DOE/RL-2009-76
Revision 0

Interim Status Groundwater Monitoring Plan for the LLBG WMA-2

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 for Public Release;
Further Dissemination Unlimited

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Executive Summary

The Low-Level Waste Management Area (LLWMA) 2, which consists of the 218-E-12B Burial Ground, is regulated via Washington State's "Hazardous Waste Management Act"[1] and its implementing requirements in *Washington Administrative Code* (WAC) 173-303-400.[2] The Washington State Department of Ecology has been authorized by the U.S. Environmental Protection Agency[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976*.[4]

This document replaces PNNL-14859,[5] as well as the two subsequent interim change notices,[6,7] to incorporate changes that have occurred at LLWMA-2 since the previous plan was written.

This document presents the groundwater monitoring plan for LLWMA-2. The plan addresses the following: (1) adequacy and attributes of the wells monitoring the groundwater at LLWMA-2; (2) sampling requirements and schedule; (3) constituents, groundwater parameters, and analytical methods necessary to determine whether past releases from the LLWMA are affecting groundwater quality; (4) procedures for evaluating groundwater quality data; and (5) reporting requirements.

This groundwater monitoring plan is the principal controlling document for conducting groundwater monitoring at LLWMA-2.

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1 RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*.

2 WAC 173-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*.

3 *Authorized State Hazardous Waste Programs*, 42 U.S.C. 6926, et seq.

4 *Resource Conservation and Recovery Act of 1976*, 42 U.S.C. 6901, et seq.

5 PNNL-14859, 2004, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

6 PNNL-14859-ICN-1, 2006, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 1, Pacific Northwest National Laboratory, Richland, Washington.

7 PNNL-14859-ICN-2, 2007, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice 2, Pacific Northwest National Laboratory, Richland, Washington.

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Contents

1 Introduction 1-1

2 Background 2-1

2.1 Facility Description and Operational History 2-2
2.2 Regulatory Basis 2-3
2.3 Waste Characteristics 2-3
2.4 Geology and Hydrogeology 2-5
2.5 Summary of Previous Groundwater Monitoring 2-8
2.6 Conceptual Model 2-9
2.6.1 Geochemical Considerations 2-9
2.6.2 Soil Moisture Factors 2-11
2.6.3 Hydrogeologic Considerations 2-11
2.7 Data Quality Objectives 2-11

3 Groundwater Monitoring 3-1

3.1 Constituent List and Sampling Frequency 3-1
3.2 Well Network 3-1
3.3 Sampling and Analysis Protocol 3-1
3.4 Differences Between This Plan and Previous Plan 3-1

4 Data Evaluation and Reporting 4-1

4.1 Data Review 4-1
4.2 Statistical Evaluation 4-1
4.3 Interpretation 4-1
4.4 Annual Determination of Monitoring Network 4-2
4.5 Reporting and Notification 4-2

5 References 5-1

Appendix

A Quality Assurance Project Plan ..... A-i

Figures

Figure 1-1. Low-Level Waste Management Area 2 in the 200 East Area 1-2
Figure 2-1. 218-E-10 Burial Ground at Low-Level Waste Management Area 2 2-2
Figure 2-2. Geologic Cross-Section Along the Southern Boundary of Low-Level Waste Management Area 2 2-6
Figure 2-3. Water Table Map for the 200 East Area, March 2008 2-7
Figure 2-4. Conceptual Model for Low-Level Waste Management Area 2 2-10
Figure 2-5. Four New Low-Level Waste Management Area 2 Network Monitoring Wells 2-15
Figure 3-1. Map Showing Locations of Existing RCRA Monitoring Wells at Low-Level Waste Management Area 2 3-4

Tables

Table 2-1. Data Quality Objectives at RCRA Sites Monitoring for Indicator Parameters 2-12
Table 3-1. Sampling Schedule for Low-Level Waste Management Area 2 3-2
Table 3-2. Attributes for Wells in the Low-Level Waste Management Area 2 Groundwater Monitoring Network 3-5
Table 4-1. Reports Required for Compliance with 40 CFR 265, Subpart F for Groundwater Monitoring 4-3

Terms

bgs	below ground surface
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FY	fiscal year
LLWMA	low-level waste management area
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
TOC	total organic carbon
TOX	total organic halides
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WAC	*Washington Administrative Code*

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1 Introduction

Low-Level Waste Management Area (LLWMA) 2 is located in the northeastern corner of the 200 East Area (Figure 1-1) of the Hanford Site and consists of the 218-E-12B Burial Ground, which contains 39 unlined trenches. The LLWMA-2 began receiving waste in 1967 and continues to receive U.S. Navy vessel reactor compartments in Trench 94. The other 38 trenches contain mainly unsegregated waste and low-level waste that have been covered with soil. The dangerous waste and dangerous waste constituents in the low-level mixed waste portions of LLWMA-2 are regulated under *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations." A *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring program for LLWMA-2 was initiated in 1987 (WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*) based on the interim status monitoring requirements of 40 *Code of Federal Regulations* (CFR) 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring") and WAC 173-303-400 ("Interim Status Facilities"). The LLWMA-2 has remained under indicator evaluation monitoring since that time. The objectives for continued indicator evaluation monitoring at LLWMA-2, as required by 40 CFR 265.92(d) ("Sampling and Analysis") are to determine the following:

- Concentrations of specified groundwater quality parameters (annually)
- Concentrations of groundwater contamination indicator parameters (semiannually)
- Elevation of the water table

The scope of this groundwater monitoring plan is to obtain the necessary groundwater data to satisfy these objectives.

This document replaces the previous monitoring plan (PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*) and includes several activities that have occurred at LLWMA-2 since that plan was issued. Chapter 2 summarizes background information, with reference to other documents for more detailed information. Chapter 2 also describes LLWMA-2 and the types of waste present, provides a brief history of groundwater monitoring, and describes the geology and hydrology pertinent to the LLWMA. This information is summarized as a site conceptual model to aid in developing the groundwater monitoring program.

Chapter 3 describes the RCRA groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols. Chapter 4 describes data evaluation and reporting, and Chapter 5 contains references. The quality assurance project plan (QAPjP) is provided in Appendix A.

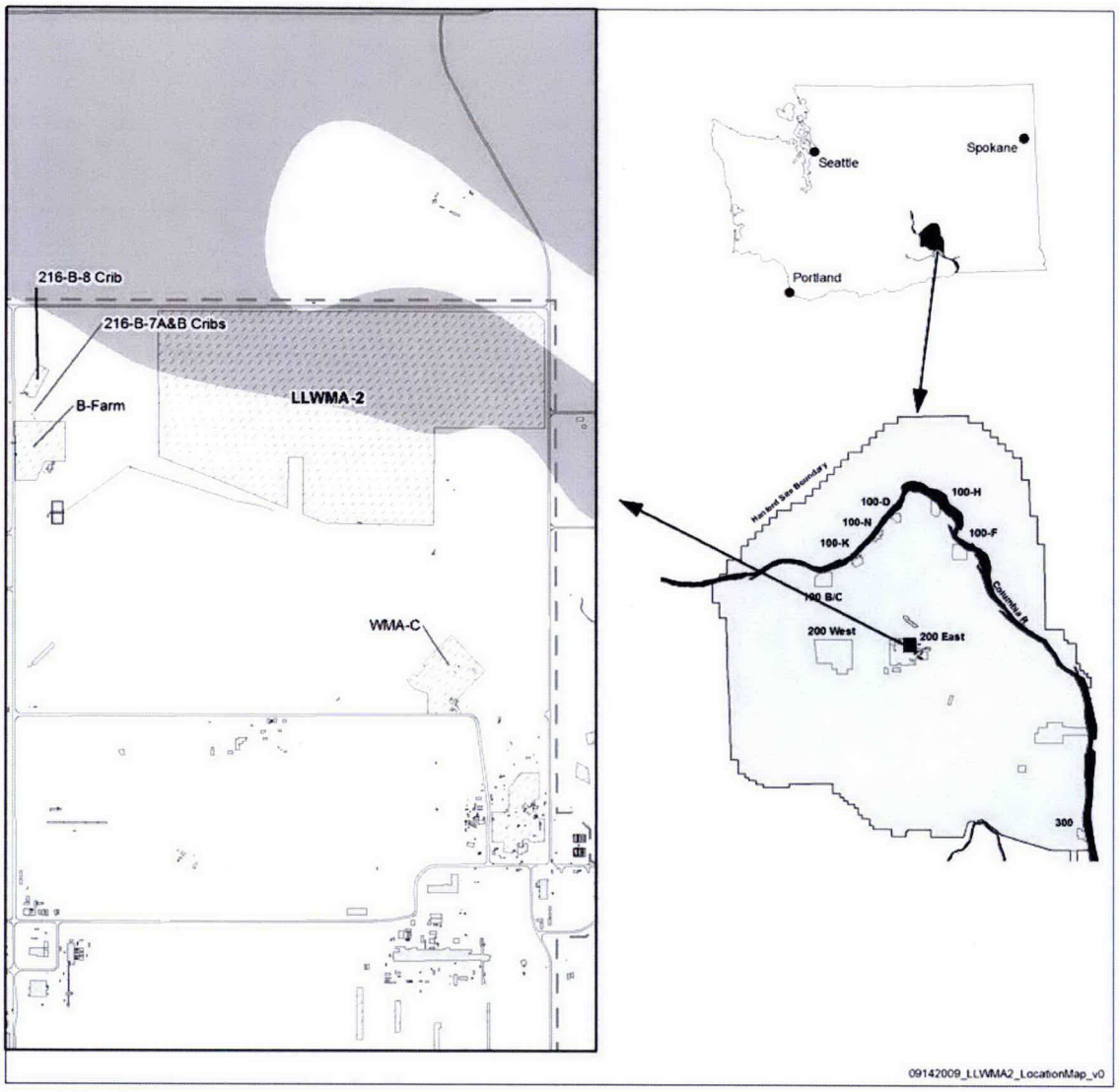


Figure 1-1. Low-Level Waste Management Area 2 in the 200 East Area

2 Background

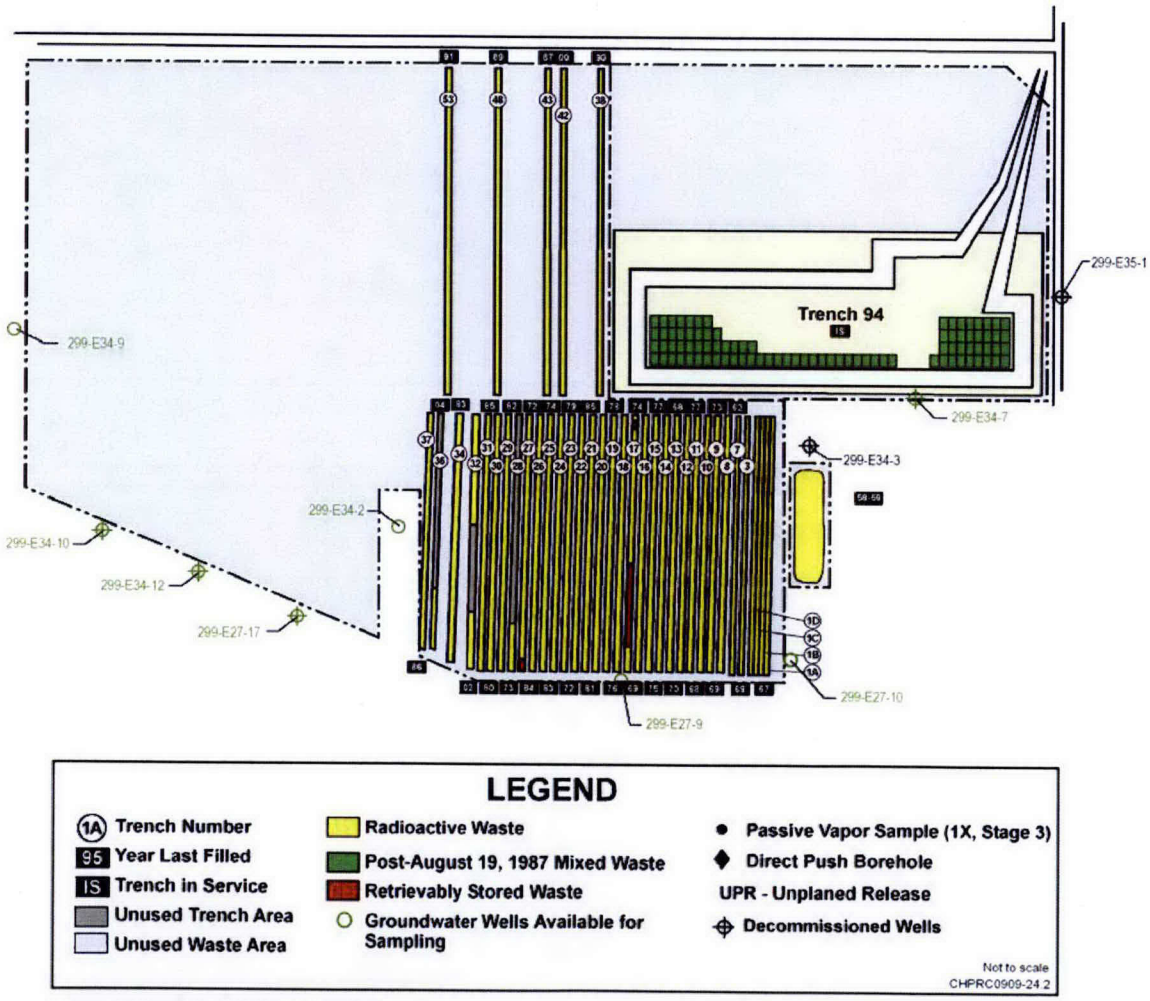
This chapter presents the LLWMA-2 facility and its operating history, the waste and waste characteristics associated with the site, the local geology and hydrology, a summary of previous monitoring of the groundwater and vadose zone contamination, and the conceptual model for groundwater flow and contaminant migration. The discussion in this chapter is summarized from earlier characterization activities reported in the following documents:

