ft		m	ft		

a. Designation of upgradient and downgradient wells, sampling frequency, and constituents were revised during 2017. DOE/RL-2016-23, Rev. 0 was in effect through May 2017, Rev. 1 from May to September, and Rev. 2 beginning in September 2017.

b. Hydraulic head data for these wells were corrected for borehole deviation from vertical. Corrections are not available for other wells in this network, which may cause reported head to be less than actual head.

0 = not in monitoring network under applicable revision of the groundwater monitoring plan

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

N/A = not applicable

P = constructed prior to *Washington Administrative Code* requirements

Q = quarterly

S = semiannual

UG = upgradient

Table 3-23. Groundwater Velocity at the 216-A-29 Ditch

Flow Direction	West-southwest
Flow Rate (m/d)	0.34
Hydraulic Conductivity (m/d) (Source)	Hanford formation and Cold Creek gravels: 17,000 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	4.0×10^{-6}
Comments	Gradient and flow direction represent average of October 2016 through September 2017; based on trend surface analysis on low-gradient well network; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 3-24. 216-A-29 Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	82	117	—	
Ammonia	µg/L	<20.7	241	—	
Calcium (unfiltered)	µg/L	23,400	76,000	—	
Calcium (filtered)	µg/L	23,100	75,200	—	
Chloride	mg/L	3.9	29	250[a]	
Chromium (unfiltered)	µg/L	<0.66	87.4	100[b]	
Chromium (filtered)	µg/L	<0.95	84.5	100[b]	
Iron (unfiltered)	µg/L	<17	542	300[a]	299-E25-34
Iron (filtered)	µg/L	<17	200	300[a]	
Magnesium (unfiltered)	µg/L	2,040	22,000	—	
Magnesium (filtered)	µg/L	6,640	21,700	—	
Manganese (unfiltered)	µg/L	<0.36	38.9	50[a]	
Manganese (filtered)	µg/L	<0.59	88.5	50[a]	299-E25-34
Nickel (unfiltered)	µg/L	<0.3	41	—	
Nickel (filtered)	µg/L	<0.32	84.8	—	
Nitrate	mg/L	1.99	57.5	45[c]	299-E25-32P
pH	—	7.84	8.57	—	
Phenol	µg/L	<1.9	<3	2,400[d]	
Potassium (unfiltered)	µg/L	4,110	9,200	—	
Potassium (filtered)	µg/L	4,340	9,120	—	
Sodium (unfiltered)	µg/L	2,520	29,000	—	
Sodium (filtered)	µg/L	9,110	29,400	—	
Specific conductance	µS/cm	223	689	—	
Sulfate	mg/L	16	161	250[a]	
Total organic carbon	µg/L	<155	9,960	—	
Total organic halides	µg/L	<2.1	23.6	—	
Turbidity	NTU	0.14	230	—	

Table 3-24. 216-A-29 Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Additional Constituents Detected, Wells 299-E25-43, 299-E25-47, 299-E25-238, and 299-E25-239[e]					
Arsenic (unfiltered)	µg/L	4.2	9.2	10	
Arsenic (filtered)	µg/L	4	9	10[b]	
Barium (unfiltered)	µg/L	21	44.3	2,000[b]	
Barium (filtered)	µg/L	20	45.3	2,000[b]	
Chromium (unfiltered)	µg/L	<1.91	10.5	100[b]	
Chromium (filtered)	µg/L	<1.6	3.6	100[b]	
Fluoride	mg/L	0.19	0.507	4[b]	
Gross alpha	pCi/L	<0.76	3.57	15[f]	
Gross beta	pCi/L	3.57	8.96	50[f]	
Lead (unfiltered)	µg/L	<0.096	0.85	15[g]	
Lead (filtered)	µg/L	<0.096	0.85	15[g]	
Selenium (unfiltered)	µg/L	<1.8	5.5	50[b]	
Selenium (filtered)	µg/L	<1.7	5.66	50[b]	
Silver (unfiltered)	µg/L	<0.023	1.09	100[a]	
Silver (filtered)	µg/L	<0.023	1.36	100[a]	

Notes: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the comparison value.

a. Secondary drinking water standard.

b. Primary drinking water standard.

c. The federal drinking water standards for nitrate is 10 mg/L expressed as nitrogen. This equates to 45 mg/L when expressed as NO_3.

d. WAC 173-340-705, "Model Toxics Control Act – Cleanup," "Use of Method B."

e. Analyzed for first year in these wells. The following constituents were analyzed but not detected in 2017: 2,4,5-TP Silvex, 2,4-D, cadmium, coliform, Endrin, Lindane, mercury, methoxychlor, and toxaphene.

f. Concentration assumed to yield a dose equivalent of 4 mrem/yr.

g. Action level.

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

3.9 Nonradioactive Dangerous Waste Landfill

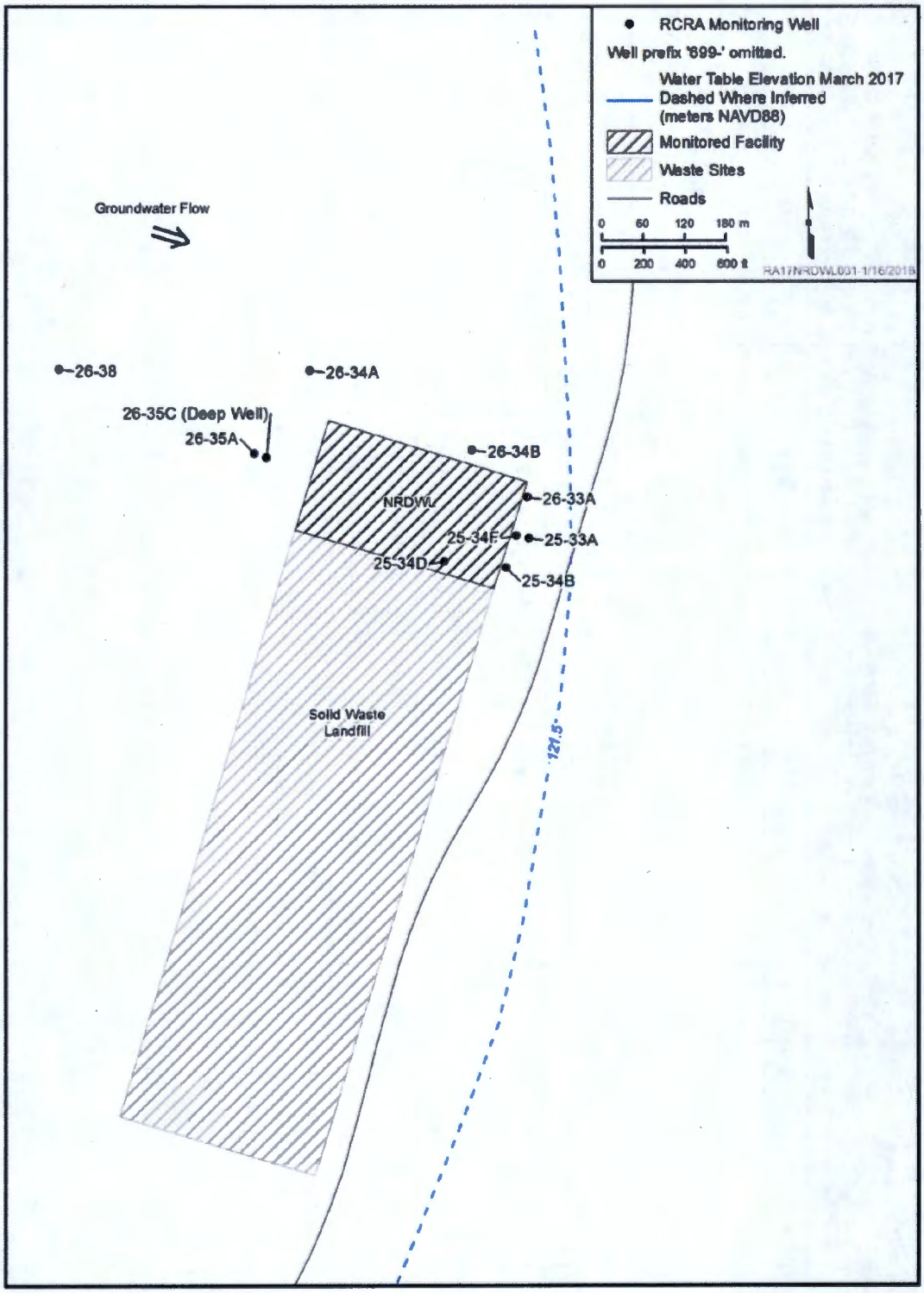
The NRDWL is a TSD unit southeast of the 200 East Area next to the Solid Waste Landfill (SWL) (Figures 1-1 and 3-15). This landfill has an area of 0.045 km^2 (0.017 mi^2) and consists of 19 parallel unlined trenches, each about 122 m (400 ft) long, 4.9 m (16 ft) wide at the base, and 4.6 m (15 ft) deep. The landfill received chemical, asbestos, and nonhazardous waste from 1975 to 1985.

