U.S. Department of Energy
Hanford Site

March 16, 2021

21-SGD-000859

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

Dear Mr. Bowen:

INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE LOW-LEVEL BURIAL GROUNDS WMA-1, DOE/RL-2009-75, REVISION 2

This letter transmits the Interim Status Groundwater Monitoring Plan for the Low-Level Burial Grounds WMA-1, DOE/RL-2009-75, Revision 2 to the Washington State Department of Ecology.

If you have any questions, please contact me, or your staff may contact Ken Kapsi, of my staff, on (509) 373-9069

Sincerely,

Michael W. Cline Digitally signed by Michael W. Cline
Date: 2021.03.16 08:30:49 -07'00'

Michael W. Cline, Director
Soil and Groundwater Division
Richland Operations Office

SGD:KAK

Attachment:
DOE/RL-2009-75 Rev 2

cc: See page 2

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DOE/RL-2009-75
Revision 2

Interim Status Groundwater Monitoring Plan for the LLBG WMA-1

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
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Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2009-75
Revision 2

Interim Status Groundwater Monitoring Plan for the LLBG WMA-1

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Terms

AEA	*Atomic Energy Act of 1954*
DOE	U.S. Department of Energy
DWMU	dangerous waste management unit
Ecology	Washington State Department of Ecology
EER	engineering evaluation report
EPA	U.S. Environmental Protection Agency
FWS	Field Work Supervisor
LLBG	Low-Level Burial Grounds
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
TOC	total organic carbon
TOX	total organic halogen
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WMA	waste management area

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1 Introduction

This document presents a revised groundwater monitoring program for the Low-Level Burial Grounds (LLBG) Waste Management Area (WMA)-1, and when issued into the operating record becomes the principal controlling document for conducting groundwater monitoring under the dangerous waste regulations (WAC 173-303, "Dangerous Waste Regulations") at LLBG WMA-1, superseding the previous plan (DOE/RL-2009-75, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*, Rev. 1, as modified by RCRA-CN-02_DOE/RL-2009-75_R1, *Interim Status Change Number 2: Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*).

This groundwater monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA), with regulations promulgated by the Washington State Department of Ecology (Ecology) in the *Washington Administrative Code* and the *Code of Federal Regulations* by reference (WAC 173-303-400, "Interim Status Facility Standards"; 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring"). This plan is required by 40 CFR 265.90(a) and (b), "Applicability," and is intended to satisfy groundwater monitoring requirements applicable to interim status treatment, storage, and disposal units (referred to as dangerous waste management units [DWMUs] in this plan) and monitors for indicator parameters in groundwater samples that are used to determine whether dangerous waste or dangerous waste constituents have entered the groundwater. This plan also monitors parameters used in establishing groundwater quality.

The U.S. Department of Energy (DOE) is revising the groundwater monitoring plan for the LLBG WMA-1 to update the monitoring network. LLBG WMA-1 is an inactive burial ground located in the 200 East Area of the Hanford Site in Washington State and overlies the 200-BP-5 Groundwater Operable Unit (Figure 1-1). LLBG WMA-1 consists of the 218-E-10 Burial Ground, which has two discrete areas. The southern portion of the burial ground contains 14 trenches that received dangerous and nondangerous waste. The northern portion of the 218-E-10 Burial Ground is unused (Figure 1-1) and is not planned for use in the future. LLBG WMA-1 received low-level industrial waste from the Hanford Site and offsite facilities from 1955 to 2000. However, there are discrete areas within LLBG WMA-1, referred to as "Green Islands," where regulated mixed waste (waste with both a radioactive and dangerous waste component) was disposed in unlined trenches.

In accordance with Section I.A of WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (hereinafter referred to as the Hanford Facility RCRA Permit), LLBG WMA-1 will continue under interim status until it is incorporated into Part III, V, and/or VI of the Hanford Facility RCRA Permit (or its successor) or until interim status is terminated. Therefore, groundwater monitoring for LLBG WMA-1 continues under interim status requirements. For regulatory purposes, the boundary of LLBG WMA-1 is identified on the Hanford Facility RCRA Permit Part A Form.

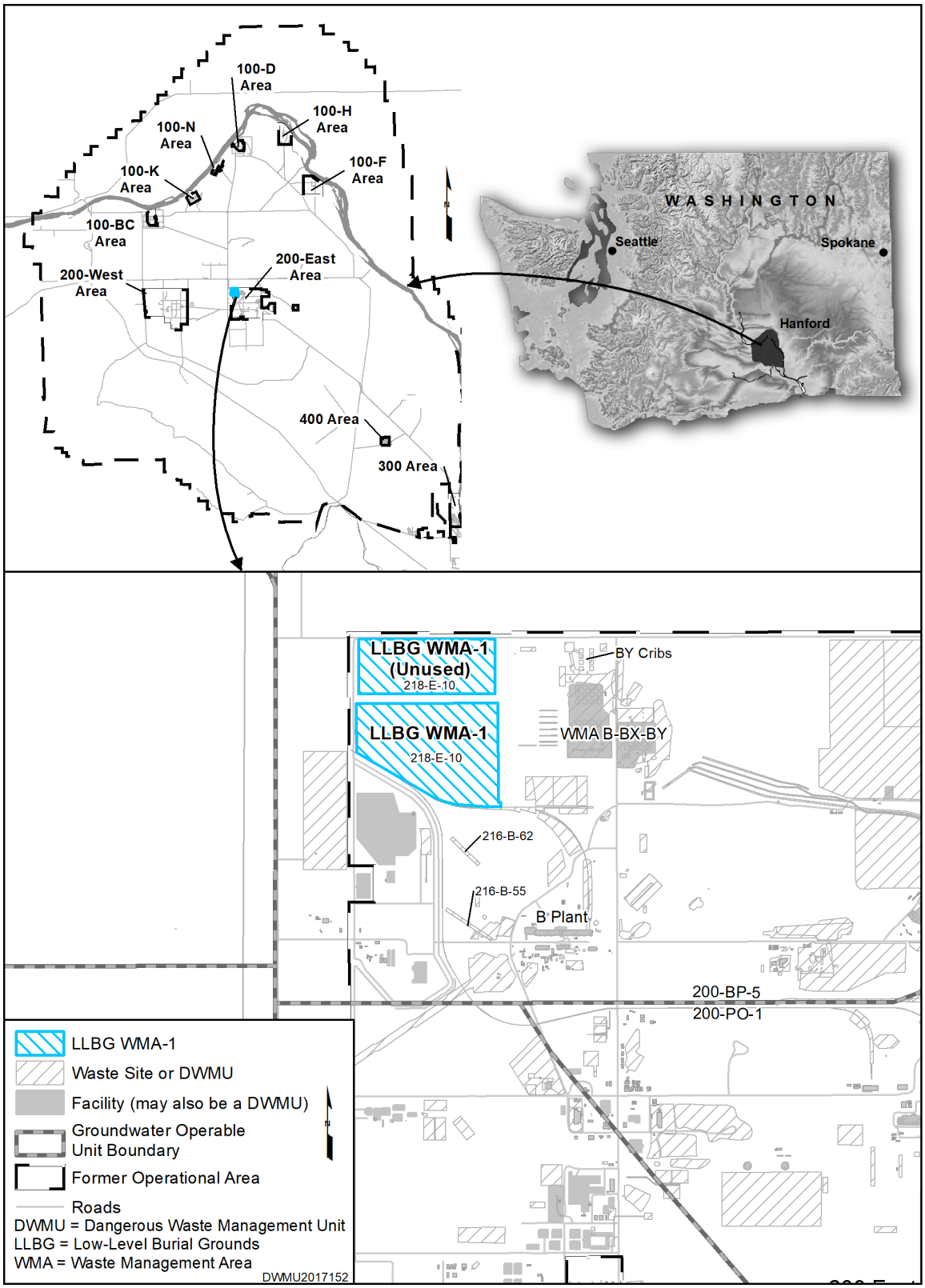

Figure 1-1. Location Map for LLBG WMA-1

SGW-60590, *Engineering Evaluation Report for Low-Level Burial Grounds Waste Management Area-1 Green Islands Groundwater Monitoring*, is one of a suite of groundwater monitoring engineering evaluation reports (EERs) for regulated units located within the Hanford Site Central Plateau that were prepared to support Part B (final status) permit application material for the future Revision 9 of WA7890008967, *Hanford Facility Dangerous Waste Permit (Site-Wide Permit)* (hereinafter referred to as the Hanford Sitewide Permit). The EERs do not create any groundwater monitoring requirements; however, they contain the most comprehensive background information supporting groundwater monitoring to date for each regulated unit. Detailed area-wide and unit-specific groundwater evaluation methodology was used to assess the locations of existing wells and propose locations for new wells that would detect groundwater contamination that may occur from each regulated unit. For the LLBG WMA-1, analysis of groundwater elevations and contaminant particle-tracking calculations, as well as an evaluation of vertical contaminant migration in groundwater, were performed to evaluate the existing monitoring well network and propose locations for three new monitoring wells.

Regular updates to the EERs are planned as new data become available and changes to groundwater conditions are identified. Because regular updates to the EERs will ensure that they remain the most updated source for unit-specific information related to groundwater monitoring, the detailed information specific to the LLBG WMA-1 that is provided in SGW-60590 is included only by reference in this interim status groundwater monitoring plan.

One of the primary objectives of the EERs is to identify a well network for the monitoring that is required at a final status unit under WAC 173-303-645, "Releases from Regulated Units." At the LLBG WMA-1, the proposed final status network also meets the requirements for monitoring under the interim status regulations of WAC 173-303-400 and 40 CFR 265, Subpart F; therefore, the well network proposed in SGW-60590 is incorporated into this plan. Table 1-1 identifies the locations where information that is pertinent to this groundwater monitoring plan is presented in SGW-60590.

Table 1-1. Locations of Pertinent Supporting/Background Information in SGW-60590, *Engineering Evaluation Report for the LLBG WMA-1 Groundwater Monitoring*

Section/Subsection	Title/Topic
2.1	Background
2.3	Waste Characteristics
2.4	Interim Status Monitoring Network and Sampling History
3.1	Stratigraphy
3.2	Hydrogeology
3.3	Groundwater Flow System
4	Contaminant Migration Conceptual Model
4.1	Vadose Zone
4.2	Soil Moisture Factors
4.3	Hydrogeologic Considerations
4.4	Groundwater Chemistry
5	Calculation Methods
6	Calculations

Table 1-1. Locations of Pertinent Supporting/Background Information in SGW-60590, *Engineering Evaluation Report for the LLBG WMA-1 Groundwater Monitoring*

Section/Subsection	Title/Topic
7	Simulation Results and Conclusions
9.3	Proposed Groundwater Monitoring Network
9.3.1	Groundwater Monitoring Well 299-E32-3
9.3.2	Groundwater Monitoring Well 299-E33-266
9.3.3	Groundwater Monitoring Well 299-E28-27
9.3.4	Groundwater Monitoring Well 299-E33-28
9.3.5	Groundwater Monitoring Well 299-E33-29
9.3.6	Groundwater Monitoring Well LLBGWMA-1_PW-1
9.3.7	Groundwater Monitoring Well LLBGWMA-1_PW-2
9.3.8	Groundwater Monitoring Well LLBGWMA-1_PW-3

This groundwater monitoring plan includes the following chapters and appendices:

- Chapter 2 describes the groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, and sampling frequency.
- Chapter 3 describes data evaluation and reporting.
- Chapter 4 provides an outline for a groundwater quality assessment plan.
- Chapter 5 contains the references cited in this plan.
- Appendix A provides the quality assurance project plan (QAPjP) and the analytical methods for LLBG WMA-1 sampling constituents.
- Appendix B contains sampling protocols.
- Appendix C provides information for the wells within the groundwater monitoring network.

1.1 Regulatory Basis

In May 1987, DOE issued a final rule (10 CFR 962, “Byproduct Material”) stating that the hazardous waste components of mixed waste are subject to RCRA regulations. Ecology gained regulatory authority over the hazardous waste components of mixed waste on August 19, 1987.

In May 1989, DOE, the U.S. Environmental Protection Agency (EPA), and Ecology signed Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). This agreement established the roles and responsibilities of the agencies involved in regulating and controlling remedial restoration of the Hanford Site, which includes LLBG WMA-1. Groundwater monitoring is conducted at LLBG WMA-1 in accordance with WAC 173-303-400(3) (and, by reference, 40 CFR 265, Subpart F), which requires monitoring to determine whether the dangerous waste constituents from LLBG WMA-1 have entered the groundwater in the uppermost aquifer underlying the unit.

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

In 1987, interim status groundwater monitoring at LLBG WMA-1 began under the indicator evaluation program requirements of 40 CFR 265, Subpart F (as referenced by WAC 173-303-400[3]). LLBG WMA-1 was monitored under an indicator evaluation program until 1989, when it entered a groundwater quality assessment program due to an exceedance of the critical mean[1] for specific conductance at a downgradient well (WHC-SD-EN-AP-021, *Interim-Status Ground-Water Quality Assessment Program Plan for Waste Management Area 1 of the 200 Areas Low-Level Burial Grounds*). In April 1994, a groundwater quality assessment report determined that elevated specific conductance was not attributable to LLBG WMA-1, but was likely caused by discharges from liquid waste disposal facilities to the south, potentially the 216-B-55 and 216-B-62 Cribs (Sections 3.2 and 4.0 in WHC-SD-EN-EV-025, *Result of the Groundwater Quality Assessment Program at Low-Level Waste Management Area 1 of the Low-Level Burial Ground*s). Groundwater monitoring subsequently returned to an indicator evaluation program.

In December 1998, a specific conductance critical mean exceedance occurred at a downgradient well. A notification letter and an assessment report were submitted to Ecology in March 1999 (Furman, 1999, "Notification of Specific Conductance Exceedance at Low-Level Waste Management Area 1 (218-E-10)"). The letter report determined that the specific conductance exceedance was associated with migration of nitrate from the BY Cribs. Based on the determination, no further action was required and groundwater monitoring subsequently returned to an indicator evaluation program.

In January 2012, the critical mean for total organic carbon (TOC) was exceeded at a downgradient well and monitoring changed to a groundwater quality assessment program (DOE/RL-2012-35, *First Determination RCRA Groundwater Quality Assessment Plan for Low-Level Burial Grounds Low-Level Waste Management Area-1*). An evaluation of the assessment sample results determined that no dangerous waste or dangerous waste constituents in groundwater were associated with LLBG WMA-1 (Chapters 2 and 3 in DOE/RL-2013-25, *First Determination RCRA Groundwater Quality Assessment Report for Low-Level Burial Grounds Low-Level Waste Management Area-1*). In January 2013, the WMA returned to an indicator evaluation monitoring program under DOE/RL-2009-75, Rev. 0, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*. In 2016, the most recent monitoring plan revision was issued (DOE/RL-2009-75, Rev. 1) and modified in 2020 via change notice (RCRA-CN-02_DOE/RL-2009-75_R1). Further details of the groundwater monitoring history are available in Section 2.4 of SGW-60590.

[1] The critical mean is a statistically determined background value that is calculated as specified under 40 CFR 265.93(b) and is used to determine if indicator parameters exhibit a significant increase (or pH decrease) in downgradient wells.

1.2 Monitoring Objectives

The objective of the groundwater monitoring program at LLBG WMA-1 is to determine the facility's impact, if any, on the quality of the underlying groundwater. This groundwater monitoring plan addresses specifically those applicable RCRA requirements for interim status DWMUs where no impact to groundwater has been identified. The regulatory requirements applicable to this groundwater monitoring plan are found in WAC 173-303-400(3) and 40 CFR 265.90 through 40 CFR 265.94, "Recordkeeping and Reporting." Table 1-2 identifies where each groundwater monitoring element of the pertinent regulation is addressed within this plan.

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
Applicability	40 CFR 265.90, "Applicability" (a) Within one year after the effective date of these regulations, the owner or operator of a surface impoundment, landfill, or land treatment facility which is used to manage hazardous waste must implement a ground-water monitoring program capable of determining the facility's impact on the quality of ground water in the uppermost aquifer underlying the facility, except as §265.1 and paragraph (c) of this section provide otherwise. (b) Except as paragraphs (c) and (d) of this section provide otherwise, the owner or operator must install, operate, and maintain a ground-water monitoring system which meets the requirements of §265.91, and must comply with §§265.92 through 265.94. This ground-water monitoring program must be carried out during the active life of the facility, and for disposal facilities, during the post-closure care period as well.	Chapter 1
Number and location of wells	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 numbers, locations, and depths must ensure that they immediately detect any statistically significant amounts of dangerous waste or dangerous waste constituents that migrate from the waste management area to the uppermost aquifer.	Section 2.2 and Table 2-4

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
Well configuration	40 CFR 265.91: (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. 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 bore hole 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 from WAC 173-303-400(3)(c)(v)(C), "Dangerous Waste Regulations," "Interim Status Facility Standards": Ground water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. Chapter 173-160 WAC may be used as guidance in the installation of wells.	Section 2.2 and Appendix C
Sample protocols Analytical methods	40 CFR 265.92, "Sampling and Analysis": (a) The owner or operator must obtain and analyze samples from the installed ground-water monitoring system. The owner or operator must develop and follow a ground-water sampling and analysis plan. He must keep this plan at the facility. The plan must include procedures and techniques for: (1) Sample collection; (2) Sample preservation and shipment; (3) Analytical procedures; and (4) Chain of custody control.	Appendix A, Section A3 and Appendix B, Sections B2 through B5
Parameters to be sampled Frequency of sampling Water-level measurements	40 CFR 265.92: (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[b]. (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 ground-water quality assessment is required under §265.93(d).] (3) Parameters used as indicators of ground-water contamination: (i) pH (ii) Specific conductance	Section 2.1 and Appendix B, Section B2.2

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
	(iii) Total organic carbon (iv) Total organic halogen (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. He 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. (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 semi-annually. (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	
Groundwater quality assessment program plan outline	40 CFR 265.93, "Preparation, Evaluation, and Response": (a) Within one year after the effective date of these regulations, the owner or operator must prepare an outline of a ground-water quality assessment program. The outline must describe a more comprehensive ground-water monitoring program (than that described in §§265.91 and 265.92) capable of determining: (1) Whether hazardous waste or hazardous waste constituents have entered the ground water; (2) The rate and extent of migration of hazardous waste or hazardous waste constituents in the ground water; and (3) The concentrations of hazardous waste or hazardous waste constituents in the ground water.	Chapter 4
Methods used to evaluate the collected data and responses	40 CFR 265.93: (b) For each indicator parameter specified in §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 §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.	Sections 3.1, 3.2, 3.3 and Appendix A

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
	(c)(2) If the comparison for downgradient wells made under paragraph (b) of this section show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional ground-water samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error. (d)(1) If the analyses performed under paragraph (c)(2) of this section confirm the significant increase (or pH decrease), the owner or operator must provide written notice to the department-within seven days of the date of such confirmation-that the facility may be affecting ground-water quality. (d)(2) Within 15 days after the notification under paragraph (d)(1) of this section, the owner or operator must develop a specific plan, based on the outline required under paragraph (a) of this section and certified by a qualified geologist or geotechnical engineer, for a ground-water quality assessment at the facility.	
Recordkeeping and reporting	40 CFR 265.93: (c)(1) If the comparisons for the *upgradient* wells made under paragraph (b) of this section show a significant increase or (pH decrease), the owner or operator must submit this information in accordance with §265.94(a)(2)(ii). 40 CFR 265.94, "Recordkeeping and Reporting": (a)(1) Keep records of the analyses required in §265.92(c) and (d), the associated ground-water surface elevations required in §265.92(e), and the evaluation required in §265.93(b) throughout the active life of the facility. (a)(2) Report the following ground-water monitoring information to the department: (ii) Annually: Concentrations or values of the parameters listed in §265.92(b)(3) for each ground-water monitoring well, along with the required evaluations for these parameters under §265.93(b). The owner or operator must separately identify any significant differences from the initial background found in the upgradient wells, in accordance with §265.93(c)(1). (iii) No later than March 1 following each calendar year: Results of the evaluations of ground-water surface elevations under §265.93(f), and a description of the response to that evaluation, where applicable.	Section 3.5 Appendix A, Sections A2.5 and A3.9

Notes: Complete reference citations are provided in Chapter 5.

