DOE/RL-2008-59
Draft REV. 1

Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

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Executive Summary

This document presents a revision to the 2010 groundwater monitoring plan (DOE/RL-2008-59[1]) for the 216-B-3 Main Pond (hereafter referred to as Main Pond) and a portion of the 216-B-3-3 Ditch. These two sites comprise a single treatment, storage, and disposal (TSD) unit and are collectively referred to as B Pond. This revised monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976*[2] (RCRA) and the implementing requirements in WAC 173-303-400[3], which in turn, specifies groundwater monitoring regulations under 40 CFR 265.[4] The U.S. Department of Energy, Richland Operations Office has undertaken revision of this RCRA groundwater monitoring plan, due to the age of the plan and to ensure that the plan contains the most current Hanford groundwater monitoring information for the TSD unit. This indicator evaluation program groundwater monitoring plan is the principal controlling document for conducting groundwater monitoring at B Pond.

B Pond is a non-operating, interim status TSD unit comprising the Main Pond and the portion of the 216-B-3-3 Ditch that flowed into the Main Pond from the 216-A-29 Ditch juncture. The Main Pond is located approximately 1,600 m (5,200 ft) east of the 200 East Area fence. The Main Pond was a natural topographic depression, diked on the eastern margin, and covers approximately 14.2 ha (35 ac).

Operation of the Main Pond began in 1945. During its operation, the Main Pond received effluent from several 200 East Area facilities including the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, 241-A Tank Farm, 242-A Evaporator, 244-AR Vault, and 284-E Power Plant. The 216-B-3-3 Ditch was an open, unlined earthen ditch, approximately 6 m (20 ft) wide at ground level, 1.8 m (6 ft) deep and

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[1] DOE/RL-2008-59, 2010, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084215.

[2] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

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

[4] 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.gpo.gov/fdsys/pkg/CFR-2010-title40-vol25/xml/CFR-2010-title40-vol25-part265.xml.

1,130 m (3,700 ft) long, that was used to transport effluent from the B Plant and PUREX Facilities to the Main Pond. In 1994, all discharges ceased and the Main Pond and 216-B-3-3 Ditch underwent interim stabilization measures.

As B Pond received wastewater contaminated with dangerous waste or dangerous waste constituents, a groundwater monitoring program in accordance with 40 CFR 265 was implemented in 1988 and revised in 1989 (WHC-SD-EN-AP-013).[5] In 1990, statistical evaluation of total organic halogen (TOX) and total organic carbon (TOC) showed that concentrations in two downgradient wells (699-43-41E and 699-43-41F) were statistically greater than background levels (PNNL-11604).[6] A required groundwater quality assessment plan for B Pond was prepared and initiated (WCH-SD-EN-AP-030).[7] In 1997, the groundwater quality assessment results (PNNL-11604) concluded that the increased concentrations of TOX and TOC were isolated occurrences and not related to releases of dangerous waste constituents from B Pond. The site was returned to an indicator evaluation program in 1998 under Rev. 1 of WHC-SD-EN-AP-013. [8]

This RCRA groundwater monitoring plan presents a revised indicator evaluation program for detection monitoring of the uppermost aquifer beneath B Pond. This plan addresses the following:

- Number, locations, and depths of wells in the B Pond groundwater monitoring network
- Sampling and analytical methods of parameters required for groundwater contamination detection monitoring

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[5] WHC-SD-EN-AP-013, 1989, *Interim-Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195064799.

[6] PNNL-11604, 1997, *Results of RCRA Groundwater Quality Assessment at the 216-B-3 Pond Facility*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/29/036/29036425.pdf.

[7] WHC-SD-EN-AP-030, 1990, *Groundwater Quality Assessment Plan for the 216-B-3 Pond System*, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0009533.

[8] WHC-SD-EN-AP-013, 1995, *Interim-Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 1, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196004500.

- Methods for evaluating groundwater quality information
- Schedule for groundwater monitoring at B Pond

This revised plan uses the existing groundwater monitoring well network as identified in the previous groundwater monitoring plan (DOE/RL-2008-59, Rev. 0) with the addition of a second upgradient well. Groundwater flow direction determinations currently indicate that west and southwest groundwater flow directions exist beneath B Pond. Groundwater in the B Pond monitoring wells will be sampled and analyzed semiannually for the parameters used as indicators of groundwater contamination (pH, specific conductance, TOC, and TOX) and annually for parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate) in accordance with 40 CFR 265.92(b)(2)&(3) and (d).[9] Field parameters (dissolved oxygen, temperature, and turbidity) will be sampled semiannually. Site-specific constituents for analysis of general water chemistry including alkalinity, metals (calcium, magnesium, and potassium) will be collected annually. Arsenic and nitrate have been identified as site-specific constituents that could be associated with B Pond operations and will be monitored annually. Water level measurements will be taken each time a sample is collected to satisfy 40 CFR 265.92(e).

This plan adds a second existing upgradient well to the monitoring network. This existing well will be used until a new upgradient well (New Well #1), positioned closer to B Pond, is drilled. When New Well #1 is ready for sampling, Well 699-45-42 will no longer be utilized in the B Pond network. Well 699-45-42 was drilled in 1948 and is currently sampled under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.[10] Well 699-45-42 and New Well #1 provide better representation of the variability in upgradient hydrogeologic conditions and constituent concentrations affecting the site. Quarterly sampling for indicators of groundwater contamination will be required for Well 699-45-42 and New Well #1 for the first year of sampling.

[9] 40 CFR 265.92, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” “Sampling and Analysis,” *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol25/xml/CFR-2010-title40-vol25-sec265-92.xml.

[10] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

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Terms

AEA	*Atomic Energy Act of 1954*
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CSM	conceptual site model
DO	dissolved oxygen
DOE	U.S. Department of Energy
ECN	Engineering Change Notice
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FWS	Field Work Supervisor
HSU	hydrostratigraphy unit
PUREX	Plutonium-Uranium Extraction
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
TEDF	Treated Effluent Disposal Facility
TOC	total organic carbon
TOX	total organic halogen
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

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1 Introduction

This document presents the revised groundwater monitoring plan for the 216-B-3 Main Pond (hereafter referred to as Main Pond) and a portion of the 216-B-3-3 Ditch and supersedes the previous plan (DOE/RL-2008-59, Rev. 0, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*). These two sites comprise a single treatment, storage, and disposal (TSD) unit and are collectively referred to as B Pond. This groundwater monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA), with regulations promulgated by the Washington State Department of Ecology (Ecology) in the *Washington Administrative Code* (WAC) and the *Code of Federal Regulations* (CFR) by reference (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards;" 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring"). This plan monitors indicator parameters in groundwater samples that are used to determine whether dangerous waste or dangerous waste constituents have entered the groundwater. This plan also monitors parameters used in establishing groundwater quality.

B Pond is a non-operating, interim status TSD unit regulated as a surface impoundment, as defined in WAC 173-303-040, "Definitions." In accordance with Section I.A of the Hanford Facility Dangerous Waste Permit (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit*), B Pond will continue to be considered an interim status unit until is it incorporated into Part III, V, and/or VI of the Permit. For regulatory purposes, the TSD unit boundary of B Pond is identified on the current Hanford Facility Dangerous Waste Permit (WA7890008967) Part A Form. The TSD unit boundary includes the Main Pond and the 216-B-3-3 Ditch from its juncture with the 216-A-29 Ditch to where the 216-B-3-3 Ditch enters the Main Pond (Figure 1-1).

The Main Pond is located approximately 1,600 m (5,200 ft) east of the 200 East Area fence (Figure 1-1). The Main Pond occupies a natural topographic depression, diked on the eastern margin, and covers approximately 14.2 ha (35 ac). The Main Pond had a maximum depth of approximately 6.1 m (20 ft) during operational use. The Main Pond received effluent from several 200 East Area facilities, including the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, 241-A Tank Farm, 242-A Evaporator, 244-AR Vault, and 284-E Power Plant. Operating records indicate that the Main Pond began receiving wastewater in 1945. Multiple ditches were used to convey wastewater to the Main Pond during its operational period. The 216-B-3-3 Ditch began receiving effluent from the B Plant and PUREX Facilities in 1970 and was an open, unlined, earthen ditch, approximately 6 m (20 ft) wide at ground level, 1.8 m (6 ft) deep, and 1,130 m (3,700 ft) long. In 1994, all discharges to the Main Pond and 216-B-3-3 Ditch ceased, and both the Main Pond and ditch underwent interim stabilization measures.

The purpose of this RCRA plan is to present an updated groundwater monitoring program for parameters used as indicators of groundwater contamination from B Pond, commonly referred to as an indicator evaluation program. This plan is intended specifically to satisfy monitoring requirements for interim status TSD units, as required by WAC 173-303-400(3) and 40 CFR 265.92, "Sampling and Analysis." This monitoring plan is the principal controlling document for conducting groundwater monitoring at B Pond. The indicator evaluation program detailed in this plan requires semiannual sampling for parameters used as indicators of groundwater contamination, as well as annual sampling for parameters establishing groundwater quality at two upgradient and three downgradient wells. This plan adds a second upgradient well to the monitoring network to provide more information on upgradient concentrations. New Well #1 will be drilled near the Main Pond to reflect upgradient conditions closer to the site. Until New Well #1 is ready for sampling, Well 699-45-42 will be included in the B Pond network. Well 699-45-42 is an upgradient well, drilled in 1948, that is currently sampled according to DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit* (as amended by TPA-CN-205, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: DOE/RL-2003-4, Revision 1, Sampling and Analysis Plan for the 200-PO-1 Operable Unit*). After New Well #1 is ready for sampling, Well 699-45-42 will no longer be sampled. Quarterly sampling will be required for both New Well #1 and 699-45-42 during the first year of monitoring for indicators of groundwater contamination. All site-specific and supporting constituents, with the exception of cadmium, are retained in this revision. Also, water level measurements are required each time a sample is collected to satisfy 40 CFR 265.92(e).

This groundwater monitoring plan addresses the operational history, current hydrogeology, and conceptual site model (CSM) for the site and incorporates knowledge about the potential for contamination originating from B Pond. Chapter 2 of this plan summarizes background information and references other documents that contain more detailed or additional information. Chapter 2 also describes B Pond and the regulatory basis, types of waste present, the pertinent geology and hydrogeology beneath B Pond and provides a brief history of groundwater monitoring. All of this information is summarized as a CSM to aid in development of the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols. Chapter 4 describes the data evaluation and reporting, Chapter 5 provides an updated outline for a groundwater quality assessment plan, and Chapter 6 contains the references cited in this plan. Appendix A provides the quality assurance project plan (QAPjP), Appendix B contains sampling protocols, and Appendix C provides information for the wells within the groundwater monitoring network.

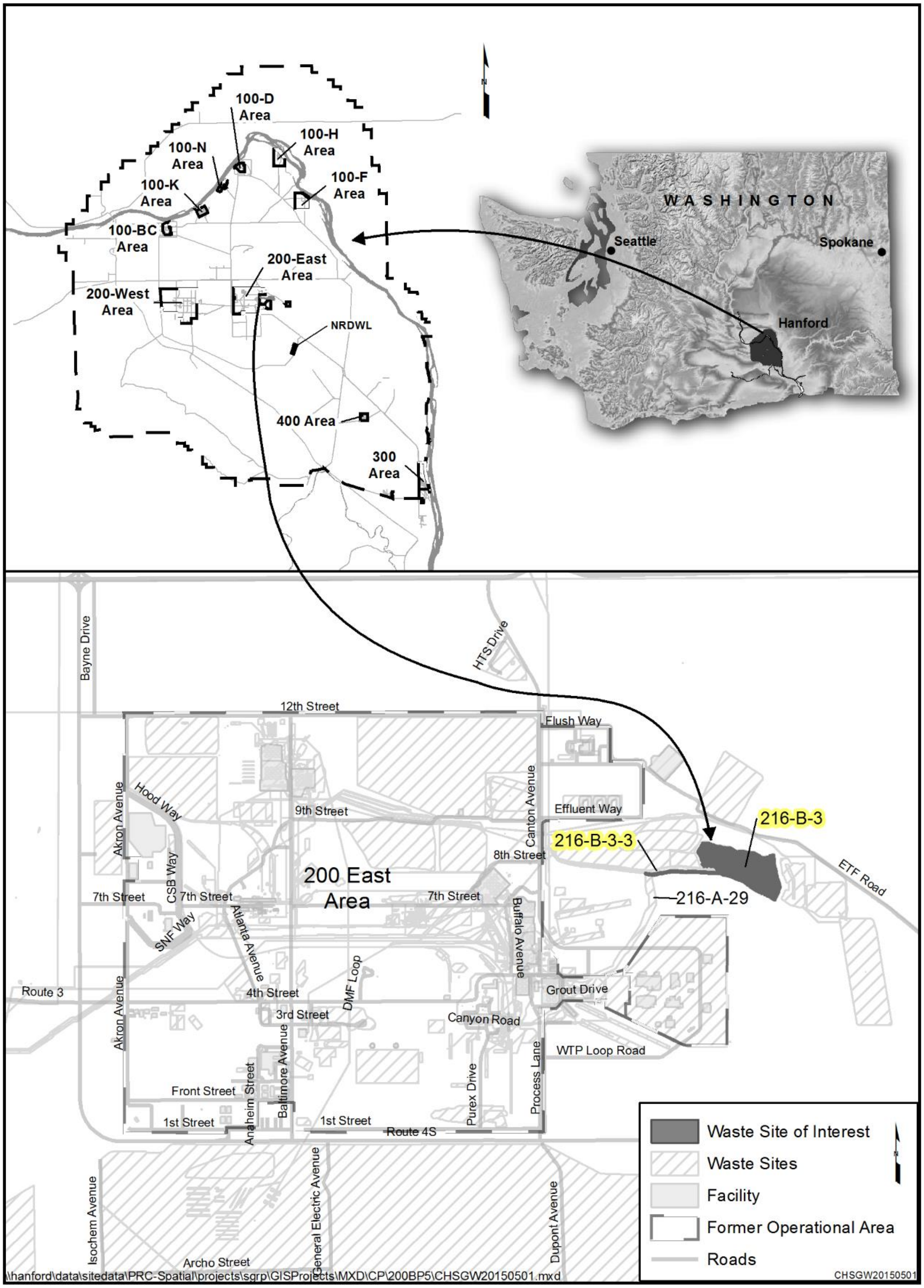

Figure 1-1. Location Map for B Pond

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2 Background

This chapter describes B Pond and its operating history, regulatory basis, wastes and waste characteristics associated with B Pond, local subsurface geology and hydrogeology, a summary of previous groundwater monitoring, and the CSM for B Pond. Other constituents, in addition to those collected to meet the requirements of 40 CFR 265.92, are included in this monitoring plan.

The information contained in this chapter was obtained from several sources, including the Waste Information Data System general summary reports, previous groundwater monitoring plans listed in Section 2.5, and the following documents:

- BHI-01367, *200-CW-1 Operable Unit Borehole/Test Pit Summary*
- DOE, 1987, *Preliminary Closure/Post-Closure Plan 216-B-3 Pond*
- DOE/RL-89-28, *216-B-3 Expansion Ponds Closure Plan*
- DOE/RL-92-05, *B Plant Source Aggregate Area Management Study Report*
- DOE/RL-93-74, *200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan Volume 1: Facility Investigation and Sampling Strategy*
- DOE/RL-2013-24, *216-B-3 Main Pond Closure Plan*
- DOE/RL-2014-32, *Hanford Site Groundwater Monitoring Report for 2013*
- PNNL-11604, *Results of RCRA Groundwater Quality Assessment at the 216-B-3 Pond Facility*
- WHC-SD-EN-AP-042, *Phase 1 Characterization of the 216-B-3 Pond System*

2.1 Facility Description and Operational History

The Main Pond began receiving effluent in 1945. The Main Pond was located in a natural topographic depression, diked on the eastern margin, covering approximately 14.2 ha (35 ac), with a maximum depth of approximately 6.1 m (20 ft) during its operational use. In the 1970s, a 1.7 ha (4.1 ac) area directly west of the Main Pond was diked to serve as an overflow area for the Main Pond. The overflow area was decommissioned and backfilled in 1985 (DOE/RL-92-05). Expansion ponds (216-B-3-A, referred to as 3A; 216-B-3-B, referred to as 3B; and 216-B-3-C, referred to as 3C) were placed in service in 1983, 1984, and 1985, respectively. The 3A and 3B expansion ponds are approximately 4.5 ha (11 ac), and the 3C expansion pond is approximately 17 ha (41 ac). Four ditches were used to convey effluent from production facilities in the 200 East Area to the Main Pond, where the water then evaporated and infiltrated into the ground. The 216-B-3-1 Ditch operated from 1945 to 1964, the 216-B-3-2 Ditch operated from 1964 to 1970, and the 216-B-3-3 Ditch operated from 1970 to 1994. The 216-B-3-3 Ditch was 1.2 to 2.4 m (4 to 8 ft) deep and 0.3 m (3 ft) wide at the bottom. The 216-A-29 Ditch, which fed into the 216-B-3-3 Ditch approximately 305 m (1,000 ft) west of the Main Pond, operated from 1955 to 1991. These ditches were decommissioned and stabilized (i.e., backfilled) over time, mostly as the result of unplanned releases of dangerous waste (DOE/RL-89-28). DOE/RL-92-05 presents operational details for these ponds and ditches. The B Pond system (not to be confused with the B Pond TSD) consists of the Main Pond, three expansion ponds, and four ditches (Figure 2-1).

Discharge volumes to the B Pond system averaged around 1.0×10^{10} L/year (2.6×10^{9} gal/year), except for a short period in the mid-1980s. From 1986 to 1991, discharges to the B Pond system totaled over 6.4×10^{10} L (1.7×10^{10} gal), with a maximum in 1988 of over 1.0×10^{11} L/year (2.6×10^{10} gal/year). Total discharge to the facility since 1945 is estimated to have exceeded 1.0×10^{12} L (2.6×10^{11} gal).

In April 1994, discharges to the Main Pond and the 3A expansion pond ceased, and all effluents were rerouted to the 3C expansion pond via a pipeline. Also in 1994, the Main Pond and 216-B-3-3 Ditch were filled with clean soil during interim stabilization activities. All vegetation was removed from the perimeter and incorporated with the fill soil. Prior to diversion of effluent from the Main Pond, the 3A, 3B, and 3C expansion ponds were clean-closed under RCRA, though the 3C expansion pond continued to receive uncontaminated discharges. RCRA clean closure of the expansion ponds indicates that no identifiable waste remains in the closed facilities. Thus, only the Main Pond and an adjoining part of the 216-B-3-3 Ditch, comprising one TSD unit, require groundwater monitoring under WAC 173-303.