NRDWL entered a groundwater quality assessment monitoring program in 2017. The site was previously monitored under a contamination indicator parameter program under DOE/RL-2015-32, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill*. In October 2016, TOC exceeded its critical mean in wells 699-25-34B and 299-26-38, and specific conductance exceeded the critical mean in well 699-25-34B. Because iron-reducing bacterial growth can affect TOC and specific conductance, the wells were cleaned prior to confirmation sampling to reduce the potential for false-positive results. The wells were resampled, and TOC was at background concentrations in both wells. Results for specific conductance were above the critical mean and consistent with historic values. DOE notified Ecology of the exceedance on January 31, 2017 (17-AMRP-0089, "Notification of Exceedance of Critical Mean Values for Specific Conductance"). DOE/RL-2017-19, *Groundwater Quality Assessment Plan for the Nonradioactive Dangerous Waste Landfill, Hanford Site*, was issued in February 2017, and quarterly assessment sampling began in April 2017.

Table 3-25 lists the current monitoring well network. During the July 2017 sampling event, well 699-25-34D was not accessible due to extreme fire danger and was not sampled. Other wells were sampled as planned. Between 2012 and 2017, water levels declined an average of 1.9 cm/yr (0.7 in./yr).

Data compiled in 2017 and used for trend surface analysis indicate an east-southeast flow direction and a hydraulic gradient of 2.5×10^{-5} m/m (Table 3-26). This flow direction generally agrees with the southeast flow direction inferred from historical plume migration in this area and hydraulic head differences in the NRDWL/SWL area compared to the 200 East Area. The average groundwater flow rate was 0.014 m/d (0.045 ft/d). The NRDWL well network continues to be located appropriately to accomplish the monitoring objectives.

Table 3-27 summarizes results of assessment monitoring for 2017. The monitoring network was sampled quarterly in 2017 to assess whether dangerous waste or dangerous waste constituents are present in the groundwater, their extent, and their rate of migration. The assessment has not been completed. "Preparation, Evaluation, and Response."Detailed evaluation and discussion of the groundwater quality assessment results will be presented in a first determination report (40 CFR 265.93(d)(4)).



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

Figure 3-15. Nonradioactive Dangerous Waste Landfill

Table 3-25. NRDWL Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency	Sampled Months and Exceptions
			m	ft	m	ft	m	ft		m	ft		
699-25-33A	Deep	1987 (C)	103.4	339.1	100.3	329.1	121.55	398.79	10/19/2017	21.2	69.7	Q	4, 7, 10
699-25-34B	DG	1986 (C)	125.7	412.4	119.6	392.4	121.57	398.85	10/19/2017	2.0	6.5	Q	4, 7, 10
699-25-34D	DG	1992 (C)	125.3	411.0	114.7	376.5	121.57	398.84	10/19/2017	6.8	22.4	Q	4, 10: Inaccessible in July
699-25-34F	DG	2015 (C)	122.6	402.2	113.4	372.2	121.58	398.88	10/16/2017	8.1	26.7	Q	4, 7, 10
699-26-33A	DG	2015 (C)	122.7	402.6	112.0	367.6	121.57	398.85	10/16/2017	9.5	31.3	Q	4, 7, 10
699-26-34A	UG	1986 (C)	125.7	412.5	119.6	392.5	121.58	398.88	10/18/2017	1.9	6.4	Q	4, 7, 10
699-26-34B	DG	1992 (C)	125.4	411.4	114.7	376.5	123.13	403.98	10/18/2017	8.4	27.5	Q	4, 7, 10
699-26-35A	UG	1986 (C)	125.9	413.2	119.8	393.2	121.58	398.89	10/16/2017	1.7	5.7	Q	4, 7, 10
699-26-35C*	DG deep	1987 (C)	103.9	341.0	100.9	331.0	121.56	398.82	10/18/2017	20.7	67.9	Q	4, 7, 10
699-26-38	DG	2014 (C)	123.1	403.9	114.0	373.9	122.58	402.18	10/18/2017	8.6	28.3	Q	4, 7, 10

Note: Requirements are from DOE/RL-2017-19, *Groundwater Quality Assessment Plan for the Nonradioactive Dangerous Waste Landfill, Hanford Site.*

* Hydraulic head data for this well were not corrected for borehole deviation from vertical, which may cause reported head to be less than actual head.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

Q = quarterly

UG = upgradient

Table 3-26. NRDWL Groundwater Velocity

Flow Direction	East-southeast
Flow Rate (m/d)	0.014
Hydraulic Conductivity (m/d) (Source)	109 (CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*)
Effective Porosity	0.2 (CP-57037)
Gradient (m/m)	2.5×10^{-5}
Comments	Gradient and direction determined by trend surface analysis of water-level data collected in March 2017; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 3-27. NRDWL Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Alkalinity	mg/L	126	246	—	
Calcium (unfiltered)	µg/L	32,200	73,000	—	
Calcium (filtered)	µg/L	32,000	71,300	—	
Chloride	mg/L	5.9	17	—	
Chromium (unfiltered)	µg/L	3.1	18.8	100[a]	
Chromium (filtered)	µg/L	3.2	11.2	100[a]	
Iron (unfiltered)	µg/L	<17	251	300[b]	
Iron (filtered)	µg/L	<22	91.1	300[b]	
Magnesium (unfiltered)	µg/L	9,080	18,000	—	
Magnesium (filtered)	µg/L	9,120	18,500	—	
Manganese (unfiltered)	µg/L	<0.31	12.3	50[b]	
Manganese (filtered)	µg/L	<0.31	12.7	50[b]	
Nickel (unfiltered)	µg/L	<0.3	11	—	
Nickel (filtered)	µg/L	<0.3	21.7	—	
Nitrate	mg/L	5.31	44.3	45[c]	
pH measurement		7.11	8.43	—	
Potassium (unfiltered)	µg/L	4,450	8170	—	
Potassium (filtered)	µg/L	4,870	7,880	—	
Sodium (unfiltered)	µg/L	14,700	27,200	—	
Sodium (filtered)	µg/L	16,700	25,000	—	

Table 3-27. NRDWL Sampling Summary for 2017

Constituent	Units	Minimum	Maximum	Comparison Value	Exceeding Well(s); Comments
Specific conductance	µS/cm	311	612	—	
Sulfate	mg/L	24.9	83	250[b]	
Temperature	°C	18.1	21.4	—	
Total organic carbon	µg/L	<155	2,000	—	
Total organic halides	µg/L	<2.1	17.4	—	
Turbidity	NTU	0.1	3.49	—	
Detected Dangerous Waste Constituents[d]					
Arsenic (unfiltered)	µg/L	<2	5.3	10[a]	
Arsenic (filtered)	µg/L	<2.2	4.7	10[a]	
Barium (unfiltered)	µg/L	35.8	70.5	2,000[a]	
Barium (filtered)	µg/L	36.4	70.7	2,000[a]	
Chromium (unfiltered)	µg/L	3.1	18.8	100[a]	
Chromium (filtered)	µg/L	3.2	11.2	100[a]	
Fluoride	mg/L	0.301	0.59	4[a]	
Gross alpha	pCi/L	<1.2	21.2	15[e]	
Gross beta	pCi/L	8.38	26.4	50[e]	
Lead (unfiltered)	µg/L	<0.096	1	15[f]	
Lead (filtered)	µg/L	0.096	1	15[f]	
Radium-226	pCi/L	< -0.0356	0.552	—	
Radium-228	pCi/L	< -0.0599	1.77	—	
Selenium (unfiltered)	µg/L	1.4	5.3	50[a]	
Selenium (filtered)	µg/L	1.5	4.7	50[a]	

