DOE/RL-2009-74
Revision 1

Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area U

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

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

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Executive Summary

Waste Management Area (WMA) U, which contains the U Tank Farm, is regulated under RCW 70.105[1] and its implementing requirements in WAC 173-303-400.[2] The Washington State Department of Ecology (Ecology) has been authorized by the U.S. Environmental Protection Agency, in accordance with *Authorized State Hazardous Waste Programs*,[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976* (RCRA),[4] including the requirements in 40 CFR 265, Subpart F.[5] The WMA U is also subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order*,[6] with Ecology identified as the lead regulatory agency for the unit.

The WMA U was placed in assessment monitoring in 2000 due to elevated specific conductance, and a groundwater quality assessment plan was implemented.[7] An assessment report of the initial findings was issued in July 2000,[8] and it was concluded that the tank farm had impacted groundwater quality. The assessment plan was updated in 2001,[9] and two subsequent interim change notices[10,11] were issued for continued RCRA groundwater quality assessment, as required by 40 CFR 265.93(d)(7).[12]

This document supersedes DOE/RL-2009-74, Rev. 0. This plan describes the WMA U facility and operating history, waste characteristics, hydrogeology, previous monitoring at

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

[2] WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*, Olympia, Washington.

[3] *Authorized State Hazardous Waste Programs*, 42 USC 6926(b), et seq.

[4] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq.

[5] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring," *Code of Federal Regulations*.

[6] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

[7] PNNL-13185, 2000, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U at the Hanford Site*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

[8] PNNL-13282, 2000, *Groundwater Quality Assessment for Waste Management Area U: First Determination*, Pacific Northwest National Laboratory, Richland, Washington.

[9] PNNL-13612, 2001, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*, Pacific Northwest National Laboratory, Richland, Washington.

[10] PNNL-13612-ICN-1, 2003, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*, Interim Change Notice 1, Pacific Northwest National Laboratory, Richland, Washington.

[11] PNNL-13612-ICN-2, 2006, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*, Interim Change Notice 2, Pacific Northwest National Laboratory, Richland, Washington.

[12] 40 CFR 265.93, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response," *Code of Federal Regulations*.

the WMA, groundwater and vadose zone contamination associated with the WMA, and the conceptual model for the WMA. The plan addresses the following:

- Adequacy of the wells monitoring the groundwater at WMA U
- Sampling requirements and schedule
- Analytes, groundwater parameters, and analytical methods necessary to determine extent of contamination from WMA U
- Procedures for evaluating groundwater quality data
- Reporting requirements

This assessment plan is the principal controlling document for conducting groundwater monitoring at WMA U.

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Terms

CAS	Chemical Abstract Services
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CY	calendar year
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FY	fiscal year
ID	identification
NAVD88	North American Vertical Datum of 1988
OU	operable unit
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
SST	single-shell tank
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
VOC	volatile organic compound
WMA	waste management area

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1 Introduction

Since 1944, the Hanford Site's single-shell tanks (SSTs) have stored both radioactive and dangerous chemical waste generated from plutonium-production and separation activities. The 149 SSTs are recognized as dangerous waste management units and are regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA), RCW 70.105 ("Hazardous Waste Management"), and its implementing requirements (WAC 173-303, "Dangerous Waste Regulations"). Only the dangerous chemical waste is regulated by RCRA; radioactive waste is regulated under the *Atomic Energy Act of 1954*.

The U Tank Farm in the Hanford Site's 200 West Area comprises Waste Management Area (WMA) U (Figure 1-1). A RCRA interim status detection groundwater monitoring program for the SSTs was implemented in 1989 (WHC-SD-EN-AP-012, *40 CFR 265 Interim Status Ground-Water Monitoring Plan for the Single-Shell Tanks*), and detection monitoring began at WMA U in 1991. The WMA was placed into assessment status in 2000 due to elevated specific conductance in downgradient monitoring wells (PNNL-13185, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U at the Hanford Site*).

This document presents a revised groundwater assessment plan for WMA U that supersedes the previous groundwater assessment plan (DOE/RL-2009-74, Rev. 0, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area U*). Background information is summarized in this document, and references are provided to other documents for additional detail.

The specific objective of this groundwater assessment plan is to fulfill requirements specified in WAC 173-303-400(3) ("Interim Status Facility Standards"), incorporating by reference 40 CFR 265.93 ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response"). These requirements specify that the concentration, rate, and extent of migration of dangerous waste constituents in the groundwater shall be determined. To meet this objective, this plan defines a network of groundwater monitoring wells; specifies the sampling frequency; and lists the dangerous constituents, indicators, and supporting constituents to be monitored in groundwater. This monitoring plan is prepared to be consistent, to the extent possible, with the final status monitoring plan that will be incorporated into the *Hanford Facility Dangerous Waste Permit Application for Single-Shell Tank Systems* (WA7890008967) in the future.

Chapter 2 of this plan summarizes background information and includes a description of WMA U and the types of waste present, a brief history of the groundwater monitoring program, and a description of the geology and hydrogeology of the area. This information is incorporated into the site conceptual model to aid in development of the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, the wells monitored, sampling frequency and protocols, and the constituents analyzed. Chapter 4 describes data evaluation, interpretation, and reporting. A list of the references cited in this document is provided in Chapter 5. Appendix A provides the quality assurance project plan (QAPjP), and Appendix B includes construction information for well 299-W19-47.

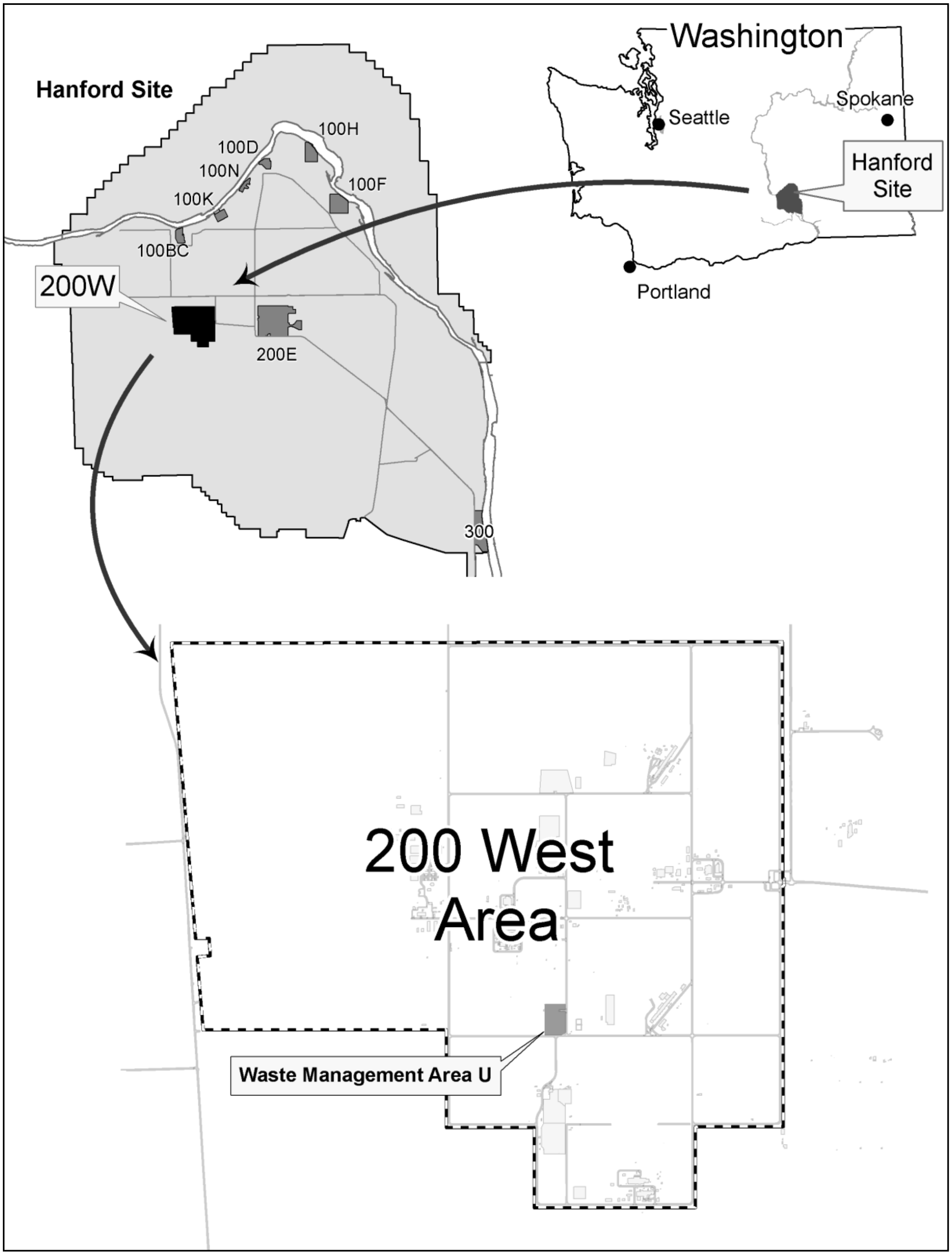

Figure 1-1. Location Map for WMA U

2 Background

This chapter provides a description of WMA U, the regulatory requirements for groundwater monitoring, and the waste characteristics. It also summarizes the hydrogeology beneath the WMA, outlines a conceptual model for contaminant migration, describes groundwater contamination in the uppermost aquifer, and addresses the data quality objectives (DQOs).

2.1 Facility Description and Operational History

The WMA U occupies an area of approximately 29,000 m^2 (310,000 ft^2) and contains 16 underground SSTs (Figure 2-1). The SSTs were constructed between 1943 and 1944. Twelve of the SSTs are 100-series tanks, which are 23 m (75 ft) in diameter and have capacities of 2,020,000 L (535,000 gal) (RPP-35485, *Field Investigation Report for Waste Management Area U)*. Four of the SSTs are 200-series tanks, which are 6 m (20 ft) in diameter and have capacities of 210,000 L (55,000 gal). The bases of both the 100-series and the 200-series tanks are approximately 11.3 m (37 ft) below ground surface. The WMA also contains a variety of ancillary equipment used to manage tank waste during operations, including six diversion boxes, the 271-UR control house, the 244-UR process vault, the 244-U double-contained receiver tank, waste transfer lines, pits, and junction boxes.

The tank farm received waste from the bismuth phosphate process between 1946 and 1948 and from the reduction-oxidation process between 1954 and 1957 (WHC-MR-0132, *History of the 200 Area Tank Farms*). In 1952, some waste was retrieved and pumped to the 242-T evaporator. Between 1952 and 1957, the metal wastes (stored in nine of the 100-series tanks) were transferred to U Plant to facilitate uranium recovery. A more detailed history of operations is presented in *Groundwater Quality Assessment for Waste Management Area U: First Determination* (PNNL-13282), *Historical Vadose Zone Contamination from U Farm Operations* (RPP-7580), and RPP-35485.