In June 1995, portions of the effluent stream were rerouted to the permitted 200 Areas Treated Effluent Disposal Facility (TEDF). The remaining streams were diverted from the 3C expansion pond to TEDF by August 1997, thus ending all routine operation of the B Pond system (Figure 2-1).

B Pond received effluent from several 200 East Area facilities, including PUREX, B Plant, 241-A Tank Farm, 242-A Evaporator, 244-AR Vault, and 284-E Power Plant. Corrosive hazardous wastes, such as nitric and sulfuric acids, were routinely discharged to B Pond via the ditches, although attempts were made to neutralize these wastes before they were discharged. Other volumetrically important chemicals discharged to B Pond included cadmium nitrate, ammonium fluoride, ammonium nitrate, hydrazine, and sodium and potassium hydroxide. Sulfuric acid and sodium hydroxide were the most frequently discharged hazardous waste. An unplanned release of cadmium nitrate (15 kg [33 lb]) from the PUREX chemical sewer was sent to B Pond in 1977 (DOE/RL-93-74). Records of dangerous waste discharges to B Pond are poor prior to 1983, and information concerning chemical (nonradioactive) releases is incomplete prior to 1987 (DOE/RL-89-28). The last known reportable discharge of chemical waste (sodium nitrate) occurred in 1987 (PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*).

2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, “Byproduct Material”), stating that the hazardous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized 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.

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

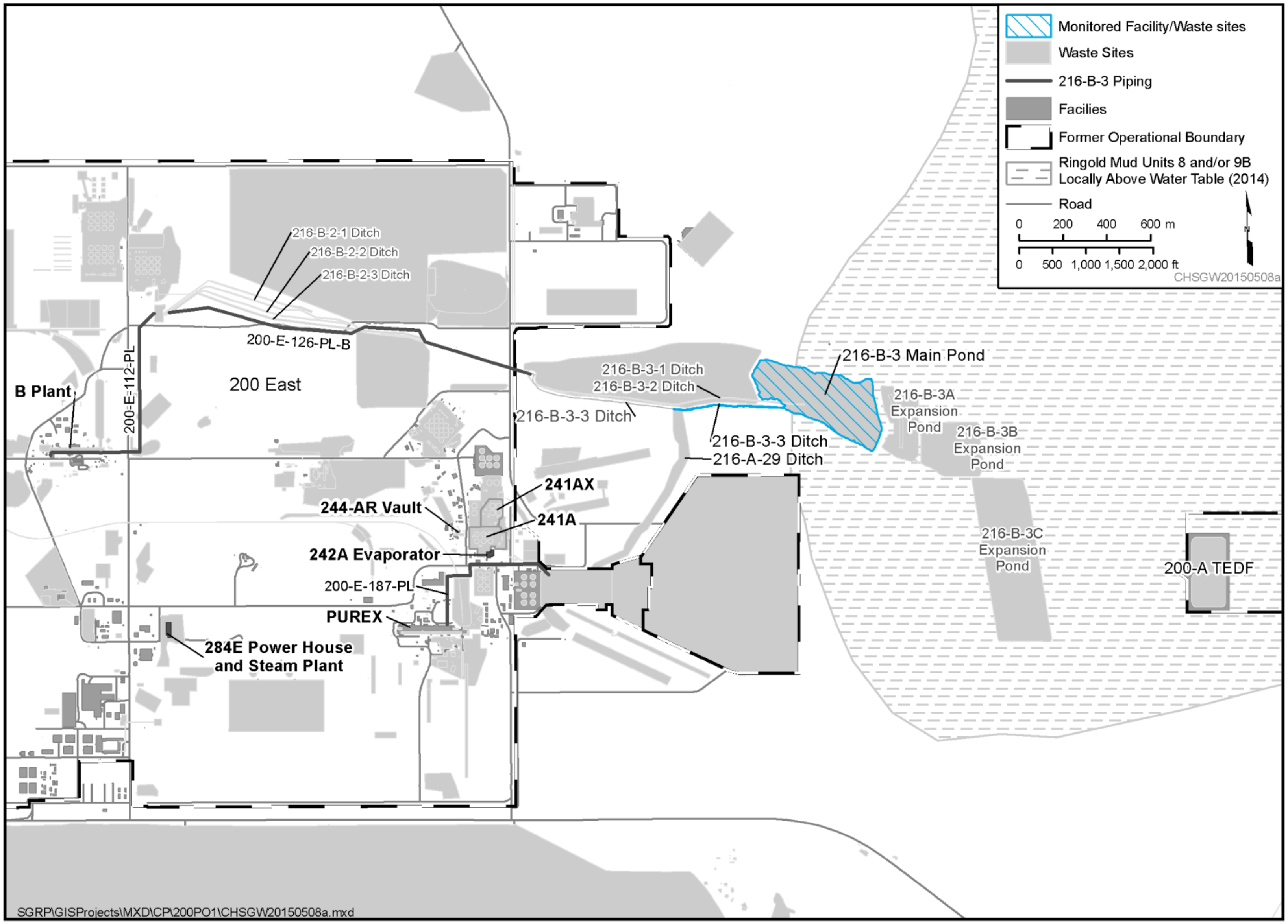


Figure 2-1. Map of the B Pond System

Dangerous waste is regulated under RCRA, as modified in 40 CFR 265 and RCW 70.105, "Hazardous Waste Management," and its implementing requirements in the Washington State dangerous waste regulations (WAC 173-303-400). Radionuclides in mixed waste may include source, special nuclear, and byproduct materials, as defined in the *Atomic Energy Act of 1954* (AEA). Both RCRA and AEA state that these radionuclide materials are regulated at DOE facilities, exclusively by DOE, acting pursuant to its AEA authority. Radionuclide materials are not hazardous/dangerous wastes and, therefore, are not subject to regulation by the State of Washington under RCRA or RCW 70.105.

Groundwater monitoring at B Pond was initiated in 1988, based on the interim status indicator evaluation program requirements of 40 CFR 265, Subpart F, and WAC 173-303-400. The initial groundwater monitoring program is described in the preliminary closure plan (DOE, 1987).

In 1994, the RCRA Part A permit application (DOE/RL-89-28) was modified to distinguish the three expansion ponds (3A, 3B, and 3C) from the Main Pond and a segment of the 216-B-3-3 Ditch. This change allowed RCRA clean closure of the expansion ponds to meet Tri-Party Agreement (Ecology et al., 1989a) Milestone M-17-10. The portion of 216-B-3-3 Ditch, west of its junction with 216-A-29 Ditch, and the 216-B-3-1 and 216-B-3-2 Ditches are RCRA past-practice facilities and are not included in the B Pond TSD unit. The 216-A-29 Ditch conveyed dangerous waste from the PUREX chemical sewer to the 216-B-3-3 Ditch. From the juncture of 216-A-29 and 216-B-3-3, waste from the PUREX chemical sewer flowed to the Main Pond. Therefore, only this eastern section of the 216-B-3-3 Ditch requires RCRA monitoring. Thus, the only portions of the original facilities that are addressed under this RCRA groundwater monitoring plan are the Main Pond and the segment of the 216-B-3-3 Ditch between the Main Pond and the 216-A-29 Ditch. The 216-A-29 Ditch is a separate TSD unit.

Activities conducted as part of the closure process for the expansion ponds included soil and sediment sampling, interim stabilization of the Main Pond and 216-B-3-3 Ditch, and decontamination and removal of structures and associated fixed equipment (DOE/RL-89-28). Soil and sediment sampling activities in support of closure were conducted in three phases. The first phases were completed from 1989 through 1992 and involved shallow soil sampling and analysis of sediments from the Main Pond, expansion ponds, and 216-B-3-3 Ditch (WHC-SD-EN-AP-042) and deep vadose zone sampling in the expansion ponds (DOE/RL-89-28). Final characterization of the vadose zone at B Pond occurred during September 1999 when 1 deep borehole and 10 trenches were excavated in the Main Pond and 216-B-3-3 Ditch (BHI-01367). Results of these investigations substantiated that soil contamination is generally shallow and of low concentrations. Detections above WAC 173-340, "Model Toxics Control Act—Cleanup," Method B cleanup levels for direct contact included cadmium, lead, silver, mercury, and Aroclor 1254 to a depth of approximately 3.4 m (11 ft) below ground surface at the Main Pond (BHI-01367). Mercury and arsenic were detected at elevated levels (maximum values of 0.51 and 14.7 mg/kg, respectively) up to 4.0 m (13 ft) below the bottom of the 216-B-3-3 Ditch. Low-level concentrations of Aroclor 1254 (maximum value of 38 µg/kg) and Aroclor 1260 (maximum value of 440 µg/kg) were detected up to 3.3 m (10 ft) below the ditch bottom (BHI-01367).

Groundwater monitoring at B Pond has been conducted under RCRA since 1988. Interim status indicator parameter monitoring was performed from 1988 to 1990 when monitoring was changed to an assessment program (40 CFR 265.93(d), "Preparation, Evaluation, and Response") due to elevated levels of total organic halogen (TOX) in a downgradient well (699-43-41E) (Izatt and Lerch, 1990, "Groundwater Quality Assessment Plan for the 216-B-3 Pond System"). In 1990, WHC-SD-EN-AP-030, Rev. 0, *Groundwater Quality Assessment Plan for the 216-B-3 Pond System*, was issued, and it was revised in 1992 with Engineering Change Notice (ECN) 166756. The assessment included the Main Pond and a portion of an inactive overflow area, the 216-B-3-3 Ditch, and the 3A, 3B, and 3C expansion ponds.

The 1997 assessment report (PNNL-11604) identified that a second downgradient well (699-43-41F) had also exceeded TOX, and total organic carbon (TOC) levels were elevated in these downgradient wells. PNNL-11604 concluded that no dangerous waste or dangerous waste constituents associated with the assessment areas could be correlated to the elevated TOX or TOC results, and B Pond was returned to indicator parameter monitoring in 1998. Several updates to the monitoring plan have since occurred, and the most recent plan was issued in 2010 (DOE/RL-2008-59, Rev. 0).

To date, no dangerous waste or dangerous waste constituents subject to WAC 173-303 have contaminated groundwater beneath B Pond. Therefore, the site remains under indicator evaluation monitoring for indicator parameters, as specified in 40 CFR 265.92(b).

The proposed RCRA closure strategy for B Pond is clean closure. Draft A of DOE/RL-2013-24 was submitted to Ecology on April 18, 2013 (13-AMPR-0155, "216-B-3 Main Pond Closure Plan, DOE/RL-2013-24, Draft A and 216-S-10 Pond and Ditch Closure Plan, DOE/RL-2006-12, Draft B").

2.3 Waste Characteristics

B Pond received effluent from several 200 East Area facilities, including the PUREX Plant, B Plant, 241-A Tank Farm, 242-A Evaporator, 244-AR Vault, and 284-E Power Plant (Figure 2-1). Dangerous waste associated with these operations came from three primary sources: (1) corrosive and dangerous waste resulting from regeneration of demineralizer columns at the PUREX Plant, (2) spills of dangerous or mixed waste from PUREX and other facilities, and (3) off-specification chemical makeups at the PUREX Plant. The dangerous waste consists of toxicity characteristic waste, acutely dangerous discarded chemical products, and state-only waste. The last known reportable discharge of chemical waste (sodium nitrate) occurred in 1987. The identity and quantity of dangerous waste disposed at B Pond are outlined in the RCRA Part A Form and presented in Table 2-1. The regulated wastes disposed included corrosive waste, cadmium, hydrazine, and dangerous waste/toxic dangerous waste.

Table 2-1. Dangerous Waste Disposed to 216-B-3 Main Pond and 216-B-3-3 Ditch from RCRA Part A Form

Waste Constituent	Quantity (kg [lb])*	Description
Nitric Acid, Sulfuric Acid, Sodium Hydroxide, Potassium Hydroxide	1,622,500 (3,577,000)	Corrosive and Toxic
Hydrazine	34,900 (77,000)	Listed
Cadmium Nitrate	76,700 (169,000)	Listed
Ammonium Fluoride/Ammonium Nitrate	8,600 (19,000)	Dangerous Waste/Toxic Dangerous Waste

* Quantity includes the water in which the chemicals were discharged.

RCRA = *Resource Conservation and Recovery Act of 1976*

Several sources of wastewater and effluent contributed to B Pond discharges during the operational life of the facility. The greatest volume consisted of raw Columbia River water. Discharges from these sources were routine scheduled releases and a few unplanned releases. The most important sources of effluent include the following:

- PUREX chemical sewer
- B Plant chemical sewer
- 242-A Evaporator steam condensate and cooling water

- 244-AR Vault cooling water
- 284-E Power Plant wastewater
- 241-A Tank Farm cooling water
- B Plant cooling water
- PUREX cooling water

Waste streams from these facilities were conveyed to the Main Pond through a system of ditches and pipelines. From the PUREX Plant, the Main Pond received mixed wastes via the 216-A-29 Ditch and PUREX cooling water line. B Plant facilities conveyed effluent via the 216-B-2-1, 216-B-2-2, and 216-B-2-3 Ditches to the 216-B-3-1, 216-B-3-2, and 216-B-3-3 Ditches, which, in turn, emptied into the Main Pond. These ditches were decommissioned and stabilized (backfilled) mostly as a result of unplanned releases of dangerous wastes (DOE/RL-89-28). During the final few years of operation, mostly uncontaminated water (essentially river water and condensate) from the B Plant and PUREX facilities was conveyed to the Main Pond and the 3A and 3C ponds via closed pipelines. Of the eight streams listed, the largest actual and potential contributors of dangerous waste to B Pond are the PUREX and B Plant chemical sewers.

2.4 Geology and Hydrogeology

The geologic units present beneath B Pond and their orientation have a significant effect on groundwater flow and contaminant migration in this area. The stratigraphy and groundwater hydrology of B Pond have been described in numerous previous studies:

- DOE/RL-93-74, *200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-3 Trench, and 216-A-29 Ditch Work/Closure Plan Volume 1: Facility Investigation and Sampling Strategy*
- DOE/RL-2009-85, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*
- DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010* (Chapter 2, "Overview of Hanford Hydrogeology and Geochemistry")
- DOE/RL-2014-32, *Hanford Site Groundwater Monitoring Report for 2013*
- ECF-Hanford-13-0029, *Development of the Hanford South Geologic Framework Model, Hanford Site Washington*
- PNL-10195, *Three Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System: FY 1994 Status Report*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- SGW-54165, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site*
- WHC-SD-EN-AP-030, *Groundwater Quality Assessment Plan for the 216-B-3 Pond System*
- WHC-SD-EN-AP-042, *Phase I Characterization of the 216-B-3 Pond System*
- WHC-SD-EN-EV-002, *Interim Hydrogeologic Characterization Report for the 216-B-3 Pond*
- WHC-SD-EN-TI-012, *Geologic Setting of the 200 East Area: An Update*

Detailed descriptions of stratigraphic relationships at B Pond are presented in DOE/RL-93-74. A description of groundwater hydrology and groundwater contamination in the region of the Hanford Site surrounding B Pond is presented in DOE/RL-2014-32. A reinterpretation of well logs and hydrostratigraphy in the 200 East Area and vicinity (PNNL-12261) has allowed a more accurate portrayal of groundwater movement beneath B Pond.

2.4.1 Stratigraphy

Figure 2-2 illustrates the general stratigraphy of the Hanford Site. Geologic cross sections that include selected wells near B Pond show the geologic units underlying the area (Figures 2-3, 2-4, and 2-5). The principal geologic units beneath B Pond include the Pleistocene Hanford formation, Miocene/Pliocene Ringold Formation, and Miocene Elephant Mountain Member of the Saddle Mountains Basalt. General characteristics of these lithostratigraphic units (from youngest to oldest) are summarized as follows:

- A discontinuous veneer of Holocene eolian silty sand or backfill mixtures of sand and gravel.

- Hanford formation – Cataclysmic flood deposits equivalent to hydrostratigraphy unit (HSU) 1. The Hanford formation consists of three facies subunits (silt dominated, sand dominated, and gravel dominated), which grade into one another both vertically and laterally (Figure 2-2). The majority of the vadose zone above the Ringold Formation units is the Hanford formation. The Hanford formation ranges in thickness from approximately 40 m (130 ft) beneath the 3C Pond to about 50 m (160 ft) at the northwestern corner of the Main Pond (Figure 2-5). On the Central Plateau, the Hanford formation is sometimes further delineated into H1, H2, and H3 lithostratigraphic sequences. H1 and H3 gravel sequences are not differentiated in those areas where the intervening sandy H2 sequence is absent. Units H1 and H3 consist of coarse-grained, basalt-rich, sandy gravels with varying amounts of silt/clay. These gravel units may also contain interbedded sand and or silt/clay lenses, and the units are notably rich in clay near the western portion of B Pond, as indicated in well logs from this area. The H2 sequence is dominated by sand to gravelly sand, with minor sandy gravel or silt/clay interbeds. Both the sand dominated and gravel dominated sequences are present near the Main Pond of the B Pond system (Figures 2-3, 2-4, and 2-5).

- Cold Creek unit (CCU) – equivalent to HSUs 2 and 3. The CCU is often undifferentiated but regionally has been subdivided into three subunits: CCU_z (Early Palouse Soil) and Unit C (caliche), both of which are primarily located in 200 West Area, and Unit G (pre-Missoula gravels), which is primarily located beneath the 200 East Area and vicinity. In much of the 200 East Area, the CCU is characterized as a quartzo-feldspathic sandy gravel (Unit G) above the Ringold Formation and below the more basaltic Hanford formation.

- Ringold Formation, Unit E – equivalent to HSU 5. Fluvial deposits with thick layers of silty sandy gravel (conglomerate), intercalated with thinner beds of overbank silts and fine-grained paleosols. In the 200 East Area, Unit E is present only in the southern quarter of the area because, in the northern three-quarters of the 200 East Area, the unit has been removed by erosion or was not deposited. Unit E has been removed through most of the far eastern portion of 200 East Area, including under the B Pond system, to approximately the May Junction Fault (located to the east of the B Pond area), by the ancestral Columbia River and Missoula floods. Unit E was not removed from the downthrown side of the fault because of the structural displacement into the basin and distance from the highest forces of the floods (PNNL-12261).

- Ringold Formation, lower mud unit – equivalent to HSU 8. This unit is composed of a sequence of fluvial overbank, paleosol, and lacustrine silt and clay, with minor sand and gravel. This unit is an aquitard, creating confining conditions, and isolating the Ringold Formation Unit E from the underlying Ringold Formation Unit A when all units are present. The Ringold lower mud sequence is not present in the middle (Figure 2-4) and northwestern portion of B Pond (Figure 2-5), but is greater than 20 m (66 ft) thick east of TEDF, generally thickening south and southeast of B Pond (Figure 2-6). The Ringold lower mud unit consists mostly of various mixtures of silt and clay (DOE/RL-93-74). This unit is particularly important to effluent infiltration and groundwater flow patterns east and southeast of the Main Pond.