- BHI-00178, *PUREX Plant Aggregate Area Management Study Technical Baseline Report*
- BHI-01177, *Borehole Summary Report for the 216-B-2-2 Ditch*
- BHI-01239, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report*
- DOE/RL-93-74, *200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan*
- DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report*
- DOE/RL-2004-60, *200-SW-1 Nonradioactive Landfills Group and 200-SW-2 Radioactive Landfills Group Operable Units Remedial Investigation/Feasibility Study Work Plan*
- PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds – An Interim Report*
- PNNL-11470, *Hanford Site Groundwater Monitoring for Fiscal Year 1996*
- PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*
- PNNL-14187, *Hanford Site Groundwater Monitoring for Fiscal Year 2002*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford Washington*
- RHO-CD-673, *Handbook for 200 Area Waste Sites*
- WHC-MR-0204, *200E & 200W Areas Low Level Burial Grounds Borehole Summary Report*
- WHC-MR-0207, *Borehole Completion Data Package for the 216-B-63 Trench – 1990*
- WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*
- WHC-SD-EN-DP-044, *1991 Borehole Completion Data Package for the Low-Level Burial Grounds*
- WHC-SD-EN-DP-049, *1992 Borehole Completion Data Package for the Low-Level Burial Grounds*
- WHC-SD-WM-TI-260, *Water Inflow Investigation at the 218-E-12A and 218-E-12B Burial Grounds*
- WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Grounds*

2.1 Facility Description and Operational History

The following summary was obtained from DOE/RL-2004-60, PNL-6820, WHC-SD-WM-TI-260, and the Waste Information Data System. The operational history discussed below also includes a brief description of adjacent sites.

The LLWMA-2 is located in the northeastern corner of the 200 East Area (Figure 1-1). The LLWMA-2 began service in 1967 and consists of the 218-E-12B Burial Ground (approximately 73.7 ha [182 ac]). The 218-E-12B Burial Ground was expanded from approximately 27 ha [66.7 ac] to contain 34 trenches and up to a potential for 138 trenches, 40 of which store waste (Figure 2-1). The landfill continues to receive U.S. Navy vessel reactor compartments in Trench 94. The other 39 trenches contain mainly unsegregated waste and low-level waste that have been covered with soil. Two trenches contain retrievably stored waste.



Years of Operation (218-E-8): 1958-59
Years of Operation (218-E-12B): 1967 - Present

Figure 2-1. 218-E-10 Burial Ground at Low-Level Waste Management Area 2

The 40 used, unlined trenches vary in length from 288 to 381 m (944 to 1,250 ft). All of the trenches are in a north-south orientation, except Trench 94 (Figure 2-1). Thirty-four of the trenches are located in the southeastern portion of the burial ground. Trench 94 is located in the northeast portion of the burial ground, and five other trenches are located to the west of Trench 94. The western portion of the burial ground has not been used.

During the operational history of the 218-E-12B Burial Ground, one unplanned release of diesel fuel was reported in Trench 94 in 1995 (e.g. waste site 200-E-8). Analytical results confirmed that the spill was #2 diesel fuel. The impacted soil was excavated and disposed.

Hanford Site history has documented the following adjacent sites, which have impacted the environment: 216-B-2-1 Ditch, 216-B-2-2 Ditch, 216-B-2-3 Ditch, 200-E-53 contaminated zone, and the 200-E burn pit. The three unlined ditches associated with unplanned releases were located to the south of LLWMA-2. One of the unplanned releases in 1986 associated with the 216-B-2-3 unlined ditch caused cooling water to enter into Trench 37 of the 218-E-12B Burial Ground (WHC-SD-WM-TI-260). Information on the releases associated with these unlined ditches is provided in Section 2.3.

The 200-E-53 contaminated zone, located to the east of the southern portion of LLWMA-2 and north of the 216-B-2-1 through 216-B-2-3 Ditches, was first documented in 1987. The source of the contamination is unknown. Further information is provided in Section 2.3.

The 200-E burn pit, located to the east of southern portion of LLWMA-2, apparently began operations in 1950 and was associated with eliminating construction and office waste, as well as paint and chemical solvent waste. Further information is provided in Section 2.3.

2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, "Byproduct Material") stating that the hazardous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Ecology (Ecology) to regulate these hazardous waste components within the State of Washington (51 FR 24504, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste"). In 1996, the Washington State Attorney General determined that the effective date of mixed waste in Washington State was August 19, 1987.

In May 1989, DOE, EPA, and Ecology signed the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989). This agreement established the roles and responsibilities of the agencies involved in regulating and controlling remedial restoration of the Hanford Site, which includes LLWMA-2. Groundwater monitoring is conducted at LLWMA-2 in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F), which requires monitoring to determine whether dangerous waste or dangerous waste constituents from the waste site have entered the groundwater. A RCRA groundwater monitoring program for LLWMA-2 was initiated in 1987 (WHC-SD-EN-AP-015) based on the interim status monitoring requirements of 40 CFR 265, Subpart F and WAC 173-303-400 and continues today.

2.3 Waste Characteristics

This section describes the waste disposed at 218-E-12B Burial Ground, unplanned releases adjacent to the burial ground, and contaminated zones adjacent the burial ground. The information was obtained from DOE/RL-2004-60, DOE/RL-2000-35, WHC-SD-WM-TI-260, BHI-00178, BHI-01177, RHO-CD-673, and the Waste Information Data System database.

The 218-E-12B Burial Ground contains solid unsegregated and low-level radiological waste. Examples of waste disposed in this burial ground include general trash, failed equipment, vent risers, filter boxes, liquid-level risers from the 216-B-14 Crib, and strontium-90-contaminated soil dredged from the 216-B-63 Ditch. The waste was generated primarily from the Plutonium-Uranium Extraction Plant, B Plant, and the 200 East Area tank farms (DOE/RL-2004-60).

Waste disposal at LLWMA-2 was generally dumped directly from trucks or was contained in cardboard cartons.[8] Historical documentation indicates that waste trenches were backfilled on a daily or weekly basis. No unplanned releases have been reported within the 218-E-12B Burial Ground. Herbicide application has been used to mitigate radioactive uptake by deep-rooted plant growth (DOE/RL-2004-60).

In 1986, water was observed in the 218-E-12B Burial Ground's Trench 36, which had not received any waste. It was determined that the water was from the unlined 216-B-2-3 Ditch. Seven investigation trenches and boreholes were used to determine the vertical and horizontal extent of released water. Based on the results of the investigation, only LLWMA-2 waste in the southern 19.8 m (65 ft) of Trench 37 (e.g., the westernmost trench in the southern portion of the 218-E-12B Burial Ground) had been contacted by the released water.

Two unplanned releases (UPR-200-E-32 and UPR-200-E-138) associated with the 216-B-2-1 and 216-B-2-2 Ditches were located to the south of LLWMA-2 and north of the 216-B-2-3 Ditch. Several inorganic chemicals are associated with the liquid disposed to these ditches, but the most prominent are sulfate and nitrate compounds (although chloride and carbonate compounds are also present) (DOE/RL-93-74).

The unplanned release at the 216-B-2-1 Ditch was associated with product via a storage tank coil leak in 1963. The total release volume, including decontamination flushing water, was approximately 4.9 million L (1.3 million gal). The extent of the contaminants is not known; however, a comparison of the release volume to the pore volume suggests that mobile contaminants have the potential to reach the groundwater.

The 216-B-2-2 Ditch received B Plant storage tank 8-1 condensate in 1970. The extent of the contamination is not known; however, a comparison of the release volume to the pore volume suggests that the effluent has the potential to reach the groundwater (DOE/RL-93-74). Subsequent remedial investigation results from the 216-B-2-2 Ditch indicated that elevated sulfate, nitrate, and chloride are present in the vadose zone soils. Sulfate had the highest reported maximum concentration (678 mg/kg), followed by nitrate with a maximum value of 330 mg/kg. The maximum concentration for chloride was 10.9 mg/kg (DOE/RL-2000-35). Four zones of increased moisture were also found at depths of 53 m, 54.9 m, 56.7 m, and 64.6 m (174 ft, 180 ft, 186 ft, and 212 ft) below ground surface (bgs). The first three zones correlate with probable thin silt horizons, and the fourth zone correlates with a potentially cemented sand interval (BHI-01177).

The 200-E-53 contaminated zone is located east of the southeast portion of the 218-E-12B Burial Ground and north of the 216-B-2 Ditches. No characterization sample results associated with this site were found.

The 200-E burn pit is a large depression with sparse vegetation located east of the southeast portion of LLWMA-2 and north of the 216-B-2 Ditches. The site received 1,500 m^3 (52,972 ft^3) of construction and office waste, paint wastes, and chemical solvents. This site was also used for a detonation event in 1984 for the disposal of unstable liquids. The chemicals detonated included: butoxyehtanol, dioxane,

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8 Information obtained from the Solid Waste Information and Tracking System database.

1,4-dioxane, hydrogen peroxide, isopropyl ether, methyl ethyl ketone, phosphoric acid, polyethylene glycol monoethyl ether, and sodium azide (BHI-00178).

2.4 Geology and Hydrogeology

The geology and hydrology of the 200 East Area, including the area of LLWMA-2, are described in detail in PNL-6820 and WHC-SD-EN-TI-290. Other reports providing significant information include PNNL-12261, WHC-MR-0204, WHC-MR-0207, WHC-SD-EN-AP-015, WHC-SD-EN-DP-044, and WHC-SD-EN-DP-049. The following discussion summarizes the information from these reports. This section also identifies the uppermost aquifer and the aquifers hydraulically interconnected beneath LLWMA-2.

In the past, LLWMA-2 underlying sediments, from the ground surface to the top of the basalt, were interpreted as Hanford formation sediments (PNL-6820). More recently, three Hanford units were defined beneath LLWMA-2 (Figure 2-2): the Hanford upper gravel unit (H1), the Hanford intermediate sand unit (H2), and the Hanford lower gravel unit (H3) (WHC-SD-EN-TI-290). Although these units were defined on the basis of the dominant lithology, significant subordinate lithologies are intercalcated in each unit. For example, the upper gravel unit, which thickens to the north and east, has silt-rich interbeds up to 1 m (3.3 ft) in thickness. These silt horizons are continuous to distances of several hundred meters and are capable of generating perched water conditions. This may have contributed to the northeastern migration of water from the 216-B-2-3 release (WHC-SD-WM-TI-260). The middle sand unit is the thickest in the southwestern portion of the 218-E-12B site and pinches out toward the east and north (Figure 2-2). The H2a (which is a transition zone between units H2 and H3) in Figure 2-2 represents a downward coursing of the Hanford sand unit where gravel horizons up to 6.1 m (20 ft) thick are present. The silt interbeds described in the Hanford upper gravels are also present in the lower gravels. The Hanford lower gravels extend into the unconfined aquifer and overly the Elephant Mountain Basalt.