Note: Minimum and maximum are based on sample results collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

a. Primary drinking water standard.

b. Secondary drinking water standard.

c. The federal drinking water standards for nitrate is 10 mg/L, expressed as nitrogen. This equates to 45 mg/L when expressed as NO_3.

d. Analyzed for one year. The following constituents were analyzed but not detected in 2017: 2,4,5-TP Silvex, 2,4-D, Endrin, Lindane, mercury, methoxychlor, silver, and toxaphene.

e. Concentration assumed to yield a dose equivalent of 4 mrem/yr.

f. Action level.

< = one or more of the results was below the detection limit

— = no comparison value

NTU = nephelometric turbidity unit

4 Corrective Action Monitoring

Two RCRA units that affected groundwater quality are monitored under final status corrective action programs. Remediation of groundwater contaminated by these units and other waste sites in the OUs is in progress under the CERCLA program.

4.1 183-H Solar Evaporation Basins

The 183-H Solar Evaporation Basins (116-H-6 waste site) (Figure 4-1) consisted of four basins in the 100-H Area. The basins were originally part of the larger 183-H water treatment facility, which had 12 additional basins. Following decommissioning of the water treatment facility, the four remaining basins were used to evaporate various liquid waste streams, including neutralized spent acid etch solutions from the 300 Area fuel fabrication facilities. The waste solutions contained various contaminants, including chromium, uranium, and nitrate. The basins were used for waste evaporation from July 1973 until November 1985 and were demolished in 1995. The contaminated soil was removed to a depth of 4.6 m (15 ft) below Basin 1 in 1996 (DOE/RL-97-48, *183-H Solar Evaporation Basins Postclosure Plan*).

Groundwater protection was demonstrated through modeling, and Ecology approved a modified RCRA closure in May 1997 (Soper, 1997, "Re: Acceptance of "Closure Certification for the 183-H Solar Evaporation Basins (T-1-4)," 96-EAP-246"). Clean closure of the site was not achieved because fluoride and nitrate levels in soil below the 4.6 m (15 ft) deep excavation exceeded the MTCA (WAC 173-340) Method B cleanup levels for groundwater protection. Therefore, the TSD unit was closed in place under the modified closure provisions of the Hanford RCRA Permit with specified measures for post-closure care.

Groundwater monitoring to meet RCRA requirements is conducted in accordance with DOE/RL-2015-28, *Final Status Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*, which was incorporated into Part VI of the Hanford RCRA Permit, Revision 8c, on May 24, 2017. This new plan supersedes PNNL-11573, *Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*. The new plan monitors total chromium (collected as a filtered sample) and nitrate as dangerous waste constituents identified for corrective action monitoring. Other constituents identified for monitoring in the previous plan (PNNL-11573) (uranium, technetium-99, and fluoride) were removed in this revised plan.

The revised groundwater monitoring plan also modified the groundwater monitoring well network. The plan removed well 199-H4-12C, which is completed in the semiconfined Ringold upper mud aquifer, from the monitoring network. Monitoring well 199-H4-12A was replaced with 199-H4-85, which is located closer to the 183-H Solar Evaporation Basins and is completed in the unconfined aquifer. New wells 199-H4-88 and 199-H4-89 were drilled in 2016 and were added to the monitoring network.

Table 4-1 lists the wells monitored for RCRA under the current revised plan. Wells are sampled semiannually for dangerous waste constituents (total chromium [filtered] and nitrate) and field parameters. New wells 199-H4-88 and 199-H4-89 will be sampled quarterly for 2 years to collect sufficient samples to support statistical evaluation. The unconfined aquifer is very thin below the 183-H Solar Evaporation Basins, and most of the wells are screened across the entire aquifer. The saturated aquifer thickness varies from less than 1 m (3 ft) in the fall during low river stage to 3 m (10 ft) in the spring and early summer during high river stage.

The results for 183-H Solar Evaporation Basins groundwater monitoring are reported semiannually. DOE prepared two semiannual reports for 2017 monitoring (SGW-61639, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: January – June 2017* [in publication]) (SGW-61763, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: July – December 2017* [in publication]).

The CERCLA P&T extraction and injection wells influence groundwater flow near the 183-H Solar Evaporation Basins. The March 2017 water table shows a local groundwater depression created by the P&T extraction wells (Figure 4-1). The estimated groundwater velocities during 2017 ranged from 0.1 to 5.1 m/d (0.7 to 16.7 ft/d), and flow directions ranged from southwest to east-northeast (Table 4-2).

Table 4-3 summarizes results from RCRA sample events performed under the newly revised monitoring plan. Total chromium (filtered sample) remained below the permit concentration limit of 48 µg/L in each of the five wells in the monitoring network. The maximum concentration observed in the network during the RCRA sample events was 19 µg/L in well 199-H4-88 (located within the footprint of Basin 1 of the 183-H Solar Evaporation Basins).

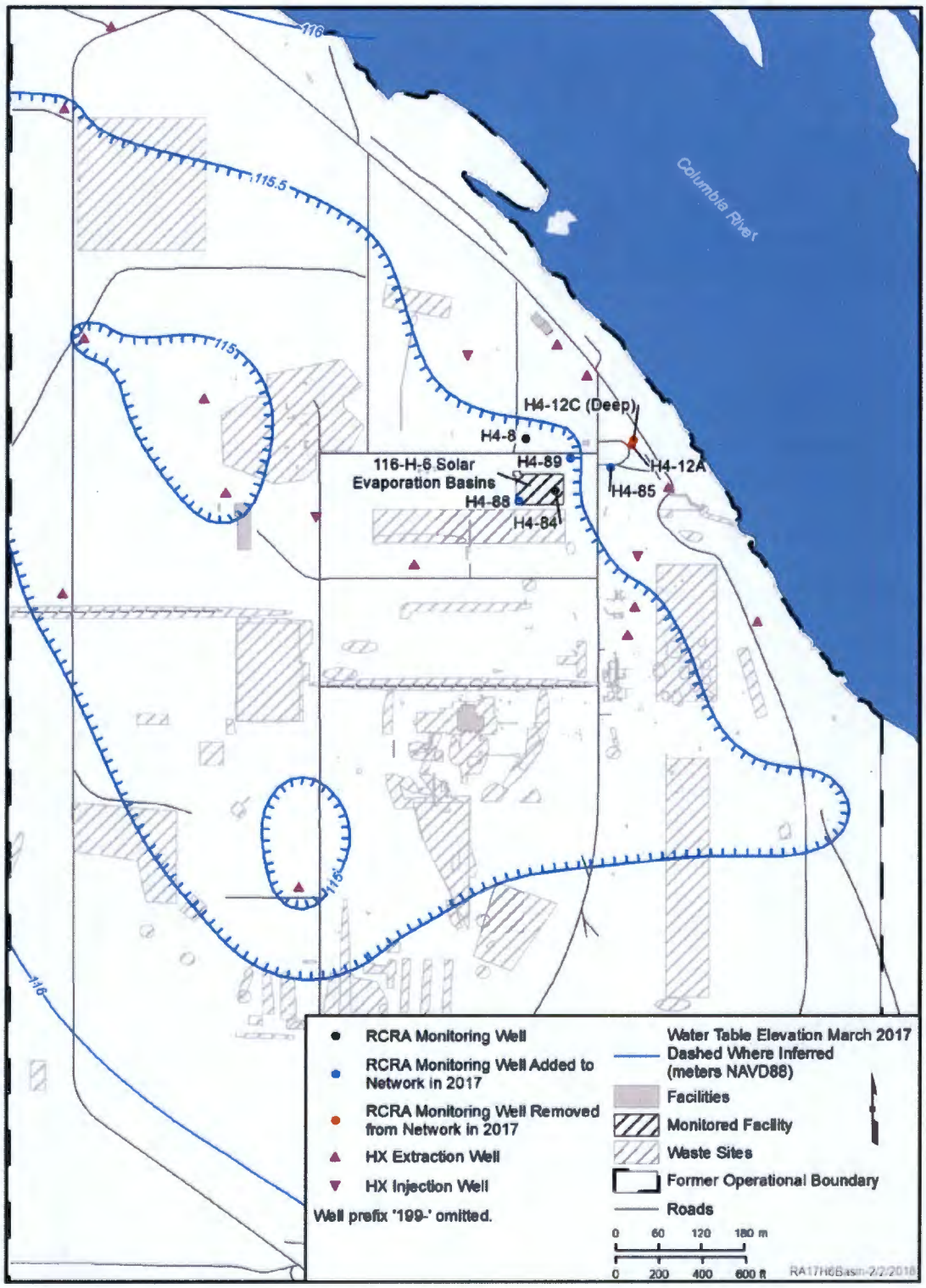
Nitrate exceeded the Hanford RCRA Permit concentration limit of 45 mg/L in wells 199-H4-88 and 199-H4-89 during both RCRA sample events (Table 4-3). The nondetect value for nitrate in well 199-H4-85 on November 10, 2017, appears to be a suspect result and is currently under additional review.