In accordance with WAC 173-303-400(3)(b), "Dangerous Waste Regulations," "Interim Status Facility Standards," for the purposes of applying the interim status standards of 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring" the federal terms "Regional Administrator" means the "Department" and "Hazardous" means "Dangerous."

In accordance with Section I.A of WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (Hanford Facility RCRA Permit), this unit will continue to be considered an interim status unit until it is incorporated into Part III, V, and/or VI of the

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan

Hanford Facility RCRA Permit (or its successor) or until interim status is terminated. Therefore, groundwater monitoring continues under interim status requirements.

a. Regulatory requirements for interim status units, where no impact to groundwater has been identified, are found in WAC 173-303-400(3) and 40 CFR 265.90, "Applicability," through 40 CFR 265.94, "Recordkeeping and Reporting," which are applicable to this groundwater monitoring plan.

b. The parameters characterizing the suitability of the groundwater as a drinking water supply, as specified in 40 CFR 265, Appendix III, "EPA Interim Primary Drinking Water Standards," are conducted only during the first year of monitoring of a unit in accordance with 40 CFR 265.92(c)(1), "Sampling and Analysis." Because the first year of monitoring at this unit has been completed, Appendix III sampling is not applicable under this plan. New wells added to the monitoring network in this plan will be sampled for the constituents identified in Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*, for the first 1-year monitoring period to evaluate for any dangerous waste constituents or inadvertent contamination that occurred from the well drilling process (e.g., introduction of oil, grease, or other well construction materials used during drilling operations).

In addition to the parameters required by 40 CFR 265.92, "Sampling and Analysis," supporting constituents are monitored at LLBG WMA-1 (Table 1-3). Sampling will be performed to support charge balance calculation (alkalinity, anions [chloride, nitrate, and sulfate] and metals [calcium, magnesium, potassium, and sodium]); identify corrosion in stainless steel well casing (chromium, iron, manganese, molybdenum, and nickel); and provide information on water properties at the time of sampling (dissolved oxygen, temperature, and turbidity).

Table 1-3. Additional Monitoring Objectives

Monitoring Objective/Rationale	Supporting Constituents and Field Measurements*
Charge balance calculations	Alkalinity Anions (chloride, nitrate, and sulfate) Metals (calcium, magnesium, potassium, and sodium)
Monitoring for stainless steel well casing corrosion constituents	Metals (chromium, iron, manganese, molybdenum, and nickel)
Information on groundwater properties at the time of sampling	Field measurements (dissolved oxygen, temperature, and turbidity)

*Sampling for supporting constituents and field measurements is not required by WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," or 40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring."

2 Groundwater Monitoring Program

This chapter describes the groundwater monitoring indicator evaluation program for LLBG WMA-1, consisting of parameters used as indicators of groundwater contamination, parameters establishing groundwater quality, supporting constituents, sampling frequency, monitoring well network, and sampling and analysis protocols. This chapter also summarizes the differences between this plan and the previous groundwater monitoring plan (DOE/RL-2009-75, Rev. 1, as modified by RCRA-CN-02_DOE/RL-2009-75_R1).

2.1 Constituent List and Sampling Frequency

Table 2-1 presents the wells in the groundwater monitoring network, parameters and constituents to be analyzed, and the sampling frequency for monitoring of LLBG WMA-1. Parameters used as indicators of groundwater contamination (pH, specific conductance, TOC, and total organic halogen [TOX]) will be sampled and analyzed semiannually (40 CFR 265.92(b)(3) and (d)(2)), except for new wells (LLBGWMA-1_PW-1 [299-E33-272], LLBGWMA-1_PW-2 [299-E28-35], and LLBGWMA-1_PW-3 [299-E33-276]), which require quarterly sampling and analysis during the first 1-year monitoring period. Parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate) will be sampled and analyzed annually (40 CFR 265.92(b)(2) and (d)(1)), except for the new wells, which will require quarterly sampling and analysis for the first 1-year monitoring period. The specific phenols to be analyzed as groundwater quality parameters are identified in Table 2-2.

Although not required to be collected under 40 CFR 265, supporting constituents (Table 1-3) will be sampled and analyzed semiannually to support interpretation of the required groundwater monitoring results and monitor the condition of the network wells[2]. New wells (LLBGWMA-1_PW-1 [299-E33-272], LLBGWMA-1_PW-2 [299-E28-35], and LLBGWMA-1_PW-3 [299-E33-276]) will be sampled quarterly for supporting constituents for the first 1-year monitoring period, after which sampling will be performed semiannually. Supporting constituents are collected as follows:

- Charge balance calculation: alkalinity, anions (chloride, nitrate, and sulfate), and metals (calcium, magnesium, potassium, and sodium)
- Well casing corrosion constituents: chromium, iron, manganese, molybdenum, and nickel
- Field measurements to provide information on water properties: dissolved oxygen, temperature, and turbidity

[2] Some supporting constituents (chloride, iron, manganese, sodium, and sulfate) that are needed to support interpretation of groundwater conditions are also required to be collected as groundwater quality parameters under 40 CFR 265.92(b)(2). The remaining supporting constituents are not required or subject to requirements under 40 CFR 265.

Table 2-1. Monitoring Well Network and Sample Schedule for LLBG WMA-1

Well Name	Purpose	WAC Compliant	RCRA-Required Parameters[a]											Supporting Constituents[b]				Table 2-3 Constituents[g]
				Contamination Indicator Parameters				Groundwater Quality Parameters										
			Water Level	pH	Specific Conductance	Total Organic Carbon	Total Organic Halogen	Chloride	Iron	Manganese	Phenols[c]	Sodium	Sulfate	Alkalinity	Anions[d]	Field Measurements[e]	Metals[f]	
299-E32-3	Upgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	N/A
299-E33-266	Upgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	N/A
299-E28-27	Downgradient	N	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	N/A
299-E33-28	Downgradient	N	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	N/A
299-E33-29	Downgradient	N	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	N/A
LLBGWMA-1_PW-1 (299-E33-272)	Downgradient	Y	E	Q4/S4	Q4/S4	Q4/S4	Q4/S4	Q/A	Q/A	Q/A	Q/A	Q/A	Q/A	Q/S	Q/S	Q/S	Q/S	Q
LLBGWMA-1_PW-2 (299-E28-35)	Downgradient	Y	E	Q4/S4	Q4/S4	Q4/S4	Q4/S4	Q/A	Q/A	Q/A	Q/A	Q/A	Q/A	Q/S	Q/S	Q/S	Q/S	Q
LLBGWMA-1_PW-3 (299-E33-276)	Downgradient	Y	E	Q4/S4	Q4/S4	Q4/S4	Q4/S4	Q/A	Q/A	Q/A	Q/A	Q/A	Q/A	Q/S	Q/S	Q/S	Q/S	Q

Note: Samples for metals that are analyzed by either method 6010 or 6020 in Table A-3 will be collected as both filtered and unfiltered samples.

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

b. Supporting constituents specified in Table 1-3 are used to support interpretation of the required groundwater monitoring results and provide a better understanding of the potential condition of the network wells. Some constituents (chloride, iron, manganese, sodium, and sulfate) are also collected as groundwater quality parameters, and are subject to collection requirements under 40 CFR 265.92. The remaining supporting constituents are not required, or subject to requirements, under 40 CFR 265. Supporting constituents will be sampled semiannually.

c. The specific phenols to be analyzed as groundwater quality parameters are identified in Table 2-2.

Table 2-1. Monitoring Well Network and Sample Schedule for LLBG WMA-1

Well Name	Purpose	WAC Compliant	RCRA-Required Parameters[a]												Supporting Constituents[b]				Table 2-3 Constituents[g]
				Contamination Indicator Parameters				Groundwater Quality Parameters											
			Water Level	pH	Specific Conductance	Total Organic Carbon	Total Organic Halogen	Chloride	Iron	Manganese	Phenols[c]	Sodium	Sulfate	Alkalinity	Anions[d]	Field Measurements[e]	Metals[f]	

d. Anions include chloride, nitrate, and sulfate.

e. Field measurements include dissolved oxygen, temperature, and turbidity.

f. Metals include calcium, magnesium, potassium, and sodium for groundwater chemistry and charge balance calculations and chromium, iron, manganese, molybdenum, and nickel for identification of well casing corrosion.

g. Sampling for the constituents identified in Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100* (Table 2-3), will be performed during the first 1-year monitoring period at newly drilled wells. This sampling will apply to new wells (LLBGWMA-1_PW-1 [299-E33-272], LLBGWMA-1_PW-2 [299 E28-35], and LLBGWMA-1_PW-3 [299-E33-276]). Sampling for these constituents may be discontinued after completion of the first year of monitoring. At the discretion of DOE, monitoring for constituents identified in Table 2-3 (or a subset of the constituents) may continue at newly installed wells beyond the first 1-year monitoring period if deemed necessary.

A = to be sampled annually
CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
E = to be sampled at every event
N = well is not constructed as a resource protection well (WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells")
N/A = not applicable
Q = to be sampled quarterly for the first year of monitoring
Q4 = to be sampled quarterly, with quadruplicate samples collected during each event
RCRA = *Resource Conservation and Recovery Act of 1976*
S = to be sampled semiannually
S4 = to be sampled semiannually, with quadruplicate samples collected during each event
WAC = Washington Administrative Code
Y = well is, or will be, constructed as a resource protection well

Table 2-2. Phenols Analyzed as Groundwater Quality Constituents

Constituent	CAS Number
2-Chlorophenol	95-57-8
2-Methylphenol (o-Cresol)	95-48-7
2-Nitrophenol (o-Nitrophenol)	88-75-5
2,3,4,6-Tetrachlorophenol	58-90-2
2,4-Dichlorophenol	120-83-2
2,4-Dimethylphenol (2,4-Xylenol)	105-67-9
2,4-Dinitrophenol	51-28-5
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
2,6-Dichlorophenol	87-65-0
3-Methylphenol (m-Cresol)	108-39-4*
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7
4-Methylphenol (p-Cresol)	106-44-5*
4,6-Dinitro-o-cresol (4,6-Dinitro-2-methyl phenol)	534-52-1
Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	88-85-7
p-Nitrophenol (4-Nitrophenol)	100-02-7
Pentachlorophenol	87-86-5
Phenol	108-95-2

Note: This table provides the specific phenols to be included for analysis as groundwater quality parameters under this monitoring plan

*Analyzed and reported as 3 & 4 methylphenol (CAS number 65794-96-9).

CAS = Chemical Abstracts Service

The analytical methods associated with the sampling constituents are provided in Table A-3 in Appendix A. Samples for metals that are analyzed by either method 6010 or 6020 in Table A-3 will be collected as both filtered and unfiltered samples.

Once installed, new wells (LLBGWMA-1_PW-1 [299-E33-272], LLBGWMA-1_PW-2 [299-E28-35], and LLBGWMA-1_PW-3 [299-E33-276]) will be sampled quarterly for the constituents identified in Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100* (Table 2-3), for the first 1-year monitoring period to evaluate for any dangerous waste constituents or inadvertent contamination that occurred from the well drilling process (e.g., introduction of oil, grease, or other well construction materials used during drilling operations). The 1-year monitoring period at new wells will be performed concurrently with monitoring for indicator parameters, groundwater quality parameters, and supporting constituents; after which, Appendix 5 constituents will no longer be sampled. However, at the discretion of DOE, monitoring for constituents identified in Appendix 5 of Ecology Publication No. 97-407 (or a subset of the constituents) may be continued beyond 1 year if deemed necessary.

Table 2-3. Appendix 5 of Ecology Publication No. 97-407 Constituents

Constituent	CAS Number	Constituent	CAS Number
Inorganic Constituents			
Antimony	7440-36-0	Mercury	7439-97-6
Arsenic	7440-38-2	Nickel	7440-02-0
Barium	7440-39-3	Selenium	7782-49-2
Beryllium	7440-41-7	Silver	7440-22-4
Cadmium	7440-43-9	Sulfide	18496-25-8
Chromium	7440-47-3	Thallium	7440-28-0
Cobalt	7440-48-4	Tin	7440-31-5
Copper	7440-50-8	Vanadium	7440-62-2
Cyanide (total and free)	57-12-5	Zinc	7440-66-6
Lead	7439-92-1	--	--
Volatile Organic Compounds			
1,1-Dichloroethane	75-34-3	Carbon tetrachloride	56-23-5
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	Chlorobenzene	108-90-7
1,1,1-Trichloroethane	71-55-6	Chloroethane	75-00-3
1,1,1,2-Tetrachloroethane	630-20-6	Chloroform	67-66-3
1,1,2-Trichloroethane	79-00-5	Chloroprene	126-99-8
1,1,2,2-Tetrachloroethane	79-34-5	Dibromochloromethane	124-48-1
1,2-Dibromo-3-chloropropane	96-12-8	p-Dichlorobenzene (1,4-Dichlorobenzene)	106-46-7
1,2-Dibromoethane	106-93-4	Dichlorodifluoromethane	75-71-8
1,2-Dichloroethane	107-06-2	Ethylbenzene	100-41-4
1,2-Dichloropropane	78-87-5	Ethyl methacrylate	97-63-2
trans-1,2-Dichloroethylene	156-60-5	Isobutanol (Isobutyl alcohol)	78-83-1
1,2,3-Trichloropropane	96-18-4	Methacrylonitrile	126-98-7

Table 2-3. Appendix 5 of Ecology Publication No. 97-407 Constituents

Constituent	CAS Number	Constituent	CAS Number
cis-1,3-Dichloropropene	10061-01-5	Methyl bromide (Bromomethane)	74-83-9
trans-1,3-Dichloropropene	10061-02-6	Methyl chloride (Chloromethane)	74-87-3
trans-1,4-Dichloro-2-butene	110-57-6	Methyl iodide (Iodomethane)	74-88-4
2-Butanone (Methyl ethyl ketone; MEK)	78-93-3	Methyl methacrylate	80-62-6
2-Propanone (Acetone)	67-64-1	Methylene bromide (Dibromomethane)	74-95-3
2-Hexanone (Methyl butyl ketone)	591-78-6	Methylene chloride	75-09-2
4-Methyl-2-pentanone (Methyl isobutyl ketone)	108-10-1	Propionitrile (Ethyl cyanide)	107-12-0
Acetonitrile (Methyl cyanide)	75-05-8	Styrene	100-42-5
Acrolein	107-02-8	Tetrachloroethene	127-18-4
Acrylonitrile	107-13-1	Toluene	108-88-3
Allyl chloride	107-05-1	Trichloroethene (TCE)	79-01-6
Benzene	71-43-2	Trichlorofluoromethane	75-69-4
Bromodichloromethane	75-27-4	Vinyl acetate	108-05-4
Bromoform	75-25-2	Vinyl chloride (Chloroethene)	75-01-4
Carbon disulfide	75-15-0	Xylenes (total) (mixed isomers)	1330-20-7
Semivolatile Organic Compounds			
1-Naphthylamine	134-32-7	Dibenzofuran	132-64-9
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	m-Dichlorobenzene (1,3-Dichlorobenzene)	541-73-1
1,2,4-Trichlorobenzene	120-82-1	Diethyl phthalate	84-66-2
1,2,4,5-Tetrachlorobenzene	95-94-3	O,O-Diethyl O-2-pyrazinyl phosphorothioate	297-97-2
1,4-Dioxane	123-91-1	p-(Dimethylamino)azobenzene	60-11-7
1,4-Naphthoquinone	130-15-4	alpha, alpha-Dimethylphenethylamine	122-09-8
2-Acetylaminofluorene	53-96-3	Dimethyl phthalate	131-11-3
2-Chloronaphthalene	91-58-7	Di-n-butyl phthalate	84-74-2
2-Chlorophenol	95-57-8	m-Dinitrobenzene	99-65-0
2-Methylphenol (o-Cresol)	95-48-7	Di-n-octylphthalate	117-84-0
2-Methylnaphthalene	91-57-6	Diphenylamine	122-39-4
2-Naphthylamine	91-59-8	Ethyl methanesulfonate	62-50-0
2-Nitrophenol (o-Nitrophenol)	88-75-5	Fluoranthene	206-44-0
2-Picoline	109-06-8	9H-Fluorene (Fluorene)	86-73-7
2,3,4,6-Tetrachlorophenol	58-90-2	Hexachlorobenzene	118-74-1
2,4-Dichlorophenol	120-83-2	Hexachlorobutadiene	87-68-3

Table 2-3. Appendix 5 of Ecology Publication No. 97-407 Constituents

Constituent	CAS Number	Constituent	CAS Number
2,4-Dimethylphenol	105-67-9	Hexachlorocyclopentadiene	77-47-4
2,4-Dinitrophenol	51-28-5	Hexachloroethane	67-72-1
2,4-Dinitrotoluene	121-14-2	Hexachlorophene	70-30-4
2,4,5-Trichlorophenol	95-95-4	Hexachloropropene	1888-71-7
2,4,6-Trichlorophenol	88-06-2	Indeno(1,2,3-cd)pyrene	193-39-5
2,6-Dichlorophenol	87-65-0	Isophorone	78-59-1
2,6-Dinitrotoluene	606-20-2	Isosafrole	120-58-1
3-Methylcholanthrene	56-49-5	Methapyrilene	91-80-5
3-Methylphenol (m-Cresol)	108-39-4	Methyl methanesulfonate	66-27-3
4-Methylphenol (p-Cresol)	106-44-5	Naphthalene	91-20-3
3,3′-Dichlorobenzidine	91-94-1	Nitrobenzene	98-95-3
3,3′-Dimethylbenzidine	119-93-7	o-Nitroaniline (2-Nitroaniline)	88-74-4
4-Aminobiphenyl	92-67-1	m-Nitroaniline (3-Nitroaniline)	99-09-2
4-Bromophenyl phenyl ether	101-55-3	p-Nitroaniline (4-Nitroaniline)	100-01-6
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	p-Nitrophenol (4-Nitrophenol)	100-02-7
4-Chlorophenyl phenyl ether	7005-72-3	n-Nitrosodi-n-butylamine	924-16-3
4-Nitroquinoline 1-oxide	56-57-5	n-Nitrosodiethylamine	55-18-5
4,6-Dinitro-o-cresol (4,6-Dinitro-2-methyl phenol)	534-52-1	n-Nitrosodimethylamine	62-75-9
5-Nitro-o-toluidine	99-55-8	n-Nitrosodiphenylamine	86-30-6
7,12-Dimethylbenz[a]anthracene	57-97-6	n-Nitroso-di-n-dipropylamine (n-Nitrosodipropylamine; Di-n-propylnitrosamine)	621-64-7
Acenaphthene	83-32-9	n-Nitrosomethylethalamine	10595-95-6
Acenaphthylene	208-96-8	n-Nitrosomorpholine	59-89-2
Acetophenone	98-86-2	n-Nitrosopiperidine	100-75-4
Aniline	62-53-3	n-Nitrosopyrrolidine	930-55-2
Anthracene	120-12-7	Pentachlorobenzene	608-93-5
Aramite	140-57-8	Pentachloroethane	76-01-7
Benz[a]anthracene (Benzo[a]anthracene)	56-55-3	Pentachloronitrobenzene	82-68-8
Benz[e]acephenanthrylene (Benzo[b]fluoranthene)	205-99-2	Pentachlorophenol	87-86-5
Benzo[k]fluoranthene	207-08-9	Phenacetin	62-44-2
Benzo[ghi]perylene	191-24-2	Phenanthrene	85-01-8
Benzo[a]pyrene	50-32-8	Phenol	108-95-2