The suprabasalt sediment beneath LLWMA-2 ranges from 54 m (177 ft) to more than 79.5 m (262 ft) thick. The water table as of June 2009 has ranged from 62.2 to 74.5 m (204 to 244.5 ft) bgs. Historically, the water table level was approximately 3.1 m (10 ft) higher in the late 1960s and 1980s due to peak production at the Hanford Site and associated artificial recharge. Initial transmissivity measurements from LLWMA-2 boreholes varied from 1,300 m^2/day (14,000 ft^2/day) in well 299-E34-3 to 7,900 m^2/day (85,000 ft^2/day) in well 299-E34-2. Due to the permeable nature of aquifer sediments, the groundwater gradient has historically been very small beneath LLWMA-2 (Figure 2-3). The groundwater flow direction beneath the LLWMA over the last 5 years has predominantly been reported as west-southwest in annual groundwater reports.

Underlying the suprabasalt sediments is the Elephant Mountain Member of the Saddle Mountains Basalt Formation. During the drilling of LLWMA-2 wells, some of the drilling extended into the upper portion of the Elephant Mountain Basalt. Examination of basalt drill cuttings found no vesicles in basalt chips from two wells (PNL-6820). Based on this information, it was concluded that past fluvial events removed part, to the entire, flow top from the Elephant Mountain Basalt in this area. This substantiates earlier conclusion that the Elephant Mountain Member acts hydrologically as an aquiclude, confining the underlying Rattlesnake Ridge aquifer.

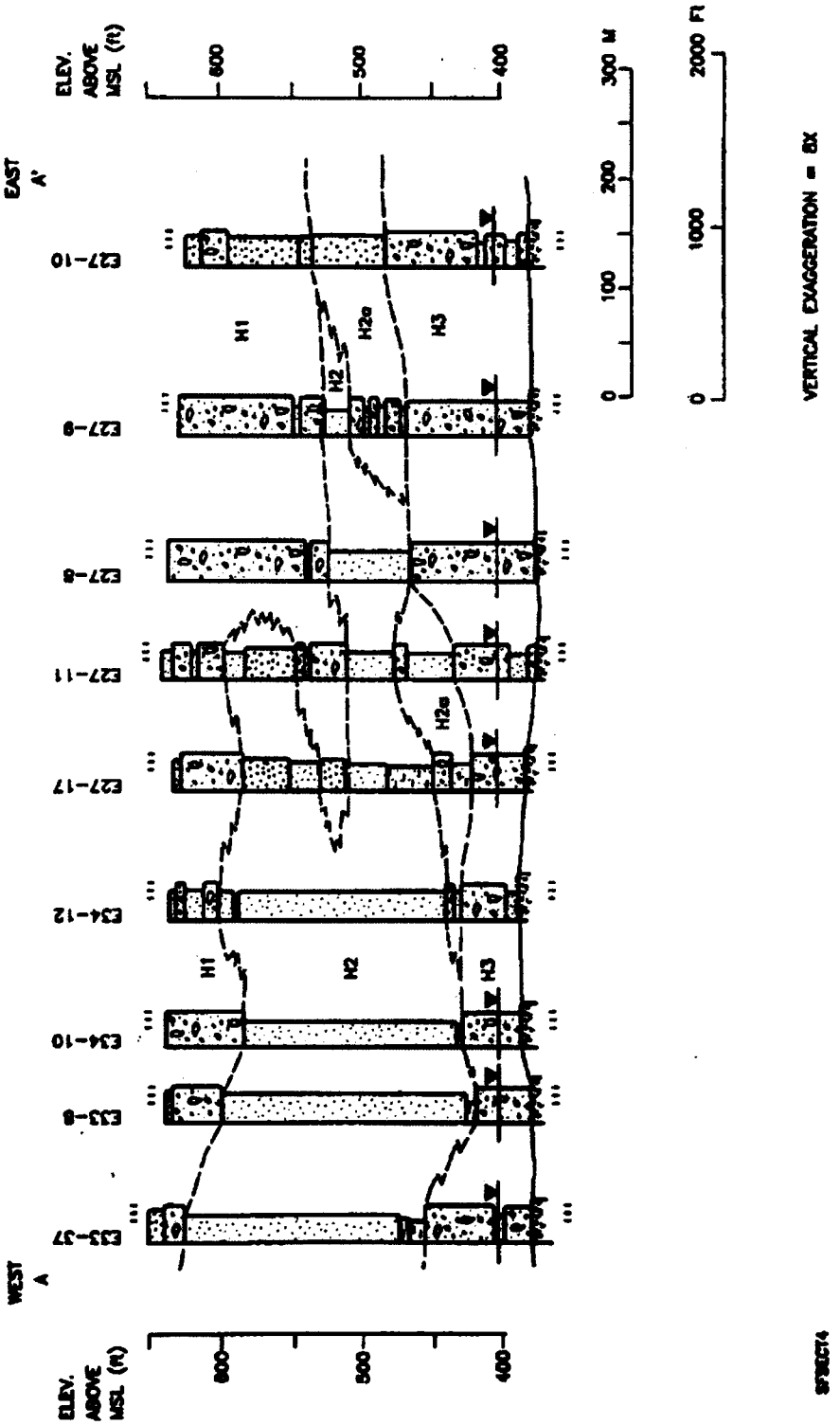

Figure 2-2. Geologic Cross-Section Along the Southern Boundary of Low-Level Waste Management Area 2

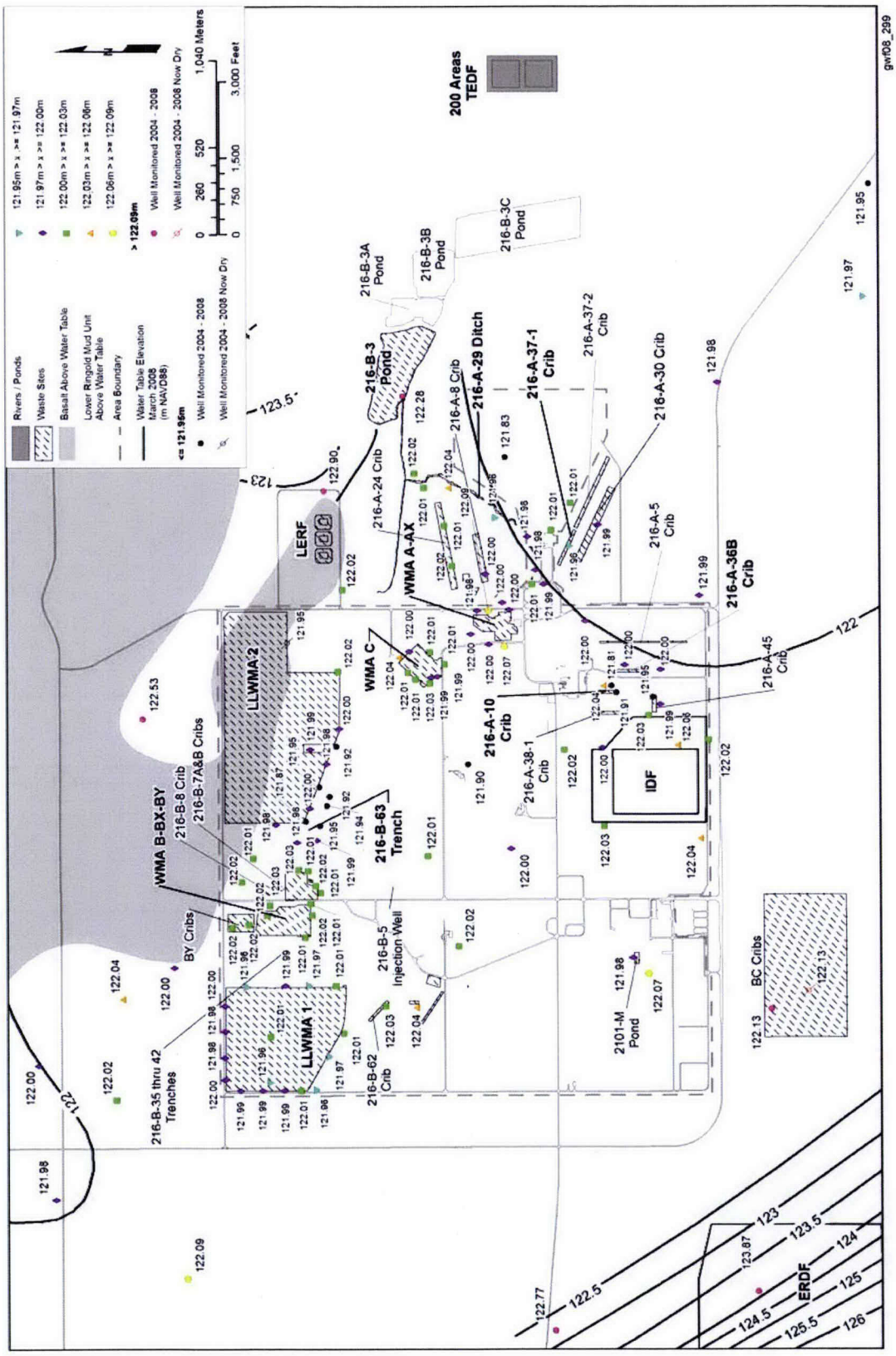

Figure 2-3. Water Table Map for the 200 East Area, March 2008

2.5 Summary of Previous Groundwater Monitoring

Groundwater monitoring was initiated at the LLWMA-2 in 1987 in accordance with WHC-SD-EN-AP-015. The groundwater beneath LLWMA-2 is sampled semiannually for indicator and groundwater quality parameters. Water levels are measured during each sampling event, as well as annually in March, as part of a comprehensive water-level measurement campaign. Groundwater monitoring results are summarized and presented in annual Hanford groundwater monitoring reports (i.e., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

The first eight RCRA-compliant monitoring wells were installed at LLWMA-2 in 1987. The initial network consisted of four upgradient wells and four downgradient wells. The initial flow direction was considered to the west and southwest. Additional wells were installed in 1989 (three wells), 1990 (one well), 1991 (three wells), and 1992 (two wells). The well screens extend from above the unconfined aquifer to various depths within the aquifer. All of the northern and eastern wells have gone dry over the past two decades for two reasons: (1) the basalt elevation is relatively high compared to the water table elevation beneath the northern and eastern portions of the burial ground, and (2) the water table level has continued to decline due to termination of Hanford Site production operations and effluent releases. The nine remaining active network monitoring wells are located along the southern and western boundary of the burial ground (Figure 2-1). The active wells monitor the upper portion of the aquifer and extend between 1.24 and 2.78 m (4.07 and 9.12 ft) into the aquifer.

Background monitoring at LLWMA-2 began in 1988, and initial background comparison values for indicator parameters (e.g., total organic carbon [TOC], total organic halides [TOX], pH, and specific conductivity) were established in 1989 using four quarters of data from upgradient wells 299-E27-10 and 299-E34-5 (PNNL-11470). Since September 1989, groundwater monitoring has been conducted primarily on a semiannual basis, except for the period between June 1990 and June 1991, when laboratory services were unavailable.

The local groundwater flow direction over the past 5 years has been reported to the west based on small differences within select wells along the southern boundary of LLWMA-2. However, over this same time period, other well groupings portray different groundwater flow directions. According to the *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project, Hanford Site* (SGW-38815), small measurement errors can have large effects on determining flow direction and velocity where the horizontal gradient is less than 0.001, as is the case for LLWMA-2. Therefore, the annual reports over this timeframe have added observations of mobile anion movement to depict flow direction. The nitrate- and sulfate-derived groundwater flow over the past 5 years has been reported to the southwest.