The tank status and inventory are documented in monthly updates of the waste tank summary report (e.g., HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*). Four tanks are known or assumed to have experienced a leak/release: U-101, U-104, U-110, and U-112. To minimize future leaks/releases, all Hanford Site SSTs have been interim stabilized, which means that the drainable liquid in each tank has been removed and transferred to double-shell tanks[13] (DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*). While this reduces the possibility of a future leak/release, releases may still be possible because some residual liquid generally remains in an interim-stabilized tank.

2.2 Regulatory Basis

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

[13] A more precise definition of an "interim stabilized tank" is one that contains less than 189,000 L (50,000 gal) of drainable interstitial liquid and less than 18,900 L (5,000 gal) of supernatant (HNF-EP-0182).

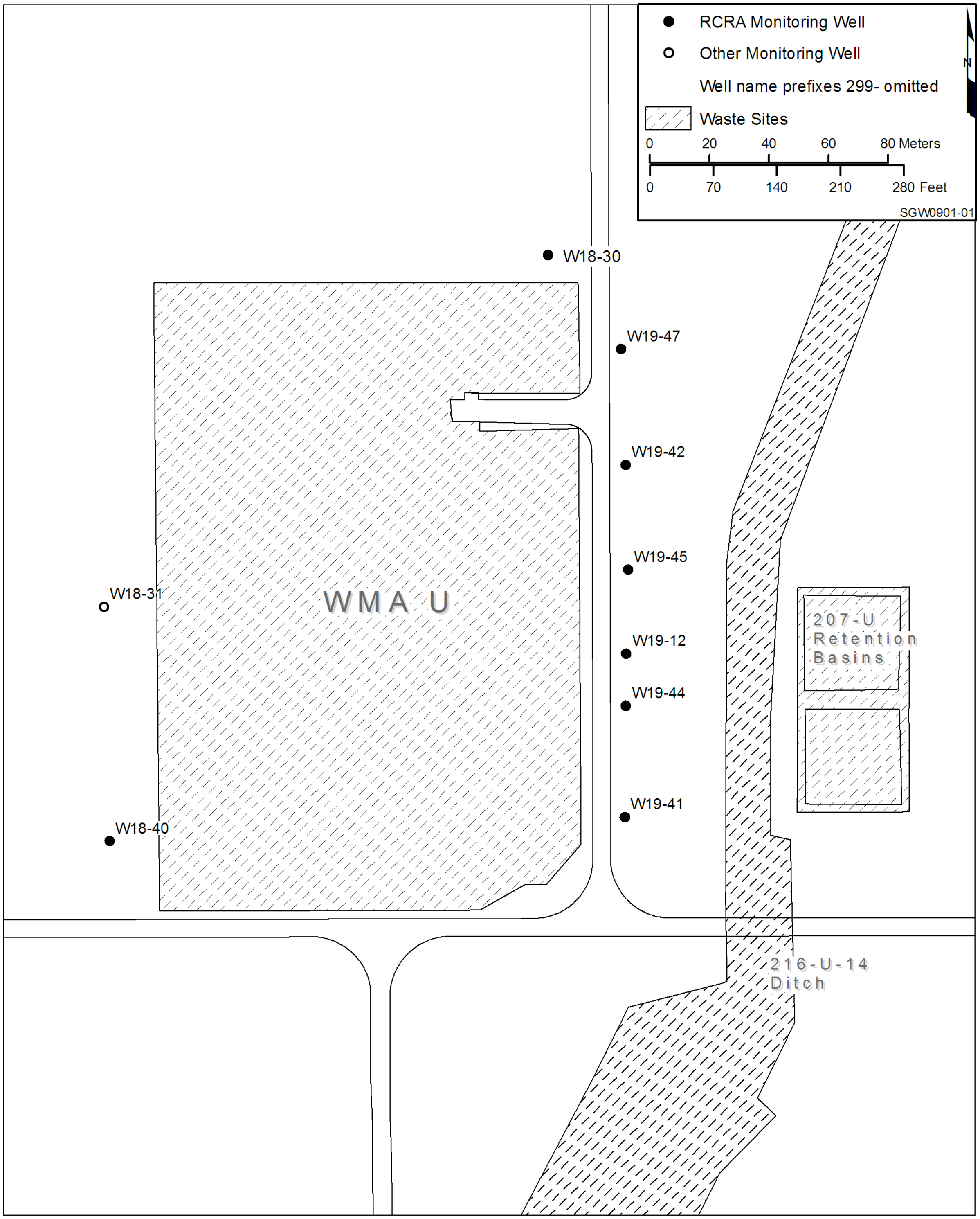

Figure 2-1. WMA U and Vicinity

Groundwater monitoring is conducted at WMA U in accordance with WAC 173-303-400(3) and, by reference, 40 CFR 265, Subpart F ("Ground-Water Monitoring"), which requires monitoring to determine whether dangerous waste or dangerous waste constituents from the waste site have entered the groundwater. The WMA was placed in assessment monitoring (40 CFR 265.93[d][4]) after elevated specific conductance in a downgradient monitoring well was observed and confirmed (PNNL-13185).

An assessment report of the initial findings was issued in July 2000 (PNNL-13282), which concluded that the tank farm had impacted groundwater quality and that tank waste constituents present in the groundwater resulted from surface water infiltration in the southern portion of the WMA. As required by 40 CFR 265.93(d)(7)(i), assessment monitoring has continued under several updates to the monitoring plan.

2.3 Waste Characteristics

Table 2-1 lists the dangerous constituents found in the Dangerous Waste Permit Application Part A (WA7890008967, *Hanford Facility Dangerous Waste Permit Application for Single-Shell Tank Farm Systems*). Mobile tank waste constituents originally identified in the groundwater included nitrate and chromium, but chromium concentrations have since declined to near the analytical detection limits (DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)

Dangerous Waste Code	Contaminant Description	Dangerous Waste Code	Contaminant Description
D001	Ignitable waste	D034	Hexachloroethane
D002	Corrosive waste	D035	Methyl ethyl ketone
D003	Reactive waste	D036	Nitrobenzene
D004	Arsenic	D038	Pyridine
D005	Barium	D039	Tetrachloroethylene
D006	Cadmium	D040	Trichloroethene (TCE)
D007	Chromium	D041	2,4,5-Trichlorophenol
D008	Lead	D043	Vinyl chloride
D009	Mercury	F001	1,1,1-Trichloroethane
D010	Selenium	F002	Methylene chloride
D011	Silver	F003	Acetone, methyl isobutyl ketone
D018	Benzene	F004	Cresol-m, -o, -p
D019	Carbon tetrachloride	F005	Methyl ethyl ketone (MEK)
D022	Chloroform	WT01	Extremely hazardous waste/ toxic dangerous waste
D028	1,2-Dichloroethane	WT02	Dangerous waste/toxic dangerous waste

Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)

Dangerous Waste Code	Contaminant Description	Dangerous Waste Code	Contaminant Description
D029	1,1-Dichloroethylene	WP01	Extremely hazardous waste/ persistent dangerous waste
D030	2,4-Dinitrotoluene	WP02	Dangerous waste/persistent dangerous waste
D033	Hexachlorobutadiene		

Notes:

WA7890008967, *Hanford Facility Dangerous Waste Permit Application for Single-Shell Tank Farm Systems*.

Analytes associated with the F001 through F005 waste codes are from WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units*.

2.4 Geology and Hydrology

The generalized stratigraphy of the Hanford Site is shown in Figure 2-2. The local stratigraphy beneath WMA U consists of unconsolidated to semiconsolidated sediments overlying basalt bedrock of the Columbia River Basalt Group. The sedimentary units present (in descending sequence) are as follows:

- Sand and gravel backfill
- Sand and gravel of the Hanford formation
- Fine-grained Cold Creek unit
- Sand and gravel of the Ringold Unit E
- Fine-grained Ringold lower mud unit
- Sand and gravel of Ringold Unit A (which overlies the basalt)

Note that the Ringold Formation upper fines (Savage Island member and Taylor Flats member) are not present beneath the WMA. The water table occurs within Ringold Unit E, and the vadose zone beneath the WMA is approximately 67 m (220 ft) thick. The base of the aquifer is the fine-grained Ringold lower mud unit. The unconfined aquifer is approximately 70 m (230 ft) thick. A more detailed description of the geology of WMA U is provided in *Subsurface Conditions Description of the U Waste Management Area* (RPP-15808) and *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U* (PNNL-13612, PNNL-13612-ICN-1, and PNNL-13612-ICN-2). *Revised Hydrogeology for the Suprabasalt Aquifer System, 200 West Area and Vicinity, Hanford Site, Washington* (PNNL-13858) describes the hydrogeology of the entire 200 West Area and vicinity.

Figure 2-3 shows the March 2009 water table map for WMA U and vicinity. Groundwater flow conditions at WMA U have varied greatly over the past several decades due to changing wastewater disposal in areas surrounding the WMA. Between 1950 and 1970, the groundwater flow direction beneath the WMA varied between southeast, east, and northeast, depending on effluent disposal volumes to the former 216-T-4 Pond to the north of the WMA and the former 216-U-10 Pond to the southwest (PNNL-16069, *Development of Historical Water Table Maps of the 200 West Area of the Hanford Site [1950-1970]*). During the 1980s, the flow direction changed from northeast to east in response to the decommissioning of the 216-U-10 Pond in 1985. In the late 1980s and early 1990s, nearby effluent discharges were occurring at the 216-Z-20 Crib to the west of the WMA and the 216-U-14 Ditch to the east (see Figure 2-3 for waste site locations). The effluent volume discharged to the 216-Z-20 Crib declined in 1992, and the flow direction beneath the WMA reversed to westerly because discharges to the 216-U-14 Ditch became dominant. Discharges to both sites had ceased by 1996, and the flow direction has been toward the east-northeast since that time.

Between January 2005 and March 2009, the water table elevation declined at an average rate of 0.29 m/yr (0.95 ft/yr) in the monitoring wells. Analysis of water-level data collected during March 2009 indicates that the hydraulic gradient magnitude is 2.2×10^{-3} m/m, and the groundwater flow rate (i.e., average linear velocity) ranges between 7 and 77 m/yr (23 and 250 ft/yr), depending on the hydraulic conductivity and effective porosity. Using values believed to be most representative, 6.12 m/d (20.1 ft/d) for the hydraulic conductivity and 0.17 for the effective porosity (both values are from a constant-rate pumping test conducted in well 299-W19-42, as provided in *Results of Detailed Hydrologic Characterization Tests: Fiscal Year 1999* [PNNL-13378]), the groundwater flow rate most representative for this site is 29 m/yr (95 ft/yr).