Table 2-3. Appendix 5 of Ecology Publication No. 97-407 Constituents

Constituent	CAS Number	Constituent	CAS Number
Benzyl alcohol	100-51-6	p-Phenylenediamine	106-50-3
Bis(2-chloroethoxy)methane	111-91-1	Pyrene	129-00-0
Bis(2-chloroethyl)ether	111-44-4	Pyridine	110-86-1
Bis(2-chloro-1-methylethyl) ether (2,2'-Oxybis(1-chloropropane))	108-60-1	Safrole	94-59-7
Bis(2-ethylhexyl) phthalate	117-81-7	Tetraethyl dithiopyrophosphate	3689-24-5
Butylbenzylphthalate	85-68-7	o-Toluidine	95-53-4
p-Chloroaniline (4-Chloroaniline)	106-47-8	O,O,O-Triethyl phosphorothioate	126-68-1
Chrysene	218-01-9	sym-Trinitrobenzene	99-35-4
Dibenz[a,h]anthracene	53-70-3	--	--
Herbicides			
2,4-D; 2,4-Dichlorophenoxyacetic acid	94-75-7	Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	88-85-7
2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	93-76-5	Pronamide	23950-58-5
Diallate	2303-16-4	Silvex; 2,4,5-TP	93-72-1
Pesticides			
4,4′-DDD	72-54-8	Endosulfan II	33213-65-9
4,4′-DDE	72-55-9	Endosulfan sulfate	1031-07-8
4,4′-DDT	50-29-3	Endrin	72-20-8
Aldrin	309-00-2	Endrin aldehyde	7421-93-4
alpha-BHC	319-84-6	Famphur	52-85-7
beta-BHC	319-85-7	Heptachlor	76-44-8
delta-BHC	319-86-8	Heptachlor epoxide	1024-57-3
gamma-BHC (Lindane)	58-89-9	Isodrin	465-73-6
Chlordane	57-74-9	Kepone	143-50-0
Chlorobenzilate	510-15-6	Methoxychlor	72-43-5
Dieldrin	60-57-1	Methyl parathion	298-00-0
Dimethoate	60-51-5	Parathion	56-38-2
Disulfoton	298-04-4	Phorate	298-02-2
Endosulfan I	959-98-8	Toxaphene	8001-35-2
Polychlorinated Biphenyls			
Aroclor 1016	12674-11-2	Aroclor 1248	12672-29-6
Aroclor 1221	11104-28-2	Aroclor 1254	11097-69-1
Aroclor 1232	11141-16-5	Aroclor 1260	11096-82-5

Table 2-3. Appendix 5 of Ecology Publication No. 97-407 Constituents

Constituent	CAS Number	Constituent	CAS Number
Aroclor 1242	53469-21-9	--	--
Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans			
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	Pentachlorodibenzofurans	30402-15-4
Hexachlorodibenzo-p-dioxins	34465-46-8	Tetrachlorodibenzo-p-dioxins	41903-57-5
Hexachlorodibenzofurans	55684-94-1	Tetrachlordibenzofurans	55722-27-5
Pentachlorodibenzo-p-dioxins	36088-22-9	--	--

Note: This table identifies the constituents in Appendix 5 of Ecology Publication No. 97-407, *Chemical Test Methods for Designating Dangerous Waste WAC 173-303-090 & -100*.

CAS = Chemical Abstracts Service

In the event that the well network is modified and an existing well[3] is added to the network, the newly added existing well will be sampled quarterly for the constituents identified in Appendix 5 of Ecology Publication No. 97-407 (Table 2-3) during the first 1-year monitoring period to evaluate for any dangerous waste constituents.

Consistent with the requirements of 40 CFR 265.92(e), water-level measurements at each monitoring well will be collected at each sampling event.

2.1.1 Sample Schedule Impacts from Well Maintenance and Sampling Logistics

Well maintenance (e.g., pump repairs, periodic well cleaning, and redevelopment) and sampling logistics resulting from multiple factors including environmental (e.g., inclement weather) and access restrictions (e.g., heightened fire danger, area access restriction due to work by other Hanford Site contractors such as in the tank farms) sometimes delay scheduled sampling events. Sampling events are scheduled by month. The Field Work Supervisor (FWS) determines the sampling schedule for a well within a given month. If a well cannot be sampled at the times determined by the FWS, then the FWS and Sample Management and Reporting group, along with the project scientist, consult to determine how best to recover or reschedule the sampling event as close to the original sampling date as possible. If it is observed during the pre-sampling walkdown that one or more network wells cannot be sampled, sampling of the well network will not begin and management will be notified. Depending on the situation, the network sampling is rescheduled as soon as feasible to meet the schedule set forth in this plan. In some cases, it may not be obvious that sampling cannot be performed until a well is accessed (e.g., an issue with a pump).

Missed sampling events that are not rescheduled within the same month are given top priority when scheduling sampling for the following month. In the event that a sampling delay has occurred and the representativeness of the samples is in question, DOE and Ecology may agree to resampling wells. DOE will provide informal notification to Ecology if sampling of the network is delayed past the end of the sampling period (e.g., quarterly, semiannual). Informal notification will be made within 4 weeks of the end of the sampling period. Ecology may provide recommendations in a timely fashion to DOE on how to proceed. Missed or cancelled sampling events are reported to DOE and are documented in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2019-65, *Hanford Site RCRA Groundwater Monitoring Report for 2019*).

[3] "Existing well" refers to any well that is already installed and was not drilled specifically for this monitoring network.

2.1.2 Well Biofouling and Total Organic Carbon Results

Biofouling of wells can result in collection of nonrepresentative groundwater samples and produce nonrepresentative analytical results for TOC. In Hanford Site wells, biofouling is often associated with iron and manganese-oxidizing bacteria. The bacterial growths are physically manifested as slime or as filamentous or flocculent accumulations. The accumulations frequently occur in the screened interval and exhibit discrete coloration (e.g., rusty orange in the case of iron-oxidizing bacteria or black in the case of manganese-oxidizing bacteria).

TOC is a nonspecific analysis that is used as an indicator of the possible presence of regulated organic compounds in groundwater. TOC represents organic compounds in the sample; this includes dissolved organic compounds as well as suspended organic particles that may be present in an unfiltered sample. Suspended organic materials in groundwater samples can include microbial biomass associated with well biofouling. Furthermore, the TOC measurement is subject to positive interference if suspended organic material (e.g., microbial biomass) or dissolved naturally occurring organic compounds (e.g., humic and fulvic acids) are present in the sample.

If elevated concentrations of TOC are measured within a well (particularly, if a TOC concentration above the critical mean is encountered), well maintenance will be contacted and appropriate follow-up activities will be defined to address any accumulated microbiological growth in the well. Well maintenance activities are designed to reduce the impact of biomass transfer from the well and generation of a resultant high TOC value. Well maintenance includes cleaning/rehabilitation of the well to ensure that the groundwater samples collected are representative of ambient groundwater conditions and not the result of sampling of biomass material present within the well. A downhole camera survey and well cleaning are scheduled immediately following receipt of an elevated TOC result where biofouling of the well is suspected. Subsequent to completing the cleaning activities, a well having an exceedance of the critical mean for TOC will be sampled for confirmational laboratory split samples as required under 40 CFR 265.93(c)(2).

2.1.3 Well Casing Corrosion

Groundwater chemistry is routinely reviewed and evaluated. If the groundwater chemistry data for a well demonstrate a consistent upward trend over time for stainless steel corrosion constituents (chromium, iron, manganese, molybdenum, and nickel) in proportionate concentrations as found in stainless steel, it may be an indicator of corrosion. These data are used to provide a better understanding of the potential condition of the network wells and are used for information only.

2.2 Monitoring Well Network

The groundwater well network identified for interim status monitoring of LLBG WMA-1 is the same as that proposed for final status monitoring in Section 9.3 in SGW-60590 and consists of two upgradient wells (299-E32-3 and 299-E33-266) and six downgradient wells (299-E28-27, 299-E28-28, 299-E28-29, LLBGWMA-1_PW-1 [299-E33-272], LLBGWMA-1_PW-2 [299-E28-35], LLBGWMA-1_PW-3 [299-E33-276]) to monitor for potential releases to the water table from LLBG WMA-1 (Figure 2-1). The network wells were selected through the methodology presented in Chapters 5 through 7 of SGW-60590, based on known groundwater conditions. The groundwater flow direction at LLBG WMA-1 is to the east-southeast (Table 1-2 in DOE/RL-2019-65). Specific details regarding the selection of the well locations is presented in Sections 9.3.1 through 9.3.8 of SGW-60590. Information on the wells comprising the network is summarized in Table 2-4.

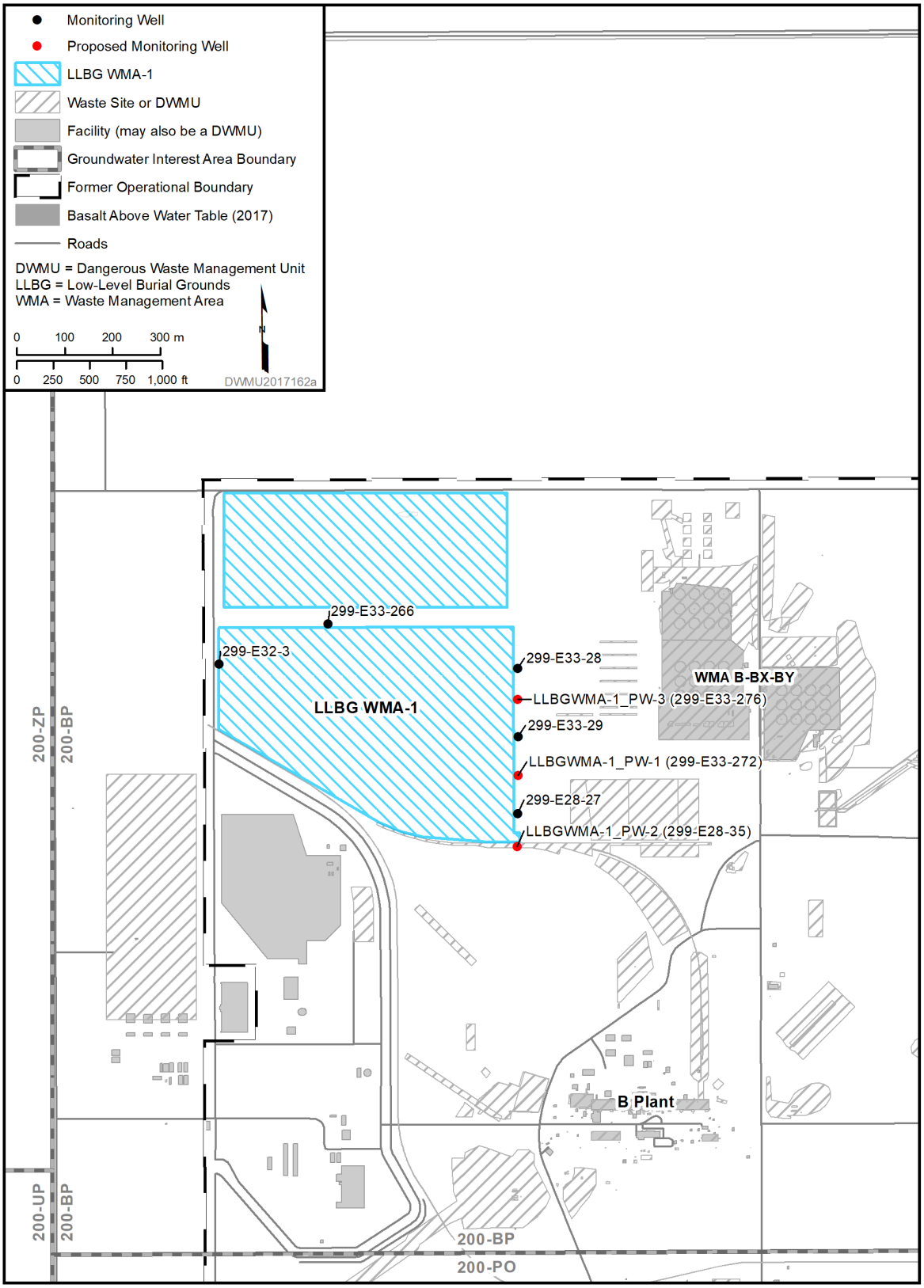

Figure 2-1. LLBG WMA-1 Monitoring Well Network

Table 2-4. Attributes for Wells in the LLBG WMA-1 Groundwater Monitoring Network

Well Name	Completion Date	Easting* (m)	Northing* (m)	Top of Casing Elevation (m [ft]) (NAVD88)	Water Table Elevation (m [ft])	Depth of Water in Screen (m [ft])	Water-Level Date
299-E28-27	9/29/1987	573226.78	137070.06	208.46 (683.93)	121.56 (398.82)	2.1 (6.9)	7/29/2020
299-E32-3	9/30/1987	572600.61	137384.00	207.29 (680.10)	121.52 (398.69)	1.8 (6.0)	7/29/2020
299-E33-28	10/15/1987	573226.37	137375.02	203.55 (667.81)	121.54 (398.74)	2.5 (8.2)	7/29/2020
299-E33-29	9/30/1987	573227.86	137231.19	206.43 (677.28)	121.49 (398.58)	1.9 (6.3)	7/29/2020
299-E33-266	4/26/2010	572828.95	137467.95	204.27 (670.16)	121.40 (398.28)	4.1 (13.5)	7/29/2020
LLBGWMA-1_PW-1 (299-E33-272)	TBD	573227.32	137150.63	TBD	TBD	TBD	TBD
LLBGWMA-1_PW-2 (299-E28-35)	TBD	573224.90	136989.00	TBD	TBD	TBD	TBD
LLBGWMA-1_PW-3 (299-E33-276)	TBD	573226.94	137309.55	TBD	TBD	TBD	TBD

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

Note: Proposed well coordinates are estimates and are subject to modification based on final well location survey.

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

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

If a well is within approximately 2 years of going dry, a replacement well is proposed; such wells that are proposed for installation at the Hanford Site are negotiated annually by Ecology, DOE, and EPA under Tri-Party Agreement Milestone M-24-00 (Ecology et al., 1989).

Construction details and pertinent information for the wells are provided in Appendix C.

2.3 Differences Between This Plan and Previous Plan

Table 2-5 identifies the main differences between this plan and the previous groundwater monitoring plan (DOE/RL-2009-75, Rev. 1, as modified by RCRA-CN-02_DOE/RL-2009-75_R1).

Table 2-5. Main Differences Between this Monitoring Plan and Previous Monitoring Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
Constituents	40 CFR 265 indicator parameters and groundwater quality parameters: included	Same	No change.
	Supporting constituents: alkalinity, anions (chloride, nitrate, and sulfate), and metals (calcium, chromium, iron, manganese, magnesium, molybdenum, nickel, potassium, and sodium) to provide additional groundwater information and detect well corrosion	Same	No change.
	Field parameters: dissolved oxygen, temperature, and turbidity	Field measurements: same	No change.
	Constituents identified in Appendix 5 of Ecology Publication No. 97-407: not applicable	Constituents identified in Appendix 5 of Ecology Publication No. 97-407: included for new wells added to network: LLBGWMA-1_PW-1 (299-E33-272), LLBGWMA-1_PW-2 (299-E28-35), and LLBGWMA-1_PW-3 (299-E33-276)	Sampling of the constituents identified in Appendix 5 of Ecology Publication No. 97-407 will evaluate for the presence of dangerous waste constituents or inadvertent contamination from the well drilling process.
Sampling frequency	40 CFR 265 indicator parameters: semiannually 40 CFR 265 groundwater quality parameters: annually	40 CFR 265 indicator parameters: semiannually at existing wells and quarterly for the first 1-year of monitoring at new wells 40 CFR 265 groundwater quality parameters: annually at existing wells and quarterly for the first 1-year of monitoring at new wells	Added sampling frequency for first 1-year of monitoring.

Table 2-5. Main Differences Between this Monitoring Plan and Previous Monitoring Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
	Supporting constituents: semiannually	Supporting constituents: semiannually at existing wells and quarterly for the first 1-year of monitoring at new wells	Frequency revised to allow sample collection at each event.
	Field parameters: semiannually	Field measurements: semiannually at existing wells and quarterly for the first 1-year of monitoring at new wells	Frequency revised to allow sample collection at each event.
	Constituents identified in Appendix 5 of Ecology Publication No. 97-407: not applicable	Constituents identified in Appendix 5 of Ecology Publication No. 97-407: quarterly for 1 year at new wells added to the network LLBGWMA-1_PW-1 (299-E33-272), LLBGWMA-1_PW-2 (299-E28-35), and LLBGWMA-1_PW-3 (299-E33-276)	Quarterly monitoring for constituents identified in Appendix 5 of Ecology Publication No. 97-407 for 1 year will provide sufficient samples to evaluate groundwater conditions at wells added to the network.
Well network	Upgradient: 299-E32-3 299-E33-266 Downgradient: 299-E28-27 299-E28-28 299-E28-29	Upgradient: 299-E32-3 299-E33-266 Downgradient: 299-E28-27 299-E28-28 299-E28-29 LLBGWMA-1_PW-1 (299-E33-272) LLBGWMA-1_PW-2 (299-E28-35) LLBGWMA-1_PW-3 (299-E33-276)	The well network for the LLBG WMA-1 is revised to match that determined in SGW-60590 for future final status monitoring under Revision 9 of the Hanford Sitewide Permit. The new monitoring network wells (e.g., LLBGWMA-1_PW-1 [299-E33-272] LLBGWMA-1_PW-2 [299-E28-35] LLBGWMA-1_PW-3 [299-E33-276]) will expand the network and allow for the detection of any contamination from LLBG WMA-1.
Groundwater flow direction	East-southeast	Same	No change.
Type of groundwater monitoring program	Indicator parameter monitoring	Same	No change.

Note: Complete reference citations are provided in Chapter 5.

*RCRA-CN-02_DOE/RL-2009-75_R1, *Interim Status Change Number 2: Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*.

2.4 Sampling and Analysis Protocol

The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status DWMUs. The QAPjP outlining the project management structure, data generation and acquisition, analytical procedures, and quality control is provided in Appendix A. Appendix B provides the sampling protocols (e.g., sampling methods, sample handling and custody, management of waste, and health and safety considerations).

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3 Data Evaluation and Reporting

This chapter discusses the evaluation and interpretation of data.

3.1 Data Review

The data review and verification tasks are discussed in the QAPjP (Appendix A).

3.2 Statistical Evaluation

The goal of the groundwater monitoring indicator evaluation program is to determine if the LLBG WMA-1 operations have affected groundwater quality beneath the DWMU based on the results of specified statistical tests. Under this plan, sampling activities and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference into WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general groundwater contamination indicator parameters (pH, specific conductance, TOC, and TOX) to background levels (critical means) to test for potential impact to groundwater. Each time a monitoring well is sampled, four replicate samples for TOC and TOX are collected, and four replicate field measurements are made for pH and specific conductance.