The derived background comparison value (i.e., critical mean) for all of the indicator parameters has been exceeded periodically throughout the history of detection monitoring. The downgradient wells that have exceeded the critical mean were explained by laboratory issues or sample collection errors. Upgradient wells (e.g., 299-E34-7) that exceeded the critical mean have been associated with either leaching or infiltration processes within the vadose zone (PNNL-14187). (Note that the source of infiltration has not been determined to date.) Well 299-E34-7, which is now dry, previously exceeded the critical mean for specific conductance, TOC, and TOX. The specific conductance was attributed mainly to sulfate, chloride, nitrate, and calcium. The TOC was consistent with subsequent oil/grease and total petroleum hydrocarbon results; however, later volatile and semivolatile analyses did not provide evidence for a specific contaminant. Likewise, no subsequent analytical contaminant result was able to be linked to the TOX results. Water level decline by 2005 caused well 299-E34-7 to be declared dry. Well 299-E27-10,

located to the southwest of well 299-E34-7, also exhibits some of the same characteristics described for well 299-E34-7.

The groundwater monitoring activities at LLWMA-2 currently consist of water-level monitoring and chemical constituent monitoring. The LLWMA-2 is sampled semiannually from a network of nine wells. Samples are analyzed semiannually for the indicator parameters, anions, and metals; samples are analyzed annually for alkalinity, mercury, lead, and phenols. Water-level measurements are collected each sampling event and in March for Hanford Sitewide monitoring. Regional water-level measurements have also been collected monthly since March 2008. Water levels will continue to be collected regionally on a monthly basis for an undetermined time period to resolve the groundwater gradient in the area with respect to high disposal discharges at the 200 Area Treated Effluent Disposal Facility, high Columbia River stages, and times when those influences are not present.

2.6 Conceptual Model

This section describes the LLWMA-2 conceptual model for potential contaminant transport to guide future groundwater monitoring. The conceptual model for contaminant release and transport is based on the following assumptions:

- Engineered barriers are not taken into account, so the model is applicable to unlined trenches.
- Average precipitation and net infiltration (5 to 10 cm/year [2 to 3.9 in./year]) prevail over the time period of interest.
- Net infiltration is assumed to occur under gravity drainage.
- Maximum vertical hydraulic conductivity in the vadose zone is assumed to be significantly larger than the net infiltration rate.
- The effective saturated porosity in the vadose zone is equal to the moisture content.
- Leaching of mobile contaminants from buried waste in unsealed containers, or contaminated soils in direct contact with the trench, is assumed to be the major potential source for contamination.
- There are no artificial sources of water (e.g., leaking potable or raw water lines, based on Hanford Site drawings).
- Extreme conditions or accidental releases are recognized as factors but would be addressed under emergency response/corrective actions.

2.6.1 Geochemical Considerations

The solubility and subsequent mobility of waste constituents in pore fluid depend on the container, chemical nature of the waste constituents, and natural subsurface geochemical conditions.

Pore fluid in the unsaturated and saturated zones beneath LLWMA-2 is slightly alkaline ($7 < pH < 8$), with appreciable amounts of bicarbonate and very little natural organic material. The lack of organic material indicates that conditions generally are oxidizing. Calcium carbonate is also abundant in vadose zone sediment. These general conditions favor sorption or retardation of many heavy metals and favor formation of anionic species, which enhances mobility for other metals (e.g., hexavalent chromium). Laboratory sorption studies have documented these effects and related mobility issues in Hanford Site media (e.g., PNNL-11800).

Based on the total beta, strontium-90, and gamma energy analysis samples collected beneath LLWMA-2 in 1986 (associated with the 216-B-2-3 release), significant contaminant migration from LLWMA-2 appears unlikely (Figure 2-4). The sediment results indicated a general decrease in concentration with depth from the trench bottoms; however, increased concentrations were reported in the deepest sample results. This appears consistent with the conclusion of WHC-SD-EN-TI-260 regarding the elevated gamma results being associated with water migration from the 216-B-2-3 Trench and not the 218-E-12B Burial Ground.

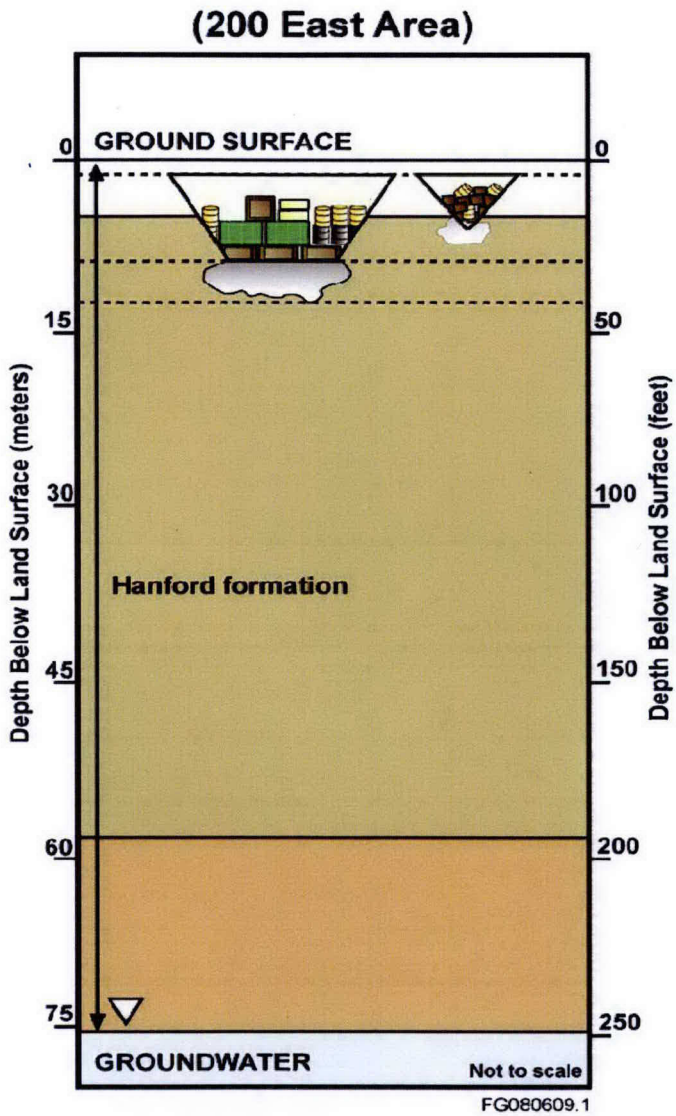

Figure 2-4. Conceptual Model for Low-Level Waste Management Area 2

2.6.2 Soil Moisture Factors

Direct precipitation is the primary driver for hypothetical leaching of waste constituents from the burial ground trenches and subsequent transport to groundwater. Contaminants in soil disposed to the trench or waste in degradable containers (e.g., cardboard boxes) subject to collapse are assumed to be leachable.

The amount of natural infiltration that can pass through the leachable buried waste and drain to the water table is controlled by the texture of the cover and backfill, as well as the degree of vegetative cover. Stratigraphic features in the soil column beneath the buried waste can also influence or retard downward migration by spreading the soil moisture laterally.

Most of the burial ground trenches are backfilled with the natural excavation materials (Hanford formation) consisting of coarse gravel, cobbles, and some interstitial sand. Some amounts of vegetation exist on the established backfilled areas and on the unused portions of LLWMA-2.

A coarse, sparse to moderately vegetated cover material allows a moderate to major fraction of the precipitation to infiltrate and potentially drain to the groundwater. It is estimated that recharge rates at the Hanford Site range from near 0 mm/year at highly vegetated sites to greater than 50 mm/year at gravel-covered nonvegetated sites (PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*).

2.6.3 Hydrogeologic Considerations

A discussion on hydrology is provided in Section 2.4. The vadose zone (e.g., ground surface to water table) beneath LLWMA-2 ranges from 54 m (177 ft) to more than 79.5 m (262 ft) bgs. The lithology of the vadose zone consists of the Hanford formation (e.g., upper gravel-dominated sequence, intermediate sand sequence, and a lower gravel sequence). Interbeds of sand and silt facies are present in each of the sequences and have the potential for generating perched aquifer (WHC-SD-EN-TI-290). These fine-grained facies also create conditions for retarding downward movement of contaminants. If the same northeast dip exists in these fine-grained sediments (which has been identified in many other sites in the 200 East Area), then lateral spreading within or on top of this unit may preferentially be toward the north-northeast.

If contaminants do breakthrough to groundwater beneath LLWMA-2, contaminants currently would move toward the southwest. This direction is based on the observed migration of nitrate and sulfate over the past 5 years and not on the subtle differences in water elevations along the southern boundary of LLWMA-2.

2.7 Data Quality Objectives

To define the required information for groundwater detection monitoring, the data quality objectives (DQO) process is used to ensure that data gathered are of appropriate quantity and quality to meet specific objectives. The DQO parameters, regulatory interim status requirements, and associated reports supporting regulatory requirements are outlined in Table 2-1.

Table 2-1. Data Quality Objectives at RCRA Sites Monitoring for Indicator Parameters

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Scope	RCRA interim status ground-water monitoring at sites where no impact to ground-water has been identified. Related requirements are found in WAC 173-303-400(3) and 40 CFR 265.90 through 265.94, as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v).	
Number and location of wells Point(s) of compliance.	**40 CFR 265.91 Ground-Water Monitoring System.** (a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of: (1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are: (i) Representative of background ground-water quality in the uppermost aquifer near the facility; and (ii) Not affected by the facility; and (2) Monitoring wells (at least three) installed hydraulically downgradient (i.e. in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer.	This plan, Section 3.2 PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington* PNNL-14859-ICN-1 PNNL-14859-ICN-2
Well configuration (depth and length of screened interval; well construction)	**40 CFR 265.91 Ground-Water Monitoring System.** (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water. **Additional requirements for WAC 173-303-400 (3)(c)(v)(C).** Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells.	This plan, Section 3.2 PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington* PNNL-14859-ICN-1 PNNL-14859-ICN-2

Table 2-1. Data Quality Objectives at RCRA Sites Monitoring for Indicator Parameters

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Frequency of sampling Types of analysis or measurement Method detection limits or accuracy and precision.	**40 CFR 265.92 Sampling and Analysis.** (b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section: (1) Parameters characterizing the suitability of the ground-water as a drinking water supply, as specified in Appendix III. *[Note: Have not listed these parameters because, in accordance with 40 CFR 265.92(c)(1) below, these analyses are conducted only during the first year. None of the RCRA sites is in its first year of monitoring.]* (2) Parameters establishing ground-water quality: (i) Chloride (ii) Iron (iii) Manganese (iv) Phenols (v) Sodium (vi) Sulfate *[Comment: These parameters are to be used as a basis for comparison in the event a groundwater quality assessment is required under 40 CFR 265.93(d).]* (3) Parameters used as indicators of ground-water contamination: (i) pH (ii) Specific conductance (iii) Total organic carbon (iv) Total organic halides (c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in paragraph (b) of this section. The owner or operator must do this quarterly for one year. (2) For each of the indicator parameters specified in paragraph (b)(3) of this section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year.	This plan, Section 3.1 and Appendix A PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington* PNNL-14859-ICN-1 PNNL-14859-ICN-2

Table 2-1. Data Quality Objectives at RCRA Sites Monitoring for Indicator Parameters

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
	40 CFR 265.92 Sampling and Analysis (cont'd). (d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies: (1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually. (2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semiannually. (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	
Methods used to evaluate the collected data	**40 CFR 265.93 Preparation, Evaluation, and Response.** (b) For each indicator parameter specified in 40 CFR 265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with 40 CFR 265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see Appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background.	This plan, Section 4.2 and Appendix A PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington* PNNL-14859-ICN-1 PNNL-14859-ICN-2

Notes:

The references cited in this table are listed in the reference section (Chapter 5) of this plan.

CFR = *Code of Federal Regulations*

DQO = data quality objective

RCRA = *Resource Conservation and Recovery Act of 1976*

WAC = *Washington Administrative Code*

The assumptions regarding LLWMA-2 groundwater monitoring based on historical observations and the recent *Groundwater Monitoring Needs Assessment for Low-Level Burial Grounds Waste Management Areas* (SGW-40037) are as follows:

- The groundwater monitoring program described in PNNL-14859 (and interim change notices) does not meets the requirements of 40 CFR 265.90(b), "Applicability," based on a southwest flow direction because there is no true upgradient well.
- Elevated specific conductance and TOC in the southeast wells (e.g., 299-E27-9 and 299-E27-10) are driven primarily by sulfate, calcium, chloride, and nitrate from an unknown source.