2.5 Summary of Previous Groundwater Monitoring

In 1999, the groundwater monitoring program for WMA U was changed from indicator parameter evaluation to groundwater assessment because specific conductance in downgradient monitoring well 299-W19-41 exceeded the critical mean value. An assessment report of the initial findings was issued in July 2000 (PNNL-13282). The report concluded that the tank farm had impacted groundwater quality and that tank waste constituents present in the groundwater resulted from surface water infiltration in the southern portion of the WMA. Subsequent annual assessment results have been included in Hanford Site annual groundwater reports (e.g., DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*).

2.5.1 Groundwater Contamination

The following discussion is summarized from DOE/RL-2008-66 and represents conditions in fiscal year (FY) 2008.

Groundwater contamination from WMA U is limited to the downgradient (east) side of the site (PNNL-13282). Constituents found in the groundwater originally included the dangerous waste chromium and the supporting constituent nitrate, but chromium concentrations have decreased in the recent past to near the analytical detection limit. Nitrate concentrations are the highest along the southern half of the site. Nitrate concentrations are increasing in all but two monitoring wells (299-W19-41 and 299-W19-44) at WMA U, including the upgradient well. During FY 2008, nitrate concentrations were above the drinking water standard (45 mg/L) in at least one sample from downgradient wells 299-W19-12, 299-W19-41, 299-W19-44, and 299-W19-45. The maximum nitrate concentration measured in a quarterly sample was 88 mg/L in well 299-W19-44 during November 2007. Concentrations are higher in downgradient wells compared to upgradient well 299-W18-40, confirming that WMA U is a source of nitrate to the aquifer. However, nitrate from an upgradient source is also affecting groundwater quality. During FY 2008, the maximum nitrate concentration measured in upgradient well 299-W18-40 was 38 mg/L in August 2008. Nitrate concentrations for some of the network monitoring wells are shown in Figure 2-4.

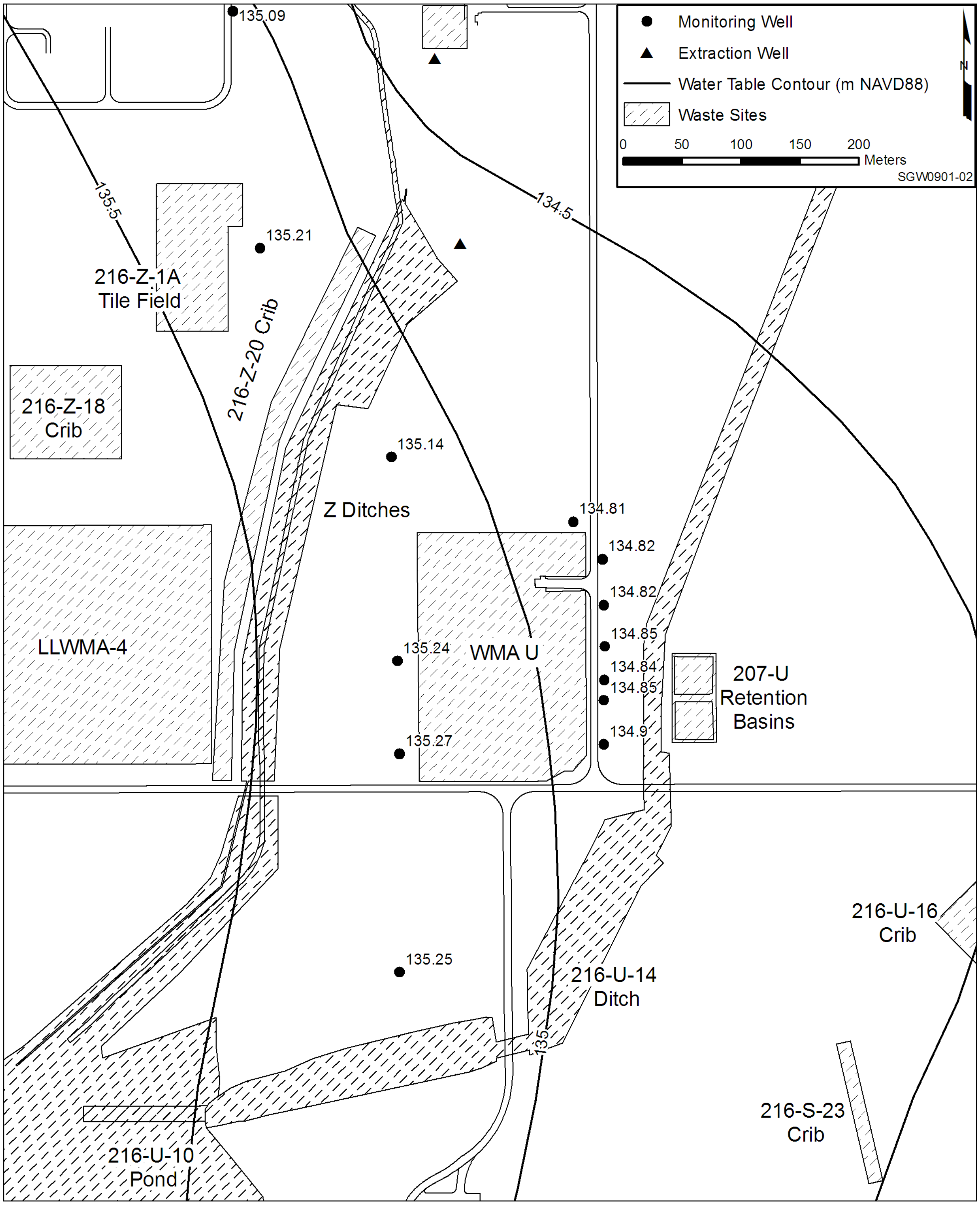

Figure 2-3. Water Table Elevations in March 2009

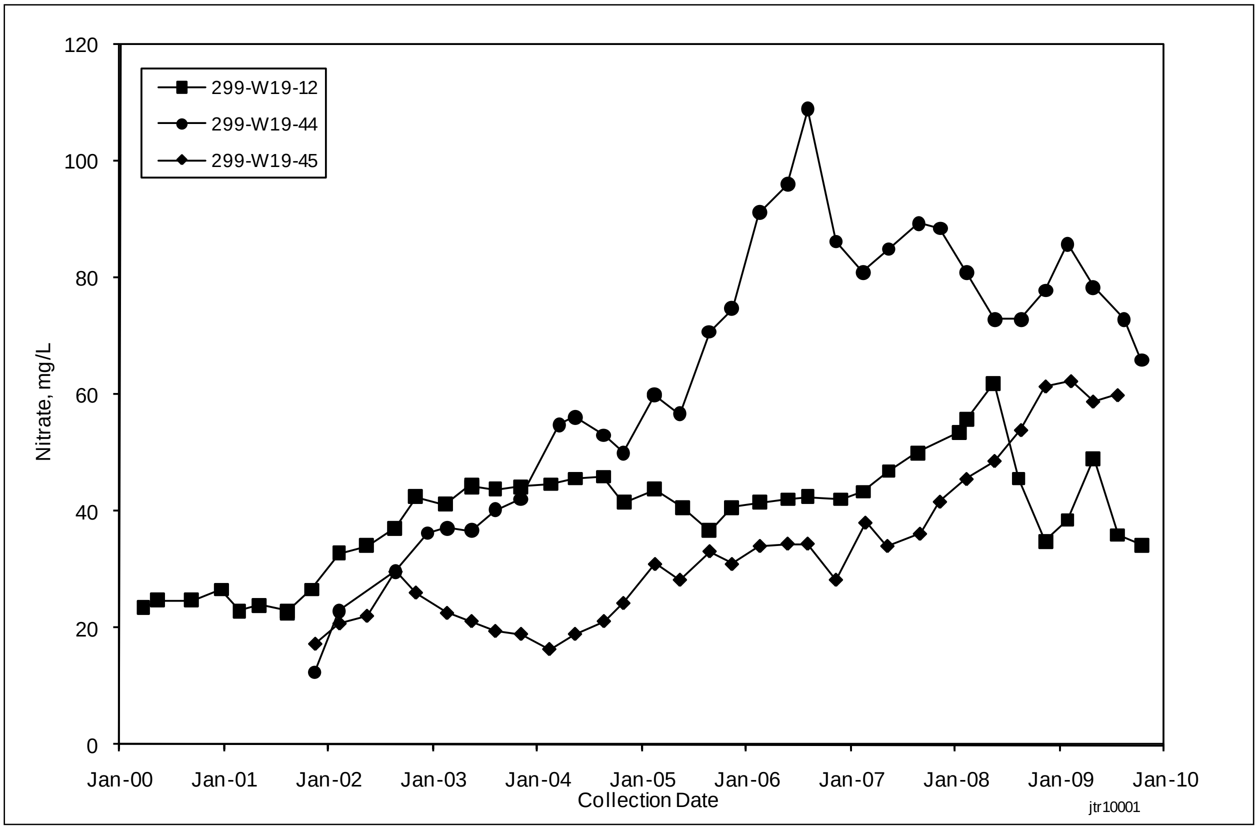

Figure 2-4. Nitrate Concentrations at WMA U

Carbon tetrachloride is found in groundwater beneath WMA U at concentrations above the drinking water standard of 5 µg/L. Well 299-W18-30 is the only well in which samples are analyzed for carbon tetrachloride, and the well had a concentration of 145 µg/L in August 2008. The regional distribution of carbon tetrachloride indicates that this constituent originates from liquid waste disposal sites at the Plutonium Finishing Plant, located northwest of WMA U. Carbon tetrachloride is monitored as part of the 200-UP-1 and 200-ZP-1 Operable Units (OUs).

2.5.2 Vadose Zone Contamination

The threat to groundwater posed by the tanks themselves has been significantly reduced for two reasons:

- All SSTs at the Hanford Site have been interim stabilized.
- Interim measures have been implemented to reduce the forces driving contamination downward to the groundwater (e.g., constructing berms around the tank farms to divert surface water runoff away from the facility, testing all nearby water lines and removing leaking water lines from service, and capping all vadose zone monitoring boreholes in the tank farms).

However, past tank leaks/releases have left portions of the vadose zone contaminated. This contamination has the potential to move downward into the groundwater, especially if a driving force is present.

To identify areas of vadose zone contamination, a surface geophysical survey was conducted in 2006 (RPP-RPT-31557, *Surface Geophysical Exploration of U Tank Farm at the Hanford Site*). This survey found a low-resistivity plume (indicating either high soil moisture or high inorganic ions) in the vicinity of tanks U-104 and U-105. This plume is consistent with releases from tank U-104 that have apparently migrated to the west in the vadose zone to beneath tank U-105. Low-resistivity plumes were not found in the vicinity of tanks U-101, U-110, and U-112.