As shown in Table 4-1, the low water table conditions during the November sampling event resulted in four of the wells being pumped dry prior to full sample volume collection. The pumps were shut off, the wells were allowed to recharge, and then sampling continued. The on/off cycling of the sampling pumps likely agitated the well water columns and stirred up sediment that normally rests on the bottom of the wells. This likely explains the unusually high turbidity in wells 199-H4-8, 199-H4-84, and 199-H4-89. In 2017, the wells were sampled with a portable (nondedicated) pump. Staff will evaluate whether installing dedicated sampling pumps with the intake located near the bottom of the screened interval will help prevent high turbidity in future low-water sampling events.

Many of the analytical results from November 2017 samples from well 199-H4-85 were anomalous, so a data review was conducted. Reported values of specific conductance (32.8 µS/cm) and anions (near or below detection limits) were unreasonably low for groundwater. Dissolved oxygen, pH, and temperature were also much lower than the data previously reported. The evaluation concluded that the data should be rejected as not representative for unknown reasons. Data review qualifiers of "R" were assigned to all of the November 10, 2017, data from well 199-H4-85. The well will be resampled, and a video survey of the well is planned.

The new corrective action monitoring plan requires calculation of the upper confidence limits (UCLs) on the mean, or visual inspection when all data are nondetects, for nitrate and filtered total chromium based on the last 8 to 10 independent samples (which may include non-RCRA sample results initially). A comparison is also required of the UCLs, or nondetect data, to the concentration limits established in the Hanford RCRA Permit.

The statistical evaluation is conducted semiannually (SGW-61639 [in publication]; SGW-61763 [in publication]). The 95% UCL for total chromium (filtered) exceeded the permit concentration limit only in samples collected for CERCLA from well 199-H4-84 (Table 4-4). For nitrate, wells 199-H4-84 and 199-H4-88 had 95% UCLs that exceeded the concentration limit (Table 4-4).



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

Figure 4-1. 183-H Solar Evaporation Basins (116-H-6 Waste Site)

Table 4-1. 183-H Groundwater Monitoring Network

Well Name	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency Old/New*	Comments; Sampling Exceptions*
		m	ft	m	ft	m	ft		m	ft		
199-H4-8	1986 (C)	117.0	383.9	114.0	373.9	114.64	376.13	11/10/2017	0.7	2.2	A/S	Well pumped dry in November; sampled after recharging
199-H4-84	2011 (C)	117.2	384.4	114.1	374.4	114.68	376.24	11/10/2017	0.6	1.8	A/S	Well pumped dry in November; sampled after recharging
199-H4-85	2013 (C)	119.7	392.6	113.6	372.7	114.48	375.58	11/10/2017	0.9	2.8	0/S	Well pumped dry in November; sampled after recharging; data later rejected
199-H4-88	2016 (C)	119.3	391.5	113.2	371.5	114.76	376.49	11/10/2017	1.5	5.0	0/Q	
199-H4-89	2016 (C)	118.6	389.2	114.1	374.2	114.43	375.42	11/10/2017	0.4	1.2	0/Q	Well pumped dry in November; sampled after recharging

Note: Requirements are from Part VI of the Hanford RCRA Permit (*Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended).

* Monitoring network was revised via permit modification beginning May 2017. Two additional wells (199-H4-12A and 199-H4-12C) were removed from the network and RCRA sampling was not required in 2017.

0 = no sampling required

A = annual

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

Q = quarterly

RCRA = *Resource Conservation and Recovery Act of 1976*

S = semiannual

Table 4-2. Groundwater Velocity at 183-H Solar Evaporation Basins

Flow Direction	March and June – southwest; October – east-northeast
Flow Rate (m/d)	March: 0.1 to 2.7; June: 0.2 to 5.1; October: 0.2 to 4.1
Hydraulic Conductivity (m/d) (Source)	15 to 140 (PNL-6728, *Geohydrologic Characterization of the Area Surrounding the 183-H Solar Evaporation Basins*)
Effective Porosity	0.1
Gradient (m/m)	March: 1.9×10^{-3}; June: 3.6×10^{-3}; October: 2.9×10^{-3}
Comments	Gradient and direction determined by trend surface analysis (automated water-level network data for June; manual data for March and October); velocity calculated from Darcy equation (gradient is influenced by the pump-and-treat system)

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 4-3. 183-H Solar Evaporation Basins Sampling Summary, 2017

Well	Sample Date	Chromium (Filtered) (µg/L)	Nitrate (mg/L)	Dissolved Oxygen (mg/L)	pH	Specific Conductance (µS/cm)	Temperature (°C)	Turbidity (NTU)
Concentration Limit		**48**	**45**	—	—	—	—	—
199-H4-8	11/10/2017	3.0 (BC)	11.1 (D)	10.65	7.54	383	18.8	100
199-H4-84	11/10/2017	2.9 (BC)	30.5 (D)	8.64	7.56	610	16.6	>1,000
199-H4-85	11/10/2017	13.7 (DR)	0.124 (UDR)	3 (R)	6.81 (R)	32.8 (R)	11.6 (R)	0.52 (R)
199-H4-88	8/29/2017	19	54.9 D	6.54	7.54	699	19.6	1.74
	11/10/2017	11.6	44.3 (D)	6.76	7.5	653	17.5	7.3
199-H4-89	8/29/2017	3.4	19.3		7.26	481	22.3	4.05
	11/10/2017	1.2 (B)	48.7 (D)	5.88	7.11	817	18.7	59.3

Notes: Sample results were collected specifically for this *Resource Conservation and Recovery Act of 1976* unit. Appendix A presents the full data set for 2017.

Yellow-highlighted cells indicate concentrations greater than the permit concentration limit.