After the updated critical mean values are established, the basic procedure for statistical comparisons is as follows. Semiannually, the monitoring data from downgradient wells are compared to the upgradient (background) results for each of the four indicator parameters. The arithmetic mean and variance must be calculated based on at least four replicate measurements on each sample, for each well monitored, and then compared with the background arithmetic mean obtained (40 CFR 265.92(c)(2)) and updated as discussed in Chapter 5 of EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*. The comparison must consider each of the individual wells in the monitoring system and must use the Student's t-test at the 0.01 level of significance to determine statistically significant increases (increases or decreases in the case of pH) over background (40 CFR 265.93(b) and Appendix IV, "Tests for Significance," to 40 CFR 265). Implementation of the statistical test method at the Hanford Site, including at LLBG WMA-1, is generally consistent with EPA 530/R-09-007. The background statistical analysis is updated annually to establish comparative values for indicator parameters. A rolling mean is used because of changing upgradient concentrations and groundwater flow conditions.

If a downgradient well comparison shows a significant increase (or pH increase or decrease), then the well is resampled. Split samples are sent to different laboratories to determine if the exceedance of the comparison value was the result of laboratory error.

If the exceedance of the statistical comparison value is confirmed by resampling, written notifications are made as detailed in Section 3.5 and in accordance with 40 CFR 265.93(d)(1).

3.3 Interpretation

Data are used to interpret groundwater conditions at LLBG WMA-1. Interpretive techniques may 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 the potential lines 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 groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituent concentrations in the aquifer to determine the extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Illustrate the relative abundances of contaminants from previously characterized Hanford Site-related processes and sources. Comparison of these ratios in groundwater can sometimes be used to distinguish among different sources of contamination (e.g., a specific process and its associated facility). Ratios may provide evidence of continuing source contamination, thereby linking contamination with a specific facility under monitoring. Evaluation of contaminant ratios in concentration trends may be used to demonstrate when facility-specific contamination no longer affects underlying groundwater.

3.4 Annual Determination of Monitoring Network

Groundwater monitoring requirements include an annual evaluation of the network to determine if it remains adequate to monitor the facility's impact on the quality of the groundwater in the uppermost aquifer underlying the facility (40 CFR 265.93(f)). The network must include at least one upgradient and at least three downgradient wells in the uppermost aquifer (40 CFR 265.91(a)(1) and (2), "Ground-Water Monitoring System").

The groundwater monitoring network will continue to be reevaluated annually to ensure that it is adequate to monitor any changing hydrogeologic conditions beneath the unit. If flow changes are observed, the LLBG WMA-1 contaminant migration conceptual model and geochemical trends will be reevaluated to determine the adequacy of the network and any necessary modifications required for the network. If a change in the groundwater flow direction occurs and the monitoring network is no longer aligned to the flow direction, then the monitoring network will be modified and a RCRA change notice or revised monitoring plan will be prepared.

Water-level measurements will continue to be collected during each sampling event. An additional and more comprehensive set of water-level measurements is made annually for selected wells on the Hanford Site. These data are presented in the annual Hanford Site RCRA groundwater monitoring reports (e.g., DOE/RL-2019-65).

3.5 Reporting and Notification

Groundwater monitoring and evaluation of groundwater surface elevation results are reported annually in accordance with the requirements of 40 CFR 265.94(a)(2). Reporting will be made in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2019-65) by March 1.

If an upgradient well comparison shows a significant increase (or pH decrease) relative to the statistical comparison value, that information is also reported (40 CFR 265.93(c)(1)) in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2019-65) by March 1.

If the exceedance of the statistical comparison value is confirmed, written notice is then provided to Ecology within 7 days (40 CFR 265.93(d)(1)) stating that the facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program must be developed and placed in the facility operating record (40 CFR 265.93(d)(2)). This plan must be submitted to Ecology (WAC 173-303-400(3)(c)(v)(D)).

4 Outline for Groundwater Quality Assessment Plan

If a groundwater contamination indicator parameter at a downgradient well significantly exceeds the background value or if pH decreases and is confirmed by verification sampling, a groundwater quality assessment plan will be prepared and submitted to Ecology, and the facility monitoring will be elevated to assessment monitoring status. The assessment program must be capable of determining whether dangerous waste or dangerous waste constituents from the facility have entered the groundwater, the rate and extent of migration, and the concentration. This chapter presents a revision of the groundwater quality assessment monitoring plan outline required by 40 CFR 265.93(a). Information on the facility description, operational history, waste characteristics, geology and hydrogeology, groundwater monitoring history, and contaminant migration conceptual model are provided in the EER for groundwater monitoring associated with this unit, which will be referenced in the groundwater quality assessment monitoring plan. An outline for the assessment plan is presented in Table 4-1.

Table 4-1. Suggested Groundwater Quality Assessment Plan Outline

Introduction
Regulatory Basis
Monitoring Objectives
Groundwater Monitoring
Constituent List and Sampling Frequency
Well Network
Sampling and Analysis Protocol
Data Evaluation and Reporting
Data Review
Data Evaluation
Interpretation
Annual Determination of Monitoring Network
Reporting, Recordkeeping, and Notification
Implementation Schedule
References
Appendix A – Quality Assurance Project Plan
Appendix B – Sampling Protocol
Appendix C – Well Construction

Notes: Information on the facility description, operational history, waste characteristics, geology and hydrogeology, groundwater monitoring history, and contaminant migration conceptual model are provided in the engineering evaluation report for groundwater monitoring associated with this unit, which will be referenced in the groundwater quality assessment monitoring plan.

Changes may be made to this outline, as applicable.

Changes may be made to this outline as applicable. The groundwater quality assessment program may include the following elements:

- Description of the investigative approach for making first determination to decide if dangerous waste or dangerous waste constituents from the facility have entered the groundwater or if the exceedance was caused by other sources (false-positive rationale)
- Description of the approach to characterize rate and extent of contaminant migration
- Number, locations, and depths of wells in the monitoring network
- Sampling and analytical methods used
- Data evaluation methods
- An implementation schedule

The results of assessment determinations will be made as soon as technically feasible and a report of the findings will be sent to Ecology. The results of the groundwater quality assessment program will then be reported annually as required by 40 CFR 265.94(b).

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Appendix A

Quality Assurance Project Plan

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Figure A-1. Project Organization A-2

Terms

DOE	U.S. Department of Energy
DQI	data quality indicator
DUP	duplicate (laboratory)
DWMU	dangerous waste management unit
EB	equipment blank
ECO	Environmental Compliance Officer
EPA	U.S. Environmental Protection Agency
FSO	Field Sample Operations
FTB	full trip blank
FWS	Field Work Supervisor
FXR	field transfer blank
HEIS	Hanford Environmental Information System
MB	method blank
MS	matrix spike
MSD	matrix spike duplicate
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
SMR	Sample Management and Reporting
SPLIT	field split
SUR	surrogate
VOC	volatile organic compound

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A1 Introduction

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. This QAPjP includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection quality assurance (QA) elements for this groundwater monitoring plan. This QAPjP is intended to supplement Hanford Site QA requirements and the contractor's environmental QA program plan.

This QAPjP is divided into the following three chapters that describe the quality requirements and controls applicable to the dangerous waste management unit (DWMU) groundwater monitoring activities:

- Chapter A2, Project Management
- Chapter A3, Data Generation and Acquisition
- Chapter A4, Data Review and Usability

A2 Project Management

This chapter addresses the management approaches planned, project goals, and planned documentation.

A2.1 Project/Task Organization

Project organization (regarding groundwater monitoring) is described in the following sections and illustrated in Figure A-1. Titles used in the project organization are for the purposes of discussing the role of the individual in the performance of the work scope. Individuals with different titles but similar/equivalent positions may fulfill these roles.

A2.1.1 U.S. Department of Energy Manager

Hanford Site operation is the responsibility of the U.S. Department of Energy (DOE). The DOE Manager is responsible for authorizing the contractor to perform activities at the Hanford Site under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; *Resource Conservation and Recovery Act of 1976* (RCRA); *Atomic Energy Act of 1954*; and Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*.

A2.1.2 U.S. Department of Energy Project Lead

The DOE Project Lead is responsible for providing day-to-day oversight of the contractor's performance of the work scope, working with the contractor to identify and work through issues, and providing technical input to DOE management.

A2.1.3 U.S. Department of Energy Prime Contractor Management

The DOE Prime Contractor Management provides oversight and coordinates with DOE in support of sampling and reporting activities. The DOE Prime Contractor Management also provides support to the Prime Contract Project Manager to ensure that work is performed safely and cost effectively.

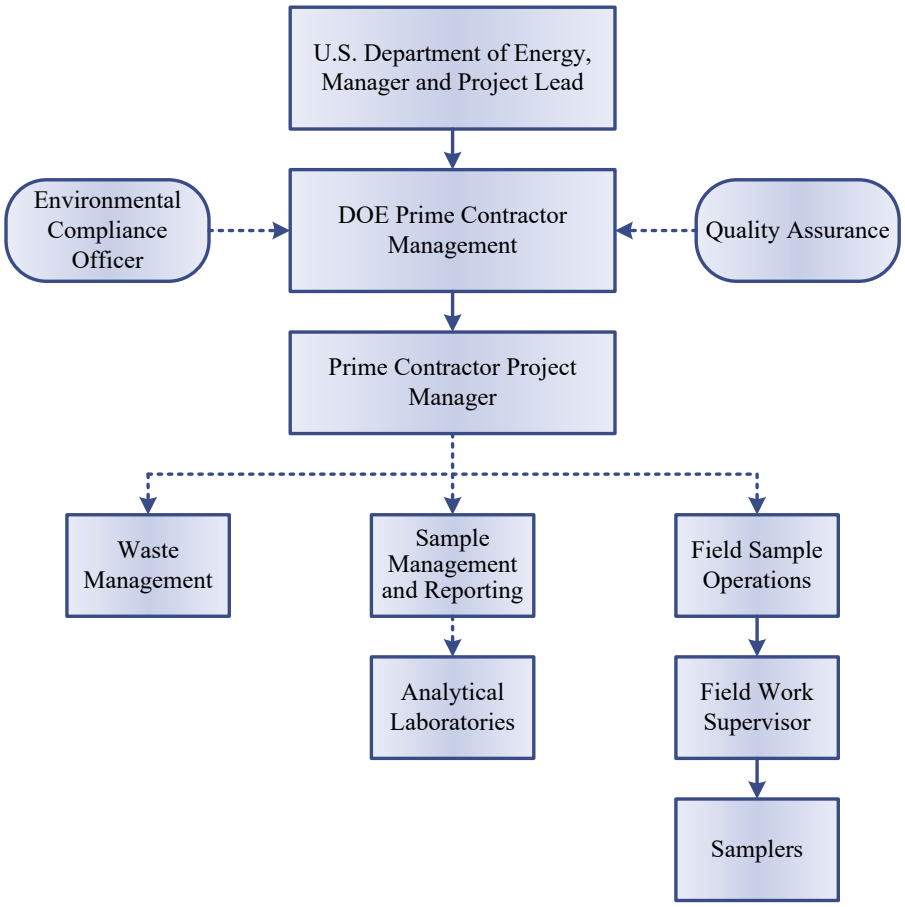

Figure A-1. Project Organization

A2.1.4 Prime Contractor Project Manager

The Prime Contractor Project Manager is responsible for direct management of activities performed to meet DWMU groundwater monitoring requirements. The Prime Contractor Project Manager coordinates with and reports to DOE and DOE Prime Contractor Management regarding DWMU groundwater monitoring requirements. The Prime Contractor Project Manager (or designee) works closely with the Environmental Compliance Officer (ECO), QA, and Sample Management and Reporting (SMR) group to integrate these and other technical disciplines in planning and implementing the work scope. The Prime Contractor Project Manager assigns staff to provide technical expertise.

A2.1.5 Sample Management and Reporting Group

The SMR group oversees offsite analytical laboratories, coordinates laboratory analytical work with this plan, and verifies that laboratories are qualified for performing Hanford Site analytical work. They generate field sampling documents, labels, and instructions for field sampling personnel and develop sample authorization forms that provide information and instruction to the analytical laboratories. The SMR group revises field sampling documents to reflect approved changes. This group's responsibilities include receiving analytical data from the laboratories, performing data entry into the Hanford Environmental Information System (HEIS) database, and arranging for data validation and recordkeeping. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with Field Sample Operations (FSO), laboratories, or other entities. The SMR group is responsible for informing the Prime Contractor Project Manager (or designee) of any issues reported by the analytical laboratories.

A2.1.6 Field Sample Operations

FSO is responsible for planning and coordinating field sampling resources and provides the Field Work Supervisor (FWS) for routine groundwater sampling operations. The FWS directs the samplers who collect groundwater samples for this groundwater monitoring plan. Samplers collect samples, complete field logbooks, data forms, and chain-of-custody forms, including any shipping paperwork, and assist sample delivery to the analytical laboratory.

A2.1.7 Quality Assurance

The QA point of contact provides independent oversight, is responsible for addressing QA issues on the project, and oversees implementation of the project QA program.

A2.1.8 Environmental Compliance Officer

ECOs provide technical oversight, direction, and acceptance of project and subcontracted environmental work, with the goal of minimizing adverse environmental impacts.

A2.1.9 Waste Management

Waste Management identifies waste management sampling/characterization activities for regulatory compliance and is responsible for data interpretation to determine waste designations and profiles. Waste Management communicates policies and practices for project compliance for waste storage, transportation, disposal, and tracking in a safe and cost-effective manner.

A2.1.10 Analytical Laboratories

The laboratories maintain custody and analyze samples in accordance with established quality systems and provide data packages containing sample and quality control (QC) results. As requested, laboratories provide explanations of results to support data review and resolve analytical issues.

A2.2 Problem Definition/Background

The purpose of this groundwater monitoring plan is to satisfy *Washington Administrative Code* and *Code of Federal Regulations* requirements (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," and 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring") for indicator parameter evaluation. Additional information on the activities to satisfy these requirements and background information on monitoring is provided in the main text of this monitoring plan.

A2.3 Project/Task Description

The focus of this plan is to monitor the parameters used as indicators of groundwater contamination and for parameters establishing groundwater quality in accordance with 40 CFR 265.92, "Sampling and Analysis"; evaluate the well network; and interpret analytical results. The indicator parameters to be monitored, along with the monitoring wells and frequency of sampling, are provided in the main text (Chapter 2). Information on the collection and analyses of groundwater from the monitoring network is provided in this appendix and in Appendix B.

A2.4 Quality Assurance Objectives and Criteria

The QA objective of this plan is the generation of analytical data of known and appropriate quality. In support of this objective, the process to assess data usability may include data verification, data validation, or a data quality indicator (DQI) evaluation. Principal DQIs are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These DQIs are defined for the purposes of this document in Table A-1.

Table A-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Possible Corrective Actions
Precision (field duplicates, laboratory sample duplicates, and matrix spike duplicates)	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the relative percent difference.	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory. Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity). • Request reanalysis or remeasurement. • Qualify the data before use.
Accuracy (laboratory control samples, matrix spikes, and surrogates)	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include laboratory control samples, spiked samples, and surrogates.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample).	If recovery does not meet objective: • Qualify the data before use. • Request reanalysis or remeasurement. • Determine if followup evaluation is needed. • Evaluate instrumentation and recalibrate, if necessary.
Representativeness (field duplicates)	Sample representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring that the approved plans were followed during sampling and analysis.	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	If results are not representative of the system sampled: • Identify the reason for the results not being representative. • Flag for further review. • Review data for usability. • If data are usable, qualify the data for limited use and define the portion of the system that the data represent. • If data are not usable, flag as appropriate. • Redefine sampling and measurement requirements and protocols. • Resample and reanalyze, as appropriate.

Table A-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Possible Corrective Actions
Comparability (field duplicate, field splits, laboratory control samples, matrix spikes, and matrix spike duplicates)	Comparability expresses the degree of confidence with which one dataset can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and quality assurance protocols.	If data are not comparable to other datasets: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.
Completeness (no QC element; addressed in data usability assessment)	Completeness is a measure of the amount of valid data collected compared to the amount of data planned. Measurements are considered valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/acceptance criteria).	If dataset does not meet the completeness objective: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future completeness.

Table A-1. Data Quality Indicators

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Possible Corrective Actions
Bias (equipment blanks, field transfer blanks, full trip blanks, laboratory control samples, matrix spikes, and method blanks)	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike).	For sampling bias: • Properly select and use sampling tools. • Institute correct sampling and subsampling processes to limit preferential selection or loss of sample media. • Use sample handling processes, including proper sample preservation, that limit the loss or gain of constituents to the sample media. • Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias. • Laboratories that are known to generate biased data for a specific analyte are asked to correct their methods to remove the bias as practicable. Otherwise, samples are sent to other laboratories for analysis.
Sensitivity (method detection limit, practical quantitation limit, and relative percent difference)	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation[b] is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet objective: • Request reanalysis or remeasurement using methods or analytical conditions that will meet required detection or limit of quantitation. • Qualify/reject the data before use.

Note: Based on SW-846 Compendium (July 2014). Available at: https://www.epa.gov/hw-sw846/sw-846-compendium.

a. Acceptance criteria for QC elements are provided in Table A-5.

b. For purposes of this groundwater monitoring plan, the lower limit of quantitation is interchangeable with the practical quantitation limit.

QC = quality control

The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. The process to assess data usability is further discussed in Chapter A4.

A2.5 Documents and Records

The Prime Contractor Project Manager (or designee) is responsible for ensuring that the current version of the groundwater monitoring plan is used and providing any updates to field personnel. Table A-2 defines the types of changes that may impact the groundwater monitoring plan and the associated approvals, notifications, and documentation requirements. Elements of the monitoring plan that are required by 40 CFR 265, Subpart F, cannot be changed.

Table A-2. Change Control for Monitoring Plans

Type of Change	Action	Documentation
Unintentional impact to groundwater monitoring plan that impacts the requirements of 40 CFR 265, Subpart F, including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of groundwater constituents or parameters, or loss of samples in transit.	Prime Contractor Project Manager provides informal notification to DOE. DOE provides informal notification to Ecology as appropriate.	Copy of informal notification to Ecology is placed in facility operating record. Annual Hanford Site RCRA groundwater monitoring report.
Planned change to groundwater monitoring activities, including addition or deletion of constituents analyzed for, change of sampling frequency, or changes to well network.	Prime Contractor Project Manager obtains DOE approval; revise monitoring plan as appropriate.	Annual Hanford Site RCRA groundwater monitoring report and revised groundwater monitoring plan as appropriate.

Reference: 40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring."

DOE = U.S. Department of Energy

Ecology = Washington State Department of Ecology

RCRA = Resource Conservation and Recovery Act of 1976

Logbooks and data forms are used to document field activities. The logbooks are identified with a unique project name and number. Individuals responsible for the logbooks are identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled documents. Data forms are also identified with a unique project name and number, may be used to record the same field information as logbooks, and are referenced in the logbooks.

The FWS, SMR group, and field crew supervisors are responsible for alignment of field instructions with the groundwater monitoring plan.

Convenience copies of laboratory analytical results are maintained in the HEIS database. Records may be stored in either electronic (e.g., in the managed records area of the Integrated Document Management System) or hardcopy format (e.g., DOE Records Holding Area). Records of analyses required by 40 CFR 265.94, "Recordkeeping and Reporting," are to be maintained throughout the active life of a facility and post-closure care period (if any).

By March 1, groundwater monitoring results are reported in the Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2019-65, *Hanford Site RCRA Groundwater Monitoring Report for 2019*).

A3 Data Generation and Acquisition

This chapter addresses data generation and acquisition so that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented. Instrument calibration and maintenance, supply inspections, and data management are also discussed.