During 2007, 20 direct-push probe holes were installed at WMA U to investigate vadose zone contamination (PNNL-17163, *Characterization of Direct Push Vadose Zone Sediments from the 214-U Single-Shell Tank Farm*). Vadose zone contamination was found in the vicinity of tank U-104, confirming the results of the geophysical survey. In addition, contamination was found near tank U-110. The contamination found at tank U-104 was largely limited to radionuclides; elevated dangerous waste or dangerous waste constituents were not found in the vadose zone near this tank. Water-extractable nitrate and chromium were found elevated in the vadose zone near tank U-110, and elevated pH and specific conductance were also found in the water extracts. The contamination extends to at least a depth of 28 m (92 ft) near tank U-104 and 30 m (98 ft) near tank U-110, which are the depths that the probe holes were installed. Contamination was not found in the two probe holes installed near tank U-101 and the single probe hole installed near tank U-112. Additional characterization efforts are needed to understand the full lateral and vertical extent of vadose zone contamination at WMA U.

2.6 Conceptual Model

DOE/ORP-2008-01 summarizes a conceptual model of tank leak/release pathways to the groundwater, and Appendix A of that document presents the conceptual model in detail. The following summary is from DOE/ORP-2008-01, as well as PNNL-13282 and PNNL-13612. Conceptual models for the tank leaks/releases at WMA U are also discussed in RPP-35485.

2.6.1 Contaminant Source

Tank leak/release events began with rapid discharge of some waste fluid volume into the subsurface from a point of entry likely having a small spatial extent (on the order of inches to rarely feet). This discharge temporarily increased the moisture content of the unsaturated soil, particularly at the point of entry. Points of entry included poorly sealed openings in the tank structure, ruptured areas of steel tank liners nearby underlying concrete shell fractures, and breaks in waste transfer lines. Natural processes then redistributed the excess moisture within the vadose zone, eventually returning the soil to ambient conditions.

The migration process occurred, for the most part, in partially saturated soils because leak/release volumes were not sufficient to fill the soil pore spaces for an appreciable length of time or very far from the point of entry. This condition is referred to as “unsaturated flow.” In addition to vertical flow, lateral flow occurred because soil layers with different hydraulic properties tend to be layered more or less horizontally by sediment deposition processes. Consequently, flow in the lateral direction could occur and be enhanced by the unsaturated conditions.

In addition to tank leaks/releases, four unplanned releases have been documented at WMA U (DOE/RL-91-52, *U Plant Source Aggregate Area Management Study Report*; RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates*; and the Waste Information Data System). The releases were at the ground surface or near the surface, and the waste volumes associated with these unplanned releases are unknown. The releases may have resulted in significant spread of contamination. One release (UPR-200-W-6) occurred in 1950 at the surface in the vicinity of the 241-U-151 and 241-U-152 diversion boxes, to the east of the southern portion of the WMA. The second release (UPR-200-W-24) occurred in 1953 and consisted of a violent chemical reaction in a blending tank in the 244-UR vault, located at the northern end of the WMA, which spread first-cycle metal waste contamination over an unspecified area. This release continued to spread to the north, beyond the fence, where the area is roped off. The third release (UPR-200-W-132) was an overflow event at the 241-UR-151 diversion box in 1956, and the fourth release (UPR-200-W-128) involved a ruptured buried waste line at tank U-103 in 1971. In *Vadose Zone Characterization Project at the Hanford Tank Farms: U Tank Farm Report* (GJO-97-1-TAR/GJO-HAN-8), significant surface contamination was reported within the tank farm, as well as several undocumented spills or leaks/releases.

2.6.2 Driving Force

External sources of water or other liquid may have driven the contamination downward. Infiltration of fresh water (as well as precipitation and unintentional, manmade releases such as leaking water lines) may move residual waste remaining in the soil downward to the groundwater. Another potential source of water was discharges to nearby wastewater disposal sites: the 216-Z-20 Crib and Z Ditches to the west, and the 216-U-14 Ditch to the east (RPP-23405). Perched water beneath these disposal sites may have migrated laterally beneath WMA U, although this has not been confirmed.

As waste fluids are migrating within the vadose zone, numerous contaminants are reacting chemically with the vadose zone soil/water system to varying degrees. Water extracts of contaminants from sediments collected from the direct-push probe holes installed at WMA U during 2007 confirmed the variable mobility of the contaminants (PNNL-17163).

2.6.3 Migration

Upon reaching the groundwater, the plumes migrate toward the east with the groundwater flow. The groundwater flow velocity has been estimated at 29 m/yr (95 ft/yr) (see Section 2.4). RPP-35485 discusses the conceptual models of tank leak/release pathways to the groundwater at WMA U in more detail.

2.7 Data Quality Objectives

The DQO process ensures that data gathered during an investigation are of the appropriate quantity and quality to meet specific objectives. The DQO parameters, regulatory interim status requirements, and associated reports supporting the regulatory requirements are outlined in Table 2-2.

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA U

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Scope	**40 CFR 265.93, "Preparation, Evaluation, and Response," as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).** (d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator: (i) Must continue to make the determinations required under paragraph (d)(4) of this section… **40 CFR 265.93, "Preparation, Evaluation, and Response," as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).** (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. **40 CFR 265.93, "Preparation, Evaluation, and Response," as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).** (d)(3) The plan to be submitted under 40 CFR 265.90(d)(1) or paragraph (d)(2) of this section must specify: (i) The number, location, and depth of wells; (ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility; (iii) Evaluation procedures, including any use of previously gathered ground-water quality information; and (iv) A schedule of implementation.	This plan, Sections 3.1 and 3.2, Chapter 4, and Appendix A PNNL-13185, *Groundwater Quality Assessment Plan for Single Shell Tank Waste Management Area U at the Hanford Site* PNNL-13612, *Groundwater Quality Assessment Plan for Single Shell Tank Waste Management Area U*, as modified by interim change notice

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA U

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Number and location of wells Point(s) of compliance	**40 CFR 265.93, "Preparation, Evaluation, and Response," as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).** (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.	This plan, Chapters 1 and 3, and Appendix A PNNL-13185, *Groundwater Quality Assessment Plan for Single Shell Tank Waste Management Area U at the Hanford Site* PNNL-13612, *Groundwater Quality Assessment Plan for Single Shell Tank Waste Management Area U*, as modified by interim change notice
Well configuration (depth and length of screened interval; well construction)	**40 CFR 265.91, "Ground-Water Monitoring System."** (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water. **Additional requirements from WAC 173-303-400 (3)(c)(v)(C).** Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells.	This plan, Section 3.2 PNNL-13185, *Groundwater Quality Assessment Plan for Single Shell Tank Waste Management Area U at the Hanford Site* PNNL-13612, *Groundwater Quality Assessment Plan for Single Shell Tank Waste Management Area U*, as modified by interim change notice

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA U

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Frequency of sampling Types of analysis or measurement Method detection limits or accuracy and precision Methods used to evaluate the collected data	**40 CFR 265.93, "Preparation, Evaluation, and Response," as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).** (d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator: (i) Must continue to make the determinations required under paragraph (d)(4) of this section on a quarterly basis until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility; or (ii) May cease to make the determinations required under paragraph (d)(4) of this section, if the ground-water quality assessment plan was implemented during the post-closure care period. (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.	This plan, Section 3.1, Chapter 4, and Appendix A PNNL-13612, *Groundwater Quality Assessment Plan for Single Shell Tank Waste Management Area U*, as modified by interim change notice

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

DQO = data quality objective

3 Groundwater Monitoring Program

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

3.1 Constituent List and Sampling Frequency

The constituent list for groundwater sampling includes those analytes on the RCRA groundwater monitoring list that may be present in SST waste. To identify these analytes, the list of primary nonradiological constituents potentially present in SST waste (RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*) was compared to those constituents listed in Appendix 5 of Ecology Publication 97-407 (*Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*), which references 40 CFR 264, Appendix IX ("Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring List"). Those constituents listed in RPP-23403 that are RCRA-regulated (i.e., listed in Appendix 5 of Ecology Publication 97-407) are included in Table 3-1.

Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System

Constituent	CAS ID	Constituent	CAS ID
VOCs			
1,1,1-Trichloroethane	71-55-6	Chloroform	67-66-3
1,1,2,2-Tetrachloroethane	79-34-5	Ethylbenzene	100-41-4
1,1,2-Trichloroethane	79-00-5	Isobutanol	78-83-1
1,1-Dichloroethene	75-35-4	Methylene chloride	75-09-2
1,2-Dichloroethane	107-06-2	Tetrachloroethene	127-18-4
2-Butanone (methyl ethyl ketone)	78-93-3	Toluene	108-88-3
2-Propanone (acetone)	67-64-1	trans-1,3-Dichloropropene	10061-02-6
4-Methyl-2-pentanone (MIBK)	108-10-1	Trichloroethene (TCE)	79-01-6
Benzene	71-43-2	Trichlorofluoromethane	75-69-4
Carbon disulfide	75-15-0	Vinyl chloride (chloroethene)	75-01-4
Carbon tetrachloride	56-23-5	Xylenes	1330-20-7
Chlorobenzene	108-90-7		
Semi-VOCs			
1,2,4-Trichlorobenzene	120-82-1	Aroclor 1260	11096-82-5
2,4,5-Trichlorophenol	95-95-4	Butylbenzylphthalate	85-68-7
2,4,6-Trichlorophenol	88-06-2	Di-n-butylphthalate	84-74-2
2,4-Dinitrotoluene	121-14-2	Di-n-octylphthalate	117-84-0

Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System

Constituent	CAS ID	Constituent	CAS ID
2-Chlorophenol	95-57-8	Fluoranthene	206-44-0
2-Methylphenol (o-cresol)	95-48-7	Hexachlorobutadiene	87-68-3
3-Methylphenol (m-Cresol)	108-39-4	Hexachloroethane	67-72-1
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	Naphthalene	91-20-3
4-Methylphenol (p-cresol)	106-44-5	Nitrobenzene	98-95-3
Acenaphthene	83-32-9	n-Nitroso-di-n-propylamine	621-64-7
Aroclor 1016	12674-11-2	n-Nitrosomorpholine	59-89-2
Aroclor 1221	11104-28-2	1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1
Aroclor 1232	11141-16-5	2-Nitrophenol (o-Nitrophenol)	88-75-5
Aroclor 1242	53469-21-9	Pyrene	129-00-0
Aroclor 1248	12672-29-6	Pyridine	110-86-1
Aroclor 1254	11097-69-1		
Inorganic Constituents (Nonradiological)			
Antimony (Sb)	7440-36-0	Lead (Pb)	7439-92-1
Arsenic (As)	7440-38-2	Mercury (Hg)	7439-97-6
Barium (Ba)	7440-39-3	Nickel (Ni)	7440-02-0
Beryllium (Be)	7440-41-7	Selenium (Se)	7782-49-2
Cadmium (Cd)	7440-43-9	Silver (Ag)	7440-22-4
Chromium (Cr)	7440-47-3	Sulfide (S^{2-})	18496-25-8
Cobalt (Co)	7440-48-4	Thallium (Tl)	7440-28-0
Copper (Cu)	7440-50-8	Vanadium (V)	7440-62-2
Cyanide (CN^{-})	57-12-5	Zinc (Zn)	7440-66-6

Notes: This table lists the primary nonradiological constituents provided in RPP-23403 that are regulated by RCRA (i.e., also listed in Appendix 5 of Ecology Publication 97-407).