B = detected at less than the contract-required detection limit but greater than the method detection limit

C = detected in both the sample and the associated quality control blank

D = reported at a secondary dilution factor

F = under review (suspected error)

NTU = nephelometric turbidity unit

R = rejected (result is not valid)

U = undetected

Table 4-4. Statistical Evaluation of 183-H Dangerous Waste Constituents, 2017

Well	Semiannual Period	Chromium (filtered) (µg/L)		Nitrate (mg/L)	
		95% UCL	Permit Concentration Limit	95% UCL	Permit Concentration Limit
199-H4-8	January–June	N/A[a]	48	N/A[a]	45
199-H4-8	July–December	N/A[a]	48	N/A[a]	45
199-H4-84	January–June	79.0[b]	48	74.6[b]	45
199-H4-84	July–December	79.9[b]	48	66.3[b]	45
199-H4-85	January–June	N/A[a]	48	N/A[a]	45
199-H4-85	July–December	N/A[a]	48	N/A[a]	45
199-H4-88	January–June	N/A[a]	48	51.5[b]	45
199-H4-88	July–December	N/A[a]	48	65.5[b]	45
199-H4-89	January–June	N/A[a]	48	N/A[a]	45
199-H4-89	July–December	N/A[a]	48	35.9	45

Sources: SGW-61639, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: January – June 2017* (in publication).

SGW-61763, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: July – December 2017* (in publication).

Note: Yellow-highlighted cell indicates the UCL exceeded a permit concentration limit.

a. None of the results in the data set exceeded the concentration limit; therefore no UCL was calculated.

b. Samples collected for *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* monitoring.

N/A = not applicable

UCL = upper confidence limit

4.2 300 Area Process Trenches

The former 300 Area Process Trenches (316-5 waste site) are monitored in accordance with the Hanford RCRA Permit. The 300 Area Process Trenches (Figure 4-2) received mixed waste effluent discharges from fuel fabrication and nuclear research laboratories in the 300 Area Industrial Complex from 1975 to 1987, followed by continued discharge of cooling water with small quantities of nonhazardous maintenance and process waste until December 1994. A comprehensive description, including a history of operations, is provided in Section 3.1.1 of the final status groundwater monitoring plan for the 300 Area Process Trenches in Part VI of the Hanford RCRA Permit, Revision 8c.

DOE remediated the 300 Area Process Trenches in 1991 under a CERCLA expedited response action by scraping contaminated soil to the north end of the trenches (DOE/RL-92-32, *Expedited Response Action Assessment for 316-5 Process Trenches*). Additional removal actions were performed in 1997 and 1998, followed by backfilling and surface restoration in 2004 (Chapter 3 of DOE/RL-2004-74, *300-FF-1 Operable Unit Remedial Action Report*). DOE/RL-93-73, *300 Area Process Trenches Modified Closure/Postclosure Plan*, which is incorporated into the Hanford RCRA Permit, states that groundwater remediation is deferred to the 300-FF-5 OU under CERCLA. DOE/RL-2014-13-ADD2, *Remedial Design*

Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater (modified by TPA-CN-700, *Tri-Party Agreement Change Notice Form: DOE/RL-2014-13-ADD2, Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater, Rev. 0*), describes the work elements and schedule for implementing the groundwater remedy selected in EPA and DOE, 2013, *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*.

Groundwater monitoring to meet RCRA requirements is conducted in accordance with the final status groundwater monitoring plan for the 300 Area Process Trenches, which was incorporated into Part VI of the Hanford RCRA Permit, Revision 8c, on May 24, 2017. This new plan supersedes WHC-SD-EN-AP-185, *Groundwater Monitoring Plan for the 300 Area Process Trenches*. The new plan monitors *cis*-1,2-dichloroethene (*cis*-1,2-DCE), TCE, and field parameters (pH, specific conductance, temperature, and turbidity). Sampling is conducted semiannually. In the new monitoring plan, the concentration limits for *cis*-1,2-DCE and TCE are 16 and 4 µg/L, respectively, consistent with the cleanup levels in the CERCLA Record of Decision (EPA and DOE, 2013). Table 3-9 in the new plan summarizes the main differences between the new plan and the previous plan.

The RCRA post-closure groundwater monitoring under the WAC 173-303-645 corrective action program uses wells at four locations: one upgradient (northwest) and three downgradient (east, southeast, and south) of the former 300 Area Process Trenches (Table 4-5). The most distant downgradient location is about 200 m (660 ft) to the southeast, along the dominant groundwater flow path from the trenches. Two wells are at each of the four locations. Well numbers ending in "A" are screened near the water table, and well numbers ending in "B" are screened in the lower portion of the unconfined aquifer.

The water table near the former trenches is not declining and is directly affected by the Columbia River stage. Dry well conditions are unlikely in the future (Section 3.2.5 of the final status groundwater monitoring plan in Part VI of the Hanford RCRA Permit, Revision 8c). Groundwater flows generally toward the south-southeast beneath the former trenches. In late February 2017, the gradient sloped to the south, and the estimated groundwater flow rate was 17 m/d (55 ft/d) (Table 4-6).

The sampling schedule for the monitoring wells is designed to accommodate two semiannual sampling events, with collection scheduled during high river stage (typically May through June) and low river stage (typically September to November). This annual report for 2017 includes *cis*-1,2-DCE and TCE results for samples collected in January, February, and March under the old plan and results for samples collected in June and October under the new plan. In 2017, sampling was performed as planned (Table 4-5).

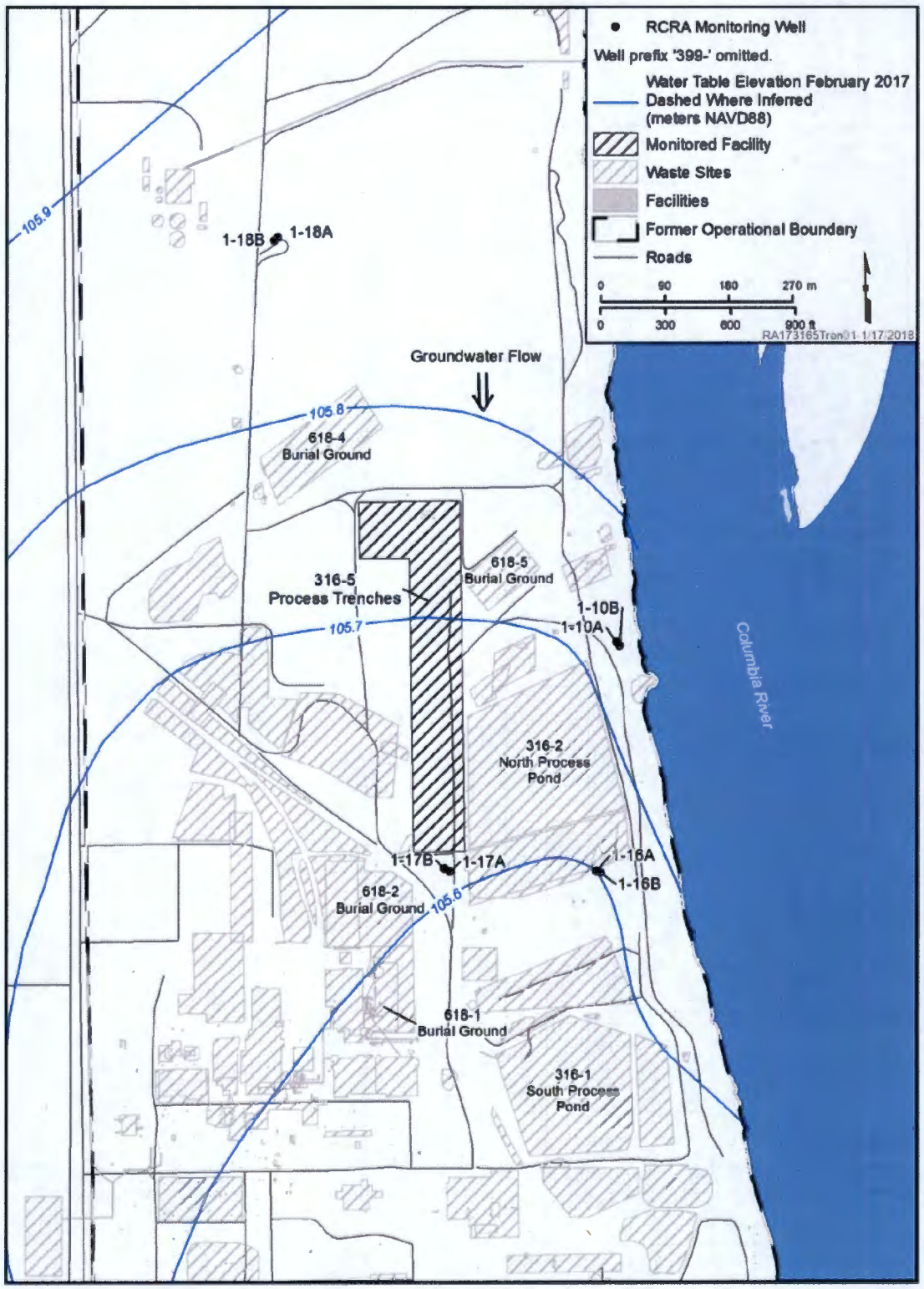
The results of 300 Area Process Trenches groundwater monitoring are reported semiannually. DOE prepared two semiannual reports for 2017 (SGW-61150, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: January – June 2017* [in publication]; SGW-61754, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: July – December 2017* [in publication]).