- The western, unused portion of LLWMA-2 will be procedurally closed (Figure 2-1).
- Four new wells will be installed for the LLWMA (two wells along the eastern boundary as upgradient wells, and two wells along the western boundary as downgradient wells) (Figure 2-5).

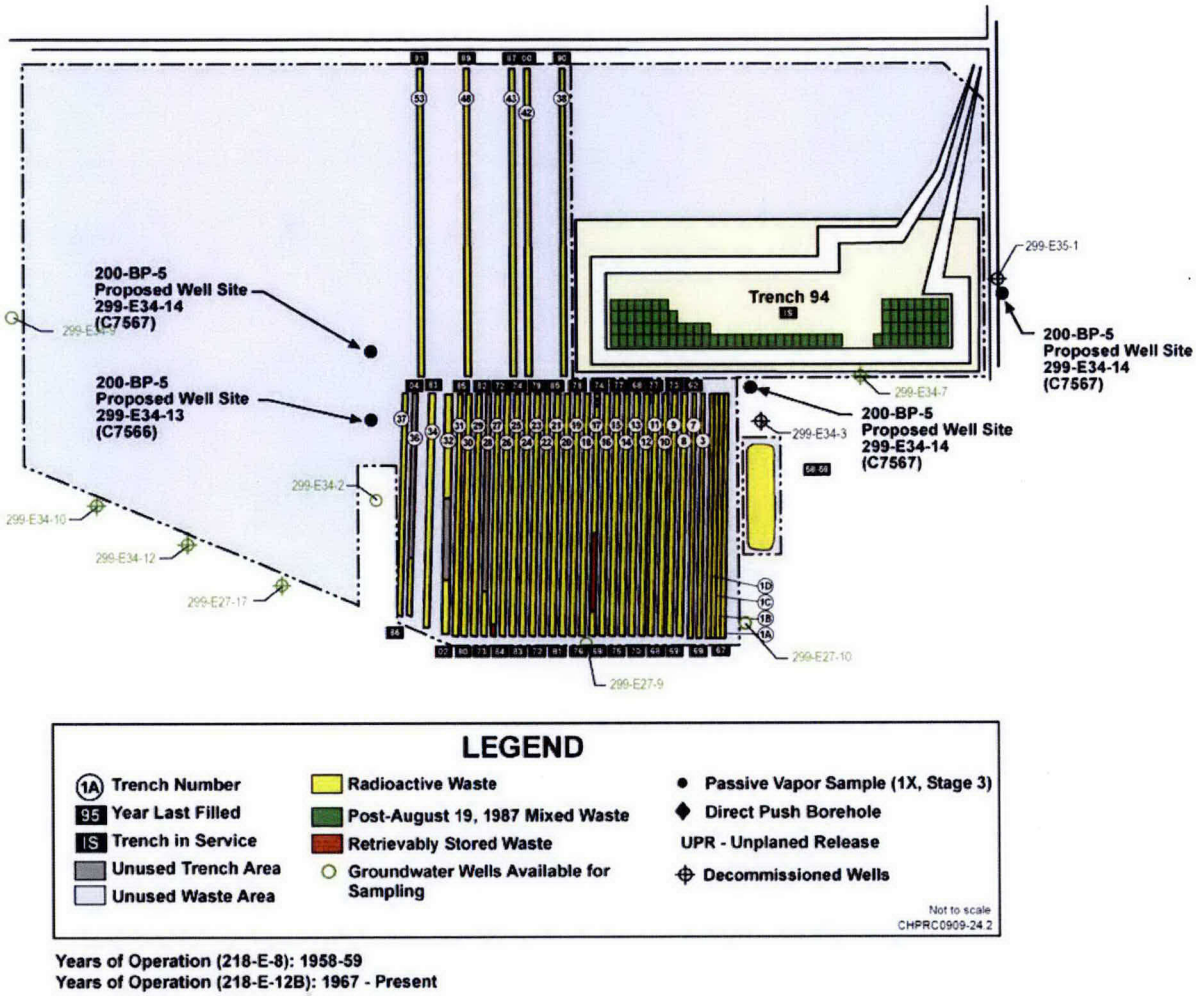

Figure 2-5. Four New Low-Level Waste Management Area 2 Network Monitoring Wells

Procedurally closing the western, unused portion and moving the western limit of the LLWMA to the west of Trenches 37 and 53 requires a revised monitoring network and plan. The recent monitoring needs assessment (SGW-40037) developed a three-tiered approach for changing the monitoring network. The first tier changes included the following:

- Adding four new monitoring wells. Two wells will be installed along the new western boundary point of compliance, just west of Trenches 37 and 53. One additional well will be installed east of Trench 94 as a replacement for well 299-E35-1 and an upgradient well for LLWMA-2. Finally, one well will be installed to the east of Trench 1a as a replacement well for well 299-E34-3 and an upgradient well for LLWMA-2. One well is planned to be completed in fiscal year (FY) 2010 and the other three wells are planned for completion in FY 2011.

- Retain the existing downgradient wells for the new monitoring network (299-E27-11, 299-E27-17, and 299-E34-2).
- Change the status of the six existing wells along the southern and western boundary of LLWMA-2 to supplemental and continue monitoring at these wells.

The second tier requirement is to perform modeling to identify the need for additional wells. The third tier requirements were to install the second tier monitoring wells.

Recommended changes to the conclusions of the monitoring needs assessment based on recent information and re-evaluation for refinement of the needs assessment logic are as follows:

- Retain wells 299-E27-8, 299-E27-9, 299-E27-10, 299-E27-11, 299-E27-17, 299-E34-2, and 299-E34-12 as part of the monitoring network. These wells provide downgradient groundwater data based on southwest flow direction, which seems more probable than a western flow direction.
- Change the groundwater gradient description of well 299-E27-10 from upgradient to cross-gradient. Additional future low-level groundwater monitoring information may require additional changes to this designation.
- Drill proposed well 299-E34-13 in FY 2010. Drill at least 1.5 m (5 ft) into the Elephant Mountain Basalt to investigate the basalt chips and complete the screen across the basalt to determine water availability. Use this information to determine whether to drill wells 299-E34-14 and 299-E34-15 in FY 2011. This decision will be based on previous basalt chip observations from two wells (299-E34-2 and 299-E34-4) in this area, which provided no evidence of flow top.
- If evidence of flow top is not present in well 299-E34-13 and water availability is not sufficient, then do not drill wells 299-E34-14 and 299-E34-15.

3 Groundwater Monitoring

This chapter lists the wells monitored, constituents analyzed, and sampling frequency. The quality assurance and quality control requirements are provided in the QAPjP in Appendix A.

3.1 Constituent List and Sampling Frequency

Table 3-1 lists the constituents to be analyzed and the frequency for the detection-level groundwater monitoring program at LLWMA-2. Note that wells 299-E34-13 through 299-E34-16 are new planned wells; one well will be drilled in FY 2010 and up to three wells will be drilled in FY 2011, depending on well production (as discussed in Section 2.7). Maintenance issues and sampling logistics can delay scheduled sampling events. If sampling of a well is delayed more than 3 months, that sampling event will be cancelled because it is nearly time for the next scheduled sampling event.

3.2 Well Network

Figure 3-1 shows the groundwater monitoring well network for LLWMA-2. Figure 2-5 shows the four new planned groundwater monitoring wells for LLWMA-2. Table 3-1 lists the wells in the groundwater monitoring network. Construction details and as-built diagrams for wells in LLWMA-2 monitoring network are described in PNL-6820, WHC-MR-0204, WHC-SD-EN-DP-044, and WHC-SD-EN-DP-049. The wells in the LLWMA-2 monitoring network may also be co-sampled as part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* sampling for the 200-BP-5 Operable Unit. Sampling for LLWMA-2 and the 200-BP-5 Operable Unit is coordinated to eliminate duplicate analyses and well trips.

Table 3-2 summarizes well attribute information, including the April 2009 depth to water in each well. All of the wells in the LLWMA-2 monitoring network are constructed to meet the requirements of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." These wells have stainless-steel casing and screen, sand pack in the screened interval, and full annular seal above. Given the current rate of water table decline (0.05 m/year [0.164 ft/year]), none of the wells in the LLWMA-2 monitoring network are expected to go dry for at least 20 years.

3.3 Sampling and Analysis Protocol

Groundwater monitoring at LLWMA-2 follows the conventions of the project and is described in the QAPjP (Appendix A).

3.4 Differences Between This Plan and Previous Plan

Initially, the only difference between this groundwater monitoring plan and the previous plan (PNNL-14859-ICN-2) is the deletion of the analytes lead and mercury. Over the next 2 years, another difference will be the addition of up to four new wells (e.g. 299-E34-13 through 299-E34-16) to the monitoring network (Figure 2-5). After completion of the two new wells at the new western edge of the burial ground, the two existing western wells will no longer be sampled for indicator or groundwater quality parameters. After the two new wells have been completed and sampled once, second tier modeling will be conducted to determine if additional monitoring wells may be needed at LLWMA-2. If additional wells are needed, a new monitoring plan will be completed. If some of the proposed wells are determined from the FY 2010 decision not to be drilled, then a revised groundwater monitoring plan will be developed to include any second tier proposed wells.

Table 3-1. Sampling Schedule for Low-Level Waste Management Area 2

Well Name	Purpose	WAC Compliant	Water Level[c]	RCRA Required Constituents[a]														
				Contaminant Indicator Parameters				Groundwater Quality Parameters						Supporting Constituents[b]			
								Anions[d]			Metals, Unfiltered, Filtered[d]						
				pH[c]	Specific Conductance[c]	Total Organic Carbon	Total Organic Halides	Chloride	Sulfate	Phenols[d]	Iron	Manganese	Sodium	Alkalinity	Dissolved Oxygen[c]	Temperature[c]	Turbidity[c]
299-E27-8	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E27-9	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E27-10	Cross-gradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E27-11	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E27-17	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-2	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-9	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-10	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-12	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-13	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-14	Downgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-15	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S
299-E34-16	Upgradient	Y	S	S4	S4	S4	S4	S	S	A	S	S	S	S	S	S	S

Table 3-1. Sampling Schedule for Low-Level Waste Management Area 2

Well Name	Purpose	WAC Compliant	Water Level[c]	RCRA Required Constituents[a]														
				Contaminant Indicator Parameters				Groundwater Quality Parameters						Supporting Constituents[b]			
								Anions[d]			Metals, Unfiltered, Filtered[d]						
				pH[c]	Specific Conductance[c]	Total Organic Carbon	Total Organic Halides	Chloride	Sulfate	Phenols[d]	Iron	Manganese	Sodium	Alkalinity	Dissolved Oxygen[c]	Temperature[c]	Turbidity[c]

Notes:

a. Constituents and parameters required by 40 CFR 265.92, "Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis."

b. Constituents not required by RCRA but needed to support interpretation.

c. Field measurement.

d. For anions, analytes include chloride, fluoride, nitrate, nitrite, and sulfate.

For metals, analytes include, but are not limited to, calcium, chromium, iron, manganese, potassium, and sodium.