CAS = Chemical Abstract Services

ID = identification

RCRA = *Resource Conservation and Recovery Act of 1976*

VOC = volatile organic compound

As described in Section 2.5.1, of the 72 analytes listed in Table 3-1, only chromium has historically been found in groundwater and attributed to releases from the WMA, although concentrations have decreased in recent years to near the analytical detection limit. In addition, nitrate is present in the groundwater and has been attributed to the WMA. Carbon tetrachloride is also found in the groundwater but originates from waste sites associated with the Plutonium Finishing Plant. Thus, chromium and the supporting constituent nitrate (along with the other supporting constituents alkalinity, major cations [metals], and major anions) are routinely sampled under RCRA in the network monitoring wells (Table 3-2). The supporting constituents provide information on general chemistry and allow for charge-balance computations to assess laboratory performance.

Sampling for the remaining constituents identified in Table 3-1 will be performed once in all wells during the first available sample event after this plan is in effect to determine if these constituents have impacted groundwater quality.[14] Those constituents not detected in groundwater will be removed from future sampling. If an organic constituent from Table 3-1 is detected in a groundwater sample and it is not attributed to contamination from another facility (e.g., carbon tetrachloride from the Plutonium Finishing Plant), a confirmation sample will be collected at the next scheduled sample event, with split samples sent to different analytical laboratories. If the detection is confirmed by positive results from both laboratories, the constituent will be added to the list of analytes for routine sampling to evaluate the extent of contamination. If the detection is not confirmed, the analyte will be removed from future sampling.

Some of the inorganic constituents included in Table 3-1 occur naturally in groundwater at concentrations above the laboratory method detection limit (e.g., barium, selenium, vanadium, and zinc). Detections of an inorganic constituent will be evaluated to determine if the constituent is present naturally by comparison to sample results from the upgradient well and comparisons to the Hanford Site background values (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). If it is determined that an inorganic constituent may be present as a contaminant from the WMA, confirmation samples will be collected (as described for the organic constituents). If contamination is confirmed, then the constituent will be added to the routine sample list to evaluate the extent of contamination. If the contamination is not confirmed, the constituent will be removed from future sampling.

Prior to this plan revision, all network monitoring wells were sampled on a quarterly frequency because RCRA regulations require that, for sites in assessment monitoring, the owner/operator "…determine (i) the rate and extent of migration of the dangerous waste or dangerous waste constituents in the groundwater; and (ii) the concentrations of the dangerous waste or dangerous waste constituents in the groundwater…" and the owner/operator "…must continue to make [these] determinations…on a quarterly basis until final closure of the facility…" (40 CFR 265.93, as referenced by WAC 173-303-400). However, if these objectives can be met without performing quarterly sampling for every well in the monitoring network, then the monitoring program would not collect unnecessary information and would be more cost effective.

The approach of using a reduced sampling frequency to meet assessment monitoring objectives in a cost-effective manner has already been adopted at other RCRA sites at Hanford. At WMA S-SX, the monitoring program was changed from 84 sample events per year (quarterly sampling of 21 monitoring wells) to 38 sample events per year by reducing the sampling frequency to semiannual or annual for many of the monitoring wells (DOE/RL-2009-73, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area S-SX*). Reduced sample frequencies have also been implemented at WMA T (DOE/RL-2009-66, *Interim Status Groundwater Quality Assessment Plan for*

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[14] Sampling was conducted under the first revision of this plan, DOE/RL-2009-74, Rev. 0. The results are reported in the Hanford Sitewide annual groundwater monitoring report (DOE/RL-2011-118).

the Single-Shell Tank Waste Management Area T) and WMA TX-TY (DOE/RL-2009-67, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY*).

To evaluate the need for quarterly sampling of each network monitoring well at WMA U, chromium trends based on the quarterly sampling results were qualitatively compared to the same trends plotted with a reduced sampling frequency. For example, Figure 3-1 depicts the chromium sample results in well 299-W18-30 since January 1, 2010, at both quarterly and semiannual sampling frequencies. The trend for each frequency is nearly identical, indicating that no loss of resolution in the trend would have occurred if this well had been sampled semiannually rather than quarterly. As another example, the quarterly chromium results for upgradient well 299-W18-40 are compared with an annual frequency in Figure 3-2. Again, the trends are nearly identical indicating that an annual frequency would have been sufficient to resolve the trend in this well.

A frequency trend analysis was performed for all wells in the monitoring network for both filtered and unfiltered total chromium sample results between January 2, 2010, and May 1, 2012. The results indicated that chromium trends are adequately resolved in all the downgradient monitoring wells with a sample frequency as low as annual. This is because the chromium concentrations are not only stable, but the concentrations are also low; the maximum filtered total chromium sample result since January 1, 2010, was 15.4 µg/L in well 299-W19-41, and the maximum unfiltered result was 30.2 µg/L in well 299-W18-30.

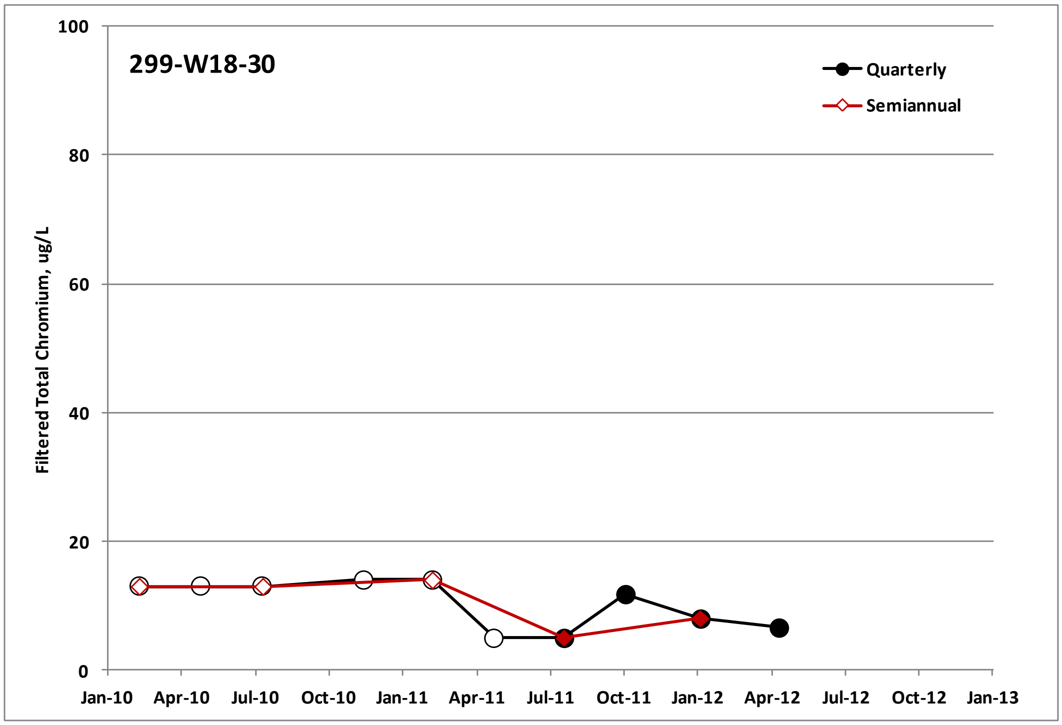

Figure 3-1. Comparison of Quarterly and Semiannual Sample Frequency Trends for Filtered Total Chromium in Well 299-W18-30

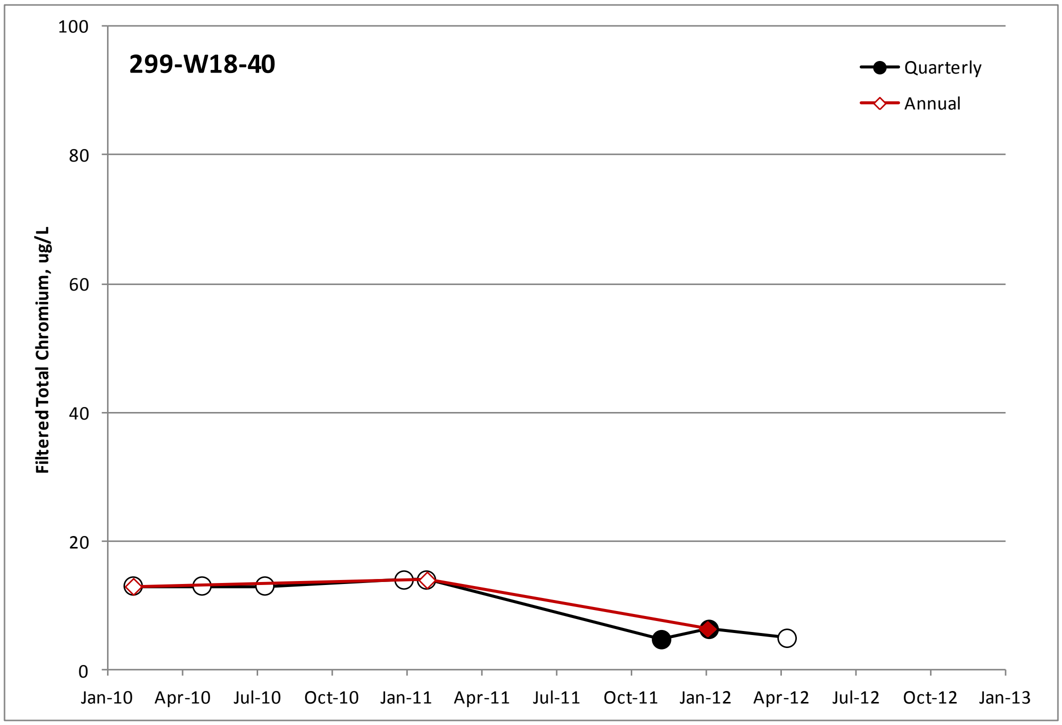

Figure 3-2. Comparison of Quarterly and Annual Sample Frequency Trends for Filtered Total Chromium in Well 299-W18-40

Another reason the concentration trends are adequately resolved by a reduced sample frequency is because the groundwater flow velocity is relatively low. As stated in Section 2.4, the best estimate of the groundwater flow rate at WMA U is 29 m/yr (95 ft/yr). Thus, 29 m (95 ft/yr) is the distance that the center of mass of a contaminant plume would be expected to migrate within a year. Changes in a concentration trend at a well are caused by spatial differences in plume concentrations migrating past the well. Therefore, the slower the rate of plume migration, the slower the rate of concentration change at a well.