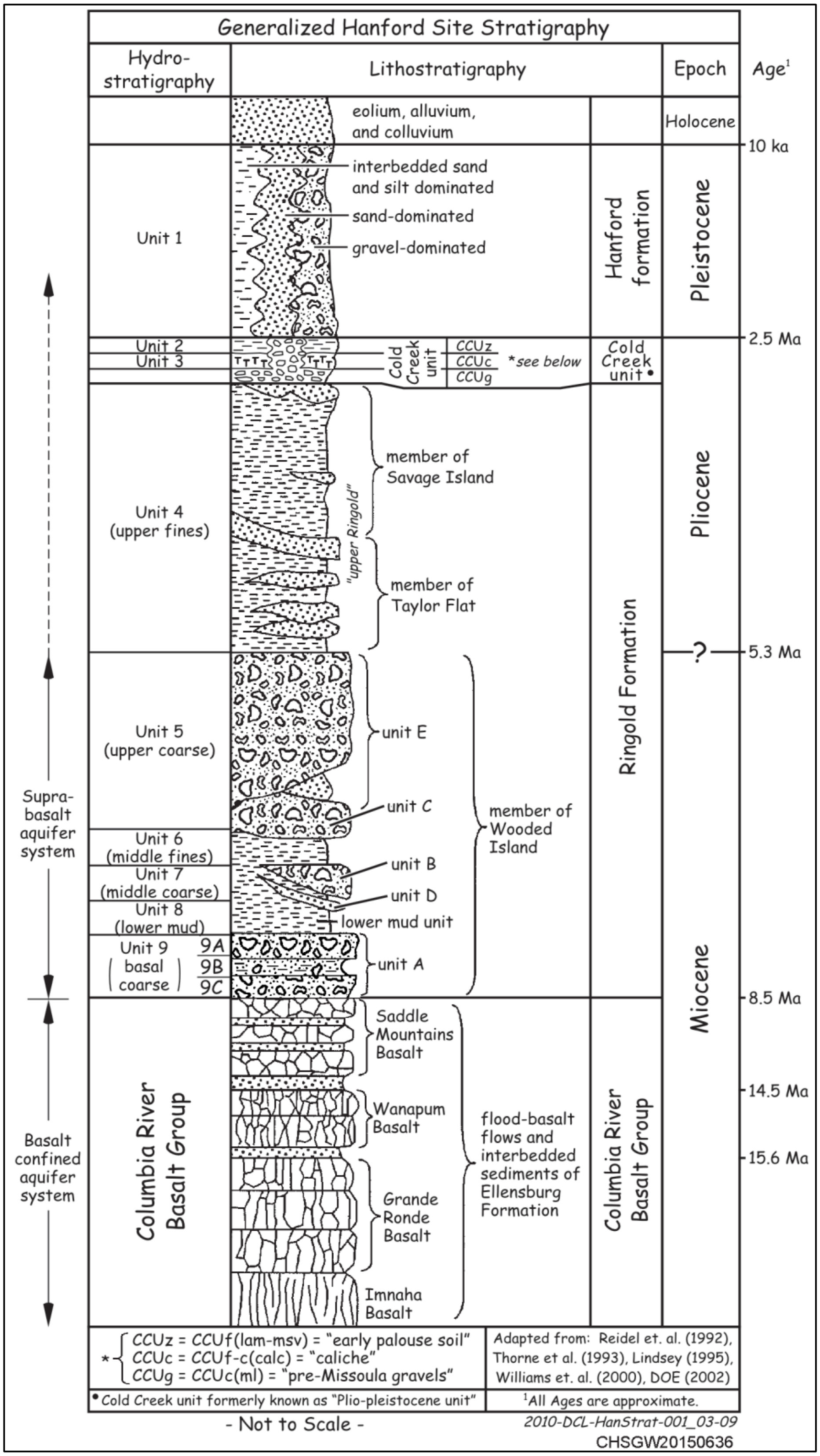
- Ringold Formation, Unit A – equivalent to HSU 9. Unit 9 can be further subdivided into three hydrostratigraphic subunits based on different lithologies and hydraulic properties (Figure 2-2). The middle subunit is characterized as a silt to clay-rich confining zone with lower permeability, defined as subunit 9B. Upper and lower subunits (9A and 9C) have much higher permeability and lower clay content and consist of consolidated silty sandy gravel deposits. Occurrence of these subunits in the B Pond area are shown on Figures 2-3, 2-4, 2-5, and 2-6.

- Bedrock consisting of Columbia River Basalt flows dip gently to the south toward the axis of the Cold Creek syncline. The two uppermost flows are within the Elephant Mountain Member of the Saddle Mountains Basalt.

2.4.2 Hydrogeology

Figure 2-6 illustrates the hydrostratigraphic relationships in the B Pond/TEDF area, hydraulic elevation heads, and groundwater flow characteristics. Because of the dipping beds of the Ringold Formation in this area and the erosional unconformable contact with the overlying Hanford formation, groundwater beneath the B Pond System can occur in both confined and unconfined states, depending on the location (Figures 2-3, 2-4, 2-5 and 2-6). The uppermost aquifer is unconfined west, southwest, and northwest of the Main Pond where the Ringold Formation confining units (Unit 8 and Unit 9B) are absent (Figures 2-4, 2-5, 2-6, 2-7 and 2-8). The aquifer becomes progressively more confined to the east and southeast of the Main Pond (Figures 2-3 and 2-6).

The Ringold Formation gravels (Units 9A and 9C) comprise the bulk of the uppermost aquifer in the B Pond area. In the south-central and southwestern part of the site (south-central portion of the Main Pond and a portion of 216-B-3-3 Ditch), the unconfined aquifer occurs in Ringold Unit 9A (Figure 2-4), as well as the Hanford formation (Figures 2-4 and 2-5). Most of the Hanford formation aquifer near B Pond is coarse-grained and highly permeable. Estimates of the saturated thickness of the uppermost aquifer vary from west to east across B Pond (Figures, 2-3, 2-4, 2-5, and 2-6). On the west side, approximately 6 m (20 ft) of unconfined Hanford formation sandy gravels are present near the northern end of the 216-A-29 Ditch. Near the east side of the Main Pond, the uppermost aquifer is made up of approximately 7 m (23 ft) of Ringold Formation Unit 9A and 5 m (16 ft) of Ringold Formation Unit 9C, both locally confined. Farther east, the uppermost aquifer includes approximately 12 m (39 ft) of Unit 9A and 6 m (20 ft) of Unit 9C near the northern end of the 3C Pond. Where hydraulic conductivities have been measured in the B Pond area, values have been calculated ranging from 1.0 m/day (3.3 ft/day) for the Ringold Formation to 640 m/day (2,100 ft/day) for the Hanford formation (WHC-SD-EN-EV-002; PNL-10195).



Note: Complete reference citations are provided in Chapter 6.

Figure 2-2. General Stratigraphy at the Hanford Site

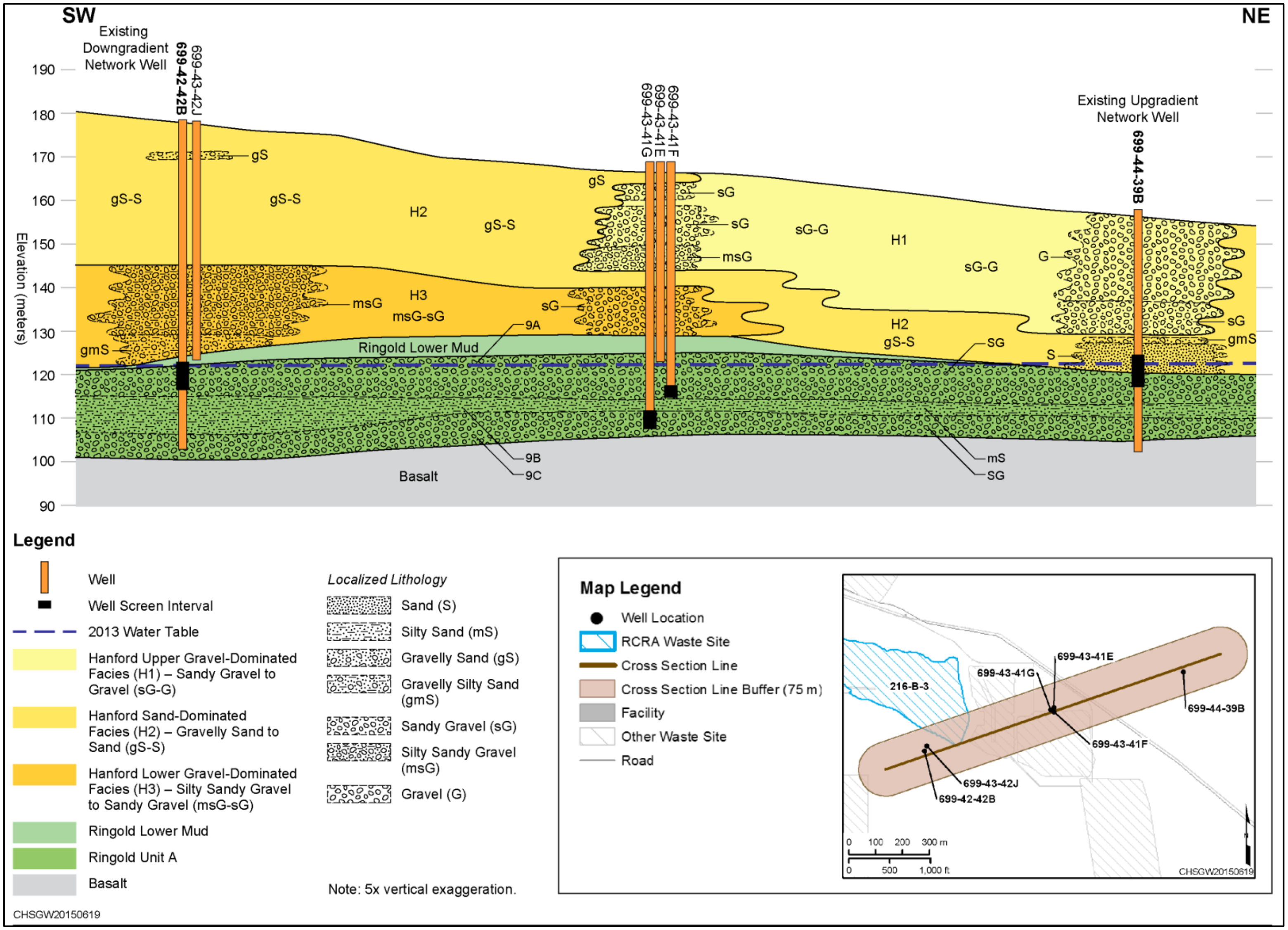


Figure 2-3. Southwest-Northeast Geologic Cross Section Showing the Stratigraphy below the Southeastern Portion of the B Pond (Main Pond)

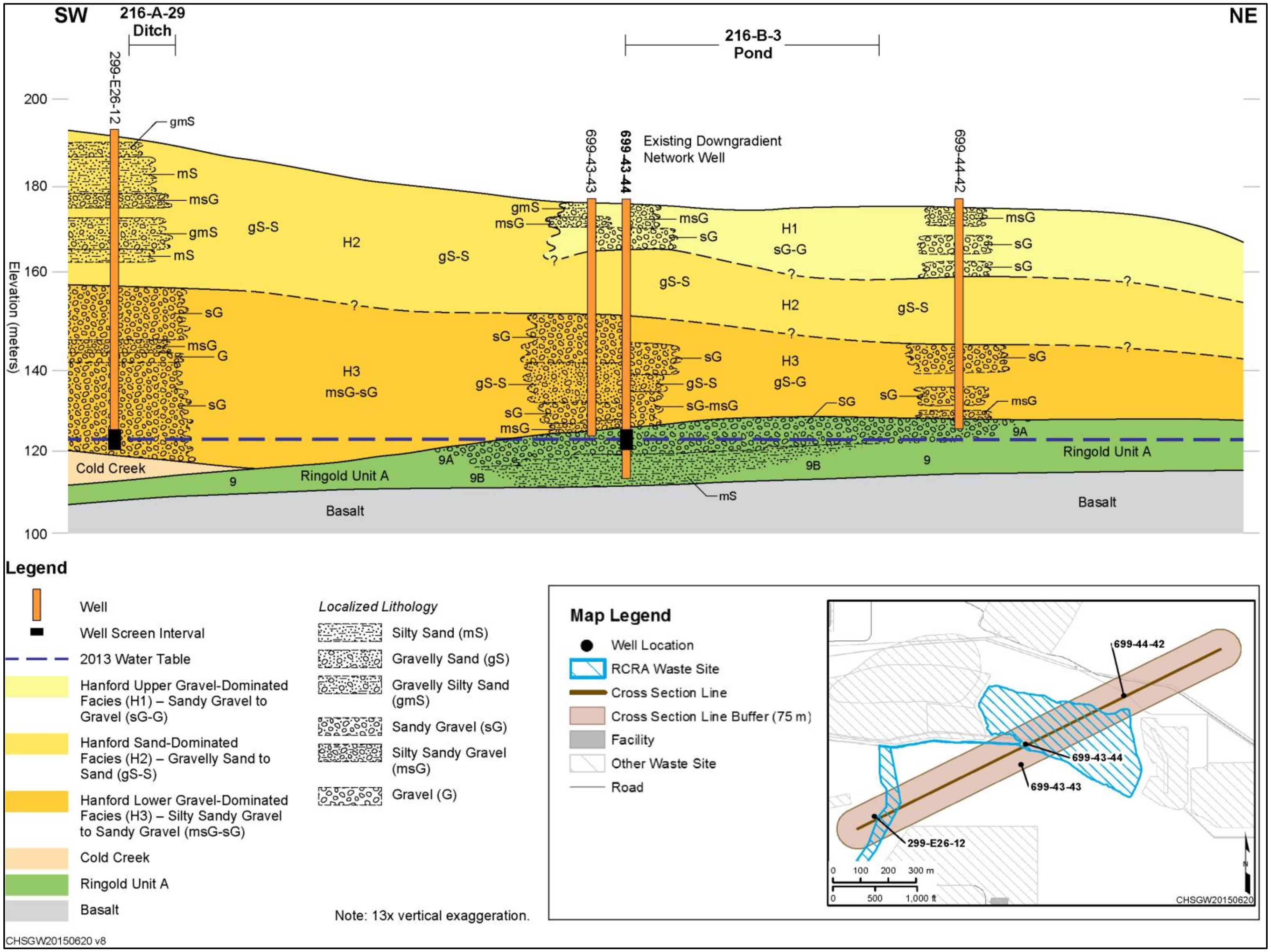


Figure 2-4. Southwest-Northeast Geologic Cross Section Showing the Stratigraphy below the Middle Portion of the B Pond

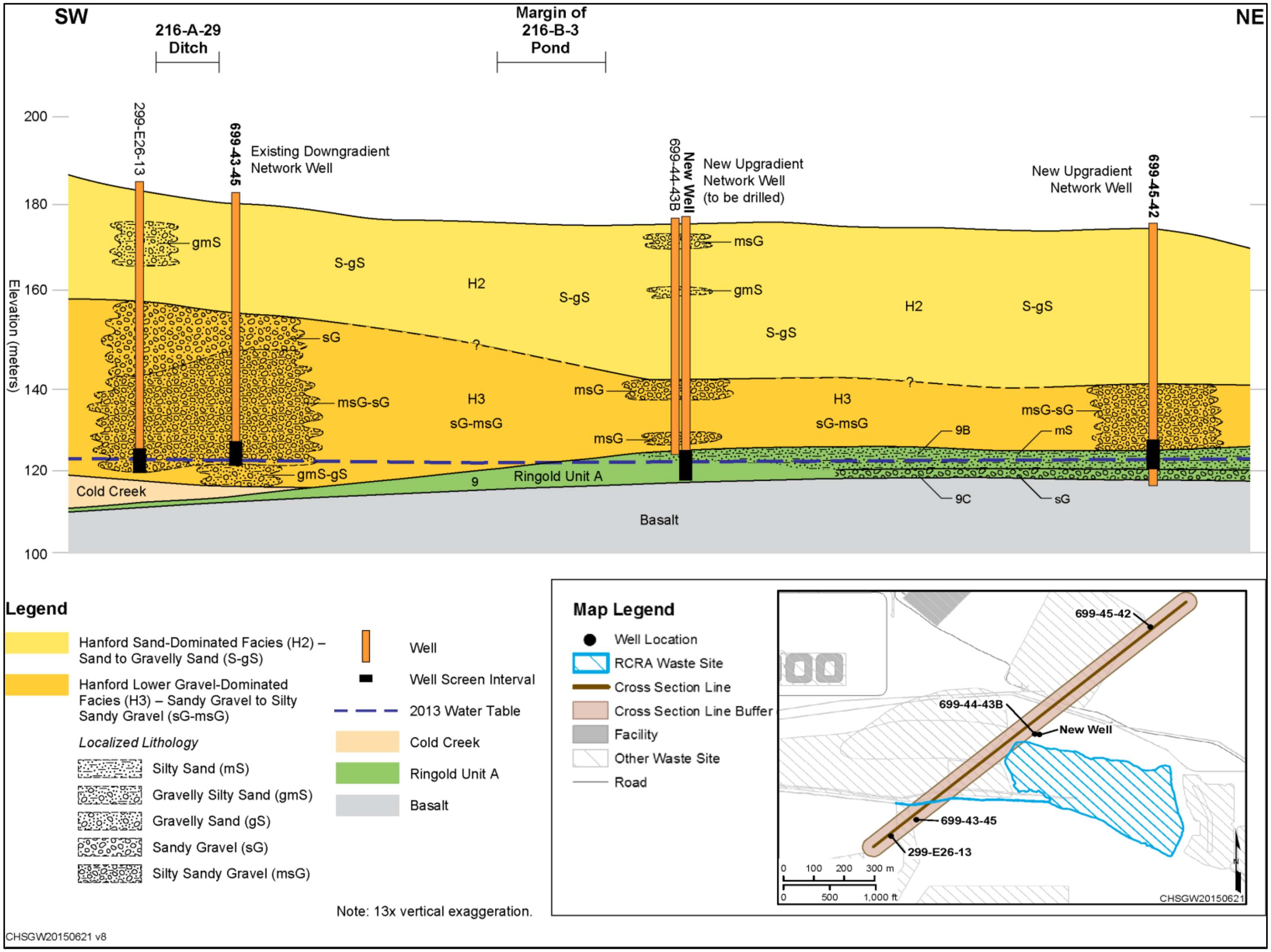


Figure 2-5. Southwest-Northeast Geologic Cross Section Showing the Stratigraphy below the Northwestern Portion of the B Pond

2.4.3 Groundwater Flow Interpretation

During active operations, groundwater beneath the B Pond was interpreted to flow radially outward in the unconfined aquifer from the hydraulic mound that was generated as the result of the large artificial effluent recharge volume. The apex of the mound was located near 216-B-3B Pond (Figure 2-9). This mound remained a major influence on flow direction even after discharges to the 3C expansion pond ended in 1997.