A3.1 Analytical Method Requirements

Sample analytical methods are presented in Table A-3. Equivalent or updated Washington State Department of Ecology-accredited methods may be substituted for the methods identified in Table A-3.

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
General Chemistry			
ALKALINITY	Alkalinity, total as CaCO3	310.1, Standard Method 2320, Standard Method 4500	5250
57-12-5	Cyanide (total)	335.4, 9012, 9014, Standard Method 4500	15.75
57-12-5	Cyanide (free)	9014	4
18496-25-8	Sulfide (total)	376.1, Standard Method 4500S	2100
TOC	Total organic carbon	9060	1050
59473-04-0	Total organic halogen	9020	31.5
Anions[c]			
16887-00-6	Chloride	300, 9056	400
14797-55-8	Nitrate, as NO3	300, 9056	525
14808-79-8	Sulfate	300, 9056	1050
Field Measurements			
--	pH	150.1, 9040, Standard Method 4500 H+	N/A
--	Dissolved oxygen	360.1, Standard Method 4500 O	N/A
--	Specific conductance	120.1, 9050, Standard Method 2520 B-97	N/A

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
--	Temperature	170.1	N/A
--	Turbidity	180.1, Standard Method 2130 B	N/A
Metals			
7440-36-0	Antimony	6020	5.25
7440-38-2	Arsenic	6020	10.5
7440-39-3	Barium	6020	5.25
7440-41-7	Beryllium	6020	1.05
7440-43-9	Cadmium	6020	2.1
7440-70-2	Calcium	6010	1050
7440-47-3	Chromium	6020	10.5
7440-48-4	Cobalt	6020	5.25
7440-50-8	Copper	6020	10
7439-89-6	Iron	6010	105
7439-92-1	Lead	6020	3.15
7439-95-4	Magnesium	6010	1050
7439-96-5	Manganese	6020	10.5
7439-97-6	Mercury	7470	0.5
7439-98-7	Molybdenum	6020	5.25
7440-02-0	Nickel	6020	21
7440-09-7	Potassium	6010	5250
7782-49-2	Selenium	6020	9.5
7440-22-4	Silver	6020	5.25
7440-23-5	Sodium	6010	1050
7440-28-0	Thallium	6020	2.1
7440-31-5	Tin	6020	10.5
7440-62-2	Vanadium	6010	52.5
7440-66-6	Zinc	6010	21
Volatile Organic Compounds			
75-34-3	1,1-Dichloroethane	8260	10
75-35-4	1,1-Dichloroethene (1,1-Dichloroethylene)	8260	10
71-55-6	1,1,1-Trichloroethane	8260	5

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
630-20-6	1,1,1,2-Tetrachloroethane	8260	2.1
79-00-5	1,1,2-Trichloroethane	8260	5
79-34-5	1,1,2,2-Tetrachloroethane	8260	5
96-12-8	1,2-Dibromo-3-chloropropane	8260	5.25
106-93-4	1,2-Dibromoethane (Ethylene dibromide [EDB])	8260	5
107-06-2	1,2-Dichloroethane	8260	5
78-87-5	1,2-Dichloropropane	8260	5
156-60-5	trans-1,2-Dichloroethylene	8260	5
96-18-4	1,2,3-Trichloropropane	8260	5
10061-01-5	cis-1,3-Dichloropropene	8260	5
10061-02-6	trans-1,3-Dichloropropene	8260	5
110-57-6	trans-1,4-Dichloro-2-butene	8260	50
78-93-3	2-Butanone (Methyl ethyl ketone [MEK])	8260	10.5
67-64-1	2-Propanone (Acetone)	8260	20
591-78-6	2-Hexanone (Methyl butyl ketone [MBK])	8260	20
108-10-1	4-Methyl-2-pentanone (Methyl isobutyl ketone [MIBK])	8260	10.5
75-05-8	Acetonitrile (Methyl cyanide)	8260	100
107-02-8	Acrolein	8260	100
107-13-1	Acrylonitrile	8260	100
107-05-1	Allyl chloride	8260	10.5
71-43-2	Benzene	8260	5
75-27-4	Bromodichloromethane	8260	5
75-25-2	Bromoform	8260	5
75-15-0	Carbon disulfide	8260	5
56-23-5	Carbon tetrachloride	8260	3
108-90-7	Chlorobenzene	8260	5
75-00-3	Chloroethane	8260	10
67-66-3	Chloroform	8260	5
126-99-8	Chloroprene (Chloro-1,3-butadiene; 2-)	8260	10

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
124-48-1	Dibromochloromethane	8260	5
106-46-7	p-Dichlorobenzene (1,4-Dichlorobenzene)	8260	4
75-71-8	Dichlorodifluoromethane	8260	10
100-41-4	Ethylbenzene	8260	4
97-63-2	Ethyl methacrylate	8260	10.5
78-83-1	Isobutanol (Isobutyl alcohol)	8260	500
126-98-7	Methacrylonitrile (2-Propenenitrile, 2-methyl-)	8260	10.5
74-83-9	Methyl bromide (Bromomethane)	8260	10
74-87-3	Methyl chloride (Chloromethane)	8260	10
74-88-4	Methyl iodide (Iodomethane)	8260	10.5
80-62-6	Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)	8260	10.5
74-95-3	Methylene bromide (Dibromomethane)	8260	10
75-09-2	Methylene chloride (Dichloromethane)	8260	5.25
107-12-0	Propionitrile (Ethyl cyanide)	8260	21
100-42-5	Styrene	8260	5
127-18-4	Tetrachloroethene (Tetrachloroethylene; Perchloroethylene)	8260	5
108-88-3	Toluene	8260	5
79-01-6	Trichloroethylene (Trichloroethene [TCE])	8260	2.1
75-69-4	Trichlorofluoromethane	8260	10
108-05-4	Vinyl acetate	8260	50
75-01-4	Vinyl chloride (Chloroethene; Chloroethylene)	8260	10
1330-20-7	Xylene (total) (mixed isomers)	8260	10

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
Semivolatile Organic Compounds			
134-32-7	1-Naphthylamine	8270	25
95-50-1	1,2-Dichlorobenzene (o-Dichlorobenzene)	8270	10.5
120-82-1	1,2,4-Trichlorobenzene	8270	13
95-94-3	1,2,4,5-Tetrachlorobenzene	8270	20
123-91-1	1,4-Dioxane (1,4-Diethylene dioxide)	8270	21
130-15-4	1,4-Naphthoquinone	8270	52.5
53-96-3	2-Acetylaminofluorene	8270	105
91-58-7	2-Chloronaphthalene (Beta-chloronaphthalene)	8270	10.5
95-57-8	2-Chlorophenol	8270	10.5
95-48-7	2-Methylphenol (o-Cresol)	8270	10.5
91-57-6	2-Methylnaphthalene	8270	10.5
91-59-8	2-Naphthylamine	8270	10.5
88-75-5	2-Nitrophenol (o-Nitrophenol)	8270	10.5
109-06-8	2-Picoline	8270	21
58-90-2	2,3,4,6-Tetrachlorophenol	8270	52.5
120-83-2	2,4-Dichlorophenol	8270	10.5
105-67-9	2,4-Dimethylphenol (2,4-Xylenol)	8270	10.5
51-28-5	2,4-Dinitrophenol	8270	52.5
121-14-2	2,4-Dinitrotoluene	8270	10.5
95-95-4	2,4,5-Trichlorophenol	8270	10.5
88-06-2	2,4,6-Trichlorophenol	8270	10.5
87-65-0	2,6-Dichlorophenol	8270	10.5
606-20-2	2,6-Dinitrotoluene	8270	10.5
56-49-5	3-Methylcholanthrene	8270	21
108-39-4[d]	3-Methylphenol (m-Cresol)	8270	--
106-44-5[d]	4-Methylphenol (p-Cresol)	8270	--
91-94-1	3,3′-Dichlorobenzidine	8270	105

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
119-93-7	3,3′-Dimethylbenzidine	8270	50
92-67-1	4-Aminobiphenyl	8270	52.5
101-55-3	4-Bromophenyl phenyl ether	8270	10.5
59-50-7	4-Chloro-3-methylphenol (p-Chloro-m-cresol)	8270	10.5
7005-72-3	4-Chlorophenyl phenyl ether	8270	10.5
56-57-5	4-Nitroquinoline 1-oxide	8270	105
534-52-1	4,6-Dinitro-o-cresol (4,6-Dinitro-2-methyl phenol)	8270	52.5
99-55-8	5-Nitro-o-toluidine (Methyl-5-nitroaniline; 2-)	8270	21
57-97-6	7,12-Dimethylbenz[a]anthracene	8270	21
83-32-9	Acenaphthene	8270	10.5
208-96-8	Acenaphthylene	8270	10.5
98-86-2	Acetophenone	8270	10.5
62-53-3	Aniline	8270	10.5
120-12-7	Anthracene	8270	10.5
140-57-8	Aramite	8270	20
56-55-3	Benz[a]anthracene (Benzo[a]anthracene)	8270	10.5
205-99-2	Benz[e]acephenanthrylene (Benzo[b]fluoranthene)	8270	10.5
207-08-9	Benzo[k]fluoranthene	8270	10.5
191-24-2	Benzo[ghi]perylene	8270	10.5
50-32-8	Benzo[a]pyrene	8270	10.5
100-51-6	Benzyl alcohol	8270	10.5
111-91-1	Bis(2-chloroethoxy)methane	8270	10.5
111-44-4	Bis(2-chloroethyl)ether	8270	10.5
108-60-1	Bis(2-chloro-1-methylethyl)ether (2,2'-Oxybis[1-chloropropane])	8270	10.5
117-81-7	Bis(2-ethylhexyl)phthalate	8270	15.7
85-68-7	Butyl benzyl phthalate (Benzyl butyl phthalate)	8270	10.5
106-47-8	p-Chloroaniline (4-Chloroaniline)	8270	10.5
218-01-9	Chrysene	8270	10.5

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
53-70-3	Dibenz[a,h]anthracene (Dibenzanthracene, 1,2,5,6-)	8270	10.5
132-64-9	Dibenzofuran	8270	10.5
541-73-1	m-Dichlorobenzene (1,3-Dichlorobenzene)	8270	10.5
84-66-2	Diethyl phthalate	8270	10.5
297-97-2	O,O-Diethyl O-2-pyrazinyl phosphorothioate (Thionazin)	8270	52.5
60-11-7	p-(Dimethylamino)azobenzene	8270	21
122-09-8	alpha, alpha-Dimethylphenethylamine	8270	52.5
131-11-3	Dimethyl phthalate	8270	10.5
84-74-2	Di-n-butylphthalate (Dibutyl phthalate)	8270	10.5
99-65-0	m-Dinitrobenzene (1,3-Dinitrobenzene)	8270	10.5
117-84-0	Di-n-octylphthalate	8270	10.5
122-39-4	Diphenylamine	8270	10.5
62-50-0	Ethyl methanesulfonate	8270	10.5
206-44-0	Fluoranthene	8270	10.5
86-73-7	9H-Fluorene (Fluorene)	8270	10.5
118-74-1	Hexachlorobenzene	8270	10.5
87-68-3	Hexachlorobutadiene	8270	10.5
77-47-4	Hexachlorocyclopentadiene	8270	10.5
67-72-1	Hexachloroethane	8270	10.5
70-30-4	Hexachlorophene	8270	525
1888-71-7	Hexachloropropene	8270	105
193-39-5	Indeno(1,2,3-cd)pyrene	8270	10.5
78-59-1	Isophorone	8270	10.5
120-58-1	Isosafrole	8270	21
91-80-5	Methapyrilene	8270	52.5
66-27-3	Methyl methanesulfonate	8270	10.5
91-20-3	Naphthalene	8270	10.5
98-95-3	Nitrobenzene	8270	10.5

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
88-74-4	o-Nitroaniline (2-Nitroaniline)	8270	21
99-09-2	m-Nitroaniline (3-Nitroaniline)	8270	21
100-01-6	p-Nitroaniline (4-Nitroaniline)	8270	21
100-02-7	p-Nitrophenol (4-Nitrophenol)	8270	21
924-16-3	n-Nitrosodi-n-butylamine	8270	10.5
55-18-5	n-Nitrosodiethylamine	8270	10.5
62-75-9	n-Nitrosodimethylamine (Dimethyl nitrosamine)	8270	10.5
86-30-6[e]	n-Nitrosodiphenylamine	8270	--
621-64-7	n-Nitroso-di-n-dipropylamine (n-Nitrosodipropylamine; Di-n-propylnitrosamine)	8270	10.5
10595-95-6	n-Nitrosomethylethylamine (Ethanamine, n-methyl-n-nitroso-)	8270	10.5
59-89-2	n-Nitrosomorpholine	8270	10.5
100-75-4	n-Nitrosopiperidine	8270	10.5
930-55-2	n-Nitrosopyrrolidine	8270	10.5
608-93-5	Pentachlorobenzene	8270	10.5
76-01-7	Pentachloroethane	8270	52.5
82-68-8	Pentachloronitrobenzene	8270	52.5
87-86-5	Pentachlorophenol	8270	52.5
62-44-2	Phenacetin	8270	21
85-01-8	Phenanthrene	8270	10.5
108-95-2	Phenol	8270	10.5
106-50-3	p-Phenylenediamine	8270	525
129-00-0	Pyrene	8270	10.5
110-86-1	Pyridine	8270	21
94-59-7	Safrole	8270	21
3689-24-5	Tetraethyl dithiopyrophosphate (Sulfotep)	8270	50
95-53-4	o-Toluidine (Methylaniline; 2-)	8270	20
126-68-1	O,O,O-Triethyl phosphorothioate	8270	52.5

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
99-35-4	sym-Trinitrobenzene (Trinitrobenzene; 1,3,5-)	8270	52.5
Polychlorinated Biphenyls			
12674-11-2	Aroclor 1016	8082	1.05
11104-28-2	Aroclor 1221	8082	1.05
11141-16-5	Aroclor 1232	8082	1.05
53469-21-9	Aroclor 1242	8082	1.05
12672-29-6	Aroclor 1248	8082	1.05
11097-69-1	Aroclor 1254	8082	1.05
11096-82-5	Aroclor 1260	8082	1.05
Herbicides			
94-75-7	2,4-D (2,4-Dichlorophenoxy acetic acid)	8151	20
93-76-5	2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	8151	1.05
2303-16-4	Diallate	8270	21
88-85-7	Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	8270	21
23950-58-5	Pronamide	8270	21
93-72-1	Silvex (2,4,5-TP)	8151	1.05
Pesticides			
72-54-8	4,4′-DDD	8081	0.1
72-55-9	4,4′-DDE	8081	0.1
50-29-3	4,4′-DDT	8081	0.1
309-00-2	Aldrin	8081	0.0525
319-84-6	alpha-BHC (Hexachlorocyclohexane;alpha)	8081	0.0525
319-85-7	beta-BHC (Hexachlorocyclohexane;beta-)	8081	0.0525
319-86-8	delta-BHC (Hexachlorocyclohexane;delta-)	8081	0.0525
58-89-9	gamma-BHC (Lindane; Hexachlorocyclohexane)	8081	0.0525
57-74-9	Chlordane	8081	1.05
510-15-6	Chlorobenzilate	8270	10.5
60-57-1	Dieldrin	8081	0.0525

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
60-51-5	Dimethoate	8270	21
298-04-4	Disulfoton	8270	52.5
959-98-8	Endosulfan I	8081	0.0525
33213-65-9	Endosulfan II	8081	0.1
1031-07-8	Endosulfan sulfate	8081	0.1
72-20-8	Endrin	8081	0.1
7421-93-4	Endrin aldehyde	8081	0.1
52-85-7	Famphur	8270	105
76-44-8	Heptachlor	8081	0.0525
1024-57-3	Heptachlor epoxide	8081	0.0525
465-73-6	Isodrin	8270	10.5
143-50-0	Kepone	8270	100
72-43-5	Methoxychlor	8081	0.5
298-00-0	Methyl parathion (O,O-Dimethyl O-P-nitrophenyl, phosphorothioate)	8270	10.5
56-38-2	Parathion	8270	52.5
298-02-2	Phorate (Phosphorodithioic acid, O,O-diethyl S-(ethylthio) methyl ester)	8270	52.5
8001-35-2	Toxaphene	8081	2.625
Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (Totals and Congeners)			
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzodioxin	8290	5.25E-05
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	8290	5.25E-05
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	8290	5.25E-05
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	8290	5.25E-05
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	8290	5.25E-05
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	8290	5.25E-05
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	8290	5.25E-05
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	8290	5.25E-05
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	8290	5.25E-05
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	8290	5.25E-05

Table A-3. Analytical Methods for the Low-Level Burial Grounds Waste Management Area-1

CAS Number[a]	Waste Constituent (Alternate Name)	Analytical Method[b]	PQL (µg/L)
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	8290	5.25E-05
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	8290	5.25E-05
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	8290	5.25E-05
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	8290	1.05E-05
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	8290	1.05E-05
38998-75-3	Total heptachlorodibenzofurans	8290	5.37E-05
37871-00-4	Total heptachlorodibenzo-p-dioxins	8290	5.25E-05
55684-94-1	Total hexachlorodibenzofurans	8290	5.25E-05
34465-46-8	Total hexachlorodibenzo-p-dioxins	8290	1.05E-04
39001-02-0	Total octachlorodibenzofurans	8290	1.05E-04
3268-87-9	Total octachlorodibenzo-p-dioxins	8290	1.07E-04
30402-15-4	Total pentachlorodibenzofurans	8290	5.25E-05
36088-22-9	Total pentachlorodibenzo-p-dioxins	8290	5.25E-05
55722-27-5	Total tetrachlorodibenzofurans	8290	1.05E-05

Note: Analytical methods and PQLs provided in this table do not represent EPA or Ecology requirements but are intended solely as guidance.

a. Value in this column is either the CAS number or the constituent identifier if no CAS number exists.

b. For EPA Methods 180.1, 300, and 335.4, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples.* For EPA Methods 120.1, 150.1, 170.1, 310.1, 360.1, and 376.1, see EPA-600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Compendium*. For Standard Methods, see APHA/AWWA/WEF, *Standard Methods for the Examination of Water and Wastewater*.

c. Dilutions for certain ion chromatography constituents may be necessary, potentially raising the PQL above the limits provided.

d. Analyzed and reported as 3 & 4 methylphenol (CAS number 65794-96-9). PQL for 3 & 4 methylphenol is 20 µg/L.

e. Analyzed and reported as diphenylamine+n-nitrosodiphenylamine. The PQL for diphenylamine+n-nitrosodiphenylamine is 10.5 µg/L.

CAS = Chemical Abstracts Service
Ecology = Washington State Department of Ecology
EPA = U.S. Environmental Protection Agency
N/A = not applicable
PQL = practical quantitation limit

A3.2 Field Analytical Methods

Field screening and survey data will be measured in accordance with applicable work practices. Field analytical methods may also be performed in accordance with manufacturer manuals. Appendix B provides further discussion on field measurements.

A3.3 Quality Control

Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects on the analytical data. Field and laboratory QC samples, and their typical frequencies, are summarized in Table A-4. Acceptance criteria for field and laboratory QC are shown in Table A-5. Data will be qualified and flagged in the HEIS database, as appropriate.