The frequency trend analysis indicated that quarterly sampling of each monitoring well is not required to adequately resolve chromium trends in the wells. Thus, to provide for a cost-effective monitoring program and to meet the requirements for quarterly assessment determinations, the monitoring approach adopted for WMA U is to sample the downgradient monitoring wells on a semiannual frequency in alternating quarters. That is, three of the seven downgradient monitoring wells are sampled in the first and third quarters of the calendar year (CY), while the remaining wells are sampled in the second and fourth quarters (Table 3-2). This approach allows for quarterly determinations of the chromium concentration in groundwater and also allows for changes in concentration trends to be identified in a timely manner. This is consistent with the approach used for sites in interim status detection monitoring, which are sampled semiannually with the objective of identifying new groundwater contamination. Upgradient well 299-W18-40 will be sampled annually. The objective of sampling this well is to establish background water quality conditions, and this can be accomplished with an annual sample frequency.

Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA U

Well	WAC Compliant	RCRA	Supporting Parameters				Field-Measured Parameters					Table 3-1 Analytes
		Chromium[a]	Nitrate	Alkalinity	Anions[b]	Metals[c]	pH	Specific Conductance	Temperature	Turbidity	Water Levels	
299-W18-30	C	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	Once
299-W18-40	C	A	A	A	A	A	A	A	A	A	A	Once
299-W19-12	N[d]	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	Once
299-W19-41	C	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	Once
299-W19-42	C	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	Once
299-W19-44	C	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	Once
299-W19-45	C	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	Once
299-W19-47	C	SO	SO	SO	SO	SO	SO	SO	SO	SO	SO	Once

Notes:

Wells completed at the top of the unconfined aquifer.

Bold/italic print indicates upgradient well.

a. Filtered and unfiltered total chromium.

b. Anions include, but are not limited to, chloride, nitrate, and sulfate.

c. Metals (filtered and unfiltered) include, but are not limited to, calcium, magnesium, potassium, and sodium.

d. Well is usable as a "Screening well...to assist in defining the extent of contamination..." as stated in EPA and Ecology's *Policy on Remediation of Existing Wells and Acceptance Criteria for RCRA and CERCLA* (Nord and Day, 1990).

A = to be sampled annually

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

Ecology = Washington State Department of Ecology

EPA = U.S. Environmental Protection Agency

N = well is not constructed as a resource protection well under WAC 173-160

Q = to be sampled quarterly

RCRA = *Resource Conservation and Recovery Act of 1976*

SE = sampled semiannually in the even quarters (i.e., second and fourth) of the calendar year

SO = sampled semiannually in the odd quarters (i.e., first and third) of the calendar year

3.2 Well Network

Table 3-2 includes the list of wells monitored for WMA U, and Figure 2-1 shows the well locations. One well, 299-W18-30, is co-sampled for the 200-UP-1 OU (under *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* [CERCLA]), although CERCLA sampling is at a lower frequency (annually). Sampling is coordinated to avoid duplication of analyses and additional well trips. Maintenance issues and sampling logistics sometimes delay scheduled sampling events. If sampling of a well is delayed by 2 months or more, that event will be cancelled, as it is nearly time for the next quarterly sampling event.

Table 3-3 summarizes well depth information, including the depth of the water column in each monitoring well. All wells are constructed of stainless-steel casing and screens with full annular seals, with the exception of well 299-W19-12, which has a perforated carbon-steel casing. All wells are equipped with dedicated sampling pumps. With the exception of 299-W19-47, as-built diagrams showing details of construction for each well are provided in PNNL-13612 (or subsequent interim change notices). The as-built diagram for well 299-W19-47 is provided in Appendix B.

Water-level measurements are collected in each well at the time of sampling. In addition, water-level measurements are collected from each of the wells shown in Table 3-3 within a single day during March of each year to support water table mapping. The water table elevation beneath WMA U has been declining at an average rate of approximately 0.30 m/yr (0.98 ft/yr) (DOE/RL-2008-01, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*), although fluctuations can occur due to operation of the nearby 200-ZP-1 pump-and-treat system. The long-term decline is the result of reduced effluent discharges to ground at the Hanford Site since the peak discharge occurred in the 1980s. The water table elevation in the 200 West Area is expected to decline a minimum of an additional 4 to 6 m (13.1 to 19.7 ft) before equilibrium conditions are re-established (DOE/RL-2008-66).

Table 3-3. Well Depths and Water Table Elevation at WMA U

Well	Completion Date	Water Table Elevation (m)[a], July 2010	Casing Elevation (m)[a]	Open Interval Bottom Elevation (m)[a]	Water Column (m), July 2010
299-W18-30	1991	134.59	206.117	133.85	0.74
299-W18-31[b]	1991	134.91[c]	203.474	134.76	0.15
299-W18-40	2001	134.97	203.413	125.91	9.06
299-W19-12	1983	134.58	206.232	129.49	5.09
299-W19-41	1998	134.64	206.531	128.01	6.63
299-W19-42	1998	134.57	206.242	127.67	6.90
299-W19-44	2001	134.59	207.277	125.78	8.81
299-W19-45	2001	134.59	206.413	126.71	7.88
299-W19-47	2004	134.57	206.276	125.68	8.89

Note: Bold/italic print indicates upgradient well.

a. North American Vertical Datum of 1988 (NAVD88).

b. Used for water-level measurements only; not enough water in well to sample.

As a consequence of the declining water table elevation, monitoring well 299-W18-30 is expected to go dry in the near future. When a well is within a few years of going dry, a replacement well is proposed. In addition, new wells could potentially be installed to better characterize the nature and extent of contamination in the groundwater. All new RCRA wells proposed for installation at the Hanford Site are negotiated annually by Ecology, DOE, and EPA under *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989) Milestone M-24-00. At the time this plan was revised, two new replacement wells are proposed to be installed at WMA U: one well for 299-W18-30 (going dry), and one well for 299-W19-12 (construction does not comply with the well construction standards found in WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells”).

In the future, the rate of decline of the water table beneath WMA U may change in response to remedial action measures. In the *Record of Decision, Hanford 200 Area, 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008) (the 200-ZP-1 OU is located in the northern portion of the 200 West Area), the selected remedy is a combination of pump-and-treat, monitored natural attenuation, flow-path control, and institutional controls. The pump-and-treat system is expected to become operational during CY 2012, and the system is designed to include extraction and injection wells in and near the northern 200 West Area (DOE/RL-2008-78, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan*). The water will be transferred to the 200 West Area groundwater treatment facility, which is being designed with a capacity of 3,785 L/min (1,000 gal/min). Operation of this system is expected to affect water levels and the groundwater flow direction at WMA U. Analysis of the future flow field indicates that the groundwater flow direction at WMA U may become more northeasterly during operation of the pump-and-treat system. Therefore, evaluation of the adequacy of the monitoring well network at WMA U and the need for replacement wells will be an ongoing process, and the list of new wells under consideration for installation at the WMA will evolve.

3.3 Sampling and Analysis Protocol

Groundwater monitoring at WMA U follows the conventions of the project and is discussed in the QAPjP (Appendix A).

4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for WMA U.

4.1 Data Review

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

4.2 Interpretation

After sampling and water-level data are validated and verified, acceptable data are used to interpret groundwater conditions at WMA U. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.
- **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:** Can sometimes be used to distinguish among different sources of contamination.

4.3 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the monitoring well network to determine if it remains adequate to monitor the WMA. The network must include upgradient and downgradient wells in the uppermost aquifer (see Appendix A). Wells proposed for installation at WMA U are described in Section 3.2.

Water-level measurements will continue to be collected before each sampling event, and more comprehensive measurements will continue to be made in March of each year. The data are presented in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2011-118).

4.4 Reporting and Notification

The results of assessment monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, “Recordkeeping and Reporting.” Reporting will be made in annual Hanford Site groundwater monitoring report.

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Appendix A

Quality Assurance Project Plan

Contents

Figure

Tables

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Terms

CRDL	contract-required detection limit
DOE	U.S. Department of Energy
DQO	data quality objective
DUP	laboratory matrix duplicate
EB	equipment blank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FTB	full trip blank
FXR	field transfer blank
GC	gas chromatography
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	Hanford Environmental Information System
IC	ion chromatography
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometry
LCS	laboratory control sample
MB	method blank
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NTU	nephelometric turbidity unit
PCB	polychlorinated biphenyl
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	U.S. Department of Energy, Richland Operations Office
RPD	relative percent difference
RSD	relative standard deviation

SUR	surrogate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
VOC	volatile organic compound

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A Quality Assurance Project Plan

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

- 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements"
- DOE O 414.1D, *Quality Assurance*
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD)
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*

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

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4-2004). This QAPjP is divided into four sections (as designated in EPA/240/B-01/003) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