The confined aquifers of Ringold Unit 9 (subunits 9A and 9C) southeast of the B Pond area appear to have been mostly isolated from a significant part of the B Pond effluent discharges (Figure 2-6). The B Pond effluent was mostly intercepted by the intervening Ringold lower mud unit (Unit 8) and diverted along the upper surface of this fine-grained unit, which is structurally dipping to the south (Figure 2-7). Where the Ringold lower mud unit (Unit 8) isolates Ringold Unit 9 aquifers 9A and 9C (Figures 2-3 and 2-6), B Pond effluent entered the overlying more permeable Hanford formation and spread laterally. Migrations appears to have occurred preferentially to the south and west of the Main Pond when saturated flow occurred in the permeable Hanford formation (Figure 2-9). Confinement of the Ringold Unit 9 aquifers to the east is supported by the fact that no hydrologic response to TEDF discharges to the vadose zone has thus far been observed in the TEDF wells completed in Unit 9A since the facility began operating in 1995. Wells in the area, including those near the 3C expansion pond and TEDF, have been showing a regional decline in head since late 1996 or early 1997 (Figure 2-6).

Some of the B Pond effluent apparently did enter Units 9A and 9C where the overlying confining layers (Ringold lower mud Unit 8 and Unit 9B) are absent (Figures 2-3, 2-4, 2-5, 2-6, 2-7, and 2-8). Groundwater sampling data indicate that any constituents associated with this effluent may not have migrated very far to the east, even though there was a hydraulic gradient in these directions at the time due to groundwater mounding and increased hydrostatic load beneath the B Pond. A stratigraphic “trap” could exist east of the B Pond System (i.e., east of 3C Pond and the TEDF) at the May Junction Fault (Figures 2-6, 2-7, and 2-8). It is postulated that the north-south trending May Junction Fault may represent a barrier to groundwater flow in Units 9A and 9C, preventing any appreciable flow to the east (PNNL-12261). Calculations of hydraulic conductivity, stratigraphic relationships recognized in the distal southeast portions of the area (e.g., south of the TEDF), and groundwater geochemistry suggest that actual movement of groundwater in an east and southeast direction has been more limited than depicted by historical interpretations of the water table around B Pond (Figure 2-9). Thus, the relatively uniform radial flow pattern envisioned in earlier reports (e.g., PNNL-11604) was likely oversimplified.

For the saturated Ringold units underlying the B Pond System and TEDF, groundwater currently flows to the west and southwest and discharges to the unconfined aquifer along the erosional boundary of confining Units 8 and 9B (Figures 2-3, 2-4, 2-5, 2-6, 2-7, and 2-8). Aquifer tests of Units 9A and 9C show that hydraulic conductivities and calculated average flow rates are low. Using a hydraulic conductivity of 1.0 m/d (3.3 ft/d) (WHC-SD-EN-EV-002 and PNL-10195), effective porosity of 0.25, hydraulic gradients of 0.0015 and 0.0013 for units 9A and 9C (respectively, derived from Figure 2-10), and the Darcy equation, the calculated average linear flow rates are 0.006 m/d (0.020 ft/d) and 0.005 m/d (0.016 ft/d) for Units 9A and 9C (respectively) for the area near B Pond.

2.5 Summary of Previous Groundwater Monitoring

Table 2-2 lists the previous groundwater monitoring plans implemented at B Pond.

Table 2-2. Previous Monitoring Plans

Document	Date Issued	Monitoring Program*
Preliminary Closure/Post-Closure Plan 216-B-3 Pond (DOE, 1987)	1987	Indicator Evaluation Program
Interim-Status Groundwater Monitoring Plan for the 216-B-3 Pond (WHC-SD-EN-AP-013, Rev. 0)	1989	Indicator Evaluation Program
Groundwater Quality Assessment Plan for the 216-B-3 Pond System (WHC-SD-EN-AP-030, Rev. 0)	1990	Groundwater Quality Assessment Plan
WHC-SD-EN-AP-030 (ECN 166756)	1992	Groundwater Quality Assessment Plan
WHC-SD-EN-AP-013, Rev. 1	1995	Indicator Evaluation Program
Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility (PNNL-13367)	2000	Indicator Evaluation Program
PNNL-13367-ICN-1	2002	Indicator Evaluation Program
Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility (PNNL-15479)	2005	Indicator Evaluation Program
Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond (DOE/RL-2008-59, Rev. 0)	2010	Indicator Evaluation Program

* The indicator evaluation program satisfies the requirements of 40 CFR 265.92(b)(2), (b)(3), (d)(1), (d)(2), and (e), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." The groundwater quality assessment program's first determination satisfies the requirements of 40 CFR 265.93(d)(4) and (d)(6), "Preparation, Evaluation, and Response."

RCRA groundwater monitoring was initiated at B Pond in 1988 in accordance with the preliminary closure plan (DOE, 1987). Under this interim status indicator evaluation plan, samples were to be collected quarterly for the first year at six planned wells and analyzed for contamination indicator parameters, groundwater quality parameters, and drinking water parameters. In 1989, the interim status indicator evaluation program was issued as a separate monitoring plan (WHC-SD-EN-AP-013, Rev. 0); it included one existing (699-42-40A), four new (699-42-42B, 699-43-43, 699-43-42J, and 699-44-42), and six planned (699-40-39, 699-41-40, 699-43-41E, 699-43-41F, 699-43-45, and 699-44-43B) downgradient wells and two existing (299-E18-1 and 299-E32-4) upgradient wells (Figure 2-11). Analysis for volatile organic constituents, hydrazine, and ammonia was also included. After the first year of sampling, the frequency changed to semiannual.

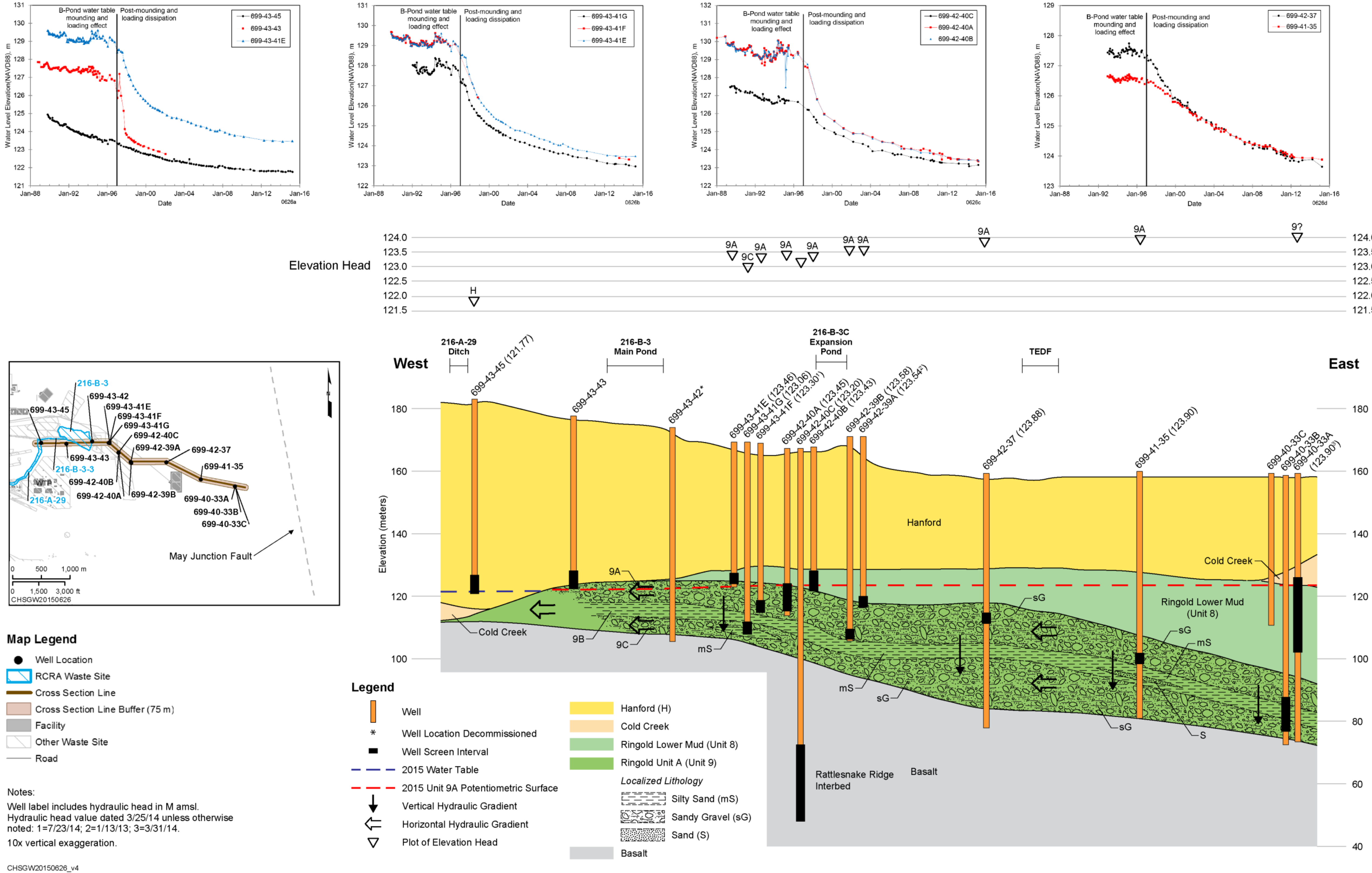


Figure 2-6. Hydrostratigraphy Extending from below B Pond Southeast toward Treated Effluent Disposal Facility

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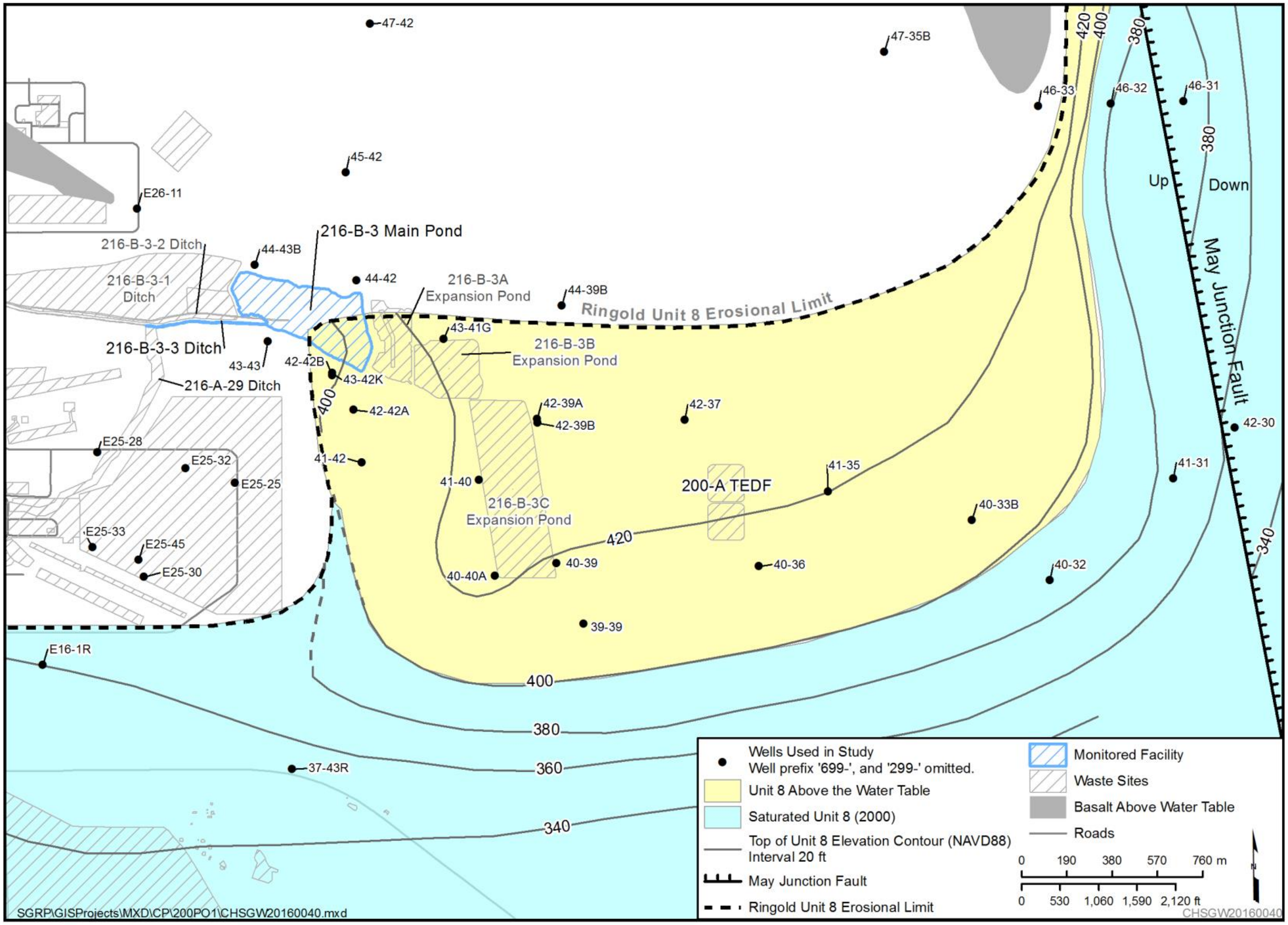

Figure 2-7. Elevation Contour Map of the Top of the Ringold Formation Unit 8, Aquifer Confining Unit (After PNNL-12261).

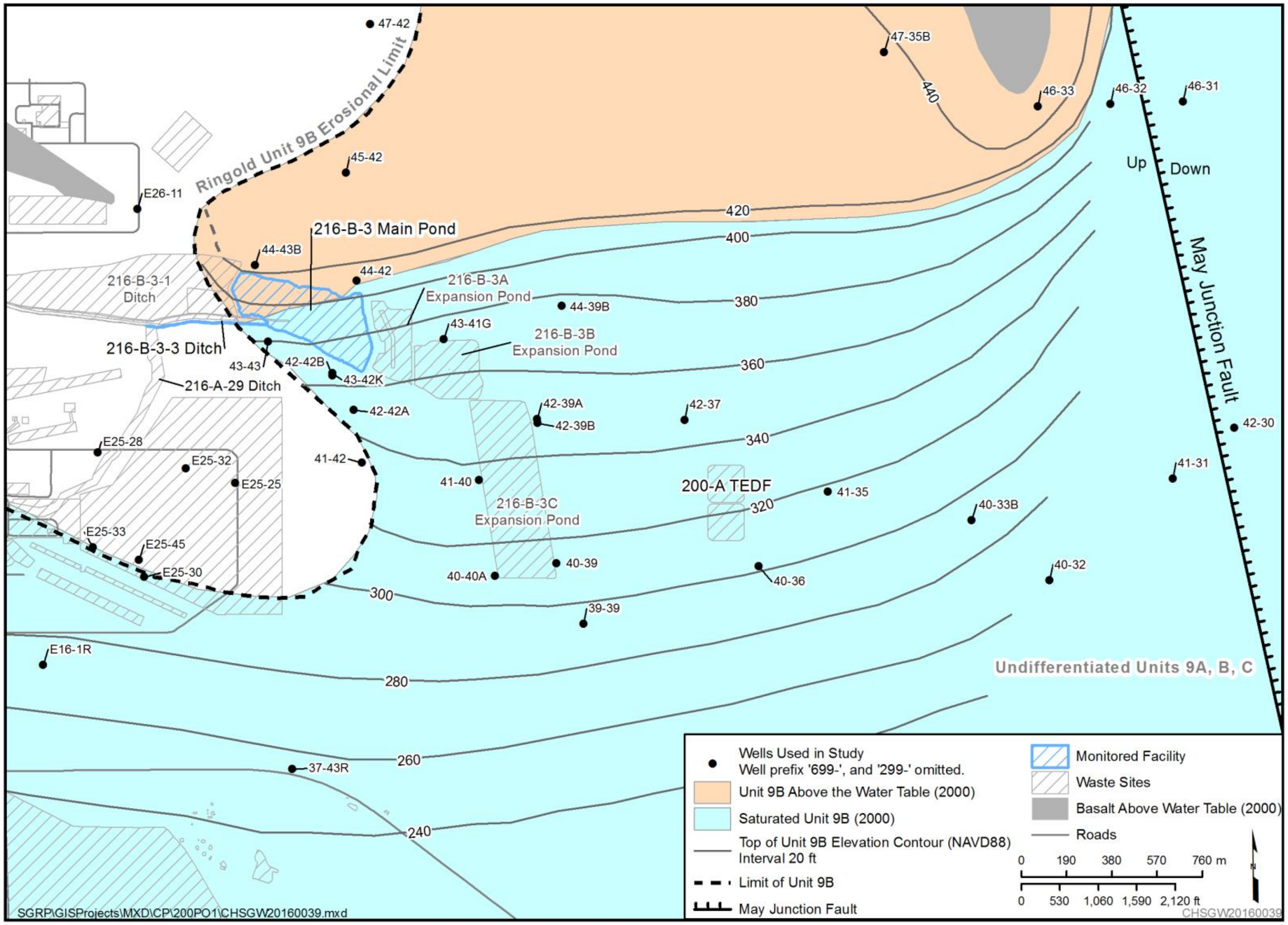

Figure 2-8. Elevation Contour Map of the Top of the Ringold Formation Unit 9B, Aquifer Confining Unit (After PNNL-12261).