Table A-4. QC Samples

Sample Type	Frequency	Characteristics Evaluated
Field QC		
Equipment blanks	1 in 20 samples when nondedicated equipment is used[a]	Contamination from nondedicated sampling equipment
Field duplicates	1 in 20 well trips[b]	Reproducibility/sampling precision
Field splits	As needed	Interlaboratory comparability
Field transfer blanks	One each day VOCs are sampled; additional field transfer blanks are collected if VOC samples are acquired on the same day for multiple laboratories	Contamination from sampling site
Full trip blanks	1 in 20 well trips[b]	Contamination from containers preservative reagents, storage, or transportation
Analytical QC[c]		
Laboratory control samples	One per analytical batch[d]	Method accuracy
Laboratory sample duplicates	One per analytical batch[d]	Laboratory reproducibility and precision
Matrix spikes	One per analytical batch[d]	Matrix effect/laboratory accuracy
Matrix spike duplicates	One per analytical batch[d]	Laboratory reproducibility, and method accuracy and precision
Method blanks	One per analytical batch[d]	Laboratory contamination
Surrogates	Added to each sample and QC sample	Recovery/yield for organic compounds

Note: The information in this table does not create U.S. Environmental Protection Agency or Washington State Department of Ecology requirements; it is intended solely as guidance.

a. For portable pumps, equipment blanks are collected 1 for every 20 well trips. Whenever a new type of nondedicated equipment is used, an equipment blank will be collected each time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination methods for the nondedicated equipment.

b. A "well trip" is defined as any time a well is accessed for sampling. Field duplicates and full trip blanks are run at a frequency of 1 in 20 well trips (i.e., 5% of the well trips) for all groundwater monitoring wells sampled within any given month (for all groundwater monitoring programs).

c. A batch is a group of up to 20 samples that behave similarly with respect to the sampling or testing procedures being employed and which are processed as a unit. Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

d. Unless not required by, or different frequency is called out, in laboratory analysis method.

QC = quality control VOC = volatile organic compound

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemistry			
Alkalinity	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Cyanide (free and total)	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Sulfide	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Total organic carbon	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Total organic halogen	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Anions			
Anions by ion chromatography	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Metals			
Metals by inductively coupled plasma/atomic emission spectrometry	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Metals by inductively coupled plasma/mass spectrometry	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Mercury by cold-vapor atomic absorption	MB	<MDL or <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
Volatile Organic Compounds			
Volatile organics by gas chromatography/mass spectrometry	MB	<MDL[f] or <5% sample concentration	Flag with "B"
	LCS	70% to 130% recovery or % recovery statistically derived[g]	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	70% to 130% recovery	Flag with "T"
	SUR	70% to 130% recovery	Review data[e]
	EB, FTB, FXR	<MDL[f] or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Semivolatile Organic Compounds			
Phenols by gas chromatography/mass spectrometry	MB	<MDL or <5% sample concentration	Flag with "B"
	LCS	70% to 130% recovery or % recovery statistically derived[g]	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	% recovery statistically derived[g]	Flag with "T"
	SUR	% recovery statistically derived[g]	Review data[e]
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Semivolatiles by gas chromatography/mass spectrometry	MB	<MDL[f] or <5% sample concentration	Flag with "B"
	LCS	70% to 130% recovery or % recovery statistically derived[g]	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	% recovery statistically derived[g]	Flag with "T"
	SUR	% recovery statistically derived[g]	Review data[e]
	EB, FTB	<MDL[f] or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Polychlorinated Biphenyls			
Polychlorinated biphenyls by gas chromatography	MB	<MDL or <5% sample concentration	Flag with "B"
	LCS	70% to 130% recovery or % recovery statistically derived[g]	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	% recovery statistically derived[g]	Flag with "N"

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
	SUR	% recovery statistically derived[g]	Review data[e]
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Herbicides			
Herbicides by gas chromatography	MB	<MDL or <5% sample concentration	Flag with "B"
	LCS	70% to 130% recovery or % recovery statistically derived[g]	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	% recovery statistically derived[g]	Flag with "N"
	SUR	% recovery statistically derived[g]	Review data[e]
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Pesticides			
Pesticides by gas chromatography	MB	<MDL or <5% sample concentration	Flag with "B"
	LCS	70% to 130% recovery or % recovery statistically derived[g]	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	% recovery statistically derived[g]	Flag with "N"
	SUR	% recovery statistically derived[g]	Review data[e]
	EB, FTB	<MDL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (Totals and Congeners)			
Dioxins/furans by high-resolution gas chromatography/high-resolution mass spectrometry	MB	<PQL or <5% sample concentration	Flag with "B"
	LCS	% recovery statistically derived[g]	Flag with "o"[b]
	DUP[c]	≤20% RPD	Review data[e]
	SUR	% recovery statistically derived[g]	Review data[e]
	EB, FTB	<PQL or <5% sample concentration	Flag with "Q"
	Field duplicate[c]	<20% RPD	Review data[e]

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action

Notes: Information in this table does not create U.S. Environmental Protection Agency or Washington State Department of Ecology requirements but is intended solely as guidance.

This table applies only to laboratory analyses. Field measurements (e.g., specific conductance, pH, dissolved oxygen, temperature, and turbidity) are not listed because they are measured in the field.

a. See Table A-3 for constituent list and analytical methods.

b. The reporting laboratory will apply the "o" flag with SMR group concurrence.

c. Applies when at least one result is greater than the laboratory PQL.

d. Either a DUP or an MS/MSD is to be analyzed to determine measurement precision. If there is insufficient sample volume, an LCS duplicate is analyzed with the acceptance criteria defaulting to the ≤20% RPD criteria.

e. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data.

f. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criteria is <5 times the MDL.

g. Laboratory-determined, statistically derived control limits based on historical data are used here. Control limits are reported with the data.

DUP	=	laboratory sample duplicate	MS	=	matrix spike
EB	=	equipment blank	MSD	=	matrix spike duplicate
FTB	=	full trip blank	PQL	=	practical quantitation limit
FXR	=	field transfer blank	QC	=	quality control
LCS	=	laboratory control sample	RPD	=	relative percent difference
MB	=	method blank	SMR	=	Sample Management and Reporting
MDL	=	method detection limit	SUR	=	surrogate

Data flags:

B, C	=	possible laboratory contamination: analyte was detected in the associated MB – laboratory applied. The B flag is used for organic analytes. The C flag is used for general chemical and inorganic analytes.
N	=	result may be biased: associated MS result was outside the acceptance limits (except gas chromatograph/mass spectrometry) – laboratory applied.
o	=	result may be biased: associated LCS result was outside the acceptance limits – laboratory applied.
Q	=	problem with associated field QC blank: results were out of limits – SMR review.
T	=	result may be biased: associated MS result was outside the acceptance limits (gas chromatograph/mass spectrometry only) – laboratory applied.

A3.3.1 Field Quality Control Samples

Field QC samples are used to monitor the integrity of field samples during sample collection, transportation, storage, and laboratory analysis. Field QC samples are submitted to the analyzing laboratories as field samples. Field QC samples are analyzed for the same set of analytes as their corresponding field samples. Field QC samples include field duplicates, field split (SPLIT) samples, and three types of field blanks (equipment blanks [EBs], field transfer blanks [FXRs], and full trip blanks [FTBs]). Field blanks are typically prepared to match the sample matrix as closely as possible using high-purity water[1]. The following describes the QC samples in more detail:

- **Equipment blanks:** EBs are used to monitor the effectiveness of the decontamination process for reusable sampling equipment. They are samples of high-purity water contacted with the sampling

[1] High-purity water is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques.

surfaces of equipment used to collect samples prior to using that equipment for field sampling. EBs are collected from each type of reusable sampling equipment to ensure that the decontamination procedures are effective for the specific equipment types. EBs will be analyzed for the same analytes as samples collected using that equipment. EB samples are not required for disposable sampling equipment.

- **Field duplicates:** Field duplicates provide information regarding the homogeneity of the sample matrix and the precision of the sampling and analysis processes. Field duplicates are two samples that are intended to be identical and are collected as close as possible in time and location. Each sample in the sample-duplicate pair receives its own unique sample number.
- **Field splits:** SPLITs are two samples that are intended to be identical and are collected as close as possible in time and location. SPLITs will be stored in separate containers and analyzed by different laboratories for the same analytes. SPLITs are interlaboratory comparison samples used to evaluate comparability between laboratories.
- **Field transfer blanks:** FXRs are used to document possible contamination during field acquisition of volatile organic compound (VOC) samples. FXRs are sample bottles (already containing any required sample preservative) filled at the sample collection site with high-purity water. The blank is sealed at the sampling site and becomes part of the sample set sent to the laboratory. FXRs are prepared daily for sites sampling for VOC analysis. Typically, one set of FXRs is prepared each day that VOC field samples are collected. If VOC samples are collected on the same day and shipped to multiple laboratories, a set of FXRs is collected for each analyzing laboratory.
- **Full trip blanks:** FTBs are used to monitor for potential sample contamination from the sampling container, preservation reagents, or storage conditions. FTBs are prepared with high-purity water and sealed prior to traveling to the sampling site, transported to the sampling site (not opened in the field), and then shipped as part of the sample set to the laboratory. The bottle set is either for volatile organic analysis only or identical to the set that will be collected in the field. Collected FTBs are typically analyzed for the same constituents as the samples from the associated sampling event.

A3.3.2 Laboratory Quality Control Samples

Internal QA/QC programs are maintained by laboratories used by the project and include the use of laboratory control samples, laboratory sample duplicates (DUPs), matrix spikes (MSs), matrix spike duplicates (MSDs), method blanks (MBs), and surrogates (SURs). These QC analyses follow U.S. Environmental Protection Agency (EPA) methods (e.g., those in the SW-846 Compendium). QC checks outside of control limits are documented in analytical laboratory reports and during a DQI evaluation, if performed. Descriptions of the various types of laboratory QC samples are as follows:

- **Laboratory control sample:** A control matrix (e.g., reagent water) spiked with analytes representative of the target analytes or a certified reference material that is used to evaluate laboratory accuracy.
- **Laboratory sample duplicate:** A second aliquot of a sample that is taken through the entire sample preparation and analytical process. DUPs are used to evaluate the precision of a method in a given sample matrix.
- **Matrix spike:** An aliquot of a sample spiked with a known concentration of target analyte(s) that is then taken through the entire sample preparation and analytical process. An MS is used to assess the bias of a method in a given sample matrix. Thus, MS results are an indicator of the effect the sample matrix has on the accuracy of measurement of the target analytes.

- **Matrix spike duplicate:** A replicate spiked aliquot of a sample that is subjected to the entire sample preparation and analytical process. MSD results are used to determine the bias and precision of a method in a given sample matrix.
- **Method blank:** An analyte-free matrix to which the same reagents are added in the same volumes or proportions as used in the sample processing. The MB is carried through the complete sample preparation and analytical process. The MB is used to quantify contamination resulting from the sample preparation and analysis.
- **Surrogate:** Used only in organic analyses, a compound added to every sample in the analysis batch (field samples and QC samples) prior to preparation. SURs are typically similar in chemical composition to the analyte being determined, but they are not normally encountered. SURs are expected to respond to the preparation and analytical process in a manner similar to the analytes of interest. Because SURs are added to every sample and QC sample, they are used to evaluate overall method performance in a given matrix.

Samples are analyzed within the holding time guidelines provided in Table A-6. In some instances, constituents in the samples not analyzed within the holding times may be compromised by volatilization, decomposition, or other chemical changes. Data from samples analyzed outside of the holding times are flagged in the HEIS database with an "H."

Table A-6. Preservation and Holding Time Guidelines for Laboratory Analyses

Constituent[a]	Preservation[b]	Holding Time
General Chemistry		
Alkalinity	Store ≤6°C	14 days
Cyanide (free and total)	Store ≤6°C, adjust pH to >12 with 50% sodium hydroxide. If oxidizing agents present, add 5 mL 0.1 N sodium arsenite/L or 0.06 g ascorbic acid/L	14 days
Sulfide	Store ≤6ºC, adjust pH to > 9 with zinc acetate and sodium hydroxide	7 days
Total organic carbon	Store <6°C, adjust pH to <2 with sulfuric acid or hydrochloric acid	28 days
Total organic halogen	Store <6°C, adjust pH to <2 with sulfuric acid	28 days
Anions		
Chloride, Sulfate	Store ≤6°C	28 days
Nitrate	Store ≤6°C	48 hours
Metals		
Metals by inductively coupled plasma-atomic emission spectrometry	Adjust pH to <2 with nitric acid	6 months

Table A-6. Preservation and Holding Time Guidelines for Laboratory Analyses

Constituent[a]	Preservation[b]	Holding Time
Metals by inductively coupled plasma/mass spectrometry	Adjust pH to <2 with nitric acid	6 months
Mercury by cold-vapor atomic absorption	Adjust pH to <2 with nitric acid	28 days
Volatile Organic Compounds		
Volatile organics by gas chromatography/mass spectrometry	Store ≤6°C, adjust pH to <2 with sulfuric acid or hydrochloric acid	7 days unpreserved 14 days maximum preserved
Semivolatile Organic Compounds		
Phenols by gas chromatography/mass spectrometry	Store ≤6°C	7 days before extraction 40 days after extraction
Semivolatiles by gas chromatography/ mass spectrometry	Store ≤6°C	7 days before extraction 40 days after extraction
Polychlorinated Biphenyls		
Polychlorinated biphenyls	Store <6°C	1 year before extraction 40 days after extraction
Herbicides		
Herbicides	Store <6°C	7 days before extraction 40 days after extraction
Pesticides		
Pesticides	Store <6°C	7 days before extraction 40 days after extraction
Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (Totals and Congeners)		
Dioxins/furans by high-resolution gas chromatography/high-resolution mass spectrometry	Store <6°C	30 days before extraction 45 days after extraction

Notes: Holding times and preservation methods are dependent on the constituent and are consistent with EPA guidance and approved analytical methods. Information in this table does not create EPA or Washington State Department of Ecology requirements but is intended solely as guidance.

The container type for a sample is available on the chain-of-custody documentation.

This table applies only to laboratory analyses. Field measurements (e.g., specific conductance, pH, dissolved oxygen, temperature, and turbidity) are not listed because they are measured in the field.

a. See Table A-3 for constituent list and analytical methods.

b. For preservation identified as stored at ≤6°C, the sample should be protected against freezing unless it is known that freezing will not impact the sample integrity.

EPA = U.S. Environmental Protection Agency

A3.4 Measurement Equipment

Each measuring equipment user will ensure that equipment is functioning as expected, properly handled, and properly calibrated per methods governing control of the measuring equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance will be recorded according to approved methods. Field screening instruments will be used, maintained, and calibrated as provided in manufacturer specifications and other approved methods.

A3.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment will meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or have been evaluated as acceptable and valid according to instrument-specific methods and specifications. Software applications will be acceptance tested prior to use in the field. Measurement and testing equipment used in the field will be subject to preventive maintenance measures to minimize downtime.

A3.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Appendix B.

A3.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed per test methods in the SW-846 Compendium and EPA/600 Method series (e.g., EPA-600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*) and will be appropriate for their use. Supplies and consumables used in sampling and analysis activities are procured under internal work processes. Supplies and consumables are checked and accepted by users prior to use.

A3.8 Nondirect Measurements

Data obtained from sources such as computer databases, programs, literature files, and historical records will be evaluated by staff assigned by the Prime Contractor Project Manager. Data used in evaluations will be identified by source. Historical data obtained from the HEIS database are usable for comparison to data collected by this groundwater monitoring plan.

A3.9 Data Management

Records of data analyses and groundwater surface elevations are maintained as required by 40 CFR 265.94.

Electronic data access will be through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided.

A4 Data Review and Usability

This chapter addresses QA activities that occur after data collection. Implementation of these activities determines whether the data conform to the specified criteria, thus satisfying the project objectives.

A4.1 Data Review and Verification

Data review and verification are performed to confirm that field and field QC sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific

sampling locations, and reviewing sample collection dates and sample preparation and analysis dates to determine if holding times were met.

The criteria for verification include, but are not limited to, review for contractual compliance (e.g., samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, and the correct application of conversion factors. Data verification is typically conducted on a portion of multimedia samples collected across projects.

The staff member, assigned by the Prime Contractor Project Manager, will also perform a data review to determine if observed changes reflect improved/degraded groundwater quality or potential data errors, which may result in a request for data review on questionable data. The laboratory may be asked to check calculations, reanalyze samples, or the well may be resampled. Results of the request for data review process are used to flag data in the HEIS database and to add comments.

A4.2 Data Validation

Data validation is performed at the discretion of the Prime Contractor Project Manager, under the direction of the SMR group. The decision to perform validation is based on the results of QC samples for individual well networks and discussions with the staff member assigned by the Prime Contractor Project Manager. If conducted, data validation (third-party) will be performed at a minimum frequency of 5% per method. Data validation evaluates the analytical quality of data from samples specifically collected for this plan.

A4.3 Reconciliation with User Requirements

The purpose of reconciliation with user requirements is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. For routine groundwater monitoring undertaken by projects, DQIs such as precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity for the specific datasets (individual data packages) will typically be evaluated on an annual basis. A DQI evaluation specific to data quality requirements specified in this plan may be performed at the discretion of the Prime Contractor Project Manager. Results of the DQI evaluation(s) will be used by the Prime Contractor Project Manager to interpret the data and determine if the data quality objectives for this activity have been met.

A5 References

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303-400, "Interim Status Facility Standards."

Appendix B

Sampling Protocol

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Terms

DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
IATA	International Air Transport Association
QA	quality assurance
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*

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B1 Introduction

Groundwater monitoring at the Hanford Site, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA) and implemented in WAC 173-303, "Dangerous Waste Regulations," has been conducted since the mid-1980s. Hanford Site groundwater sampling methods contain sampling precautions to be taken; identify equipment and its use; cleaning and decontamination practices; records and documentation; and sample collection, management, and control activities. Together, Appendices A and B discuss the sampling and analysis elements for the groundwater monitoring plan: sample collection, sample preservation and holding times, chain-of-custody control, analytical methods, and field and laboratory quality assurance (QA)/quality control (QC).

This appendix provides elements of the sampling protocols and techniques used for the groundwater monitoring plan. The main text of the groundwater monitoring plan identifies the monitoring wells that will be sampled, constituents to be analyzed, and sampling frequency for the groundwater monitoring at the dangerous waste management unit.

B2 Sampling Methods

Sampling may include but is not limited to the following methods:

- Field screening measurements
- Groundwater sampling
- Water-level measurements

Groundwater samples will be collected according to the current and applicable field practices. Groundwater samples are collected after field measurements of purged groundwater have stabilized as follows:

- **pH** – two consecutive measurements agree within 0.2 pH units
- **Temperature** – two consecutive measurements agree within 0.2°C (0.4°F)
- **Conductivity** – two consecutive measurements agree within 10% of each other
- **Turbidity** – less than 5 nephelometric turbidity units prior to sampling (or the recommendation by staff assigned by the Prime Contractor Project Manager at the time of collection)

Dissolved oxygen will also be measured in the field. Dissolved oxygen is not required to be stable prior to sample collection.

Environmental-grade electric submersible pumps will typically be used for well purging and sample collection in existing wells with a flow rate not exceeding 7.6 L/min (2 gal/min). In the event a well exhibits insufficient productivity to support purging and sampling using the environmental-grade electric submersible pumps, adjustable-rate bladder pumps with typical flow rates of 0.1 to 0.5 L/min (0.026 to 0.13 gal/min) may be employed. As environmental-grade electric submersible pumps are replaced when they reach the end of their service lives due to age, normal wear, or failure, they will be replaced with adjustable-rate bladder pumps. The same purge protocol described for environmental-grade electric submersible pumps will be used for the adjustable-rate bladder pumps.

Unless special directions are provided by the staff assigned by the Prime Contractor Project Manager at the time of the sample collection, wells are typically purged at a flow rate not to exceed 7.6 L/min (2 gal/min). Purging will continue until stable readings of selected field water quality parameters are achieved (as described above).