A1 Project Management

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

A1.1 Project/Task Organization

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

A1.1.1 Regulatory Project Manager

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

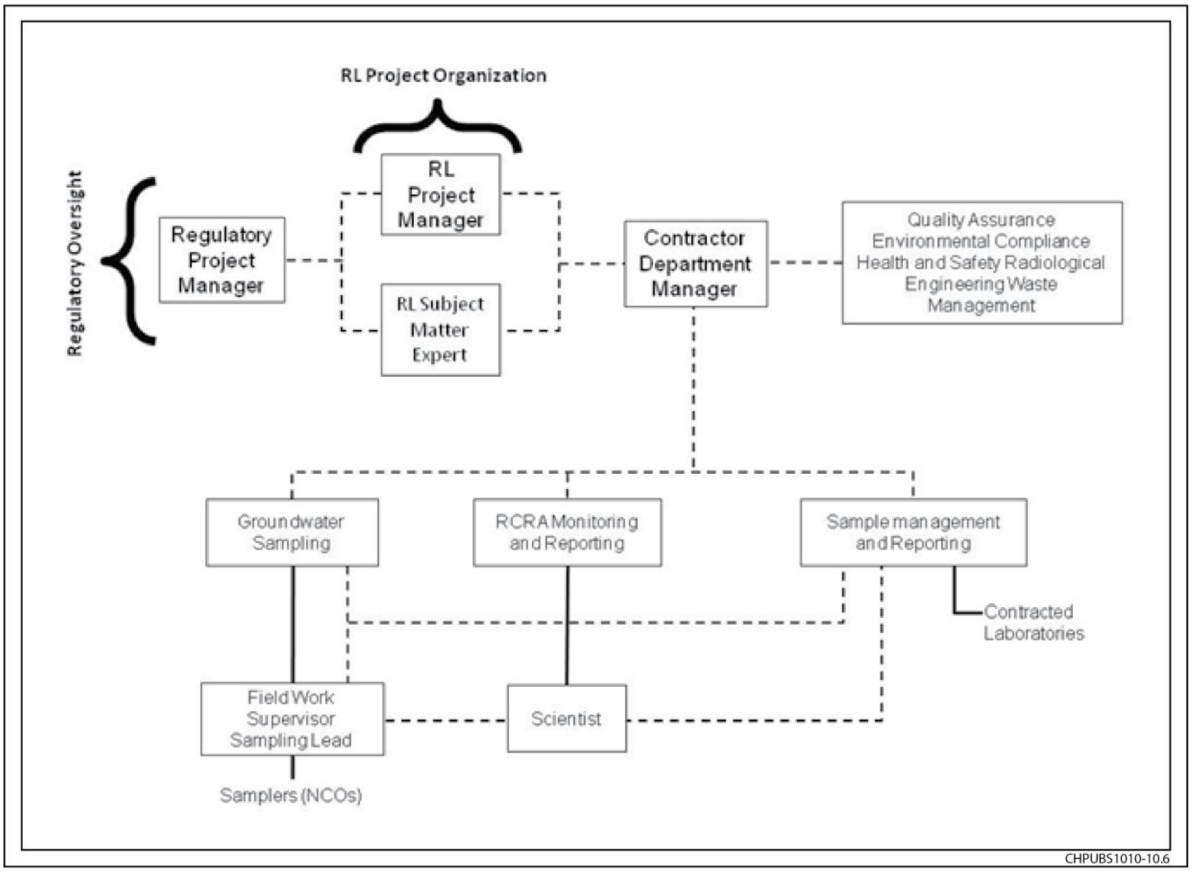

Figure A-1. Project Organization

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

Hanford Site cleanup is the responsibility of RL. The RL project manager is responsible for authorizing the contractor to perform activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the Tri-Party Agreement (Ecology et al., 1989a) for the Hanford Site.

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

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

A1.1.4 Contractor Groundwater Remediation Department Manager

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

A1.1.5 Groundwater Sampling Operations

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

A1.1.6 RCRA Monitoring and Reporting

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

A1.1.7 Sample Management and Reporting Organization

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

A1.1.8 Contract Laboratories

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

A1.1.9 Quality Assurance

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

A1.1.10 Environmental Compliance Officer

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

A1.1.11 Health and Safety

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

A1.1.12 Waste Management

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

A1.2 Problem Definition/Background

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

A1.3 Project/Task Description

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

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

A1.4 Quality Objectives and Criteria

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

A1.5 Special Training/Certification

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

A1.6 Documents and Records

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

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

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

Table A-1. Actions and Documentation for Regulatory Notification

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

RCRA = *Resource Conservation and Recovery Act of 1976*

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*).

A2 Data Generation and Acquisition

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

A2.1 Sampling Process Design (Experimental Design)

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

A2.1.1 Regulatory Requirements

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

A2.1.2 Judgmental Sampling

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

A2.2 Sampling Methods

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

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

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

A2.3 Sample Handling and Custody

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

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

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

A2.4 Analytical Methods

Information on analytical methods is provided in Tables A-2 and A-3. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. The primary contractor participates in oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

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

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Metals Analyzed by ICP Method – Unfiltered/Filtered			
Calcium	P, HNO_3 to pH <2	SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e]	1,000
Chromium			10
Magnesium			750
Potassium			4,000
Sodium			500
Anions by IC			
Chloride	P	EPA/600 Method 300.0[f]	200
Nitrate			250
Sulfate			500
Other			
Alkalinity	G/P	Standard Method[g] 2320, EPA/600 Method 310.1 EPA/600 Method 310.2	5,000
Conductivity, field	Field measurement	Instrument/meter	1 µohm
pH, field measurement	Field measurement	Instrument/meter	0.1
Temperature	Field measurement	Instrument/meter	
Turbidity, field measurement	Field measurement	Instrument/meter	0.1 NTU

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

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

c. Detection limit units, unless otherwise indicated.

d. SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

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

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

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

EPA = U.S. Environmental Protection Agency

IC = ion chromatography

ICP = inductively coupled plasma

NTU = nephelometric turbidity unit

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Metals Analyzed by ICP Method – Unfiltered/Filtered			
Barium	P, HNO_3 to pH <2	SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e]	20
Beryllium			5
Cadmium			5
Cobalt			20
Copper			10
Nickel			40
Silver			10
Vanadium			25
Zinc			10
Trace Metals – Unfiltered/Filtered			
Antimony	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	6
Arsenic			10
Lead			5
Mercury	G, HNO_3 to pH <2	SW-846 Method 7470A, EPA/600 Method 200.8	0.5
Selenium	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	10
Thallium			5
Volatile by GC/MS			
1,1-Dichloroethene	G, no headspace	SW-846 Method 8260B	10
1, 2-Dichloroethane			5
1,1,1-Trichloroethane			5
1,1,2-Trichloroethane			5
1,1,2,2-Tetrachloroethane			5
Acetone (2-propanone)			20
Benzene			5
Carbon disulfide			5
Carbon tetrachloride			5
Chlorobenzene			5

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Chloroform			5
Ethylbenzene			5
Isobutanol			500
Methylene chloride			5
Methyl ethyl ketone (2-butanone)			10
Methyl isobutyl ketone (4-methyl-2-pentanone) (MIBK)			10
Tetrachloroethene			5
Toluene			5
trans-1,3-Dichloropropene			5
Trichloroethene			5
Trichlorofluoromethane			10
Vinyl chloride (chloroethene)			10
Xylenes			10
Semivolatiles by GC/MS			
1,2-Dichlorobenzene (o-Dichlorobenzene)	Amber glass	SW-846 Method 8270D	10
1,2,4-Trichlorobenzene			10
2-Chlorophenol			10
2-Methylphenol (o-cresol)			10
2-Nitrophenol (o-Nitrophenol)			20
2,4-Dinitrotoluene			10
2,4,5-Trichlorophenol			10
2,4,6-Trichlorophenol			10
3-Methylphenol (m-cresol)			20
4-Chloro-3-methylphenol (p-Chloro-m-cresol)			10
4-Methylphenol (p-cresol)			10
Acenaphthene			10

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Butylbenzylphthalate			10
Di-n-butylphthalate			10
Di-n-octylphthalate			10
Fluoranthene			10
Hexachlorobutadiene			10
Hexachloroethane			10
n-Nitroso-di-n-propylamine			10
n-Nitrosomorpholine			10
Naphthalene			10
Nitrobenzene			10
Pyrene			10
Pyridine			20
PCBs			
Aroclor 1016	G	SW-846 Method 8082	0.5
Aroclor 1221			0.5
Aroclor 1232			0.5
Aroclor 1242			0.5
Aroclor 1248			0.5
Aroclor 1254			0.5
Aroclor 1260			0.5
Other			
Cyanide	P, NaOH to pH >12	SW-846 Method 9012, Standard Method[f] 4500, EPA/600 Method 335.2	5
Sulfide	G/P, 2 mL 2N zinc acetate and NaOH pH >9, cool 4°C	Sulfides – 9030	500

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

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

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

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

c. Detection limit units.

d. SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

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

f. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

EPA = U.S. Environmental Protection Agency
GC/MS = gas chromatography/mass spectrometry
ICP = inductively coupled plasma
PCB = polychlorinated biphenyl

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

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

A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks (EBs). Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-4.

Table A-4. QC Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field QC		
Full trip blank (FTB)	Contamination from containers or transportation	One per 20 well trips
Field transfer blank (FXR)	Contamination from sampling site	One each day; VOCs sampled
Equipment blank (EB)	Contamination from non-dedicated equipment	As needed[a]
Replicate/duplicate sample	Reproducibility	One per 20 well trips
Laboratory QC		
Method blank (MB)	Laboratory contamination	One per batch
Laboratory duplicate	Laboratory reproducibility	See footnote b
Matrix spike (MS)	Matrix effect and laboratory accuracy	See footnote b
Matrix spike duplicate (MSD)	Laboratory reproducibility/accuracy	See footnote b
Surrogate (SUR)	Recovery/yield	See footnote b
Laboratory control sample (LCS)	Method accuracy	One per batch

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

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

QC = quality control

VOC = volatile organic compound

A2.5.1 Field Quality Control Samples

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

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

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

The EBs are samples in which high-purity reagent water is passed through the pump or placed in contact with the sampling surfaces of the equipment to collect blank samples identical to the sample set that will be collected. The EB bottles are placed in the same storage containers with the samples from the associated sampling event. The EB samples are analyzed for the same constituents as the samples from the associated sampling event. The EBs are used to evaluate the effectiveness of the cleaning process to ensure that samples are not cross-contaminated from previous sampling events.

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

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

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

A2.5.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks [MBs], laboratory control samples [LCSs]/blank spikes, and matrix spikes [MSs]) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, and will be run at the frequency specified in that reference, unless superseded by agreement.

A2.5.3 Quality Control Requirements

Table A-5 lists the acceptance criteria for QC samples, and Table A-6 lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking Hanford Site background well water with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper concentration limit determined for Hanford Site groundwater. Investigations shall be conducted for double-blind standards that are outside of acceptance limits. The results from these standards are used to determine the acceptability of the associated parameter data.

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

Method[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemical Parameters			
Alkalinity Conductivity pH	MB[b]	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS[e]	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

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

Method[a]	QC Element	Acceptance Criteria	Corrective Action
Ammonia and Anions			
Anions by IC Cyanide Sulfide	MB	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Metals			
Arsenic Cadmium Chromium Lead Mercury Selenium Thallium ICP metals ICP/MS metals	MB	<CRDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	MSD	≤20% RPD[c]	Data reviewed[d]
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
VOCs			
Volatiles by GC/MS	MB	<MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB, FXR	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

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

Method[a]	QC Element	Acceptance Criteria	Corrective Action
Semi-VOCs			
PCBs by GC Phenols by GC Semivolatiles by GC/MS	MB	<2 times MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed[d]
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

a. Refer to Tables A-2 and A-3 for specific analytical methods.

b. Does not apply to pH.