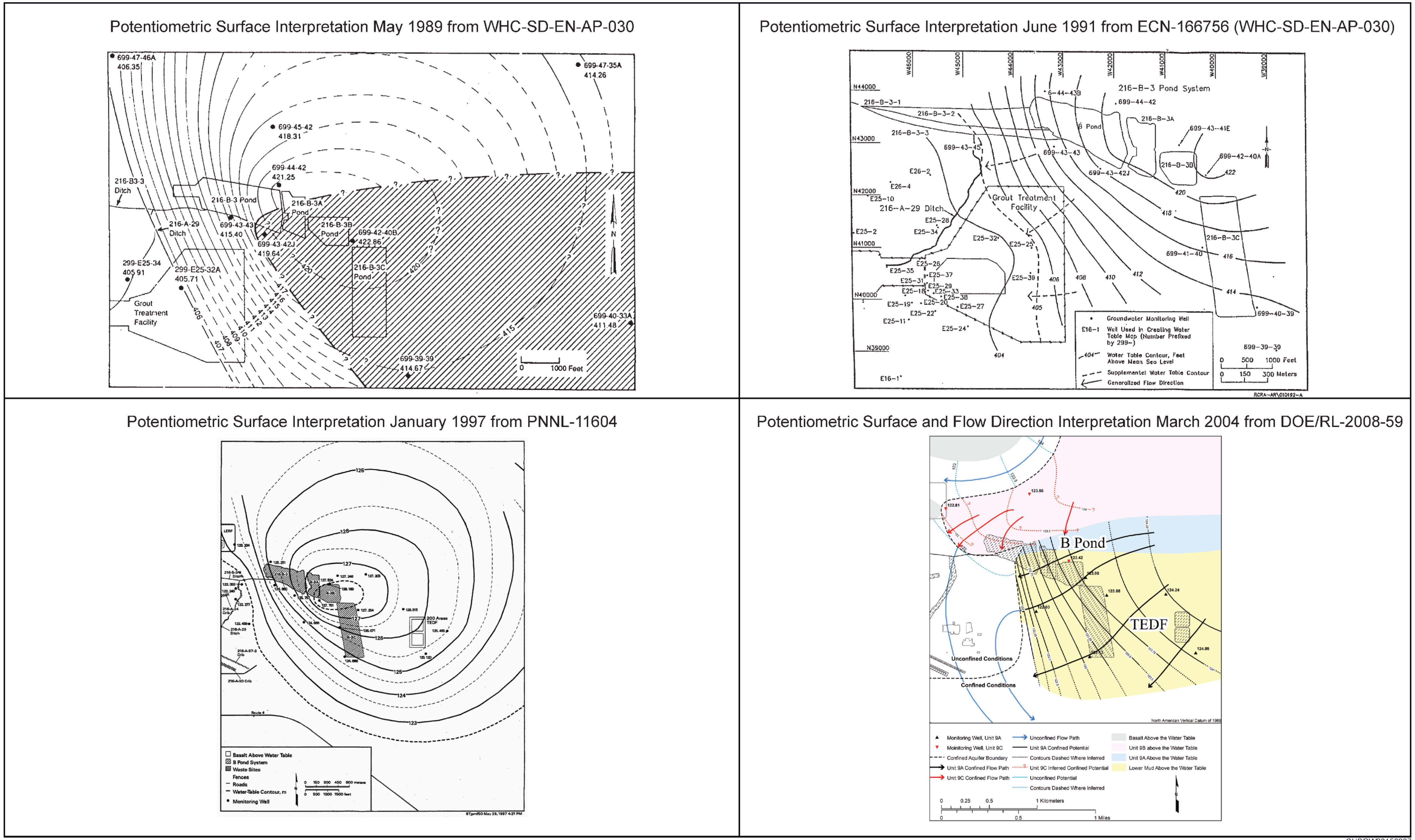

Figure 2-9. Historic Potentiometric Surface and Groundwater Flow Pattern Interpretations in the B Pond Area 1989, 1991, 1997, and 2004

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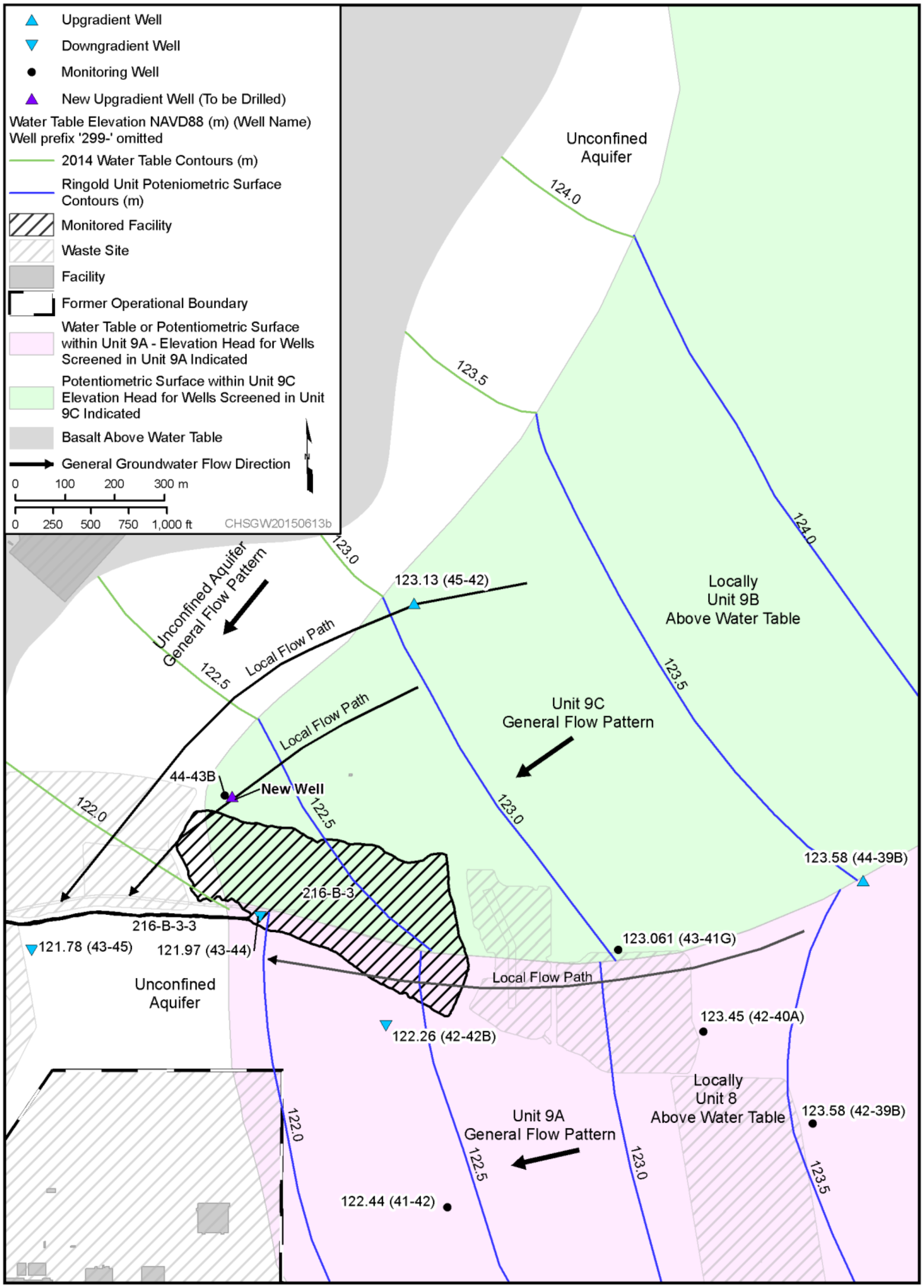

1
2 **Figure 2-10. Groundwater Flow near B Pond in 2014**

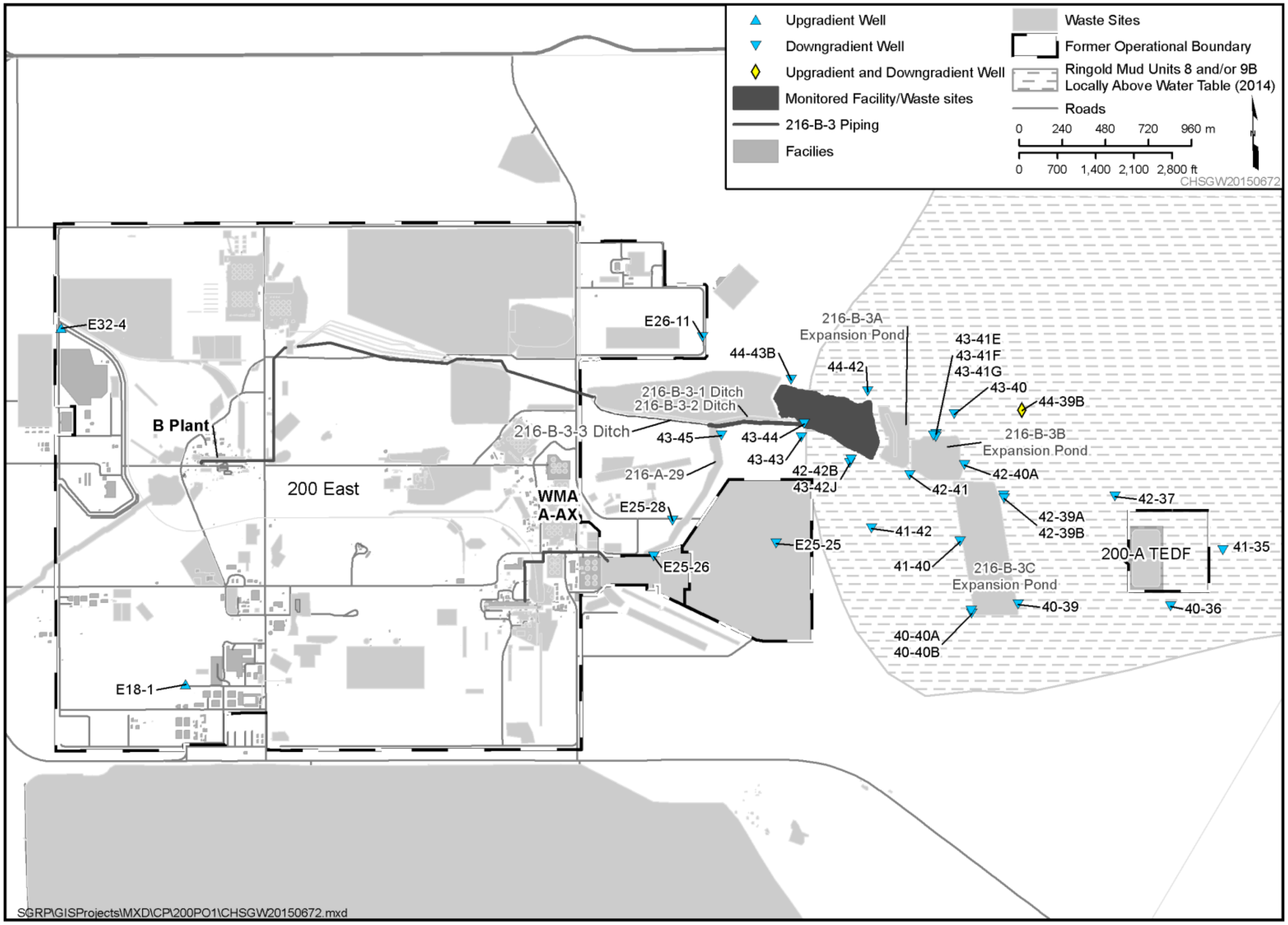

Figure 2-11. Historical RCRA Groundwater Network Wells Used to Monitor the B Pond System

Groundwater monitoring was changed from a RCRA indicator evaluation program to an assessment program in 1990 because of elevated levels of TOC and TOX in two downgradient wells (699-43-41E and 699-43-41F) (PNNL-11604). A groundwater quality assessment plan (WHC-SD-EN-AP-030, Rev. 0) was prepared in 1990 and revised in 1992 (ECN 166756). The plan included 11 downgradient wells (699-40-39, 699-41-40, 699-42-40A, 699-42-42B, 699-43-41E, 699-43-41F, 699-43-42J, 699-43-43, 699-43-45, 699-44-42, and 699-44-43B) and two upgradient wells (299-E18-1 and 299-E32-4). Seven downgradient wells (699-40-40A, 699-40-40B, 699-42-39A, 699-42-39B, 699-42-41, 699-43-40, and 699-43-41G), installed in 1991, were also included (Figure 2-11). Constituents included contamination indicator parameters, groundwater quality parameters, drinking water parameters, site-specific parameters (ammonium, hydrazine, and total organics), and assessment parameters (herbicides, pesticides, enhanced volatiles, acid/base/neutrals, and polychlorinated biphenyls).

Samples for the groundwater assessment were collected from 1994 to 1996. Results of the groundwater quality assessment were issued in 1997 (PNNL-11604) and found that only one compound, tris(2-chloroethyl) phosphate, may have contributed to the elevated TOX results. No compounds were identified as a contributor to elevated TOC. Due to the low concentrations of TOX and TOC, no further investigation was performed and monitoring returned to an indicator evaluation program under WHC-SD-EN-AP-013, Rev. 1. The revised plan included 16 downgradient wells (699-40-36, 699-40-39, 699-40-40A, 699-41-35, 699-41-40, 699-41-42, 699-42-37, 699-42-39B, 699-42-41, 699-42-42B, 699-43-40, 699-43-41E, 699-43-41G, 699-43-45, 699-44-39B, and 699-44-43B) and two upgradient wells (299-E18-1 and 299-E32-4) (Figure 2-11). Samples were collected quarterly and analyzed for contamination indicator parameters and site-specific parameters (gross alpha, gross beta, alkalinity, turbidity, anions, semivolatile organic compounds, and metals).

The number of wells in the B Pond monitoring network was reduced in 1995 after clean closure of the 3A, 3B, and 3C expansion ponds to eliminate redundancy and focus resources on additional hydrochemical analyses in the remaining wells. Three of the wells no longer in the B pond network were part of the TEDF groundwater monitoring network. These three wells were monitored for informational purposes only and were not part of the RCRA-regulated B Pond network. In 1996, an upgradient well (299-E18-1) was removed from the network to reduce redundancy. The other upgradient well (299-E32-4) was shared with the low-level burial grounds facility in the 200 East Area (Figure 2-11).

Hydrazine was last included as a B Pond constituent in the 1995 monitoring plan revision (WHC-SD-EN-AP-013, Rev. 1). PNNL-11604 reports that hydrazine was only detected in three samples, with a maximum of 5 µg/L at Well 699-40-36. Because hydrazine was discharged as an off-specification chemical, it is considered a listed waste (U133). During the investigation of the Main Pond and 216-B-3-3 Ditch, a "contained-in" determination was requested and approved by Ecology for soils associated with investigation derived waste and any future contaminated soil designations for the Main Pond and 216-B-3-3 Ditch (Hedges, 2000, "Approval of the Contained-In Determination Request for Hydrazine"). A groundwater contained-in request approach was approved by Ecology for hydrazine (01-GWVZ-015, "Sampling and Analysis Instruction [SAI] for Hydrazine Sampling in Groundwater Associated with the 216-B-3 Main Pond and 216-A-29 Ditch;" Becker-Khaleel, 2001, "Sampling and Analysis Instructions for Hydrazine Sampling in Groundwater Associated with the 216-B-3 Main Pond and 216-A-29 Ditch"). Based on review of results from the sampling effort, hydrazine is not considered a contaminant of interest at B Pond due to rapid oxidation in the environment to nitrogen and water.

In 1998, a revision to the interim status indicator evaluation groundwater monitoring plan was proposed in PNNL-11903, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*, which incorporated final status sampling requirements under WAC 173-303-645, "Releases from Regulated Units," in anticipation of approval of an updated closure plan. Statistical methods for intrawell groundwater data evaluation were included. Although PNNL-11903 was never implemented, it was used as a basis for the subsequent monitoring plan revision. Groundwater monitoring continued under WHC-SD-EN-AP-013, Rev. 1.

From late 1998 through early 2000, the network was restructured (existing wells were dropped or added) to adjust for changes in the groundwater flow direction following cessation of effluent disposal to the facility, compensate for the drying of some wells, and reduce redundancy in monitoring locations. In September 1999, a new downgradient well (699-43-44) was installed to fill a gap in coverage left by drying of a well (699-43-43) and compensate for changes in groundwater flow directions beneath B Pond. The well was completed in conjunction with vadose zone contaminant characterization for the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 200-CW-1 operable unit.

In 2000, a revised monitoring plan (PNNL-13367, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*) was issued based on PNNL-11903. PNNL-13367 incorporated final status requirements elements under WAC 173-303-645 but also included the constituents and indicator parameters required for an interim status program under 40 CFR 265. An intrawell statistical evaluation approach was included for a two-year trial evaluation. The plan included three downgradient wells (699-42-42B, 699-43-44, and 699-43-45) and one upgradient well (699-44-39B) (Figure 2-11). Semiannual sampling was included for indicator parameters, field parameters (alkalinity, dissolved oxygen [DO], turbidity, and temperature), and site-specific parameters (gross alpha and gross beta). Annual sampling for groundwater quality parameters was also included. Arsenic was identified as a previously detected groundwater contaminant but was not known to be associated B Pond. Therefore, arsenic and nitrate (which may have originated from B Pond) were included for sampling as part of a sitewide surveillance effort.

In 2002, PNNL-13367 was revised (PNNL-13367-ICN-1) to update the constituents and well network and incorporate a control chart statistical analysis method based on Ecology guidance (Goswami, 2001, "Statistical Assessment for the 300 Area Resource Conservation and Recovery Act of 1976 [RCRA] Ground Water Monitoring Plan"). The plan added a downgradient well (699-43-43) (Figure 2-11). Revised constituents were included for semiannual sampling of site-specific indicator parameters (specific conductance, gross alpha, and gross beta), field parameters (alkalinity, DO, pH, turbidity, and temperature), and additional chemical parameters (arsenic and nitrate as part of sitewide surveillance efforts and cadmium, lead, mercury, and silver for a four-year evaluation period based on previous soil investigation results [Section 2.2]). Annual sampling for groundwater quality parameters was also included.

In 2005, a revised monitoring plan (PNNL-15479) was issued to reestablish the sampling frequency and evaluation requirements under an interim status indicator evaluation program, while results of the alternate statistical approach from PNNL-13367-ICN-1 were evaluated. The anticipated closure plan had not been approved, and final status monitoring elements from the previous plan were removed in PNNL-15479. The statistical analysis method returned to that for interim status indicator parameter evaluation under 40 CFR 265. Semiannual sampling was included for indicator parameters and field parameters (alkalinity, DO, turbidity, and temperature). Annual sampling for groundwater quality parameters, anions (chloride, sulfate, and nitrate), and metals (calcium, magnesium, potassium, and sodium) was included. Cadmium, lead, mercury, and silver were not included for further monitoring because no anomalous concentrations or trends had been identified during the four-year evaluation (PNNL-15479). The network included three downgradient wells (699-42-42B, 699-43-44, and 699-43-45) and one upgradient well (699-44-39B) (Figure 2-11).