Field measurements (except for turbidity) are typically obtained using an instrumented flow-through cell located at the wellhead. Groundwater is pumped directly from the well to the flow-through cell. At the beginning of the sample event, field crews attach a clean stainless steel sampling manifold to the riser discharge. The manifold has two valves and two ports: one port is used only for purgewater, and the other port is used to supply water to the flow-through cell. Probes are inserted into the flow-through cell to measure pH, temperature, specific conductance, and dissolved oxygen, if required by the main text. Turbidity is measured by collecting an aliquot of water from the purgewater valve and inserting the sample vial into a turbidimeter. Purgewater, including the water passing through the flow-through cell, is then discharged to a tank on a purgewater truck.

Collection of the field measurement data will commence when a volume of water equal to the volume of the pump riser pipe has been extracted and discharged to a purgewater truck, field measurements have stabilized, the hose supplying water to the flow-through cell is disconnected, and a clean stainless steel drop leg is attached for sampling collection. The flow rate does not exceed 7.6 L/min (2 gal/min) during sampling to minimize the loss of volatiles (if any) and prevent overfilling the bottles. Sample bottles are filled in a sequence designed to minimize loss of volatiles (if any). If both filtered and unfiltered samples are required (see Table 2-1), filtered samples are collected after collection of the unfiltered samples.

Samples may be filtered in the field using a 0.45 µm filter as noted on the chain-of-custody form. Unfiltered samples are collected in conjunction with filtered samples to determine if metal constituents being monitored (excluding hexavalent chromium, if one of the monitored constituents) occur as both suspended and dissolved phases, or in only one state. The evaluation of suspended and dissolved metals provides supporting information for groundwater geochemical characteristics, as well as indication of well integrity such as the presence of dislodged well encrustation, well corrosion products, or failure of the well screen filter pack. For certain types of samples, preservatives are required. Based on the analytical methods used, preservatives are generally added to the collection bottles before their use in the field. Sample preservation and holding times for groundwater samples are provided in Appendix A (Table A-6) and are based on the analytical method identified in Appendix A (Table A-3). Container types, preservatives, and volumes will be identified on the chain-of-custody form. This groundwater monitoring plan defines a sample as a filled sample bottle for purposes of starting the clock for holding time restrictions.

Holding time is the maximum allowable period between sample collection and analysis. Exceeding holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Holding times depend on the constituent and are listed in analytical method compilations such as APHA/AWWA/WEF, *Standard Methods for the Examination of Water and Wastewater*; SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*; and the EPA/600 Method series (e.g., EPA-600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*).

B2.1 Decontamination of Drilling and Sampling Equipment

Drilling of wells is not addressed by this groundwater monitoring plan. Therefore, a discussion of the decontamination of drilling equipment is not included.

Sampling equipment will be decontaminated in accordance with sampling equipment decontamination methods. To prevent potential contamination of the samples, care should be taken to use decontaminated equipment for each specific sampling activity.

Special care should be taken to avoid the following common ways in which cross contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

Decontamination of sampling equipment and pumps is typically performed using high-purity water[1] in each step. Three rinse cycles are performed to decontaminate sampling equipment: detergent rinse, acid rinse, and water rinse. During the detergent rinse, equipment is washed in a phosphate-free detergent solution, followed by rinsing with water in three sequential containers. After the third water rinse, equipment that is stainless steel or glass is rinsed in a 1 M nitric acid solution (pH less than 2). Equipment is then rinsed with water in three sequential containers (the water rinses following the acid rinse are conducted in separate water containers that are not used for detergent rinse). Following the final water rinse, equipment is rinsed in hexane and then placed on a rack to dry. Dry equipment is loaded into a drying oven. The oven is set at approximately 50°C (122°F) for items that are not metal or glass or at approximately 100°C (212°F) for metal or glass. Once reaching temperature, equipment is baked for approximately 20 minutes and then cooled. Equipment is then removed from the oven and enclosed in clean, unused aluminum foil using surgical gloves. The wrapped equipment is stored in a custody-locked, controlled access area. Water-level measurement tapes (portion that came in contact with groundwater) are decontaminated using a high-purity water rinse and dried with disposable towels.

To decontaminate sampling pumps that are not permanently installed, the pump cowling is first removed, washed (if needed) in phosphate-free detergent solution, and then reinstalled on the pump. The pump is then submerged in phosphate-free detergent solution, and 11.4 L (3 gal) of solution is pumped through the unit and disposed. Detergent solution is then circulated through the submerged pump for 5 minutes. The pump is removed from solution and rinsed with water. The pump is submerged in water, and 30.3 L (8 gal) of water is pumped through the unit and disposed. The pump is removed from the water, and the intake and housing are covered with plastic sleeving. Cleaning is documented on a tag that is affixed to the pump with the following information:

- Date of pump cleaning
- Pump identification
- Comments (if any)
- Signature of person performing decontamination

[1] High-purity water is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques.

B2.2 Water Levels

For each sampling event, measurement of the groundwater surface elevation at each monitoring well is required by 40 CFR 265.92(e), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." Using a calibrated depth measurement tape, the depth to water is recorded in each well prior to sampling. When two consecutive measurements are taken that agree within 6 mm (0.24 in.), the final determined measurement is recorded, along with the date and time for the specific event. The depth to groundwater is subtracted from the elevation of a reference point (usually the top of the casing) to obtain the water-level elevation. The top of the casing is a known elevation reference point because it has been surveyed to local reference data.

B3 Documentation of Field Activities

Logbooks for field activities are identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook, and only authorized persons may make entries in logbooks. Logbook entries will be reviewed by the sampling Field Work Supervisor, cognizant scientist/engineer, or other responsible manager; the review will be documented with a signature and date. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

Data forms for field activities are also identified with a unique project name and number. Data forms may be used to collect field information; information recorded on data forms is the same as for logbooks. The data forms are referenced in the logbooks.

The following information is recorded in logbooks or on data forms:

- Day and date; time task started; weather conditions; and names, titles, and organizations of personnel performing the task
- Purpose of visit to the task area
- Details of field tests that were conducted, and references to forms that were used and methods followed in conducting the activity
- Details of field calibrations and surveys that were conducted, and references to forms that were used, other data records, and methods followed in conducting the calibrations and surveys
- Details of samples collected and the preparation (if any) of splits, duplicates, or blanks
- Time, equipment type, serial or identification number, and methods followed for decontaminations and equipment maintenance performed (reference the page number[s] of any logbook where detailed information is recorded)
- Equipment failures or breakdowns that occurred, with a brief description of replacements

B4 Calibration of Field Equipment

Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work processes, and/or field instructions that provide direction for equipment calibration or verification of accuracy by analytical methods. Calibration records will include the raw calibration data, identification of the standards used, associated reports, date of analysis, and analyst's name or initials. Results from instrument calibration activities are recorded.

Field instrumentation calibration and QA checks will be performed as follows:

- Prior to initial use of a field analytical measurement system
- At a minimum, at the frequency recommended by the manufacturer or methods, or as required by regulations
- Upon failure to meet specified QC criteria
- Daily calibration checks will be performed and documented for each instrument used (these checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data; analysis times will be sufficient to establish detection efficiency and resolution)
- Using standards for calibration that are traceable to a nationally recognized standard agency source or measurement system (manufacturer's recommendations for storage and handling of standards, if any, will be followed)

B5 Sample Handling

Sample handling and transfer methods preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape will be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date.

A sampling and analytical database is used to track samples from the point of collection through the laboratory analysis process.

B5.1 Containers

Samples will be collected, where and when appropriate, in break-resistant containers. The field sample collection record will indicate the lot number of the bottles used in sample collection. When commercially precleaned containers are used in the field, the name of the manufacturer, lot identification, and certification will be retained for documentation.

Containers will be capped and stored in an environment that minimizes the possibility of sample container contamination. If contamination of the stored sample containers occurs, corrective actions will be implemented to prevent reoccurrences. Contaminated sample containers cannot be used for a sampling event. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. Container types and sample amounts/volumes are identified on the chain-of-custody form.

B5.2 Container Labeling

Each sample is identified by affixing a standardized label or tag to the container. This label or tag will contain the sample identification number. The label will identify or provide reference to associate the sample with the date and time of collection, preservative used (if applicable), analysis requested, and collector's name or initials. Sample labels may be either preprinted or handwritten in indelible or waterproof ink.

B5.3 Sample Custody

Sample custody protocols maintain sample integrity throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory.

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility for custody of the sample changes, new and previous custodians will sign the record and note the date and time.

The following minimum information is provided on a completed chain-of-custody form:

- Project name
- Collectors' names
- Unique sample number
- Date, time, and location (or traceable reference thereto) of sample collection
- Matrix
- Preservatives
- Chain-of-possession information (i.e., signatures and printed names of each individual involved in the transfer of sample custody and storage locations, and dates/times of receipt and relinquishment)
- Requested analyses (or reference thereto)
- Shipped-to information (i.e., analytical laboratory performing the analysis)

Sample custody will be maintained within subcontract laboratories in accordance with documented protocols.

B5.4 Sample Transportation

Packaging and transportation instructions will comply with applicable transportation regulations and U.S. Department of Energy (DOE) requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT). Carrier-specific requirements, defined in the current edition of International Air Transport Association (IATA) *Dangerous Goods Regulations*, will also be considered when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents will be considered hazardous material in transportation and transported according to DOT/IATA requirements. If the sample material is known or can be identified, then it will be classified, described, packaged, marked, labeled, and shipped according to the specific instructions for that material.

B6 Management of Waste

Waste materials generated during sample activities, including purgewater and decontamination fluids, will be collected and managed in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* as authorized under Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Milestone M-024, and the waste control plan or waste management plan associated with the applicable groundwater operable unit.

For waste designation purposes, wells listed in the main text of the monitoring plan may be surveyed in the Hanford Environmental Information System, and the maximum concentration for each analyte within the most recent 5 years will be evaluated for use in creating a waste profile, if necessary.

Packaging and labeling during waste storage and transportation will meet WAC 173-303, DOE, and DOT requirements, as appropriate.

Offsite analytical laboratories are responsible for the disposal of unused sample quantities and wastes generated during analytical processes.

B7 References

40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," Code of Federal Regulations. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5.

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Appendix C

Well Construction

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C1 Introduction

This appendix provides the following information for the existing Low-Level Burial Grounds (LLBG) Waste Management Area (WMA)-1 groundwater monitoring wells:

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

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

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

Figures C-1 through C-5 provide construction and completion summaries for the existing network wells.

Table C-1. Hydrogeologic Monitoring Unit Classification Scheme

Unit	Description
TU	**Top of Unconfined.** Screened across the water table or the top of the open interval is within 1.5 m (5 ft) of the water table, and the bottom of the open interval is no more than 10.7 m (35 ft) below the water table.
TB	**Top of Basalt.** Open to less than 9.1 m (30 ft) above and below the top of basalt.

Table C-2. Sampling Interval Information for Wells within the LLBG WMA-1 Network

Well Name	Hydrogeologic Unit Monitored	Elevation Top of Open Interval (m [ft] NAVD88)	Elevation Bottom of Open Interval (m [ft] NAVD88)	Open Interval Length (m [ft])	Drilling Method
299-E28-27	TU	125.6 (411.9)	119.5 (391.9)	6.1 (20.0)	Cable tool
299-E32-3	TU	125.8 (412.7)	119.7 (392.7)	6.1 (20.0)	Cable tool
299-E33-28	TU	125.1 (410.5)	119.0 (390.5)	6.1 (20.0)	Cable tool
299-E33-29	TU, TB	125.7 (412.2)	119.6 (392.2)	6.1 (20.0)	Cable tool
299-E33-266	TU, TB	123.4 (404.8)	117.3 (384.8)	6.1 (20.0)	Becker hammer

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

TB = Top of Basalt, as described in Table C-1

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

Table C-3. Planned Location, Depth, and Screen Interval for Proposed Wells Within the LLBG WMA-1 Network

Well ID	Easting* (m)	Northing* (m)	Surface Elevation (m [ft] NAVD88)	Water Table Elevation (m [ft] NAVD88)	Depth to Water (m [ft] bgs)	Drill Depth (m [ft] bgs)	Final Well Diameter (cm [in.])	Screen Interval (m [ft] bgs)	Sump and End Cap Interval (m [ft] bgs)
LLBGWMA-1 _PW-1	573227.32	137150.63	TBD	TBD	TBD	TBD	TBD	TBD	TBD
LLBGWMA-1 _PW-2	573224.90	136989.00	TBD	TBD	TBD	TBD	TBD	TBD	TBD
LLBGWMA-1 _PW-3	573226.94	137309.55	TBD	TBD	TBD	TBD	TBD	TBD	TBD

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

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

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

bgs = below ground surface

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

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 E Water Supply
Driller's Name: Murphy/Robinson
Drilling Company: Kaiser Engineers
Date Started: 02Sep87

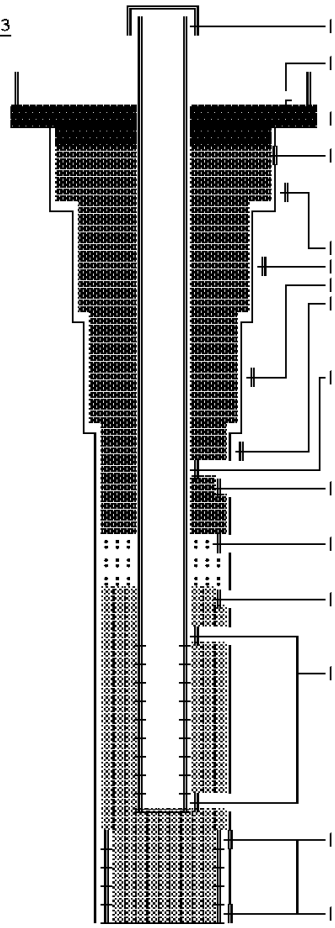
Sample Method: Drive barrel
Additives Used: Hard tool
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 29Sep87

WELL NUMBER: 299-E28-27
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 44,595 E/W W 54,670
State Coordinates: N 449,756 E 2,240,541
Start Card #: Not documented T R S
Elevation Ground surface: 678.18-ft (Brass cap)

Depth to water: 273.2-ft Sep87
(Ground surface) 276.4-ft 25Jun93

GENERALIZED STRATIGRAPHY Log Geologist's

0-10 Silty, sandy GRAVEL
10-15: Sandy GRAVEL
15-55: Silty sandy GRAVEL
55-60: Sandy GRAVEL
60-65: Silty gravelly SAND
65-70: SAND
70-80: Gravelly SAND
80-90: Silty SAND
90-95: Silty gravelly SAND
95-100: SAND
100-110: Gravelly SAND
110-115: Silty gravelly SAND
115-120: Gravelly SAND
120-125: SAND
125-140: Gravelly SAND
140-145: SAND
145-150: Gravelly SAND
150-185: SAND
185-190: Silty gravelly SAND
190-195: Silty SAND and GRAVEL
195-210: Sandy GRAVEL
210-220: SILT, SAND and GRAVEL
220-225: Gravelly SAND
225-230: Silty SAND
230-240: Gravelly SAND
240-290: GRAVEL, SAND and SILT
290-295: SAND
295-300: Silty sandy GRAVEL
300-301: Gravelly SAND



Elevation of reference point: [680.37-ft] (top of casing)
Height of reference point above ground surface [2.2-ft]
Depth of surface seal [4.5-258.2-ft]
Type of surface seal:
Bentonite crumbles to 258.2-ft
4-ft x 4-ft x 6-in surface pad extending 4.5-ft into annulus
Hole diameter,
0-58.3-ft, 17-in nominal
58.3-124.0-ft, 13-in nominal
124.0-206.9-ft, 11-in nominal
206.9-301.5-ft, 9-in nominal
4-in ID stainless steel casing, +2.2-269.8-ft, #20-slot
Bentonite crumbles, 4.5-258.2-ft
Bentonite pellets, 258.2-263.8-ft
Silica sand pack, 263.8-301.5-ft, 20-30-mesh
4-in stainless steel screen, 269.8-289.8-ft, #20-slot
8-in stainless steel telescoping screen, 291.2-301.5-ft, # 30-slot
Borehole drilled depth: [301.5-ft]

Drawing By: RKL/2E28-27.ASB
Date : 10Sep93
Reference : HANFORD WELLS

Figure C-1. Well 299-E28-27 Construction and Completion Summary (1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E28-27

WELL DESIGNATION	:	299-E28-27
RCRA FACILITY	:	Low Level Burial Grounds, 218-E-10
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 44,595 W 54,670 [07Dec87-200E]
LAMBERT COORDINATES	:	N 449,756 E 2,240,541 [HANCONV]
DATE DRILLED	:	Sep87
DEPTH DRILLED (GS)	:	301.5-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	273.2-ft, Sep87 276.4-ft, 25Jun93
CASING DIAMETER	:	4-in, stainless steel, +2.2-289.9-ft.
ELEV TOP CASING	:	680.37-ft [07Dec87-200E]
ELEV GROUND SURFACE	:	678.18-ft, Brass cap [07Dec87-200E]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	4-in, 269.9-289.9-ft; 8-in, 291.2-301.5-ft
COMMENTS	:	FIELD INSPECTION, 06Feb90, 4-in stainless steel casing, no protective casing. Capped and locked. 4-ft by 4-ft concrete pad, 4 posts, brass marker with stamped ID. OTHER;
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LLBG monthly water level measurement, 01Dec87-25Jun93,
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling and w/l monitoring 93
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

Figure C-1. Well 299-E28-27 Construction and Completion Summary (2 of 2)

WELL CONSTRUCTION AND COMPLETION SUMMARY

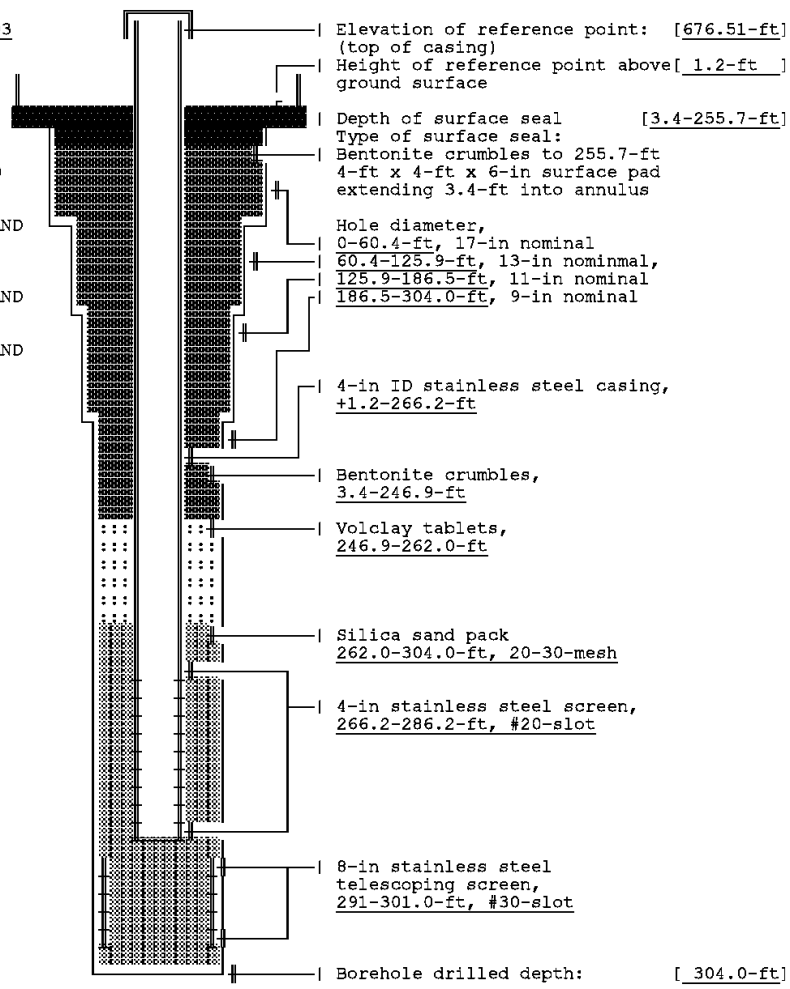
Drilling Method: Cable tool
Drilling Fluid Used: 200 E Water Supply
Driller's Name: M. Thoreson O. Amos/D. St George
Drilling Company: Kaiser Engineers
Date Started: 14Aug87
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr:
Company Location: Hanford
Date Complete: 30Sep87