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

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

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

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

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

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

CRDL = contract-required detection limit
DUP = duplicate
EB = equipment blank
FTB = full trip blank
GC/MS = gas chromatography/mass spectrometry
IC = ion chromatography
LCS = laboratory control sample
MB = method blank
MDL = method detection limit
MS = matrix spike
PCB = polychlorinated biphenyl
QC = quality control
RPD = relative percent difference
VOC = volatile organic compound

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated MB)
N = result may be biased (associated MS result was outside the acceptance limits)
Q = problem with associated field QC sample (blank and/or duplicate results were out of limits)

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

Table A-6. Blind Standard Constituents and Schedule

Constituents	Frequency	Accuracy (%)	Precision (% RSD)*
Nitrate	Quarterly	±25%	≤25%
Chromium	Annually	±20%	≤25%

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

RSD = relative standard deviation

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

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

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

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

A2.7 Instrument/Equipment Calibration and Frequency

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

A2.8 Inspection/Acceptance of Supplies and Consumables

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

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

A2.9 Nondirect Measurements

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

A2.10 Data Management

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

All field activities will be recorded in the field logbook.

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

A3 Assessment and Oversight

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

A3.1 Assessments and Response Actions

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

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

A3.2 Reports to Management

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

A4 Data Validation and Usability

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

A4.1 Data Review, Verification, and Validation

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

A4.2 Verification and Validation Methods

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

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

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

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

A4.3 Reconciliation with User Requirements

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

A5 References

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40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

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

40 CFR 265.94, "Recordkeeping and Reporting."

40 CFR 265, Subpart F, "Ground-Water Monitoring."

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Appendix B

Well Construction Information for 299-W19-47

WELL CONSTRUCTION SUMMARY REPORT

Start Date 04/23/04
Finish Date 08/25/04
Page 1 of 1

Well ID C4258	Well Name 299-W19-47
Project RCRA/CERCLA drilling, FY 2004	Approximate Location East side of WMA-U/200 West
Drilling Company Blue Star Enterprises	Other Companies FH, CHG
Driller David Curry License # 2617	Geologist(s) C. Martinez, J. Whalen, D. Weekes

TEMPORARY CASING AND DRILL DEPTH

*Size/Grade/Lbs Per Ft	Interval	Shoe O D / I D
$11^3/_8$ / $10^3/_4$ CS, FJ	0' - 268'	20"/$10^7/_8$"
	-	
	-	
	-	
	-	

*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design

DRILLING METHOD / HOLE DIAMETER (in.) / INTERVAL (ft)

DRILLING METHOD	HOLE DIAMETER (in.) / INTERVAL (ft)
Auger	Diameter ___ From ___ to ___
Cable Tool (drive barrel)	Diameter $8^5/_8$" From 0' to 95'
Air Rotary	Diameter ___ From ___ to ___
A R w/Sonic	Diameter ___ From ___ to ___
Cable tool (hard tool)	Diameter 10" From 95' to 140'
Cable tool (drive barrel)	Diameter $8^5/_8$" From 140' to 241'
Cable tool (DB)	Diameter $9^1/_2$" From 241' to 245'
Cable tool (DB)	Diameter $8^5/_8$" From 245' to 269'

Drilling Fluid n/A

Total Drilled Depth 269'	Hole Dia @ TD $8^5/_8$"
Total Amt Of Water Added During Drilling	
Well Straightness Test Results Passed on 06/08/04 using 20' long CS, $9^7/_8$" OD Tool.	Static Water Level 226.84' Date 08/09/04

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Spectral Gamma	0' - 268'	06/02, 06/03 & 06/07/04		-	
	-			-	
	-			-	

COMPLETED WELL

Size/Wt /Material	Depth	Thread	Slot Size	Type	Interval Annular Seal/Filter Pack	Volume	Mesh Size
4" ID SS 304 Sch 5 riser	+ - 227.05'	F480	n/A	Portland Cement (94#)	0' - 10.7'	7	n/A
4" ID SS 304 sch. 5 wellscreen	227.05' - 262.04'	F480	0.020"	Granular bentonite (50#)	10.7' - 215.8'	196	n/A
4" ID SS 304 sch 5 sump	262.04' - 265.02'	F480	n/A	Bentonite Pellets (50#)	215.8' - 220.7'	7	3/8"
	-			Colorado Silica Sand (50#)	220.7' - 269'	62	10-20
	-				-		

OTHER ACTIVITIES

Aquifer Test well development	Date 08/23/04 to 08/25/04	Well Decommission	Yes No	Date
Description B 264.6 \ M 251.6 \ T 240.1 \ Final Turb (NTU) 4.58 (B) \ 3.34 (m) 1.54 NTU. GPM: B 24, 22, 31, 10 \ M 21, 20 \ T 10		Description		

WELL SURVEY DATA (if applicable)

	Protective Casing Elevation
Washington State Plane Coordinates	Brass Survey Marker Elevation

COMMENTS / REMARKS

Vol. calcs: P.C. => 7 bags @ 1.285 ft³/bag = 9.00 ft³. Granules => 196 bags @ 0.71 ft³/bag = 139.16 ft³.
Pellets => 7 buckets @ 0.62 ft³/bucket = 4.34 ft³; 10-20 sand => 62 bags @ 0.535 ft³/bag = 33.17 ft³.

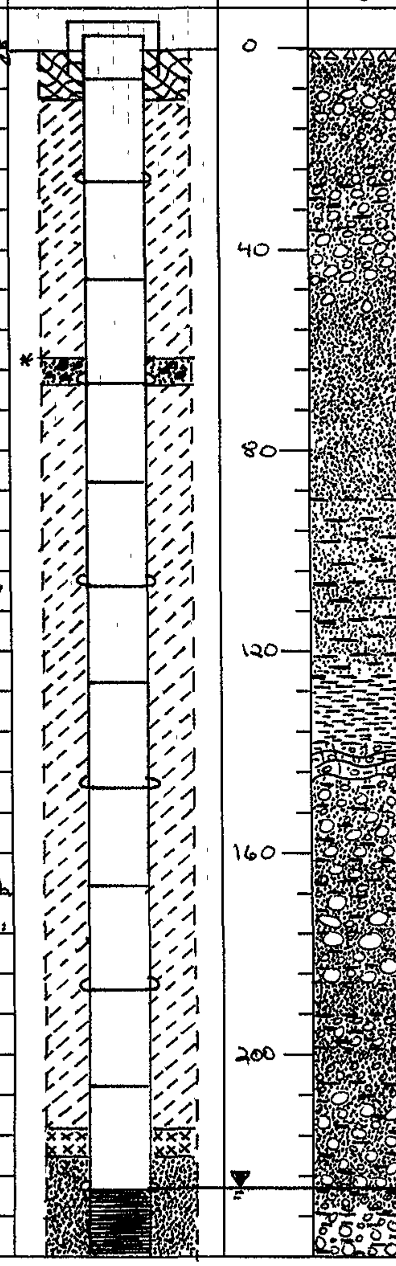
Reported By	Title	Signature	Date
Charlene Martinez	Geologist	Charlene Martinez	09/14/04

A-6003-658 (04/03)

WELL SUMMARY SHEET

Start Date 04/23/04	Page 1 of 2
Finish Date. 08/09/04	
Well ID: C4258	Well Name 299-W19-47
Location East side of WMA-U / 200 West	Project. RCRA / CERCLA drilling, FY2004
Prepared By Charlene Martinez, Date 08/11/04	Reviewed By L.D. Walker, Date. 8-24-04
Signature Charlene Martinez	Signature. LD Walker

CONSTRUCTION DATA — Description	Depth in Feet	GEOLOGIC/HYDROLOGIC DATA — Lithologic Description
11 7/8" / 10 7/8" temporary casing used.	0	0'-1' Backfill material
6" ID SS304 protective casing set + 1.0' above permanent		1'-8' SAND(S) Hanford Fmtn
4" ID SS304, sch.5 riser: + 2.0' → 227.05'		8'-15' sandy GRAVEL(sG)
Portland Cement: 0' → 10.7'		15'-16.5' SAND(S)
Granular Bentonite: 10.7' → 215.8'		16.5'-17.5' sandy GRAVEL(sG)
*Formation slough 62.3' → 66.3'	40	17.5'-23' SAND(S)
3/8" Bentonite Pellets: 215.8' → 220.7'		23'-27' sandy GRAVEL(sG)
10-20 mesh Colorado Silica Sand: 220.7' → 269'		27'-36' silty sandy GRAVEL(msG)
4" ID SS304, sch5, 0.020-inch cont. wire-wrap wellscreen: 227.05' → 262.04'		36'-47' sandy GRAVEL(sG)
All depths in feet below ground surface		47'-53' gravelly SAND(gS)
All temporary casing removed from ground.	80	53'-90' SAND(S)
		90'-124' silty SAND(mS)
	120	124'-138' SILT(m) (Cold Creek unit)
		138'-145' CALICHE, Silty Sandy Gravel (msG)
		145'-162' Silty Sandy GRAVEL (msG)
	160	162'-165' Sandy GRAVEL(sG)
		165'-185.5' Silty Sandy GRAVEL (msG)
		185.5'-192' Sand (S)
	200	192'-198.5' silty sandy gravel (msG)
		198.5'-201' sand (S)
		201'-204' sandy gravel (sG)
		204'-227' silty sandy gravel (msG)
		227'-229' sandy GRAVEL(sG)



A-6003-643 (03/03)

WELL SUMMARY SHEET

Start Date: 04/23/04	Page 2 of 2
Finish Date: 08/09/04	
Well ID: C4258	Well Name: 299-W19-47
Location: East side of WMA-U/200 West	Project: RCRA/CERCLA drilling, FY 2004
Prepared By: Charlene Martinez — Date 08/11/04	Reviewed By: L.D. Walker — Date 8-24-04
Signature: Charlene Martinez	Signature: [signature]

CONSTRUCTION DATA: Description	Diagram	Depth in Feet	Graphic Log	GEOLOGIC/HYDROLOGIC DATA: Lithologic Description
4" ID SS304, sch. 5 sump: 262.04' → 265.02'		240		229' - 238' silty sandy GRAVEL (msG)
				238' - 244' sandy GRAVEL (sG)
				244' - 260' silty sandy GRAVEL (msG)
				260' - 266' sandy GRAVEL (sG)
				266' - 269' silty sandy GRAVEL (msG)
	TD => 269' bgs	280		
				TD @ 269' bgs
				Static water => 226.84' bgs (08/09/04)
NCR-04-GRP-015 issued on the formation slough condition at 62.3' → 66.3'				
All depths in feet below ground surface.				
All temporary casing removed from ground.				

A-6003-643 (03/03)

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Distribution

	MS	Quantity
U.S. Department of Energy, Richland Operations Office		
N.M. Bland	A5-11	1
R.D. Hildebrand	A6-38	1
J.G. Morse	A5-11	1
DOE Public Reading Room	H2-53	1
U.S. Department of Energy, Office of River Protection		
L.A. Huffman	H6-60	1
C.J. Kemp	H6-60	1
CH2M HILL Plateau Remediation Company – Electronic Distribution		
F.H. Biebesheimer	R3-50	
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