During 2017, TCE concentrations were below the Hanford RCRA Permit limit and were mostly below the analytical detection limit (Table 4-7). The trace detections of TCE in well 399-1-16A may be from the former 300 Area Process Trenches or the former 316-2 North Process Pond.

In all of the well 399-1-16B samples, *cis*-1,2-DCE continued to exceed the permit limit, with concentrations ranging from 136 to 191 µg/L. Lower levels of *cis*-1,2-DCE were detected in well 399-1-17B, with a maximum of 1.9 µg/L.

In accordance with Section 3.3.2 of the final status groundwater monitoring plan in Part VI of the Hanford RCRA Permit, Revision 8c, a statistical evaluation was performed to compare the dangerous waste constituent results to the permit concentration limits. The evaluation applies to results at individual point of compliance (downgradient) wells (Table 4-5). The 95% UCL on the mean is used for results that exceed concentration limits. A nonstatistical analysis is used for results that are less than concentration limits.

The statistical evaluation is conducted semiannually (SGW-61150 [in publication]; SGW-61754 [in publication]). The only 95% UCL that exceeded the permit concentration limit in a downgradient well was for *cis*-1,2-DCE in well 399-1-16B (Table 4-8).



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

Figure 4-2. 300 Area Process Trenches (316-5 Waste Site)

Table 4-5. 300 Area Process Trenches Groundwater Monitoring Network

Well Name	Location	Year Installed	Elevation Screen Top		Elevation Screen Bottom		Hydraulic Head		Head Date	Water Column		Sample Frequency Old/New*	Comments; Sampling Exceptions
			m	ft	m	ft	m	ft		m	ft		
399-1-10A	DG	1986 (C)	106.9	350.8	102.3	335.8	104.76	343.69	10/24/2017	2.4	7.9	S8/S2	None
399-1-10B	DG deep	1991 (C)	82.7	271.3	79.6	261.3	104.83	343.93	10/22/2017	25.2	82.6	S8/S2	None
399-1-16A	DG	1986 (C)	107.0	351.0	102.4	336.0	104.71	343.53	10/24/2017	2.3	7.5	S8/S2	None
399-1-16B	DG deep	1987 (C)	84.8	278.4	81.8	268.4	105.79	347.07	10/24/2017	24.0	78.7	S8/S2	None
399-1-17A	DG	1986 (C)	107.7	353.5	103.2	338.5	104.77	343.72	10/24/2017	1.6	5.2	S8/S2	None
399-1-17B	DG deep	1986 (C)	85.0	278.8	81.9	268.8	104.79	343.79	10/24/2017	22.8	75.0	S8/S2	None
399-1-18A	UG	1986 (C)	107.3	352.1	102.8	337.1	105.20	345.16	10/22/2017	2.5	8.0	S8/S2	None
399-1-18B	UG deep	1987 (C)	86.0	282.1	82.9	272.1	105.25	345.31	10/22/2017	22.3	73.2	S8/S2	None

Note: Requirements are from the Hanford RCRA Permit (*Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended).

* Monitoring network was revised via permit modification beginning May 24, 2017.

C = constructed as a resource protection well in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

DG = downgradient

UG = upgradient

S2 = sampled semiannually (twice per year)

S8 = sampled semiannually with four samples in each semiannual period (8 months per year)

Table 4-6. Groundwater Velocity at 300 Area Process Trenches

Flow Direction	South
Flow Rate (m/d)	17
Hydraulic Conductivity (m/d) (Source)	9,000 (ECF-300FF5-11-0151, *Groundwater Flow and Uranium Transport Modeling in Support of the 300 Area FF-5 RI/FS*)
Effective Porosity	0.17
Gradient (m/m)	3.1×10^{-4}
Comments	Gradient and direction determined by trend surface analysis of data collected in February 2017; velocity calculated from the Darcy equation

Source: ECF-Hanford-17-0241, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017.*

Table 4-7. 300 Area Process Trenches Dangerous Waste Constituents, 2017

Well	Sample Date	*cis*-1,2 DCE (µg/L)	TCE (µg/L)	Well	Sample Date	*cis*-1,2 DCE (µg/L)	TCE (µg/L)
Permit Concentration Limit		**16**	**4**	**—**	**—**	**16**	**4**
399-1-10A	1/12/2017	0.3 (U)	0.3 (U)	399-1-17A	1/12/2017	0.3 (U)	0.3 (U)
399-1-10A	2/6/2017	0.3 (TU)	0.3 (U)	399-1-17A	2/6/2017	0.3 (TU)	0.3 (U)
399-1-10A	3/6/2017	0.3 (U)	0.3 (U)	399-1-17A	3/3/2017	0.3 (U)	0.3 (U)
399-1-10A	6/2/2017	0.3 (U)	0.3 (U)	399-1-17A	6/2/2017	0.3 (U)	0.32 (J)
399-1-10A	10/24/2017	0.3 (U)	0.3 (U)	399-1-17A	10/24/2017	0.3 (U)	0.3 (U)
399-1-10B	1/12/2017	0.1 (U)	0.25 (U)	399-1-17A	10/24/2017	0.3 (U)	0.3 (U)
399-1-10B	2/6/2017	0.1 (U)	0.25 (U)	399-1-17B	1/12/2017	0.72 (J)	0.25 (U)
399-1-10B	3/6/2017	0.1 (U)	0.25 (U)	399-1-17B	2/6/2017	1.3	0.25 (U)
399-1-10B	6/2/2017	0.1 (U)	0.25 (U)	399-1-17B	3/3/2017	1.6	0.25 (U)

Table 4-7. 300 Area Process Trenches Dangerous Waste Constituents, 2017

Well	Sample Date	*cis*-1,2 DCE (µg/L)	TCE (µg/L)	Well	Sample Date	*cis*-1,2 DCE (µg/L)	TCE (µg/L)
399-1-10B	10/22/2017	0.1 (U)	0.25 (U)	399-1-17B	6/2/2017	1.9	0.25 (U)
399-1-16A	1/12/2017	0.1 (U)	0.25 (U)	399-1-17B	10/24/2017	1.2	0.25 (U)
399-1-16A	2/6/2017	0.1 (U)	0.31 (J)	399-1-18A	1/12/2017	0.1 (U)	0.25 (U)
399-1-16A	3/3/2017	0.1 (U)	0.35 (J)	399-1-18A	2/6/2017	0.1 (U)	0.25 (U)
399-1-16A	6/2/2017	0.1 (U)	0.25 (U)	399-1-18A	3/3/2017	0.1 (U)	0.25 (U)
399-1-16A	10/24/2017	0.1 (U)	0.25 (U)	399-1-18A	6/2/2017	0.1 (U)	0.25 (U)
399-1-16B	1/12/2017	191 (D)	1.99 (J)	399-1-18A	10/22/2017	0.15 (U)	0.16 (U)
399-1-16B	1/12/2017	184 (D)	1.84 (J)	399-1-18B	1/12/2017	0.3 (U)	0.3 (U)
399-1-16B	2/6/2017	143 (DT)	1.56 (J)	399-1-18B	2/6/2017	0.3 (TU)	0.3 (U)
399-1-16B	3/3/2017	136 (D)	1.88 (DJ)	399-1-18B	3/3/2017	0.3 (U)	0.3 (U)
399-1-16B	6/2/2017	136 (D)	1.73 (J)	399-1-18B	6/2/2017	0.3 (U)	0.3 (U)
399-1-16B	10/24/2017	160 (D)	1.2	399-1-18B	10/22/2017	0.3 (U)	0.3 (U)