A = sampled annually

CFR = *Code of Federal Regulations*

LLWMA = low-level waste management area

RCRA = *Resource Conservation and Recovery Act of 1976*

S = sampled semiannually

S4 = sampled semiannually with quadruplicate samples taken

VOA = volatile organic analysis

WAC = *Washington Administrative Code*

Y = well is constructed to the resource protection well standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells"

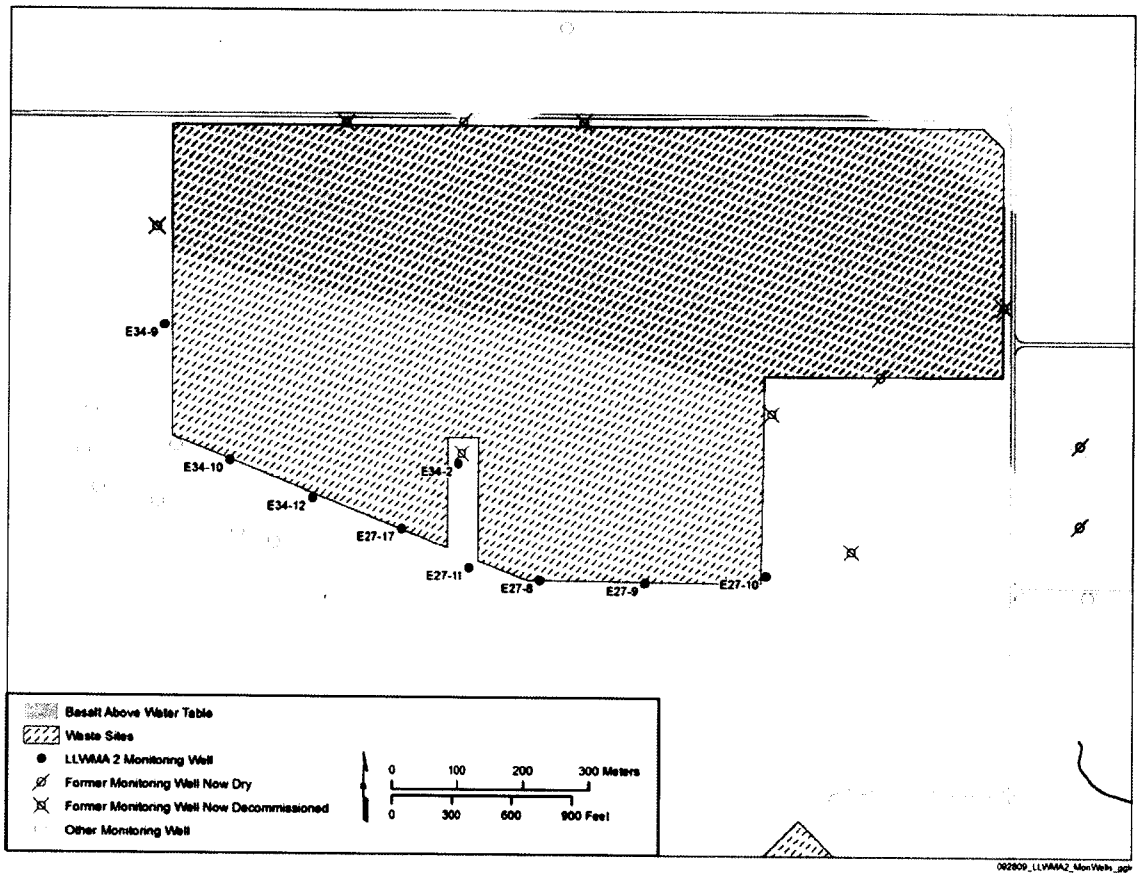

Figure 3-1. Map Showing Locations of Existing RCRA Monitoring Wells at Low-Level Waste Management Area 2

Table 3-2. Attributes for Wells in the Low-Level Waste Management Area 2 Groundwater Monitoring Network

Well Name	Completion Date	Easting (m)	Northing (m)	Brass Survey Marker Elevation (m NAVD88)	Water Table Elevation (m amsl)	Screened Interval (m) NAVD88	Water Remaining, (m) (April 2009)
299-E27-8	9/30/87	137044.178	574759.08	No value	121.972	225.5 - 245.5	2.23
299-E27-9	08/31/87	137040.904	574917.649	*No value*	121.987	219.8 - 239.1	2.5
299-E27-10	08/19/87	137052.481	575100.298	*190.81*	121.933	212.1 - 232.4	1.99
299-E27-11	10/18/89	137062.736	574652.93	196.264	121.909	230.4 – 251.4	2.26
299-E27-17	11/11/91	137122.01	574547.31	No value	121.929	223.2 - 224.2	2.78
299-E34-2	09/30/87	137220.694	574634.81	No value	121.919	230.2 - 240.4	2.39
299-E34-9	11/05/91	137429.82	574186.02	No value	121.984	212.63 - 233.4	1.24
299-E34-10	10/29/91	137224.57	574284.4	No value	122.032	225.29 - 246.0	1.73
299-E34-12	04/15/92	137168.544	574411.004	194.823	121.921	223.9 - 244.21	1.45
299-E34-13	TBD	TBD	TBD	TBD	TBD	TBD	TBD
299-E34-14	TBD	TBD	TBD	TBD	TBD	TBD	TBD
299-E34-15	TBD	TBD	TBD	TBD	TBD	TBD	TBD
299-E34-16	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Notes:

All wells are constructed to the standards of resource protection wells in accordance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." Stainless-steel casing and screen, sand pack around screen or "channel pack" screen, and annular seal around casing.

Shaded rows show the anticipated network monitoring wells after the four new wells (299-E34-13 through 299-E34-16) are installed and sampled once.

Bold/italic print indicates upgradient wells for a southwest flow direction.

Water levels measured in April 2009.

amsl = above mean sea level

NAVD88 = North American Vertical Datum of 1988

TBD = to be determined

WAC = *Washington Administrative Code*

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4 Data Evaluation and Reporting

This chapter discusses the data evaluation and reporting for LLWMA-2.

4.1 Data Review

Data review, validation, and verification are discussed in the QAPjP in Appendix A.

4.2 Statistical Evaluation

The goal of RCRA detection monitoring is to determine if LLWMA-2 has affected groundwater quality beneath the site. For most RCRA treatment, storage, and disposal units at the Hanford Site, this is determined based on the results of specified statistical tests. The sampling procedures and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference in WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general contamination indicator parameters (e.g., TOC, TOX, pH, and specific conductance) in downgradient wells to background levels obtained from upgradient wells.

There is one current cross-gradient well at LLWMA-2 (Table 3-1) that was previously used for deriving a statistical comparisons value. Each year, a new calculation is generally completed to derive the background comparison value of significance because of the variability of upgradient groundwater. Since there is no current upgradient well, the current values will remain in place until a new upgradient well is in place and sampled quarterly for one year. Thus, the current upgradient indicator parameter derived in January 2009 will be compared with each downgradient well indicator parameter result to determine if a significant increase has occurred. In addition, groundwater quality results are used to verify ion balance and relative change associated with specific conductance measurements. If questions arise from the ion balance, the laboratory results are reviewed for errors (as discussed in Appendix A). Also, phenol analyses are ran for further evaluation of potentially elevated TOC or TOX indicator parameters.

4.3 Interpretation

After the data are validated and verified, acceptable data are used to interpret groundwater conditions at LLWMA-2. Interpretive techniques include the following:

- Hydrographs: Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- Water table maps: Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential on the maps.
- Trend plots: Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.
- Plume maps: Mapped distributions of chemical constituent concentrations in the aquifer to determine extent of contamination. Changes in plume distribution over time assist in determining plume movement and groundwater flow direction.
- Contaminant ratios: Can sometimes be used to distinguish among different sources of contamination.

4.4 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the groundwater monitoring network to determine if it remains adequate to monitor the LLWMA. The network must include upgradient and downgradient wells in the uppermost aquifer. The groundwater flow direction beneath LLWMA-2 has been predominantly reported to the southwest since 2002 based on nitrate and sulfate movement.

Water-level measurements will be collected before each sampling event. A more comprehensive set of water-level measurements has been made for the northeastern portion of the 200 East Area each month since April 2009. The measurements are corrected, if needed, to account for borehole deviation from vertical, and the resulting data are plotted on a map. The data will be presented in the annual groundwater monitoring report.

Any new RCRA wells needed as a result of the second tier modeling at LLWMA-2 will be negotiated and prioritized by Ecology, DOE, and EPA and approved under Tri-Party Agreement Milestone M-24-00.

4.5 Reporting and Notification

Results of detection monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66). Notifications will be made as outlined in Table 4-1.

If comparisons for the upgradient well show a statistically significant increase (and/or pH decrease), the information is reported in the annual groundwater report. If the comparisons for a downgradient well show a significant increase (and/or pH decrease), then one or both of the following actions are taken: (1) the well is resampled and split samples are sent to different laboratories to determine if the exceedance of the comparison value was the result of laboratory error, and/or (2) the original samples may be re-analyzed if laboratory error is suspected.

If the exceedance of the statistical comparison value is confirmed by resampling, then written notice is provided to the regulatory agency within 7 days that the monitored facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program will be developed and submitted (40 CFR 265.93[d], "Preparation, Evaluation, and Response"). In some instances, it is possible to determine immediately that the statistical finding is not the result of contamination from the facility. In that case, the regulatory agency is notified but an assessment program is not instituted.

Table 4-1. Reports Required for Compliance with 40 CFR 265, Subpart F for Groundwater Monitoring

Submittal	Submittal Period	Reporting Vehicle	Regulatory Requirement
First year of sampling: concentrations of interim primary drinking water constituents, identifying those that exceed limits	Quarterly	Complete[a]	40 CFR 265.94(a)(2)(i)
Concentration and statistical analyses of groundwater contamination indicator parameters, noting significant differences in upgradient wells	Annually (by March 1 of following year)	Annual Hanford Site groundwater monitoring report	40 CFR 265.94(a)(2)(ii)
Results of groundwater surface elevation evaluation and description of response, if appropriate	Annually (by March 1 of following year)	Annual Hanford Site groundwater monitoring report	40 CFR 265.94(a)(2)(iii)
Outline for groundwater quality assessment program	Within one year after effective date of regulations	S&GRP document or letter	40 CFR 265.93(a)
Notification of statistical exceedance[b]	Within 7 days of verification	Letter to Ecology	40 CFR 265.93(c)
Assessment plan[b]	Within 15 days of notification	S&GRP document or letter	40 CFR 265.93(d)
Determinations under assessment program[b]	As soon as technically feasible; annually thereafter	S&GRP document, letter, or annual Hanford Site groundwater monitoring report	40 CFR 265.93(d)(5) and 40 CFR 265.94(b)

Notes:

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities."

a. Requirement was fulfilled during first year of sampling via published reports. Quarterly submittal of data continues via the Hanford Environmental Information System database.

b. Required if exceedance occurs and is verified.

CFR = *Code of Federal Regulations*

Ecology = Washington State Department of Ecology

S&GRP = Soil and Groundwater Remediation Project

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40 CFR 265.93, "Preparation, Evaluation, and Response."

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Appendix A

Quality Assurance Project Plan

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Contents

A1 Project Management A-1
A1.1 Project/Task Organization A-1
A1.1.1 Regulatory Project Manager A-1
A1.1.2 U.S. Department of Energy, Richland Operations Office Project Manager A-2
A1.1.3 U.S. Department of Energy, Richland Operations Office Subject Matter Expert A-2
A1.1.4 Contractor Groundwater Remediation Department Manager A-2
A1.1.5 Groundwater Sampling Operations A-3
A1.1.6 RCRA Monitoring and Reporting A-3
A1.1.7 Sample Management and Reporting Organization A-3
A1.1.8 Contract Laboratories A-3
A1.1.9 Quality Assurance A-3
A1.1.10 Environmental Compliance Officer A-3
A1.1.11 Health and Safety A-3
A1.1.12 Waste Management A-3
A1.2 Problem Definition/Background A-4
A1.3 Project/Task Description A-4
A1.4 Quality Objectives and Criteria A-4
A1.5 Special Training/Certification A-4
A1.6 Documents and Records A-4
A2 Data Generation and Acquisition A-5
A2.1 Sampling Process Design (Experimental Design) A-5
A2.1.1 Regulatory Requirements A-5
A2.1.2 Judgmental Sampling A-5
A2.2 Sampling Methods A-6
A2.3 Sample Handling and Custody A-6
A2.4 Analytical Methods A-6
A2.5 Quality Control A-8
A2.5.1 Field Quality Control Samples A-9
A2.5.2 Laboratory Quality Control Samples A-10
A2.5.3 Quality Control Requirements A-10
A2.6 Instrument/Equipment Testing, Inspection, and Maintenance A-13
A2.7 Instrument/Equipment Calibration and Frequency A-14
A2.8 Inspection/Acceptance of Supplies and Consumables A-14
A2.9 Non-Direct Measurements A-14

A2.10 Data Management A-14
A3 Assessment and Oversight A-14
A3.1 Assessments and Response Actions A-15
A3.2 Reports to Management A-15
A4 Data Validation and Usability A-15
A4.1 Data Review, Verification, and Validation A-15
A4.2 Verification and Validation Methods A-15
A4.3 Reconciliation with User Requirements A-16
A5 References A-16

Figure

Figure A-1. Project Organization A-2

Tables

Table A-1. Actions and Documentation for Regulatory Notification A-5
Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents A-7
Table A-3. Quality Control Samples A-9
Table A-4. Field and Laboratory Quality Control Elements and Acceptance Criteria A-11
Table A-5. Blind Standard Constituents and Schedule A-13

Terms

CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DQO	data quality objective
EB	equipment blank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FTB	full trip blank
FXR	field transfer blank
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document*
HEIS	Hanford Environmental Information System
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	U.S. Department of Energy, Richland Operations Office
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

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A Quality Assurance Project Plan

The contractor's quality assurance (QA) program describes the contractor's QA structure, requirements, implementation methods, and responsibilities. The contractor's environmental QA program plan provides the requirements for collecting and assessing environmental data in accordance with the following:

- 10 *Code of Federal Regulations* (CFR) 830, Subpart A, "Nuclear Safety Management," "Quality Assurance Requirements"
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD)
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5
- U.S. Department of Energy (DOE) O 414.1C, *Quality Assurance*

This quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection including the planning, implementation, and assessment of sampling, field measurements, and laboratory analyses. Section 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989a), Attachment 2, "Action Plan," require that QA/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal (TSD) units, as well as for past-practice processes. The HASQARD requirements (DOE/RL-96-68) also apply to this work.