The indicator evaluation program that monitors parameters required for groundwater contamination detection continues to this day. Rev. 0 of this current groundwater monitoring plan (DOE/RL-2008-59) was issued in 2010. The groundwater monitoring activities of DOE/RL-2008-59 (Rev. 0) sampled from a network of four wells (699-42-42B, 699-43-44, 699-43-45, and 699-44-39B). Samples were analyzed semiannually for parameters used as indicators of groundwater contamination and annually for parameters establishing groundwater quality, supporting constituents (temperature and turbidity), metals (calcium, magnesium, potassium, and sodium), and contaminants of interest (arsenic, cadmium, and nitrate). Water level measurements were collected each time a sample was obtained from a network well. The network wells were also included in the annual comprehensive March water level measurement campaign (SGW-38815, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project*). Since 1988, groundwater monitoring results for B Pond have been summarized annually in RCRA groundwater monitoring report annual reports (1989 to 1995) and then as part of the sitewide annual groundwater monitoring reports (1996 to present).

Monitoring results from one upgradient well (699-44-39B) and two downgradient wells (699-42-42B and 699-43-44) for pH, specific conductance, nitrate, and sulfate since 1990 and recent (2012 to early 2015) TOC and TOX values are shown in Figure 2-12. This group of network wells monitors flow and constituent concentrations within Ringold Unit 9A (Figure 2-12). Since 1990, pH and specific conductance values for all three wells have generally displayed a level trend. Over this time period, pH values have been slightly higher in an upgradient well (699-44-39B). Specific conductance has generally shown lower values in this upgradient well than the two downgradient wells. Both sulfate and nitrate, which contribute to specific conductance, have most often had level or increasing concentrations in all three wells over time. Downgradient Well 699-43-44 has shown the lowest sulfate and nitrate values, potentially resulting from its proximity to a transitional mixing zone, where levels may be impacted by flow within the Hanford unconfined aquifer (Figures 2-4 and 2-10). Recent semiannual monitoring results for TOC, completed since 2012, indicate an increasing concentration trend for both upgradient and downgradient wells. Both the upgradient and downgradient wells show similar concentrations. Other than an anomalous value in 2012, TOX concentrations have generally been stable, with concentrations at or near the laboratory reporting limit in all three wells (Figure 2-12).

Monitoring results for pH, specific conductance, nitrate, and sulfate since 1990 and recent (2012 to early 2015) TOC and TOX values from upgradient well 699-45-42 (Figure 2-10) and downgradient well 699-43-45 (Figure 2-10) are shown in Figure 2-13. These two network wells are utilized to monitor flow and constituent concentrations upgradient of the site, where Well 699-45-42 is completed in the Ringold Unit 9C and downgradient of the site, where Well 699-43-45 is screened in the Hanford formation (Figures 2-5 and 2-10). Well 699-45-42 will be temporarily included in the updated B Pond monitoring network presented in this plan (See Chapter 3).

Because of the geology and local flow patterns in the area, groundwater moves from Unit 9C near Well 699-45-42, enters the Hanford formation, and is then directed toward Well 699-43-45, which is located downgradient of the Main Pond and the 216-B-3-3 Ditch (Figure 2-10). New upgradient Well #1, which will be installed closer to the Main Pond, will be positioned along a similar though shorter flow path moving toward Well 699-43-45 (Figure 2-10). Since 1990, pH and specific conductance values for wells 699-45-42 and 699-43-45 have both generally displayed a level trend. Over this time, pH values have been slightly lower in upgradient Well 699-45-42. Specific conductance values measured in the upgradient well have tended to be higher than in downgradient Well 699-43-45. Sulfate concentrations have trended upward in both wells with higher concentrations consistently occurring in upgradient Well 699-45-42. Nitrate levels in downgradient Well 699-43-45 had been lower than the upgradient well until late 2008 when a sharp increase in concentrations began (Figure 2-13). As with the analytical results for wells monitoring Ringold Unit 9A, TOC values for downgradient Well 699-43-45 have shown an upward trend since 2012. Two TOC sampling events are available for upgradient Well 699-45-42 during the period from 2012 to 2015. One data point is slightly higher than the downgradient value, and the other is anomalously high and currently under data quality review. TOX values for downgradient Well 699-43-45 have been variable since 2012 but have recently shown levels at or near the laboratory detection limit. Two TOX values from upgradient Well 699-45-42 obtained in 2015 were low level, consistent with the concentration trend measured in downgradient Well 699-43-45 for the same period.

2.6 Conceptual Site Model

This section describes the B Pond CSM for potential contaminant transport to guide groundwater monitoring. The CSM describes the current understanding of the contaminant release and transport and includes the following observations and assumptions:

- Discharges over the lifetime of the B Pond system were sufficient for wastewater to reach groundwater.

- Conceptual models for vadose zone contaminant fate (DOE/RL-93-74; DOE/RL-99-07, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan*) and subsequent soil chemistry testing suggest that most of the contaminated effluent directed to the B Pond infiltrated into the ditches leading to the Main Pond, with a portion of the effluent reaching as far as the Main Pond itself. The possible pathways for contamination reaching groundwater would be from remobilization of existing contamination in the vadose zone beneath the Main Pond. Some effluent could have been intercepted in the vadose zone by the Ringold lower mud unit (Unit 8), potentially moving laterally along this perching layer toward the Hanford unconfined aquifer to the south and east.

- The potential for continued migration of residual contamination from the vadose zone to groundwater is unlikely due to the cessation of liquid effluent discharges and lack of any water pipelines or other direct sources of recharge. Infiltration of natural precipitation is the only potential force capable of moving a significant portion of the remaining contaminants to the groundwater. The risk of infiltration and the potential for vertical migration of contaminants, however, is considered low because of low annual precipitation.

- Historical groundwater analyses in the B Pond area have not revealed any contamination by dangerous waste or dangerous waste constituents. Extensive sampling of vadose zone soil across the B Pond area has indicated low levels of cadmium, lead, mercury, and arsenic (DOE/RL-89-28; WHC-SD-EN-AP-042; BHI-01367). Distribution coefficients for cadmium (6.7 mL/g), lead (80 mL/g), mercury (10 mL/g), and arsenic (29 mL/g) (DOE/RL-2011-50, *Regulatory Basis and Implementation of a Graded Approach to Evaluation of Groundwater Protection* and ECF-Hanford-12-0023, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological Analytes in the 100 Areas and 300 Area*) suggest very low potential migration rates to the water table. Analyses for total and dissolved concentrations of these metals in groundwater in the B Pond area from 2010 to 2015 revealed no anomalous concentrations or trends for these constituents. Based on soil characterization and groundwater monitoring results, the impact to groundwater from constituents detected in the vadose zone is minor.

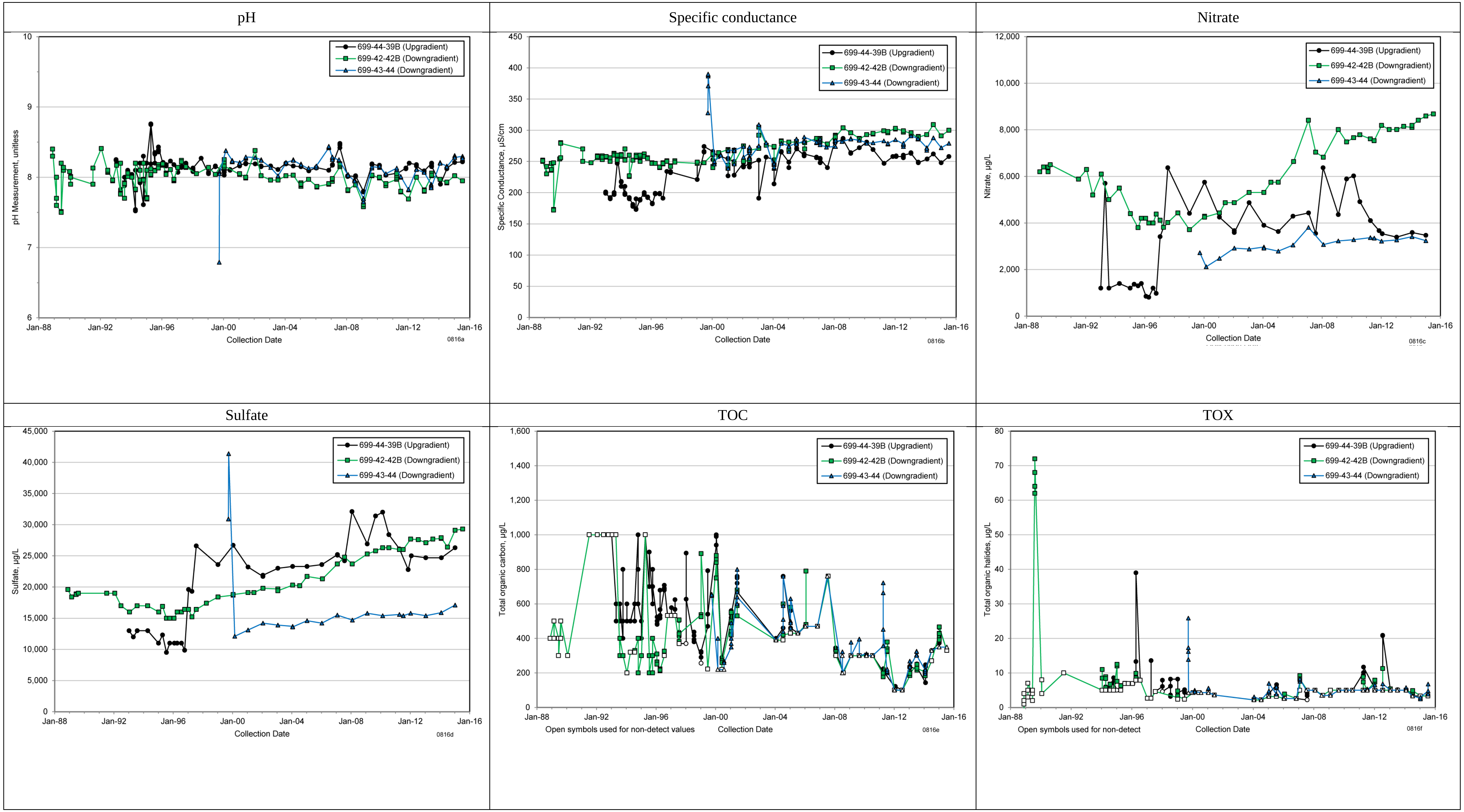

Figure 2-12. pH, Specific Conductance, Nitrate, Sulfate, TOC, and TOX Time Series Trend Plots Showing Concentrations for Upgradient Well 699-44-39B versus Downgradient Wells 699-42-42B and 699-43-44

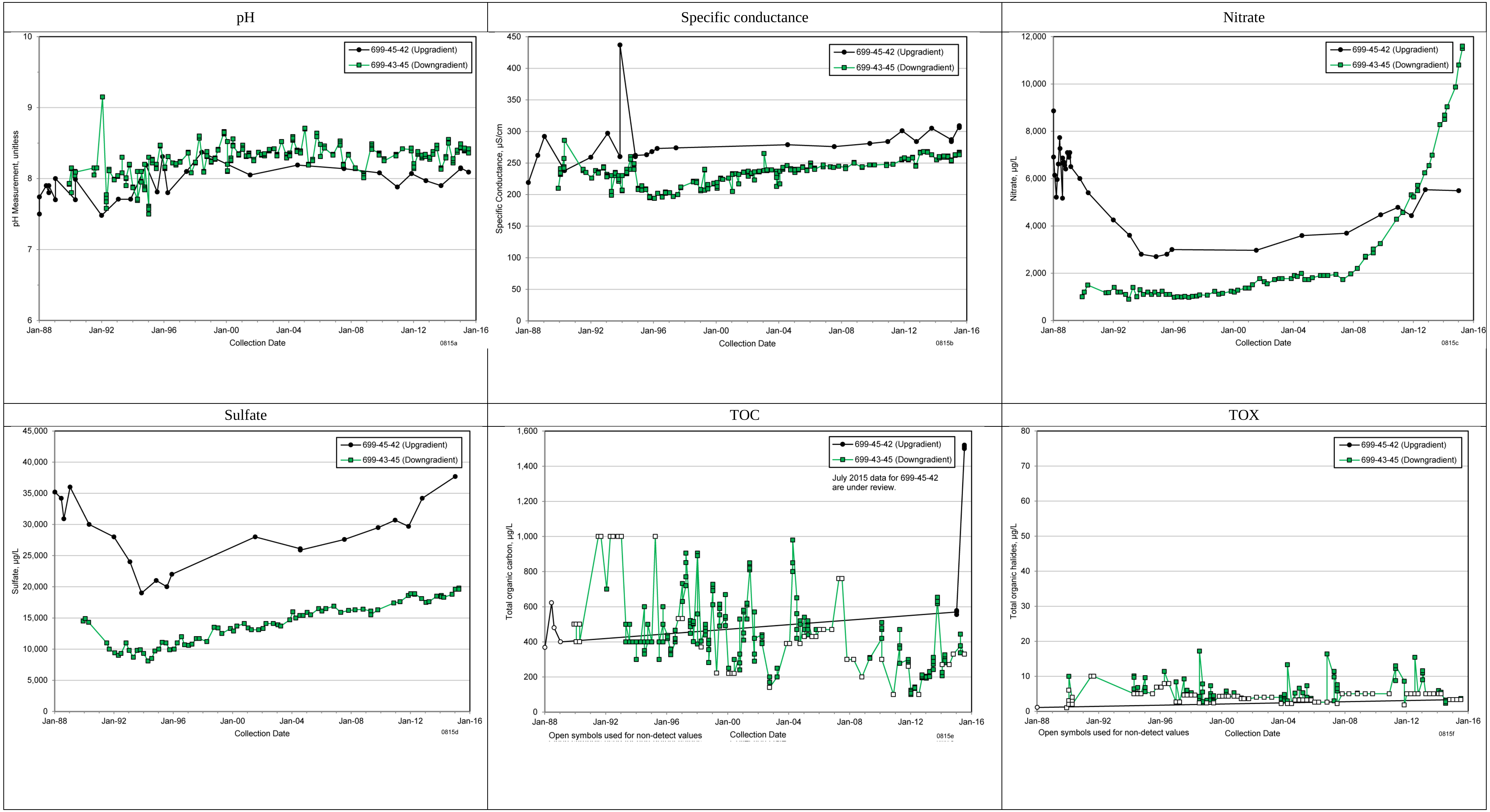

Figure 2-13. pH, Specific Conductance, Nitrate, Sulfate, TOC, and TOX Time Series Trend Plots Showing Concentrations for Upgradient Well 699-45-42 versus Downgradient Well 699-43-45

- The uppermost aquifers in the B Pond area appear to have been mostly isolated from a significant part of the B Pond effluent discharges. The intervening, fine-grained units (Ringold lower mud Units 8 and 9B) intercepted infiltrating effluent in some areas around B Pond diverting the wastewater down along the surface of the stratigraphic units, predominantly to the south. Where these fine-grained confining units are thin or absent, generally near the western end of the Main Pond, effluent reached Units 9A and 9C. Groundwater sampling data indicate that constituents associated with this effluent apparently did not migrate very far to the east or south, even though there was a hydraulic gradient in these directions due to groundwater mounding beneath B Pond.

- Artificial recharge, groundwater mounding, and the resultant loading effect caused an increase in confined aquifer hydrostatic pressure in stratigraphic units both below the point of infiltration and to the east and southeast of the B Pond. Declining hydraulic head has been occurring since cessation of surface discharges to B Pond circa 1997. Aquifer head losses in the confined portions of the Ringold 9A and 9C Units are expected to continue but at a lower rate as groundwater returns to pre-Hanford conditions.

2.7 Monitoring Objectives

The groundwater monitoring program at B Pond is conducted with the objectives of determining the facility's impact, if any, on the quality of the underlying groundwater. This groundwater monitoring plan addresses specifically those applicable RCRA requirements for interim status TSD units where no impact to groundwater has been identified. The regulatory requirements applicable to this groundwater monitoring plan are found in WAC 173-303-400(3) and 40 CFR 265.90, "Applicability," through 265.94, "Recordkeeping and Reporting." Table 2-3 identifies where each groundwater monitoring element of the pertinent applicable regulations is addressed within this plan. Site-specific constituents (Table 2-4) will also be collected for general groundwater chemistry, which will support the evaluation of upgradient and downgradient water chemistry variations (e.g., data used for Stiff diagrams and charge balance determinations). Field parameters will be collected to provide information on water properties at the time of sampling.

Table 2-3. Pertinent RCRA Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
Number and Location of Wells	40 CFR 265.91, "Ground-Water Monitoring System": (a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of: (1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are: (i) Representative of background ground-water quality in the uppermost aquifer near the facility; and (ii) Not affected by the facility; and (2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their numbers, locations, and depths must ensure that	Section 3.2

Table 2-3. Pertinent RCRA Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
	they immediately detect any statistically significant amounts of dangerous waste or dangerous waste constituents that migrate from the waste management area to the uppermost aquifer.	
Well Configuration	40 CFR 265.91: (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated, and packed with gravel or sand, where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground water. Additional requirements from WAC 173-303-400(3)(c)(v)(C), "Dangerous Waste Regulations," "Interim Status Facility Standards": Ground water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. Chapter 173-160 WAC may be used as guidance in the installation of wells.	Section 3.2 and Appendix C
Parameters to be Sampled Frequency of Sampling Water-Level Measurements	40 CFR 265.92, "Sampling and Analysis": (b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section: (1) Parameters characterizing the suitability of the ground water as a drinking water supply, as specified in Appendix III(2) Parameters establishing ground-water quality: (i) Chloride (ii) Iron (iii) Manganese (iv) Phenols (v) Sodium (vi) Sulfate [Comment: These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required under §265.93(d).] (3) Parameters used as indicators of ground-water contamination: (i) pH (ii) Specific conductance (iii) Total organic carbon (iv) Total organic halogen	Section 3.1 and Appendix B, Section B2.2
	(c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in paragraph (b) of this section. He must do this quarterly for one year.	