Note: Yellow-highlighted cells indicate exceedances of a permit concentration limit.

cis-1,2 DCE = *cis*-1,2-dichloroethene

D = analyte was reported at a secondary dilution factor

J = estimated value; constituent detected at a level less than the required detection limit and greater than or equal to the method detection limit

T = spike and/or spike duplicate sample recovery is outside control limits

TCE = trichloroethene

U = undetected

Table 4-8. Statistical Evaluation of 300 Area Process Trenches Dangerous Waste Constituents, 2017

Well	Semiannual Period	*cis*-1,2 DCE (µg/L)		TCE (µg/L)	
		95% UCL	Permit Concentration Limit	95% UCL	Permit Concentration Limit
399-1-10A	January–June	N/A*	16	N/A*	4
399-1-10A	July–December	N/A*	16	N/A*	4
399-1-10B	January–June	N/A*	16	N/A*	4
399-1-10B	July–December	N/A*	16	N/A*	4
399-1-16A	January–June	N/A*	16	N/A*	4
399-1-16A	July–December	N/A*	16	N/A*	4
399-1-16B	January–June	185.2	16	N/A*	4
399-1-16B	July–December	182.4	16	N/A*	4
399-1-17A	January–June	N/A*	16	N/A*	4
399-1-17A	July–December	N/A*	16	N/A*	4
399-1-17B	January–June	N/A*	16	N/A*	4
399-1-17B	July–December	N/A*	16	N/A*	4

Sources: SGW-61150, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: January – June 2017* (in publication).

SGW-61754, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: July – December 2017* (in publication).

Note: Yellow-highlighted cell indicates the UCL exceeded a permit concentration limit.

* None of the results in the data set exceeded the concentration limit; therefore, no UCL was calculated.

cis-1,2 DCE = *cis*-1,2-dichloroethene
N/A = not applicable
TCE = trichloroethene
UCL = upper confidence limit

This page intentionally left blank.

5 References

10-EMD-0080, 2010, "Class 1 Modifications to the Hanford Facility Resource Conservation and Recovery Act Permit Quarter Ending June 30, 2010," Enclosure 1, Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=1007220374.

16-AMRP-0032, 2015 "Request for Removal of 218-E-12B Trench 94 from the Hanford Facility Resource Conservation and Recovery Act/Dangerous Waste Permit Application Part A Form for the Low-Level Burial Grounds Operating Unit Group" (letter to J.A. Hedges, Washington State Department of Ecology, from R.J. Corey, U.S. Department of Energy, Richland, Washington, November 20. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0079237H.

17-AMRP-0089, 2017, "Notification of Exceedance of Critical Mean Values for Specific Conductance" (letter to Alexandra K. Smith, Washington State Department of Ecology, from R.J. Corey), U.S. Department of Energy, Richland Operations Office, Richland, Washington, February 7. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0072443H.

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=821b3a92b47bf77af198c434f81d5504&mc=true&node=pt40.26.265&rgn=div5.

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://science.energy.gov/~/media/bes/pdf/nureg_0980_v1_no7_june2005.pdf.

BHI-00725, 1996, *100-N Pilot Project: Proposed Consolidated Groundwater Monitoring Program*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197173616.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.

CP-47631, 2016, *Model Package Report: Central Plateau Groundwater Model, Version 8.3.4*, Rev. 3, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0069098H.

CP-57037, 2015, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080149H.

DOE/RL-92-32, 1992, *Expedited Response Action Assessment for 316-5 Process Trenches*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D196105947.

DOE/RL-93-73, 1995, *300 Area Process Trenches Modified Closure/Postclosure Plan*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D196000405.

DOE/RL-96-61, 1997, *Hanford Site Background: Part 3, Groundwater Background*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197226378.

DOE/RL-97-48, 1997, *183-H Solar Evaporation Basins Postclosure Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197226569.

DOE/RL-2004-74, 2005, *300-FF-1 Operable Unit Remedial Action Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=DA01233219.

DOE/RL-2008-53, 2014, *216-A-29 Ditch Closure Plan (D-2-3)*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0085226.

DOE/RL-2008-59, 2010, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084215.

DOE/RL-2008-59, 2017, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0071410H.

DOE/RL-2008-59, 2017, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0066771H.

DOE/RL-2008-60, 2012, *Interim Status Groundwater Monitoring Plan for the 216-B-63 Trench*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091409.

DOE/RL-2008-61, 2010, *Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087634.

DOE/RL-2008-61, 2015, *Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*, Draft Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079699H.

DOE/RL-2008-61, 2017, *Interim Status Groundwater Monitoring Plan for the 216-S-10 Pond and Ditch*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0069130H.

DOE/RL-2009-66, 2012, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area T*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0091408.

DOE/RL-2009-67, 2012, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0091264.

DOE/RL-2009-68, 2012, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-3*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0091262.

DOE/RL-2009-69, 2012, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-4*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0091410.

Modified by:

TPA-CN-718, 2016, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-69, Interim Status Groundwater Monitoring Plan for the LLBG WMA-4, Revision 2*, dated May 12, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0076959H.

DOE/RL-2009-73, 2011, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Waste Management Area S-SX*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=1103070707.

DOE/RL-2009-74, 2012, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area U*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0087626.

DOE/RL-2009-75, 2016, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0074656H.

DOE/RL-2009-76, 2015, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-2*, Draft Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0078749H.

DOE/RL-2009-77, 2010, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area C*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0084330.

DOE/RL-2010-92, 2011, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1106271470.

DOE/RL-2010-92, 2017, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071316H.

DOE/RL-2010-92, 2017, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0066775H.

DOE/RL-2010-93, 2011, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1108241345.

DOE/RL-2010-93, 2016, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0073381H.

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://www.hanford.gov/c.cfm/sgrp/GWRep10/html/start10.htm.

DOE/RL-2011-118, 2011, *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-2012-15, 2013, *Remedial Investigation/Feasibility Study for the 100-NR-1 and 100-NR-2 Operable Units*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0088368.

DOE/RL-2012-53, 2012, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area B-BX-BY*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0091056.

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: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0068832H.

DOE/RL-2014-13-ADD2, 2015, *Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081151H.

Modified by:

TPA-CN-700, 2015, *Tri-Party Agreement Change Notice Form: DOE/RL-2014-13-ADD2, Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater, REV. 0*, dated November 17, U.S. Department of Energy, Richland Operations Office, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079229H.

DOE/RL-2015-28, 2016, *Final Status Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0074644H.

DOE/RL-2015-32, 2016, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0074641H.

DOE/RL-2015-49, 2016, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0073187H.

DOE/RL-2016-09, 2016, *Hanford Site Groundwater Monitoring Report for 2015*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0075314H.

DOE/RL-2016-23, 2016, *216-A-29 Ditch Interim Status Groundwater Quality Assessment Monitoring Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0078183H.

DOE/RL-2016-23, 2017, *216-A-29 Ditch Interim Status Groundwater Quality Assessment Monitoring Plan*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0069681H.

DOE/RL-2016-23, 2017, *216-A-29 Ditch Interim Status Groundwater Quality Assessment Monitoring Plan,* Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0066773H.

DOE/RL-2016-41, 2016, *Action Memorandum for the 200-BP-5 Operable Unit Groundwater Extraction*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0073242H

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-2017-19, 2017, *Groundwater Quality Assessment Plan for the Nonradioactive Dangerous Waste Landfill, Hanford Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0072142H.