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4). This QAPjP is divided into four sections (designated in EPA/240/B-01/003) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

A1 Project Management

This section addresses the basic aspects of project management and will ensure that the project has defined goals, that the participants understand the goals and the approaches used, and that the planned outputs are appropriately documented.

A1.1 Project/Task Organization

The project organization in regard to planning, sampling, analysis, and data assessment is described in the following subsections and is shown in Figure A-1. For each functional primary contractor role, there is a corresponding oversight role within DOE.

A1.1.1 Regulatory Project Manager

The Washington State Department of Ecology (Ecology) project manager is responsible for oversight of the work being performed under this groundwater monitoring plan. Ecology will work with the DOE Richland Operations Office (RL) to resolve concerns regarding the work as described in this QAPjP. Ecology can request this plan during a regulatory compliance inspection for review.

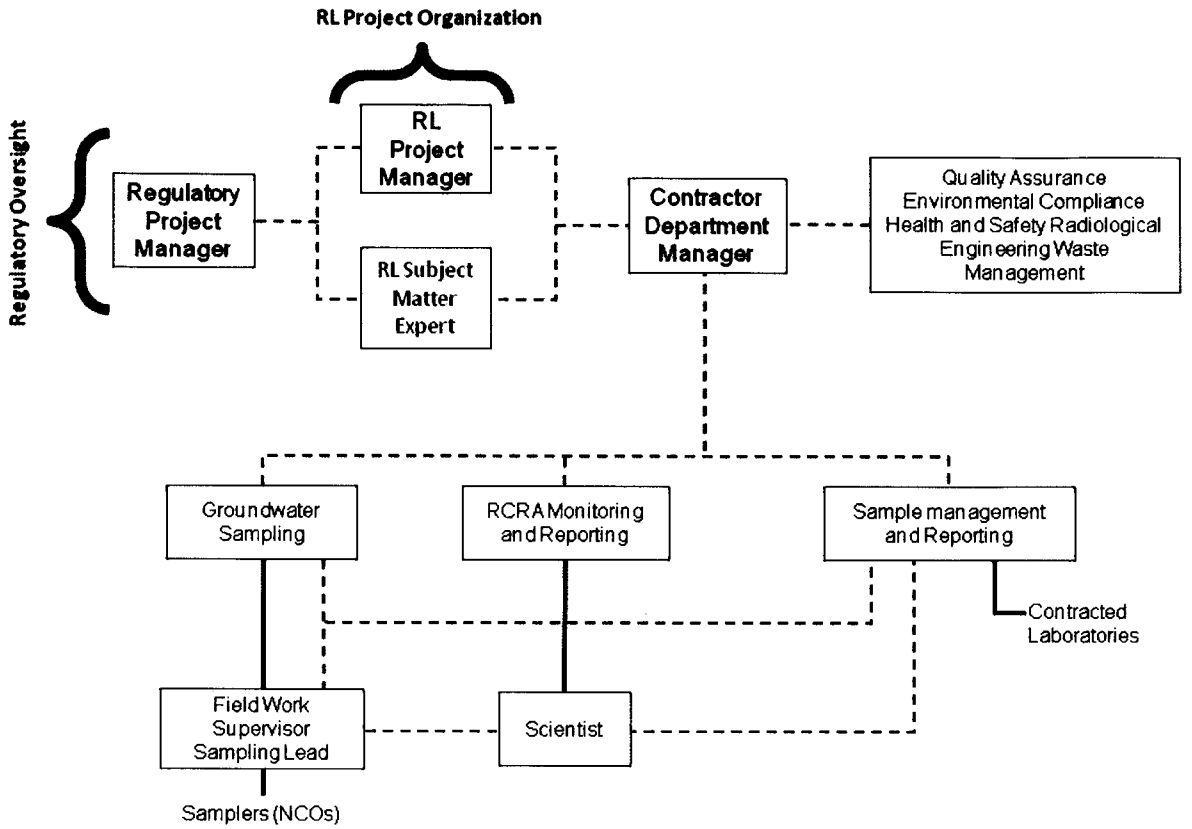

Figure A-1. Project Organization

A1.1.2 U.S. Department of Energy, Richland Operations Office Project Manager

Hanford Site cleanup is the responsibility of RL. The RL project manager is responsible for authorizing the contractor to perform activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the Tri-Party Agreement for the Hanford Site.

A1.1.3 U.S. Department of Energy, Richland Operations Office Subject Matter Expert

The RL subject matter expert is responsible for day-to-day oversight of the contractor's performance of workscope, for working with the contractor and the regulatory agencies to identify and work through issues, and for providing technical input to the RL project manager.

A1.1.4 Contractor Groundwater Remediation Department Manager

The contractor groundwater remediation department manager provides oversight for all activities and coordinates with DOE, the regulators, and primary contractor management in support of sampling and reporting activities. The remediation department manager also provides support to the RCRA Monitoring and Reporting manager to ensure that work is performed safely and cost effectively.

A1.1.5 Groundwater Sampling Operations

Groundwater sampling operations is responsible for planning and coordinating field sampling resources and provides the field work supervisor for routine groundwater sampling operations. The field work supervisor directs the samplers, who collect groundwater samples in accordance with the sampling and analysis plan, and corresponding standard procedures and work packages. The samplers also complete the field logbook and chain-of-custody forms, including any shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

A1.1.6 RCRA Monitoring and Reporting

The RCRA Monitoring and Reporting manager is responsible for direct management of activities performed to meet RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager coordinates with and reports to DOE and primary contractor management regarding RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager assigns scientists to provide technical expertise.

A1.1.7 Sample Management and Reporting Organization

The Sample Management and Reporting organization coordinates laboratory analytical work to ensure that laboratories conform to HASQARD requirements (or their equivalent), as approved by DOE, the U.S. Environmental Protection Agency (EPA), and Ecology. Sample Management and Reporting receives analytical data from the laboratories, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. Sample Management and Reporting is responsible for informing the RCRA Monitoring and Reporting manager of any issues reported by the analytical laboratories.

A1.1.8 Contract Laboratories

The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanations of results to support data validation. The laboratories must meet site-specific QA requirements and must have an approved QA plan in place.

A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project documents, including data quality objective (DQO) summary reports, sampling and analysis plans, and the QAPjP; and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA point of contact must be independent of the unit generating the data.

A1.1.10 Environmental Compliance Officer

The environmental compliance officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work, and also develops appropriate mitigation measures with the goal of minimizing adverse environmental impact.

A1.1.11 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulations or by internal primary contractor work requirements.

A1.1.12 Waste Management

Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

A1.2 Problem Definition/Background

The problem definition, as required by *Washington Administrative Code* (WAC) 173-303-400 ("Dangerous Waste Regulations," "Interim Status Facility Standards") and 40 CFR 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Groundwater Monitoring"), is outlined in the main text discussion of this monitoring plan. The background is also provided in the monitoring plan.

A1.3 Project/Task Description

The project description is provided in Chapters 3 and 4 of this monitoring plan and includes the selection of appropriate dangerous waste or dangerous waste constituents, collection and analyses of groundwater from the monitoring network, interpretation of analytical results, evaluation of the monitoring network, and reporting.

The target analytes, along with the monitoring wells and frequency of sampling, are provided in Chapter 3.

A1.4 Quality Objectives and Criteria

The quality objectives and criteria for groundwater monitoring are defined in the tables provided in this QAPjP in order to meet the evaluation requirements stated in the monitoring plan.

A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility of collecting and transporting groundwater samples according to the Dangerous Waste Training Plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

A1.6 Documents and Records

The project scientist is responsible for ensuring that the current version of the groundwater monitoring plan is used and for providing any updates to field personnel. Version control is maintained by the administrative document control process. Significant changes to the plan that affect DQOs will be reviewed and approved by DOE and the regulatory agency prior to implementation. Table A-1 defines the types of changes that may be made to the sampling design and the documentation requirements.

Logbooks and data forms are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for the logbooks shall be identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes.

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements therein.

Table A-1. Actions and Documentation for Regulatory Notification

Type of Change	Action	Documentation
Temporary addition of wells or constituents, or increased sampling frequency	RCRA Monitoring and Reporting manager approval; notify regulatory agency, if appropriate	Project's schedule tracking system
Unintentional impact to groundwater monitoring plan including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of indicator parameters, loss of samples in transit, etc.	Electronic notification	RCRA annual report
Planned change to groundwater monitoring activities, including addition or deletion of constituents or wells, change of sampling frequency, etc.	Revise monitoring plan	Revised RCRA groundwater monitoring plan
Anticipated unavoidable changes (e.g., dry wells)	Electronic notification; revise monitoring plan	RCRA annual report and revised groundwater monitoring plan

Notes:

RCRA = *Resource Conservation and Recovery Act of 1976*

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

A2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

A2.1 Sampling Process Design (Experimental Design)

The sampling design is based on regulatory requirements and judgmental sampling.

A2.1.1 Regulatory Requirements

The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status TSD units.

A2.1.2 Judgmental Sampling

The selection of sampling and analysis requirements is based on knowledge of the feature or condition under investigation and is also based on professional judgment. The TSD monitoring is based on professional judgment. Conclusions depend on the validity and accuracy of professional judgment.

A2.2 Sampling Methods

Sampling is described in the contractor's environmental QA program plan, including the following:

- Field sampling methods
- Sample preservation, containers, and holding times
- Corrective actions for sampling activities
- Decontamination of sampling equipment

The groundwater sampling operations supervisor must ensure that situations that may impair the usability of samples and/or data are documented in field logbooks or on nonconformance report forms in accordance with internal corrective action procedures, as appropriate. The groundwater sampling operations supervisor will note any deviations that occur from the standard procedures for sample collection, contaminants of potential concern, sample transport, or monitoring. The groundwater sampling operations supervisor is also responsible for coordinating all activities related to the use of field monitoring equipment (e.g., dosimeters and industrial hygiene equipment). Field personnel will document in the logbook all noncompliant measurements taken during field sampling. Ultimately, the groundwater sampling operations supervisor is responsible for developing, implementing, and communicating corrective action procedures; for documenting all deviations from procedure; and for ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely impact data quality or impair the ability to acquire data or failure to follow procedure will be documented in accordance with internal corrective action procedures, as appropriate.

A2.3 Sample Handling and Custody

A sampling and data tracking database is used to track samples from the point of collection through the laboratory analysis process. Laboratory analytical results are entered and maintained in the HEIS database. Each sample is identified and labeled with a unique HEIS sample number. The contractor's environmental QA program plan specifies sample handling information, including the following:

- Container requirements
- Container labeling and tracking process
- Sample custody requirements
- Shipping and transportation

Sample custody during laboratory analysis is addressed in the applicable laboratory's standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by the Sample Management and Reporting organization.