WELL NUMBER: 299-E32-3
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 45,631 E/W W 56,721
State Coordinates: N 450,787 E 2,238,487
Start Card #: Not documented T R S
Elevation Ground surface: 675.32-ft (Brass cap)

Depth to water: 269.0-ft Sep87
(Ground surface) 273.6-ft 25Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl = Slightly

0-65 Silty sandy GRAVEL
65-75: Sl silty gravelly SAND
75-80: Sl silty sl gravelly SAND
80-90: Sl silty gravelly SAND
90-105: Sl gravelly SAND
105-110: Sl silty sl gravelly SAND
110-120: Sl silty SAND
120-125: Silty SAND
125-130: Gravelly SAND
130-135: Sl silty sl gravelly SAND
135-140: Sl silty SAND
140-147: Silty SAND
147-150: Sl silty sl gravelly SAND
150-180: Sl silty SAND
180-195: SAND
195-200: Sandy GRAVEL
200-275: Silty sandy GRAVEL
275-280: Sl silty gravelly SAND
280-285: Silty sandy GRAVEL
285-290: SAND
290-295: Sl silty SAND
295-300: Silty sandy GRAVEL
300-303: Sl silty gravelly SAND
303-304: Gravelly SAND



Drawing By: RKL/2E32-03.ASB
Date : 10Sep93
Reference : HANFORD WELLS

Figure C-2. Well 299-E32-3 Construction and Completion Summary (1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E32-3

WELL DESIGNATION	:	299-E32-3
RCRA FACILITY	:	Low Level Burial Grounds, WMA-1
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 45,631 W 56,721
LAMBERT COORDINATES	:	N 450,787 E 2,238,487
DATE DRILLED	:	Sep87
DEPTH DRILLED (GS)	:	304.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	269.0-ft, 04Sep87; 273.6-ft, 25Jun93
CASING DIAMETER	:	4-in, stainless steel, +1.2-266.2-ft.
ELEV TOP CASING	:	676.51-ft
ELEV GROUND SURFACE	:	675.32-ft (Brass cap)
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	4-in, stainless steel, #20-slot, 266.2-286.2-ft; 8-in, stainless steel, #30-slot, 291.0-301.0-ft
COMMENTS	:	FIELD INSPECTION, 07Feb90; 4-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable capped and locked, brass cap in pad with well ID. Not in radiation zone.
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LLBG monthly water level measurement, 01Dec87-25Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

Figure C-2. Well 299-E32-3 Construction and Completion Summary (2 of 2)

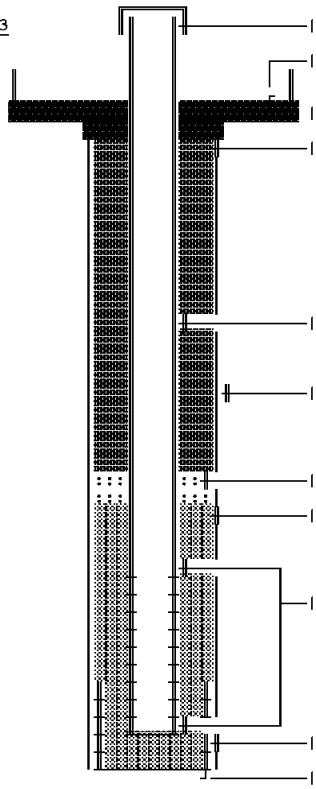
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 299-E33-28 / TEMPORARY WELL NO:
Drilling Fluid Used: 200 E Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 45,596 E/W W 54,668
Driller's Name: Watkins/Cordon	WA State Lic Nr: 1271/0079	State Coordinates: N 450,758 E 2,240,540
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 24Sep87	Date Complete: 15Oct87	Elevation Ground surface: 662.66-ft (Brass cap)

Depth to water: 257-ft Oct87
(Ground surface)260.8-ft 25Jun93

GENERALIZED Geologist's STRATIGRAPHY Log
(Sl=Slightly)

5-40: Silty sandy GRAVEL
40-50: Gravelly SAND
50-60: Sl gravelly, sl silty SAND
60-75: Sl silty gravelly SAND
75-80: Sl gravelly SAND
80-85: Gravelly SAND
85-90: SAND
95-105: Sl gravelly SAND
105-110: SAND
110-115: Silty SAND
115-120: Sl gravelly silty SAND
120-130: Sl GRAVELLY, sl silty SAND
130-135: Sl silty gravelly SAND
135-160: SAND
160-165: Sl silty gravelly SAND
165-170: Sl gravelly, sl silty SAND
170-175: Sl silty gravelly SAND
175-185: Silty sandy GRAVEL
185-210: SAND
210-245: Silty sandy GRAVEL
245-250: Sl silty gravelly SAND
250-265: Silty sandy GRAVEL
265-270: Sl silty gravelly SAND
270-275: Silty sandy GRAVEL



Elevation of reference point: [664.23 ft] (top of casing)
Height of reference point above ground surface [1.6-ft]
Depth of surface seal [3.8-241.5-ft]
Type of surface seal: Bentonite crumbles, 3.8-241.5-ft
Has 4-ft x 4-ft x 6-in concrete pad extending 3.8-ft into annulus
4-in ID stainless steel casing, +1.6-255.7-ft
Hole diameter, 9-in nominal 3.8-278.3-ft
Volclay pellets 241.5-247.8-ft
Silica sand pack, 247.8-278.3-ft, 20-30-mesh
4-in stainless steel screen, 255.7-275.7-ft, #20-slot
8-in stainless steel telescoping screen, 268.0-278-ft, #30-slot
Borehole drilled depth: [278.3-ft]

Drawing By: RKL/2E33-28.ASB
Date : 13Sep93
Reference : HANFORD WELLS

Figure C-3. Well 299-E33-28 Construction and Completion Summary (1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E33-28

```
WELL DESIGNATION     :   299-E33-28
RCRA FACILITY        :   Low Level Burial Grounds - WMA-1
CERCLA UNIT          :   200 Aggregate Area Management Study (200-BP-1)
HANFORD COORDINATES  :   N  45,596   W    54,668 [07Dec87-200E]
LAMBERT COORDINATES  :   N 450,758   E 2,240,540 [HANCONV]
DATE DRILLED         :   Nov87
DEPTH DRILLED  (GS)  :   278-ft
MEASURED DEPTH (GS)  :   275-ft, Nov89 TV
DEPTH TO WATER (GS)  :   257-ft, Oct87;
                         260.8-ft, 25Jun93
CASING DIAMETER      :   4-in, stainless steel, +1.6-255.7-ft
ELEV TOP OF CASING   :   664.23-ft,        [07Dec87-200E]
ELEV GROUND SURFACE  :   662.66, Brass cap [07Dec87-200E]
PERFORATED INTERVAL  :   Not applicable
SCREENED INTERVAL    :   255.7-275.7-ft, 4-in, #20-slot stainless steel
COMMENTS             :   FIELD INSPECTION, 06Feb90
                         4-in stainless steel casing. 4x4-ft concrete pad.  4 posts.
                         Well identification stamped on brass cap in pad.
                         Not in radiation zone.
                         OTHER:
AVAILABLE LOGS       :   Geologist
TV SCAN COMMENTS     :   19Nov89, depths referenced to ground surface;
                         Depth to bottom: 275-ft
                         Bottom of casing: 275-ft
                         Depth to water: 259.9-ft
                         Screen: 256-275-ft
                         Clean, ready for sampling.
DATE EVALUATED       :   13Nov90
EVAL RECOMMENDATION  :   1.  No remediation required.  Surface seal is 3 3/4-ft, not >18-ft per WAC 173-160.
LISTED USE           :   LLBG monthly water level measurement, 02Dec87-25Jun93;
CURRENT USER         :   WHC ES&M w/l monitoring and RCRA sampling,
                         WHC ER monitoring
PUMP TYPE            :   Hydrostar, intake at 274.9-ft, (top-of-casing).
MAINTENANCE          :   12Oct89; Removed hydrostar pump for camera survey.
                         19Oct89; TV camera survey.
                         02Nov89; TV camera survey.
                         28Nov89; Reinstalled hydrostar pump.
```

Figure C-3. Well 299-E33-28 Construction and Completion Summary (2 of 2)

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 E Water Supply
Driller's Name: Murphy/Robinson
Drilling Company: Kaiser Engineers
Date Started: 17Aug87

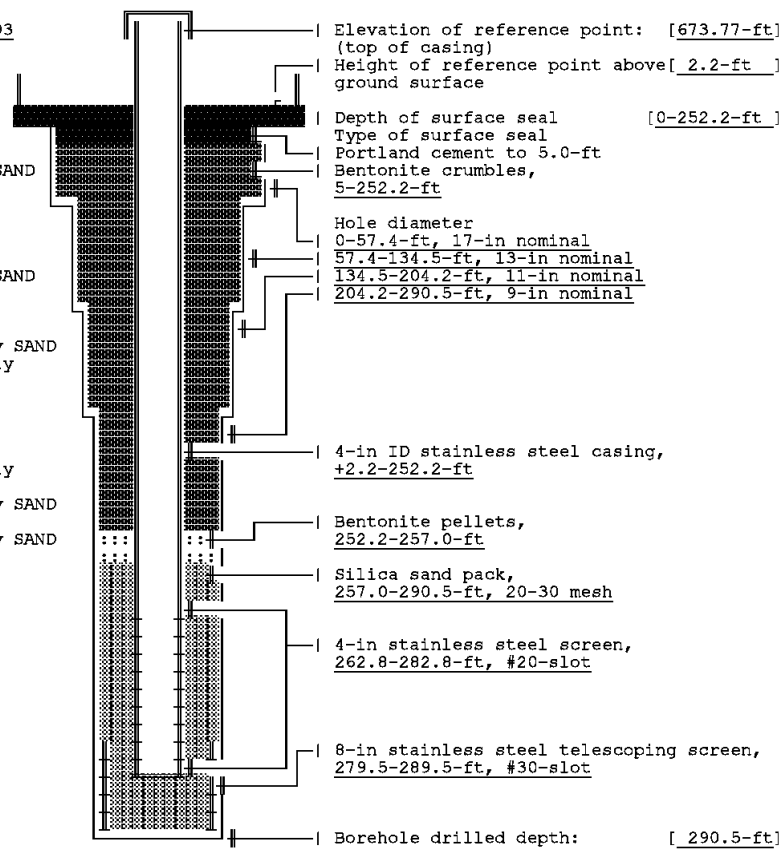
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr:
Company Location: Hanford
Date Complete: 30Sep87

WELL NUMBER: 299-E33-29
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 45,124 E/W W 54,665
State Coordinates: N 450,285 E 2,240,544
Start Card #: Not documented T R S
Elevation Ground surface: 671.53-ft (Brass cap)

Depth to water: 265.7-ft Sep87
(Ground surface) 269.7-ft 25Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's

0-5: GRAVEL
5-55: Silty sandy GRAVEL
55-60: Slightly silty gravelly SAND
60-70: Slightly silty, slightly gravelly SAND
70-75: Slightly silty SAND
75-80: Slightly gravelly SAND
80-85: Gravelly SAND
85-90: Slightly silty gravelly SAND
90-95: SAND
95-105: Slightly gravelly SAND
105-120: SAND
120-125: Slightly silty gravelly SAND
125-130: Slightly silty, slightly gravelly SAND
130-135: Slightly silty SAND
135-140: SAND
140-145: Slightly silty SAND
145-150: Slightly gravelly SAND
150-160: Slightly silty, slightly gravelly SAND
160-165: Slightly silty gravelly SAND
165-180: Slightly gravelly SAND
180-185: Slightly silty gravelly SAND
185-205: SAND
205-215: Sandy SILT
215-250: Silty sandy GRAVEL
250-255: Sandy GRAVEL
255-280: Silty sandy GRAVEL
280-285: SAND
285-290: GRAVEL
290 : BASALT



Drawing By: RKL/2E33-29.ASB
Date : 13Sep93
Reference : HANFORD WELLS

Figure C-4. Well 299-E33-29 Construction and Completion Summary (1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E33-29

WELL DESIGNATION	:	299-E33-29
RCRA FACILITY	:	Low Level Burial Grounds, 218-E-10
CERCLA UNIT	:	200 Aggregate Area Management Study (200-BP-5)
HANFORD COORDINATES	:	N 45,124 W 54,665 [07Dec87]
LAMBERT COORDINATES	:	N 450,285 E 2,240,544 [HANCONV]
DATE DRILLED	:	Sep87
DEPTH DRILLED (GS)	:	290.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	265.7-ft, Sep87, 269.7-ft, 25Jun93
CASING DIAMETER	:	4-in, stainless steel, +2.2-262.8-ft.
ELEV TOP CASING	:	673.77-ft, [07Dec87]
ELEV GROUND SURFACE	:	671.53-ft, Brass cap [07Dec87]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	4-in, 262.8-282.8-ft; 8-in, 279.5-289.5-ft
COMMENTS	:	FIELD INSPECTION, 02Jun90, 4-in stainless steel casing, no protective casing. Capped and locked. 4-ft by 4-ft concrete pad, 4 posts, brass marker with stamped ID. OTHER;
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LLBG monthly water level measurement, 01Dec87-25Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, WHC ER characterization
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

Figure C-4. Well 299-E33-29 Construction and Completion Summary (2 of 2)

WELL SUMMARY SHEET		Start Date: 4/9/10 Finish Date: 4/26/10	Page 1 of 2
Well ID: C7565		Well Name: 299-E33-266	
Location: 100 m W of 299-E33-30		Project: 5 M-24 RCRA Monitoring Wells	
Prepared By: Ryan W. Brauchla	Date: 4/28/10	Reviewed By: L. D. Walker	Date: 8/9/10
Signature: Ryan W. Brauchla		Signature: L. D. Walker	

CONSTRUCTION DATA

Description

Stainless Steel Protective Casing: 3.0 ft above ground surface

Portland Cement Type I/II: 0 - 10.2 ft bgs

4-in I.D. Stainless Steel Type 304, Permanent Blank Casing: + 2.06 - 263.05 ft bgs

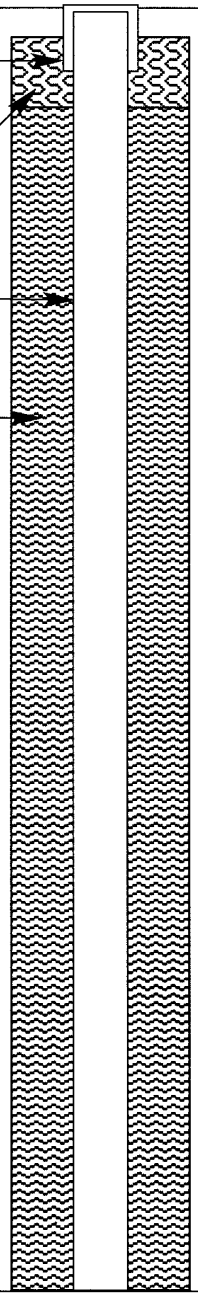
Granular Bentonite Crumbles: 10.2 - 252.3 ft bgs

All temporary drill casing was removed from the ground.

All depths are in feet below ground surface.

Borehole drilled with 9-inch O.D. casing. 0.0 - 286.06 ft bgs

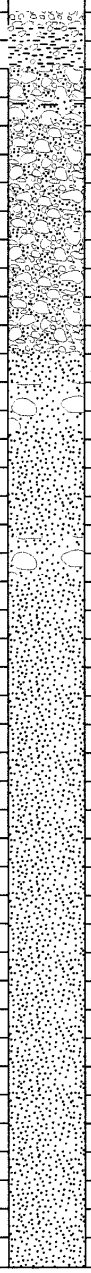
Diagram



GEOLOGIC/HYDROLOGIC DATA

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

Graphic Log



Lithologic Description/Groundwater Sample Depths (ft bgs)

0-1 Gravel (G)
1-8 Gravelly Silt (gM)
8-12 Sandy Gravel (sG)
12-15 Silty Sandy Gravel (msG)
15-48 Sandy Gravel (sG)
48-52 Sand (S)
52-59 Gravelly Sand (gS)
59-74 Sand (S)
74-79 Gravelly Sand (gS)
79-199 Sand (S)

Figure C-5. Well 299-E33-266 Construction and Completion Summary (1 of 2)

WELL SUMMARY SHEET	Start Date: 4/9/10 Finish Date: 4/26/10	Page 2 of 2

Well ID: C7565		Well Name: 299-E33-266	
Location: 100 m W of 299-E33-30		Project: 5 M-24 RCRA Monitoring Wells	
Prepared By: Ryan W. Brauchla	Date: 4/28/10	Reviewed By: L.D. Walker	Date: 8-9-10
Signature:		Signature:	

CONSTRUCTION DATA

Description

Granular Bentonite Crumbles:
10.2 - 252.3 ft bgs

4-in I.D. Stainless Steel Type 304,
Permanent Blank Casing:
+ 2.06 - 263.05 ft bgs

1/4-in Bentonite Pellets:
252.3 - 258.2 ft bgs

Primary Filter Pack
10-20 Mesh Colorado Silica Sand:
258.2 - 286.06 ft bgs

Static Water Level
267.72 ft bgs (4/26/10)

4-in I.D. Stainless Steel Type ~~304,~~ 316
20 Slot (0.020-in) Screen:
263.05- 283.07 ft bgs

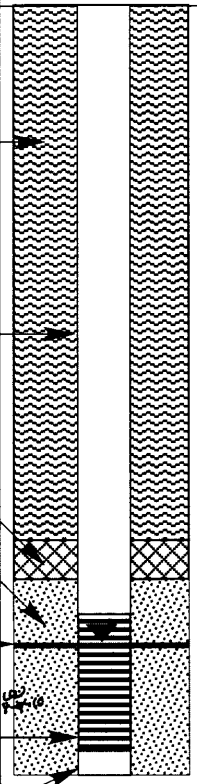
4-in, I.D. Stainless Steel
Sump/End Cap:
283.07 - 286.06 ft bgs

All temporary drill casing was removed from the ground.

All depths are in feet below ground surface.

Borehole drilled with 9-inch O.D. casing.
0.0 - 286.06 ft bgs

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 180, 200, 220, 240, 260, 280, 300

Graphic Log

Lithologic Description/Groundwater Sample Depths (ft bgs)

79-199 Sand (S)
199-203 Gravel (G)
203-209 Gravelly Sand (gS)
209-222 Sand (S)
222-233 Gravelly Sand (gS)
233-251 Sandy Gravel (sG)
251-256 Silty Sandy Gravel (msG)
256-283 Gravel (G)
283-286.06 Basalt
Total Depth Drilled: 286.06 ft bgs (4/23/10)

Figure C-5. Well 299-E33-266 Construction and Completion Summary (2 of 2)

C2 References

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

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

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