ECF-300FF5-11-0151, 2012, *Groundwater Flow and Uranium Transport Modeling in Support of the 300 Area FF-5 RI/FS*, Rev. 3, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0078650H.

ECF-Hanford-13-0029, 2017, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington, Fiscal Year 2016 Update,* Rev. 4, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0072357H.

ECF-Hanford-16-0015, 2016, *Calculation of Critical Means for Calendar Year 2016 RCRA Groundwater Monitoring,* Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0076177H.

ECF-Hanford-17-0009, 2017, *Calculation of Critical Means for Calendar Year 2017 RCRA Groundwater Monitoring*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0069780H.

ECF-Hanford-17-0241, 2018, *Hydraulic Gradients and Velocity Calculations for RCRA Sites in 2017,* Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., 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, 2016, *Cyanide Clarification of Free and Total Cyanide Analysis for Safe Drinking Water Act (SDWA) Compliance,* U.S. EPA, Office of Ground Water and Drinking Water, Cincinnati, Ohio. Available at: http://www.azdhs.gov/documents/preparedness/state-laboratory/lab-licensure-certification/technical-resources/additional-resources/cyanide-clarification-free-and-total-cyanide-analysis-safe-drinking-water.pdf.

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

EPA and DOE, 2013, *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*, U.S. Environmental Protection Agency and U.S. Department of Energy, Richland, Washington, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087180.

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

HNF-EP-0182, 2016, *Waste Tank Summary Report for Month Ending November 30, 2017*, Rev. 359, Washington River Protection Solutions, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0067188H.

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/.

PNL-6728, 1988, *Geohydrologic Characterization of the Area Surrounding the 183-H Solar Evaporation Basins*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D195063972.

PNL-6820, 1989, *Hydrogeology of the 200 Areas Low-Level Burial Grounds—An Interim Report*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195066506. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195066592. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195066599.

PNL-8335, 1992, *Application of Three Aquifer Test Methods for Estimating Hydraulic Properties Within the 100-N Area*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0034486.

PNNL-11573, 1997, *Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D1659822.

PNNL-11810, 1998, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas S-SX at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D198175192.

PNNL-13282, 2000, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U: First Determination*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D2760779.

PNNL-13400, 2000, *Groundwater Flow and Transport Calculations Supporting the Immobilized Low-Activity Waste Disposal Facility Performance Assessment*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084437.

PNNL-15315, 2006, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area A-AX at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15315.pdf.

PNNL-15479, 2005, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*, Pacific Northwest National Laboratory, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA01649608.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.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.

RHO-CD-798, 1979, *Current Status of the 200 Area Ponds*, Rockwell Hanford Operations, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0072752H.

RPP-26744, 2005, *Hanford Soil Inventory, Rev. 1*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081114H.

RPP-35485, 2007, *Field Investigation Report for Waste Management Area U*, Rev. 0, CH2M HILL Hanford Group, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080440H.

RPP-7218, 2000, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0069094H.

RPP-7884, 2002, *Field Investigation Report for Waste Management Area S-SX*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8974033.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8974041.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8974046.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8974049.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0911240245.

RPP-ENV-37956, 2014, *Hanford 241-A/AX Farm Leak Inventory Assessment Report*, Rev. 2, Washington River Protection Solutions, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0075796H.

RPP-ENV-39658, 2010, *Hanford SX-Farm Leak Assessments Report*, Rev. 0, Washington River Protection Solutions, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/RPP-ENV-39658_Rev_0.pdf.

RPP-RPT-48589, 2011, *Hanford 241-S Farm Leak Assessment Report*, Rev. 0, Washington River Protection Solutions, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080435H.

SGW-41072, 2017, *Liquid Effluent Retention Facility Engineering Evaluation and Characterization Report*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=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-59713-VA, 2017, *LLWMA-3 Groundwater Monitoring: 299-W10-31 Specific Conductance and TOX,* CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0069144H.

SGW-61120, 2017, *Meeting Notes – Briefing to Ecology on LLWMA-3 RCRA Groundwater Monitoring,* Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0069145H.

SGW-61150, 2018, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: January – June 2017*, in publication, CH2M HILL Plateau Remediation Company, Richland, Washington.

SGW-61435, 2018, *2017 LERF Hydrogeology Investigation*, in publication, CH2M HILL Plateau Remediation Company, Richland, Washington.

SGW-61639, 2018, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: January – June 2017*, in publication, CH2M HILL Plateau Remediation Company, Richland, Washington.

SGW-61754, 2018, *Post-Closure Corrective Action Groundwater Monitoring Report for the 300 Area Process Trenches: July – December 2017*, in publication, CH2M HILL Plateau Remediation Company, Richland, Washington.

SGW-61763, 2018, *Post-Closure Corrective Action Groundwater Monitoring Report for the 183-H Solar Evaporation Basins: July – December 2017*, in publication, CH2M HILL Plateau Remediation Company, Richland, Washington.

Soper, Wayne W., 1997, "Re: Acceptance of "Closure Certification for the 183-H Solar Evaporation Basins (T-1-4)," 96-EAP-246" (letter to J. Wagner, U.S. Department of Energy, Richland Operations Office, and M. Little, Bechtel Hanford Inc., from W.W. Soper), Washington State Department of Ecology, Kennewick, Washington, May 13. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0080812H.

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.

303-040, "Definitions."

303-400, "Interim Status Facility Standards."

303-645, "Releases from Regulated Units."

303-9905, "Dangerous Waste Constituent List."

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

340-705, "Use of Method B."

WHC-EP-0287, 1989, *Waste Stream Characterization Report*, 4 vols., Westinghouse Hanford Company, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195064218.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195064321.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195064332.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195064333.

WHC-EP-0342, 1990, *B Plant Chemical Sewer Stream-Specific Report*, Addendum 6, Westinghouse Hanford Company, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196020546.

WHC-MR-0132, 1990, *A History of the 200 Area Tank Farms*, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0081013H.

WHC-SD-EN-AP-038, 1996, *Groundwater Monitoring Plan for the 1301-N, 1324-N/NA, and 1325-N Sites*, Rev. 2, Westinghouse Hanford Company, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/pdf.cfm?accession=D196188468.

WHC-SD-EN-AP-045, 1991, *Groundwater Monitoring Plan for the 216-A-29 Ditch*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/pdf.cfm?accession=0080437H.

WHC-SD-EN-AP-185, 1995, *Groundwater Monitoring Plan for the 300 Area Process Trenches*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196020117.

WRPS-55779-FP, 2013, *Hanford Tank Waste to WIPP – Maximizing the Value of our National Repository Asset – 14230,* Rev. A, Washington River Protection Solutions, Richland, Washington. Available at: https://www.osti.gov/scitech/biblio/1105036.

Zachara, John M., Jeff Serne, Mark Freshley, Fred Mann, Frank Anderson, Marcus Wood, Tom Jones, and Dave Myers, 2007, "Geochemical Processes Controlling Migration of Tank Wastes in Hanford's Vadose Zone," *Vadose Zone Journal* 6(4):985-1003. Available at:
http://digitalcommons.unl.edu/usdoepub/301.

This page intentionally left blank.

Appendix A

Appendix A

2017 Groundwater Data for Hanford Site RCRA Monitoring Wells

This page intentionally left blank.

A Monitoring Data for 2017

This appendix consists of a compilation of groundwater data, including laboratory analytical results, field measurements, and water level measurements, for the *Resource Conservation and Recovery Act of 1976* (RCRA)[1] dangerous waste management units discussed in this report. The data are organized by site. The data for each site are tabulated in two Microsoft Excel® files provided electronically with paper copies of this report. The files include data for RCRA wells but are not limited to RCRA constituents or sampling events. Online users may find groundwater data via the Environmental Dashboard Application at https://ehs.hanford.gov/eda.

[1] *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.

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

This page intentionally left blank.