A2.4 Analytical Methods

Information on analytical methods is provided in Table A-2. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. The primary contractor participates in oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Contamination Indicator Parameters			
Total organic carbon	G/P, HCL to pH <2	SW-846[d] Method 9060	1,000
Total organic halides	G, H_2SO_4 to pH <2, no head space	SW-846[d] Method 9020	20
Metals Analyzed by Inductively Coupled Plasma Method – Unfiltered/Filtered			
Calcium	P, HNO_3 to pH <2	SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e]	1,000
Cadmium			5
Sodium			500
Manganese			5
Potassium			4,000
Iron			50
Magnesium			750
Anions by Ion Chromatography			
Chloride	P; none	EPA/600 Method 300.0[f]	200
Nitrate			250
Nitrite			250
Sulfate			500
Other			
Alkalinity	G/P; none	Standard Method[g] 2320, EPA/600 Method 310.1 EPA/600 Method 310.2	5,000
Conductivity, field	N/A	Instrument/meter	1 µohm
pH, field measurement	N/A	Instrument/meter	0.1
Phenol	G, residual chlorine 0.0008% $Na_2S_2O_3$	SW-846 Method 8040	5
Temperature	Field measurement	Instrument/meter	

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]

Notes:

a. All samples will be collected in plastic (P) or glass (G) containers and will be cooled to 4°C upon collection.

b. Constituents grouped together are analyzed by the same method, unless otherwise indicated.

c. Detection limit units, unless otherwise indicated.

d. SW-846, *Methods for Evaluation of Solid Waste: Physical/Chemical Methods.*

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. Analytical method adapted from Method 300.0, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography* (EPA-600/4-84-017).

g. *Standard Methods for the Examination of Water and Wastewater* (APHA et al. 2005).

EPA = U.S. Environmental Protection Agency

N/A = not applicable

Laboratories providing analytical services in support of this QAPjP will report errors to the Sample Management and Reporting project coordinator, who will then initiate a sample disposition record. The error-reporting process is intended to document analytical errors and the resolution of those errors with the project scientist. The corrective action program addresses the following:

- Evaluation of impacts of laboratory QC failures on data quality
- Root-cause analysis of QC failures
- Evaluation of recurring conditions that are adverse to quality
- Trend analysis of quality-affecting problems
- Implementation of a quality improvement process
- Control of nonconforming materials that may affect quality

A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-3.

Table A-3. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field QC		
Full trip blank	Contamination from containers or transportation	1 per 20 well trips
Field transfer blank	Contamination from sampling site	1 each day; volatile organic compounds sampled
Equipment blank	Contamination from non-dedicated equipment	As needed[a]
Replicate/duplicate samples	Reproducibility	1 per 20 well trips
Laboratory QC		
Method blanks	Laboratory contamination	1 per batch
Laboratory duplicates	Laboratory reproducibility	See footnote[b]
Matrix spikes	Matrix effect and laboratory accuracy	See footnote[b]
Matrix spike duplicates	Laboratory reproducibility/accuracy	See footnote[b]
Surrogates	Recovery/yield	See footnote[b]
Laboratory control samples	Method accuracy	1 per batch

Notes:

a. For portable Grundfos® (registered trademark of Grundfos Pumps Corporation, Colorado Springs, Colorado) pumps, equipment blanks are collected 1 per 10 well trips. Whenever a new type of non-dedicated equipment is used, an equipment blank shall be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination procedure for the non-dedicated equipment.

b. As defined in the laboratory contract or quality assurance plan, and/or analysis procedures.

QC = quality control

A2.5.1 Field Quality Control Samples

Field QC samples will be collected to evaluate the potential for cross-contamination and field sampling performance. The QC samples and the required frequency for collection are described in this section.

Full trip blanks (FTBs) are prepared by the sampling team prior to traveling to the sampling site. The FTB is filled with high-purity reagent water. The bottles are sealed and transported, unopened, to the field in the same storage containers used for samples collected that day. Collected FTBs are analyzed for the same constituents as the samples. The FTBs are used to evaluate potential contamination of the samples due to the sample bottles, preservative, handling, storage, or transportation.

Field transfer blanks (FXRs) are preserved volatile organic analysis sample bottles that are filled at the sample collection site with high-purity reagent water that has been transported to the field. After collection, FXR bottles are sealed and placed in the same storage containers with the samples from the associated sampling event. The FXR samples are analyzed for volatile organic compounds only. The FXRs are used to evaluate potential contamination caused by conditions in the field.

Equipment blanks (EBs) are samples in which high-purity reagent water is passed through the pump or placed in contact with the sampling surfaces of the equipment to collect blank samples identical to the

sample set that will be collected. The EB bottles are placed in the same storage containers with the samples from the associated sampling event. The EB samples are analyzed for the same constituents as the samples from the associated sampling event. The EBs are used to evaluate the effectiveness of the cleaning process to ensure that samples are not cross-contaminated from previous sampling events.

For the field blanks (i.e., FTBs, FXRs, and EBs), results above two times the method detection limit are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the method detection limit.

Field duplicates, also known as replicates, are two samples that are collected as close as possible to the same time and same location, and they are intended to be identical. Field duplicates are stored and transported together and are analyzed for the same constituents. The field duplicates are used to determine precision for both sampling and laboratory measurements. The results of the field duplicates must have precision within 20 percent, as measured by the relative percent difference. Only field duplicates with at least one result greater than five times the method detection limit or minimum detectable activity are evaluated.

Double-blind samples contain a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The laboratory is not informed that the samples are QC samples. The project submits double-blind samples to assess analytical precision and accuracy.

A2.5.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spikes, and matrix spikes) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, and will be run at the frequency specified in that reference, unless superseded by agreement.

A2.5.3 Quality Control Requirements

Table A-4 lists the acceptance criteria for QC samples, and Table A-5 lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking Hanford Site background well water with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper limit of concentration determined in groundwater on the Hanford Site. Investigations shall be conducted for double-blind standards that are outside of acceptance limits. The results from these standards are used to determine the acceptability of the associated parameter data.

Holding time is the elapsed time period between sample collection and analysis. The contractor's environmental QA program plan provides a table with holding times. Exceeding the required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, as specified in SW-846 or *Methods of Chemical Analysis of Water and Wastes* (EPA/600/4-79/020). Data associated with exceeded holding times are flagged with an "H" in the HEIS database. Data that exceed the holding time shall be maintained but potentially may not be used in statistical analyses.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned Water Pollution and Water Supply Performance Evaluation studies. The groundwater project periodically audits the analytical laboratories to identify and solve quality problems, or to prevent such problems from occurring. Audit results are used to improve performance, and the summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

Failure of QC will be determined and evaluated during data validation and the data quality assessment process. Data will be qualified, as appropriate.

Table A-4. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemical Parameters			
Alkalinity Chemical oxygen demand Conductivity pH Total organic carbon Total organic halides	MB[b]	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS[e]	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Ammonia and Anions			
Anions by IC	MB	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Metals			
ICP metals ICP/MS metals	MB	<CRDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	MSD	≤20% RPD[c]	Data reviewed[d]
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Semivolatile Organic Compounds			
Phenols by GC	MB	<2 times MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed[d]
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

Table A-4. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action

Notes:

a. Refer to Table A-2 for specific analytical methods.

b. Does not apply to pH.

c. Laboratory-determined, statistically derived control limits may also be used. Such limits are reported with the data.

d. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data as suspect ("Y" flag) or rejected ("R" flag).

e. Applies to total organic carbon and total organic halides only.

f. Applies only in cases where one or both results are greater than five times the detection limit.

g. Determined by the laboratory based on historical data. Control limits are reported with the data.

h. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criteria is less than five times the MDL.

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated method blank)

N = result may be biased (associated matrix spike result was outside the acceptance limits)

Q = problem with associated field QC sample (blank and/or duplicate results were out of limits)

Abbreviations:

CRDL = contract-required detection limit

DUP = laboratory matrix duplicate

EB = equipment blank

FTB = full trip blank

FXR = field transfer blank

GC = gas chromatography

IC = ion chromatography

ICP = inductively coupled plasma

ICP/MS = inductively coupled plasma/mass spectrometry

LCS = laboratory control sample

MB = method blank

MDL = method detection limit

MS = matrix spike

MSD = matrix spike duplicate

QC = quality control

RPD = relative percent difference

SUR = surrogate

Table A-5. Blind Standard Constituents and Schedule

Constituents	Frequency	Accuracy (%)	Precision (% RSD)[a]
Fluoride	Quarterly	±25%	≤25%
Chloride	Quarterly	±25%	≤25%
Chromium	Annually	±20%	≤20%
Iron	Semiannually	±20%	≤20%
Magnesium	Annually	±20%	≤20%
Manganese	Annually	±20%	≤20%
Nitrate	Quarterly	±25%	≤25%
Sodium	Annually	±20%	≤20%
TOC[b]	Quarterly	Varies according to spiking compound	Varies according to spiking compound
TOX[c]	Quarterly	Varies according to spiking compound	Varies according to spiking compound

Notes:

a. If the results are less than five times the required detection limit, then the criterion is that the difference of the results of the replicates is less than the required detection limit.

b. The spiking compound generally used for TOC is potassium phthalate. Other spiking compounds may also be used.

c. Two sets of spikes for TOX will be used. The spiking compound for one set should be 2,4,5-trichlorophenol. The spiking compound for the second set should include the constituents used for the volatile organic compounds sample (carbon tetrachloride, chloroform, and trichloroethylene).

RSD = relative standard deviation

TOC = total organic carbon

TOX = total organic halides

A2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to minimize measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and the onsite organization's QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with SW-846, or with auditable HASQARD and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

A2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in the environmental QA program plan. Standards used for calibration will be certified and traceable to nationally recognized performance standards. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used to support sampling and analysis activities are procured in accordance with internal work requirements and processes that describe the contractor's acquisition system and the responsibilities and interfaces necessary to ensure that items procured/acquired for contractor meet the specific technical and quality requirements. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

Supplies and consumables that are procured by the analytical laboratories are procured, checked, and used in accordance with the laboratory's QA plan.

A2.9 Non-Direct Measurements

Non-direct measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. If evaluation includes data from historical sources, whenever possible such data will be validated to the same extent as the data generated as part of this effort. All data used in evaluations will be identified by source.

A2.10 Data Management

The Sample Management and Reporting organization, in coordination with the RCRA Monitoring and Reporting manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements that govern data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the Tri Party Agreement Action Plan (Ecology et al. 1989b). The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file.

All field activities will be recorded in the field logbook.

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample disposition record will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution of the errors with the RCRA Monitoring and Reporting manager. Sample disposition records become a permanent part of the analytical data package for future reference and for records management.

A3 Assessment and Oversight

The elements discussed in this section address the activities for assessing the effectiveness of project implementation and the associated QA and QC activities. The purpose of the assessment is to ensure that the QAPjP is implemented as prescribed.

A3.1 Assessments and Response Actions

The contractor management, Regulatory Compliance, Quality, and/or Health and Safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this QAPjP.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratory's QA plan. The primary contractor conducts oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

A3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to the Sample Management and Reporting organization, which initiates a sample disposition record in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the RCRA Monitoring and Reporting manager.

A4 Data Validation and Usability

The elements in this section address the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying project objectives. These elements are further discussed in the contractor's environmental QA program plan.

A4.1 Data Review, Verification, and Validation

The criteria for verification may include review for completeness (e.g., all samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

A4.2 Verification and Validation Methods

The work activities shall follow documented procedures and processes for data validation and verification, as summarized below. Validation of groundwater data consists of assessing whether the data collected and measured truly reflect aquifer conditions. Verification means assessing data accuracy, completeness, consistency, availability, and internal control practices to determine overall reliability of the data collected. Other DQOs that shall be met include proper chain-of-custody, sample handling, use of proper analytical techniques as applied for each constituent, and the quality and acceptability of the laboratory analyses conducted.

Groundwater monitoring staff perform checks on laboratory electronic data files for formatting, allowed values, data flagging (i.e., qualifiers), and completeness. Hardcopy results are verified to check for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems encountered during analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff work with the laboratory to correct the problem found during the analysis.

The data validation process provides the requirements and guidance for validating groundwater data that are routinely collected. Validation is a systematic process of reviewing verified data against a set of criteria (provided in Section A2.5) to determine whether the data are acceptable for their intended use.

Results of laboratory and field QC evaluations, double-blind sample results, laboratory performance evaluation samples, and holding-time criteria are considered when determining data usability. Staff review the data to identify whether observed changes reflect changes in groundwater quality or potential data errors, and they may request data reviews of laboratory, field, or water-level data for usability purposes. The laboratory may be asked to check calculations or re-analyze the sample, or the well may be resampled. Results of the data reviews are used to flag the data appropriately in the HEIS database (e.g., "R" for reject, "Y" for suspect, or "G" for good) and/or to add comments.

A4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet project DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

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