Table 2-3. Pertinent RCRA Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
	(2) For each of the indicator parameters specified in paragraph (b)(3) of this section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year. (d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies: (1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually. (2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semi-annually. (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	
Methods Used to Evaluate the Collected Data and Responses	40 CFR 265.93, "Preparation, Evaluation, and Response": (b) For each indicator parameter specified in §265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with §265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see Appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background. (c)(2) If the comparison for downgradient wells made under paragraph (b) of this section show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional ground-water samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error. (d)(1) If the analyses performed under paragraph (c)(2) of this section confirm the significant increase (or pH decrease), the owner or operator must provide written notice to the department-within seven days of the date of such confirmation-that the facility may be affecting ground-water quality. (d)(2) Within 15 days after the notification under paragraph (d)(1) of this section, the owner or operator must develop a specific plan, based on the outline required under paragraph (a) of this section and certified by a qualified geologist or geotechnical engineer, for a ground-water quality assessment at the facility.	Section 4.1, 4.2, 4.3 and Appendix A

Table 2-3. Pertinent RCRA Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
Recordkeeping and Reporting	40 CFR 265.94, "Recordkeeping and Reporting": (a)(1) Keep records of the analyses required in §265.92(c) and (d), the associated ground-water surface elevations required in §265.92(b) throughout the active life of the facility. (a)(2) Report the following ground-water monitoring information to the department: (ii) Annually: Concentrations or values of the parameters listed in §265.92(b)(3) for each ground-water monitoring well, along with the required evaluations for these parameters under §265.92(b). The owner or operator must separately identify any significant differences from the initial background found in the upgradient wells, in accordance with §265.92(c)(1).	Section 4.5 Appendix A, Section A2.6

Note: The references cited in this table are listed in the reference section (Chapter 6) of this plan.

a. RCRA regulatory requirements for interim status TSD units, where no impact to groundwater has been identified, are found in WAC 173-303-400(3), "Dangerous Waste Regulations," "Interim Status Facility Standards," and 40 CFR 265.90, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Applicability," through 40 CFR 265.94, "Recordkeeping and Reporting," which are applicable to this groundwater monitoring plan.

b. The parameters characterizing the suitability of the groundwater as a drinking water supply, as specified in 40 CFR 265, Appendix III, "EPA Interim Primary Drinking Water Standards," are not listed because, in accordance with 40 CFR 265.92(c)(1), "Sampling and Analysis," these analyses are conducted only during the first year of monitoring.

CFR = *Code of Federal Regulations*

RCRA = *Resource Conservation and Recovery Act of 1976*

TSD = treatment, storage, and disposal

Table 2-4. Additional Monitoring Objectives

Monitoring Objective	Site-Specific Constituent
Metals – additional metals (calcium, magnesium, and potassium) used in ion balance and to support water chemistry analysis. Arsenic has been identified as a site-specific contaminant in the groundwater that could be associated with B Pond operations. Current concentrations appear to be more regionally influenced, but levels are near the drinking water standard. Continued monitoring for continuity from previous plan.	Arsenic, calcium, magnesium, and potassium
Nitrate has been identified as a site-specific contaminant in the groundwater that could be associated with B Pond operations.	Nitrate
Alkalinity – used in ion balance and to support water chemistry analysis.	Alkalinity
Field parameters provide information on water properties at the time of sampling.	Dissolved oxygen, temperature, and turbidity

.

3 Groundwater Monitoring Program

This chapter describes the groundwater monitoring indicator evaluation program for B Pond consisting of a monitoring well network, parameters used as indicators of groundwater contamination, parameters establishing groundwater quality, and sampling and analysis protocols. The monitoring program presented herein has been revised from that presented in the previous plan (DOE/RL-2008-59, Rev. 0).

B Pond will be closed through an approved RCRA closure plan. At that time, groundwater monitoring requirements (pursuant to WAC 173-303-645), if applicable to B Pond, will be determined.

3.1 Constituents List and Sampling Frequency

Table 3-1 presents the wells in the groundwater monitoring network, parameters analyzed as required for RCRA monitoring, and sampling frequency for monitoring of B Pond. Parameters used as indicators of groundwater contamination (pH, specific conductance, TOC, and TOX) will be sampled (quadruplicate samples) and analyzed semiannually (40 CFR 265.92[b][3] and [d][2]), except for the first year of monitoring of Well 699-45-42 and New Well #1, which will require quarterly sampling and analyses. Parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate) will be sampled and analyzed annually (40 CFR 265.92[b][2] and [d][1]).

New Well #1 will be drilled upgradient of B Pond. Until New Well #1 is ready for sampling, Well 699-45-42, which is an existing upgradient well, will be included in the B Pond monitoring network. Well 699-45-42 was installed in 1948 and has not been previously utilized for RCRA monitoring. This well has been used as part of the CERCLA monitoring program and is currently sampled according to DOE/RL-2003-04 (as amended by TPA-CN-205). During the first year of RCRA monitoring, Well 699-45-42 and New Well #1 will be sampled quarterly for indicators of groundwater contamination to establish baseline conditions. Table 3-1 presents the parameters analyzed and sampling frequency for the first year at Well 699-45-42 and New Well #1. At the end of the first year, monitoring will thereafter be conducted along the same frequency as other established wells and as provided in Table 3-1. Water level measurements at each monitoring well will be determined each time a sample is obtained (40 CFR 265.92[e]).

Although not required by regulation, additional constituents will be monitored and are identified in Table 3-1. Arsenic and nitrate have been identified as site-specific contaminants in groundwater that could be associated with B Pond operations. Nitrate is widely disseminated in the 200 East Area at elevated levels that have a significant impact on specific conductance values. Differentiation of regional from potential local contributions is needed. Arsenic was detected at low levels in characterization soil samples collected in the 216-B-3-3 Ditch, but it has only been detected in the site groundwater at levels below the drinking water standard. It is included in this plan for continuity with previous monitoring conducted at B Pond. Additional metal constituents support calculations of water chemistry ion charge balance and include calcium, magnesium, and potassium. Site-specific and additional metal constituents will be sampled annually. Field parameters (dissolved oxygen, temperature, and turbidity) will be sampled semiannually.

Cadmium was included as a site-specific constituent in the previous groundwater monitoring plan for B Pond but is not included in this plan. Although cadmium is known to have been a constituent discharged to B Pond as cadmium nitrate, it has been analyzed in samples collected from the B Pond network since 1989 and has generally not been detected.

Maintenance problems and sampling logistics sometime delay scheduled sampling events. Sampling events are scheduled by month. The Field Work Supervisor (FWS) determines the specific times within a given month that a well is sampled. If a well cannot be sampled at the times determined by the FWS, then the FWS and Sampling Management and Reporting group, along with the project scientist, consult on how best to recover or reschedule the sampling event as close to the original sampling date as possible. Missed sampling events that are not rescheduled within the same month are given top priority when rescheduling in the following month. Missed or cancelled sampling events are reported to the DOE Richland Operations Office, at the appropriate Unit Managers Meeting, and in the annual groundwater monitoring report.

3.2 Monitoring Well Network

The B Pond monitoring network consists of two existing upgradient wells (699-44-39B and 699-45-42 [to be replaced by New Well #1]) and three downgradient wells (699-43-45, 699-43-44, and 699-42-42B). A new upgradient well (New Well #1) will be drilled adjacent to the Main Pond to determine upgradient conditions closer to the site. After New Well #1 is ready for sampling, Well 699-45-42 will no longer be used. Figure 3-1 shows the configuration of the groundwater monitoring network. Information on the attributes of the network wells is summarized in Table 3-2.

Based on the orientation of geologic strata and hydrology beneath B Pond, Well 699-44-39B, completed in Ringold Unit 9A, and Well 699-45-42 and New Well #1, completed in Ringold Unit 9C, are appropriately located for upgradient monitoring. These wells occur along upgradient flow paths that cross the site. Groundwater locally flows beneath the Ringold Unit 8 mud and/or Ringold 9B confining layers near these wells and discharges to downgradient portions of the aquifers southwest and south of the Main Pond and 216-B-3-3 Ditch (Figures 2-10 and 3-1).

Only a few groundwater wells are present close to B Pond, and most often, they vary in completion depth. Not all wells meet WAC 173-160 “Minimum Standards for Construction and Maintenance of Wells.” The following criteria were used in selecting wells for RCRA monitoring of B Pond:

- Locations of the upgradient and downgradient wells with respect to the waste site boundary and groundwater flow path
- Well screen position with respect to the saturated zone of interest and appropriate flow path
- Suitable well construction such that the sampling data provided are comparable with other network wells
- Compliance with WAC 173-160

One of the upgradient wells (699-45-42) that will be temporarily used for monitoring B Pond is considered appropriate for the monitoring objectives, but it is not compliant with WAC 173-160 as a resource protection well that is suitable as a RCRA standard or equivalent well. Per agreement between DOE and Ecology, noncompliant wells are identified and placed on the prioritized drilling schedule for replacement consistent with site-wide cleanup priorities as described in Milestone M-024-58 which is contained in the Tri-Party Agreement Action Plan (Ecology et al., 1989b), as revised. Well 699-45-42 is included in this milestone for future replacement.

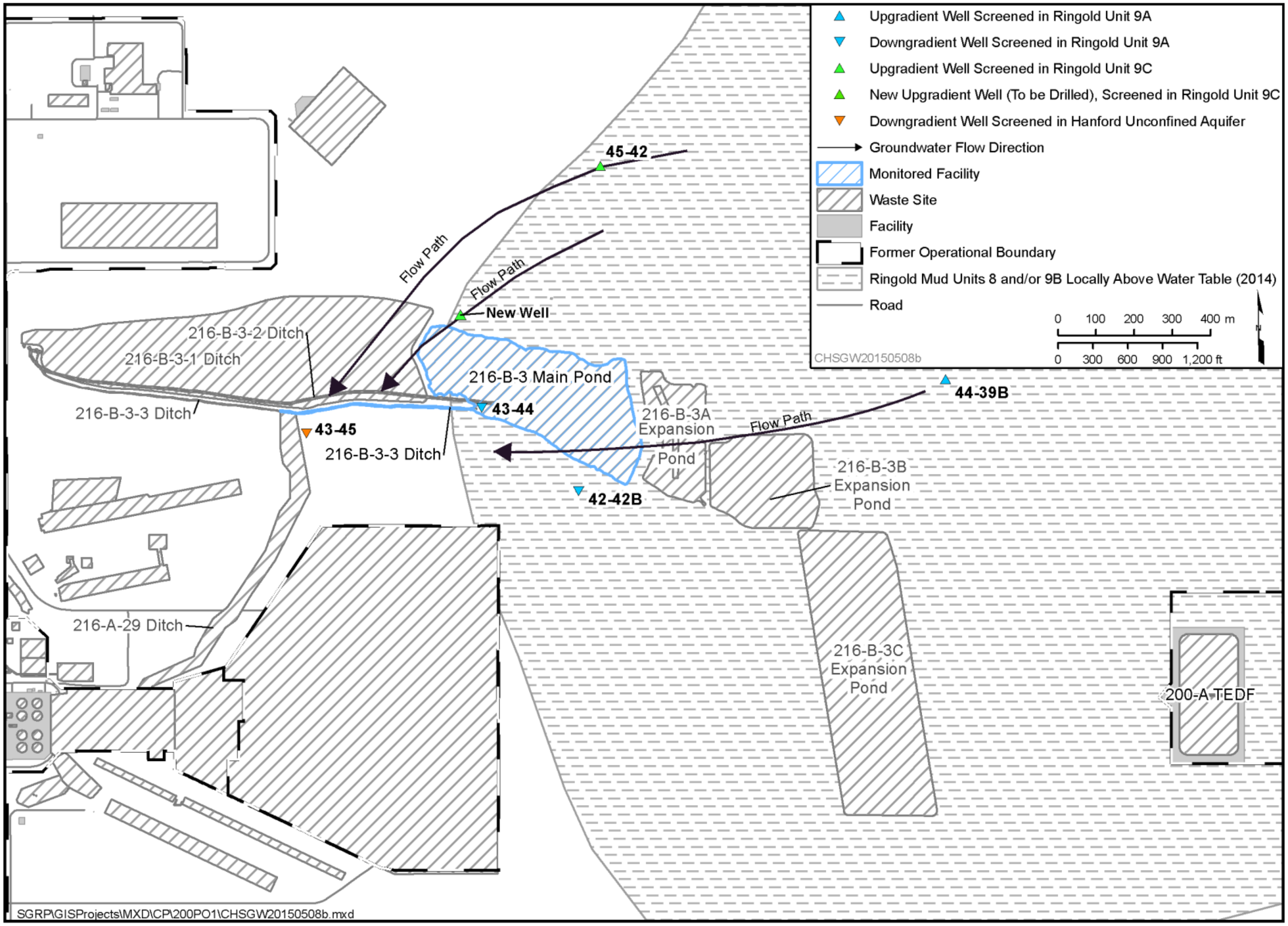

Figure 3-1. 216-B-3 Pond RCRA Monitoring Network

Table 3-1. Monitoring Well Network for B Pond

			RCRA-Required Parameters[a]											Site-Specific Constituents[b]				
				Contamination Indicator Parameters				Groundwater Quality Parameters										
Well Name	Purpose	WAC Compliant	Water Level	pH	Specific Conductance	Total Organic Carbon	Total Organic Halogen	Chloride	Iron (F/UF)	Manganese (F/UF)	Phenols	Sodium (F/UF)	Sulfate	Arsenic (F/UF)	Nitrate	Field Parameters[c]	Alkalinity	Metals[d] (F/UF)
699-42-42B	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S	A	A
699-43-44	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S	A	A
699-43-45	Downgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S	A	A
699-44-39B	Upgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S	A	A
699-45-42[e,f]	Upgradient	N	Q	Q4	Q4	Q4	Q4	A	A	A	A	A	A	A	A	Q	A	A
699-45-42[f,g]	Upgradient	N	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S	A	A
New Well #1[e]	Upgradient	Y	Q	Q4	Q4	Q4	Q4	A	A	A	A	A	A	A	A	Q	A	A
New Well #1[g]	Upgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	S	A	A

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

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

c. Field parameters include dissolved oxygen, temperature, and turbidity.

d. Metals; analytes include, but are not limited to, the following common soil minerals for charge balance computations: calcium, magnesium, and potassium.

e. Constituents and sampling frequency for Well 699-45-42 and New Well #1 only for first year of monitoring.

f. Well 699-45-42 will be included in the B Pond network until New Well #1 is ready for sampling. After New Well #1 is ready for sampling, 699-45-42 will no longer be sampled.

g. Constituents and sampling frequency for Well 699-45-42 and New Well #1 after first year of monitoring.

A = to be sampled annually
CFR = *Code of Federal Regulations*
F/UF = filtered and unfiltered
N = well is not constructed as a resource protection well (WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells")
Q = to be sampled quarterly
Q4 = to be sampled quarterly, with quadruplicate samples collected during each event
RCRA = *Resource Conservation and Recovery Act of 1976*
S = to be sampled semiannually
S4 = to be sampled semiannually, with quadruplicate samples collected during each event
WAC = *Washington Administrative Code*
Y = well is, or will be, constructed as a resource protection well (WAC 173-160)

Table 3-2. Attributes for Wells in the B Pond Groundwater Monitoring Network

Well Name	Completion Date	Easting (m)	Northing (m)	Screened Unit	Screen Top (m [ft] bgs)	Screen Bottom (m [ft] bgs)	Water Depth (m [ft] bgs)	Remaining Water Column (m [ft])	Water Level Date
699-42-42B	1988	576998.10	136433.92	Ringold 9A	55.9 (183.5)	62.0 (203.5)	55.3 (181.5)	6.7 (22.1)	7/14/2015
699-43-44	1999	576744.71	136652.85	Ringold 9A	52.1 (171.0)	58.2 (191.0)	54.7 (179.3)	3.6 (11.7)	7/14/2015
699-43-45	1989	576283.82	136585.73	Hanford	55.8 (183.0)	62.0 (203.3)	60.5 (198.4)	1.5 (5.0)	7/14/2015
699-44-39B	1992	577960.62	136727.39	Hanford/ Ringold 9A	30.1 (98.9)	37.0 (121.4)	32.9 (107.9)	4.1 (13.5)	7/14/2015
699-45-42	1948	577055.09	137286.37	Ringold 9C	48.2 (158.0)	54.9 (180.0)	53.5 (175.4)	1.4 (4.6)	7/14/2015
New Well #1	TBD	576688.38	136896.72	TBD	TBD	TBD	TBD	TBD	NA

Note: Coordinates are in Washington Coordinate System of NAD83, *North American Datum of 1983*, South Zone/1991 Adjustment.

bgs = below ground surface
NA = not applicable
TBD = to be determined

While the rate of decline in water levels has slowed in B Pond wells, sometimes a well can go dry. If a well is within approximately 2 years of going dry, a replacement well will be proposed. All new RCRA wells proposed for installation at the Hanford Site are negotiated annually by Ecology, DOE, and EPA under Tri-Party Agreement (Ecology et al., 1989a) Milestone M-24-00.

Construction details and pertinent information for the wells are provided in Appendix C. Some wells are co-sampled with other monitoring programs (e.g., monitored to meet CERCLA requirements). Monitoring requirements for those other monitoring programs are described in separate plans. The reported data from those other monitoring programs are supplementary to information gathered under this plan.

3.3 Differences between This Plan and Previous Plan

Table 3-3 identifies the main differences between this plan and the previous groundwater monitoring plan.

In this revised plan, a second upgradient well is added to the monitoring network to provide better representation of aquifer variability upgradient of B Pond. New Well #1 will be drilled upgradient near the northwest corner of the Main Pond. Until New Well #1 is ready for sampling, existing Well 699-45-42 will be included in the B Pond network. First year monitoring requirements for contamination indicator parameters are required for Well 699-45-42 and New Well #1. Cadmium is no longer included for monitoring.

Table 3-3. Main Differences between this Plan and Previous Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
Constituents	Indicator parameters, groundwater quality parameters, and water chemistry	Same	No change
	Supporting constituents	Same	No change
	Site-specific constituents – arsenic, cadmium, and nitrate	Site-specific constituents – arsenic and nitrate	Cadmium is removed as a site-specific constituent. Cadmium has been analyzed since 1989, but it is not detected.
Sampling Frequency	Indicator parameters – semiannual	Indicator parameters – same	No change
	Groundwater quality parameters – annual	Groundwater quality parameters – same	No change
	Supporting constituents – semiannual/annual	Supporting constituents – same	No change
	Contaminants of interest – annual	Site-specific constituents – annual	No change

Table 3-3. Main Differences between this Plan and Previous Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
		First-year monitoring for New Well #1 and Well 699-45-42 – quarterly	A second upgradient well is added to the monitoring network. Well 699-45-42 will be used until New Well #1 is ready for sampling. Both wells require quarterly first-year monitoring frequency
	Water level measurements – every sampling event	Water level measurements – same	No change
Well Network	One upgradient, three downgradient wells	Two upgradient, three downgradient	A second upgradient monitoring well is added to provide better representation of upgradient hydrogeology and constituent concentrations impacting the site. New Well #1 will be drilled upgradient of B Pond. Until New Well #1 is ready for sampling, existing well 699-45-42 will be included as the second upgradient well.
Groundwater Flow Direction	West to southwest	Same	No change
Type of Groundwater Monitoring Program	Interim status indicator evaluation program	Same	No change
Background Arithmetic Mean Recalculated	Calculated annually using one upgradient well	Calculated annually using two upgradient wells	Two wells provide better representation of hydrogeologic and constituent variability upgradient of the site.
Groundwater Quality Assessment Plan Outline	None	Chapter 5	Update outline to current norms.

* DOE/RL-2008-59, Rev. 0, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*.

3.4 Sampling and Analysis Protocol

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

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4 Data Evaluation and Reporting

This chapter discusses the evaluation and interpretation of data.

4.1 Data Review

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

4.2 Statistical Evaluation

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

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

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

If the exceedance of the statistical comparison value is confirmed by resampling, then written notifications are made as detailed in Section 4.5 and in accordance with 40 CFR 265.

4.3 Interpretation

Data are used to interpret groundwater conditions at B Pond. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases and increases and seasonal or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential on the maps.

- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or 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.

4.4 Annual Determination of Monitoring Network

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

The current groundwater monitoring network will continue to be re-evaluated to ensure that it is adequate to monitor any changing hydrogeologic conditions beneath the unit. If flow changes are observed, the B Pond CSM and groundwater constituents will be re-evaluated to determine network efficiency and any necessary modification requirements for the network.

Water level measurements will continue to be collected before each sampling event. An additional and more comprehensive set of water level measurements is made annually for selected wells on the Hanford Site, and the data are presented in the annual groundwater monitoring reports.

4.5 Reporting and Notification

Groundwater monitoring results are reported annually in accordance with the requirements of 40 CFR 265.94. Reporting will be made in the annual groundwater monitoring reports.

If a comparison for an upgradient well shows a significant increase (or pH decrease) relative to the statistical comparison value, that information is also reported in the annual groundwater monitoring report.

If the exceedance of the statistical comparison value is confirmed, written notice is then provided to Ecology within 7 days (40 CFR 265.93[d][1]) stating that the facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program must be developed and submitted to Ecology (40 CFR 265.93[d][2] and WAC 173-303-400[3][c][v][D]). In some instances, it is possible to determine immediately that the statistical finding is not the result of contamination from the facility. In that case, Ecology is notified, and a groundwater quality assessment program is not instituted.

5 Outline for Groundwater Quality Assessment Plan

If a groundwater contamination indicator parameter at a downgradient well significantly exceeds the background value or if pH decreases and is confirmed by verification sampling, a detailed assessment plan will be prepared and submitted to Ecology and the facility monitoring will be elevated to assessment monitoring status. The assessment program must be capable of determining whether dangerous waste or dangerous waste constituents from the facility have entered the groundwater, their rate and extent of migration and their concentration. This chapter presents a revision of the groundwater quality assessment monitoring plan outline required by 40 CFR 265.93(a). An outline for the assessment plan is presented in Table 5-1. The groundwater quality assessment program may include the following elements:

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

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

Table 5-1. Revised Groundwater Quality Assessment Plan Outline

- Introduction
- Background
  - Facility Description and Operational History
  - Regulatory Basis
  - Waste Characteristics
  - Geology and Hydrogeology
  - Summary of Previous Groundwater Monitoring and Results
  - Conceptual Site Model
  - Monitoring Objectives
- Groundwater Monitoring
  - Constituent List and Sampling Frequency
  - Well Network
  - Sampling and Analysis Protocol
- Data Evaluation and Reporting
  - Evaluation of Dangerous Waste Constituents
  - Interpretation
  - Annual Determination of Monitoring Network
  - Reporting and Notification
- References
- Appendix A – Quality Assurance Project Plan
- Appendix B – Sampling and Analysis Protocol
- Appendix C – As-Built Drawings of Wells in Well Network

6 References

01-GWVZ-015, 2001, "Sampling and Analysis Instruction (SAI) for Hydrazine Sampling in Groundwater Associated with the 216-B-3 Main Pond and 216-A-29 Ditch" (letter to J.A. Hedges, Washington State Department of Ecology, from J.G. Morse), U.S. Department of Energy, Richland Operations Office, Richland, Washington, March 13. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8684490.

10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2011-title10-vol4/pdf/CFR-2011-title10-vol4-part962.pdf.

13-AMRP-0155, 2013, "216-B-3 Main Pond Closure Plan, DOE/RL-2013-24, Draft A and 216-S-10 Pond and Ditch Closure Plan, DOE/RL-2006-12, Draft B" (letter to J.A. Hedges, Washington State Department of Ecology, from J.A. Dowell), U.S. Department of Energy, Richland Operations Office, Richland, Washington, April 18. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0088979.

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

265.90, "Applicability."

265.91, "Ground-Water Monitoring System."

265.92, "Sampling and Analysis."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Appendix III, "EPA Interim Primary Drinking Water Standards."

Subpart F, "Ground-Water Monitoring."

51 FR 24504, 1986, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste," *Federal Register*, July 3, 1986.

Atomic Energy Act of 1954, as amended, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at: http://epw.senate.gov/atomic54.pdf.

BHI-01367, 2000, *200-CW-1 Operable Unit Borehole/Test Pit Summary Report*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079504H.

Becker-Khaleel, Brenda, 2001, "Sampling and Analysis Instructions for Hydrazine Sampling in Groundwater Associated with the 216-B-3 Main Pond and 216-A-29 Ditch" (letter to J.G. Morse, U.S. Department of Energy, Richland Operations Office), Washington State Department of Ecology, Richland, Washington, August 27. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8818746.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE, 1987, *Preliminary Closure/Post-Closure Plan 216-B-3 Pond*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196002555.

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

DOE/RL-89-28, 1994, *216-B-3 Expansion Ponds Closure Plan*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196043318. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196043344.

DOE/RL-92-05, 1993, *B Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196125912. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196125952.

DOE/RL-93-74, 1995, *200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-33 Trench, and 216-A-29 Ditch Work/Closure Plan Volume 1: Field Investigation and Sampling Strategy*, Draft B, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196025269.

DOE/RL-99-07, 2000, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8434692.

DOE/RL-2003-04, 2005, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA01974685.

DOE/RL-2008-59, 2010, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084215.

DOE/RL-2009-85, 2012, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091415.

DOE/RL-2011-01, 2011, *Hanford Site Groundwater Monitoring Report for 2010*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/c.cfm/sgrp/GWRep10/html/start10.htm.

DOE/RL-2011-50, 2011, *Regulatory Basis and Implementation of a Graded Approach to Evaluation of Groundwater Protection*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093361.

DOE/RL-2013-24, 2013, *216-B-3 Main Pond Closure Plan*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0088979.

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

ECF-Hanford-12-0023, 2014, *Groundwater and Surface Water Cleanup Levels and Distribution Coefficients for Nonradiological Analytes in the 100 Areas and 300 Area*, Rev. 3, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1408041057.

ECF-Hanford-13-0029, 2014, *Development of the Hanford South Geologic Framework Model, Hanford Site Washington*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080813H.

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

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order Action Plan*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

EPA 530/R-09-007, 2009, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*, Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/osw/hazard/correctiveaction/resources/guidance/sitechar/gwstats/unified-guid.pdf.

Goswami, Dib, 2001, "Statistical Assessment for the 300 Area Resource Conservation and Recovery Act of 1976 (RCRA) Ground Water Monitoring Plan" (letter to M.J. Furman, U.S. Department of Energy, Richland Operations Office), Washington State Department of Ecology, Richland, Washington, May 7. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8244190.

Hedges, Jane, 2000, "Approval of the Contained-In Determination Request for Hydrazine" (letter to K.M. Thompson, U.S. Department of Energy, Richland Operations Office), Washington State Department of Ecology, Richland, Washington, June 22. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA01233858.

Izatt, R.D. and R.E. Lerch, 1990, "Groundwater Quality Assessment Plan for the 216-B-3 Pond System" (letter to T.L. Nord, Washington State Department of Ecology), U.S. Department of Energy, Richland Operations Office, Richland, Washington, June 4. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0009308.

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

PNL-10195, 1994, *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System: FY 1994 Status Report*, Rev. 0, Pacific Northwest Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199061222.

PNNL-11604, 1997, *Results of RCRA Groundwater Quality Assessment at the 216-B-3 Pond Facility*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/29/036/29036425.pdf.

PNNL-11903, 1998, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D198150620.

PNNL-12261, 2000, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, Rev. 0, Pacific Northwest Laboratory, Richland, Washington (also cited as Williams et al., 2000). Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0906180659.

PNNL-13367, 2000, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1662819.

PNNL-13367-ICN-1, 2002, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2760901.

PNNL-15479, 2005, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15479.pdf.

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

Reidel, S.P., K.A. Lindsey, and K.R. Fecht, 1992, *Field Trip Guide to the Hanford Site*, WHC-MR-0391, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D196136627.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

SGW-38815, 2009, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082378H.

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

Thorne, P.D., M.A. Chamness, F.A. Spane, V.R. Vermeul, and W.D. Webber, 1993, *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1993 Status Report*, PNL-8971, Pacific Northwest Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/10116050-9Pd7wr/native/10116050.pdf.

TPA-CN-205, 2008, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: DOE/RL-2003-4, Revision 1, Sampling and Analysis Plan for the 200-PO-1 Operable Unit*, dated June 18, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0905200814.

WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit*, as amended, Washington State Department of Ecology, Richland, Washington. Available at: http://www.ecy.wa.gov/programs/nwp/permitting/HDWP/USDOE/LERF-ETF/1-6-14/Parts-I-and-II-11-19-13-Class-2-GW-updates.pdf.

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

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

303-040, "Definitions."

303-400, "Interim Status Facility Standards."

303-645, "Releases from Regulated Units."

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

WHC-SD-EN-AP-013, 1989, *Interim-Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195064799.

WHC-SD-EN-AP-013, 1995, *Interim-Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 1, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196004500.

WHC-SD-EN-AP-030, 1990, *Groundwater Quality Assessment Plan for the 216-B-3 Pond System*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=E0009533.

WHC-SD-EN-AP-030, 1992, *Groundwater Quality Assessment Plan for the 216-B-3 Pond System*, Engineering Change Notice 166756, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196090661.

WHC-SD-EN-AP-042, 1991, *Phase I Characterization of the 216-B-3 Pond System*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079693H.

WHC-SD-EN-EV-002, 1990, *Interim Hydrogeologic Characterization Report for the 216-B-3 Pond*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079656H.

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

Appendix A

Quality Assurance Project Plan

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Contents

Tables

Figure

Terms

CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQA	data quality assessment
DQI	data quality indicator
EB	equipment blank
ECO	Environmental Compliance Officer
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FEAD	format for electronic analytical data
FTB	full trip blank
FWS	Field Work Supervisor
GC/MS	gas chromatography/mass spectrometry
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document* (DOE/RL-96-68)
HEIS	Hanford Environmental Information System
LCS	laboratory control sample
MDL	method detection limit
MB	method blank
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
PS	post-digestion spike
PQL	practical quantitation limit
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR	request for data review

RPD	relative percent difference
SAF	Sampling Authorization Form
S&GRP	Soil and Groundwater Remediation Project
SMR	Sample Management and Reporting
SPLIT	field split
SUR	surrogate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

A1 Introduction

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. It includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection requirements and controls based on the quality assurance (QA) elements found in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5), and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD). Sections 6.5 and 7.8 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*) require the QA/quality control (QC) and sampling and analysis activities to specify QA requirements for treatment, storage, and disposal (TSD) units, as well as for past practice processes. This QAPjP also describes the applicable requirements and controls based on guidance found in Washington State Department of Ecology (Ecology) Publication No. 04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*, and EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans* (EPA QA/G-5). This QAPjP is intended to supplement the contractor's environmental QA program plan.

This QAPjP is divided into the following four sections, which describe the quality requirements and controls applicable to the B Pond groundwater monitoring activities: Project Management, Data Generation and Acquisition, Assessment and Oversight, and Data Review and Usability.

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A2 Project Management

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

A2.1 Project/Task Organization

The contractor, or its approved subcontractor, is responsible for planning, coordinating, sampling, and shipping samples to the laboratory. The contractor is also responsible for preparing and maintaining configuration control of the groundwater monitoring plan and assisting the U.S. Department of Energy (DOE)-Richland Operations Office (RL) project manager in obtaining approval of the groundwater monitoring plan and future proposed revisions. Project organization (regarding routine groundwater monitoring) is described in the following sections and illustrated in Figure A-1.

A2.1.1 DOE-RL Project Manager

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

A2.1.2 DOE-RL Technical Lead

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

A2.1.3 Soil and Groundwater Remediation Project Manager

The Soil and Groundwater Remediation Project (S&GRP) manager provides oversight for all activities and coordinates with DOE-RL and primary contractor management in support of sampling and reporting activities. The S&GRP manager also provides support to the S&GRP RCRA groundwater manager to ensure that work is performed safely and cost effectively.

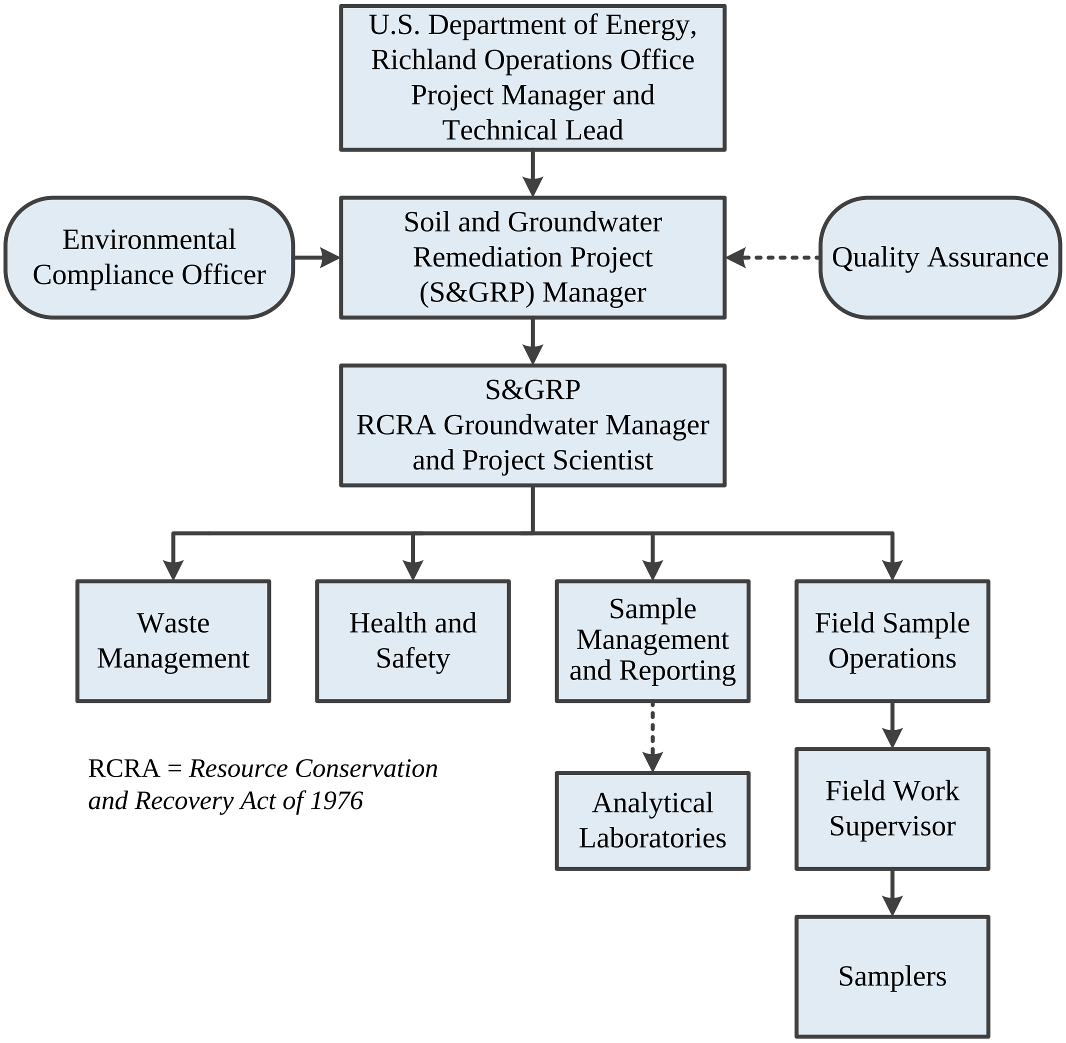

Figure A-1. Project Organization

A2.1.4 S&GRP RCRA Groundwater Manager

The S&GRP RCRA groundwater manager is responsible for direct management of activities performed to meet RCRA TSD monitoring requirements. The S&GRP RCRA groundwater manager coordinates with, and reports to, DOE-RL and primary contractor management regarding RCRA TSD monitoring requirements. The S&GRP RCRA groundwater manager (or delegate) works closely with the Environmental Compliance Officer (ECO), QA, Health and Safety, and Sample Management and Reporting (SMR) group to integrate these and other technical disciplines in planning and implementing the work scope. The S&GRP RCRA groundwater manager assigns scientists to provide technical expertise.

A2.1.5 Sample Management and Reporting Group

The SMR group coordinates laboratory analytical work to ensure that laboratories conform to the requirements of this plan. The SMR group generates field sampling documents, labels, and instructions for field sampling personnel and develops the Sampling Authorization Form (SAF), which provides information and instruction to the analytical laboratories. The SMR group receives analytical data from the laboratories, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with the Field Sample Operations, laboratories, or other entities. The SMR group is responsible for informing the S&GRP RCRA groundwater manager of any issues reported by the analytical laboratories.

A2.1.6 Field Sample Operations

The Field Sample Operations is responsible for planning and coordinating field sampling resources and provides the Field Work Supervisor (FWS) for routine groundwater sampling operations. The FWS directs the nuclear chemical operators (samplers), who collect groundwater samples in accordance with this groundwater monitoring plan and in accordance with corresponding standard procedures and work packages. The FWS ensures that samplers are appropriately trained and available. The samplers collect all salient samples in accordance with sampling documentation. 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.

In addition, pre-job briefings are conducted by the Field Sample Operations, in accordance with work management and work release requirements, to evaluate activities and associated hazards by considering various factors including the following:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required

A2.1.7 Quality Assurance

The QA point of contact is responsible for addressing QA issues on the project and overseeing implementation of the project QA requirements. Responsibilities include reviewing project documents, including the QAPjP, and participating in QA assessments on sample collection and analysis activities, as appropriate.

A2.1.8 Environmental Compliance Officer

The ECO 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.

A2.1.9 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.

A2.1.10 Waste Management

Waste Management is responsible for identifying waste management sampling/characterization requirements, to ensure regulatory compliance, and interpreting data to determine waste designations and profiles. Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

A2.1.11 Analytical Laboratories

The analytical laboratories analyze samples, in accordance with established procedures and the requirements of this plan, and provide necessary data packages containing analytical and QC results. The laboratories provide explanations of results to support data review and in response to resolution of analytical issues. The laboratories are evaluated under the DOE Consolidated Audit Program and must be accredited by Ecology for the analyses performed for S&GRP.

A2.2 Problem Definition/Background

The purpose of this groundwater monitoring plan is to satisfy the requirements of *Washington Administrative Code* (WAC) 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," and Title 40 *Code of Federal Regulations* (CFR) 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring." Specifics on the activities to satisfy the requirements are provided in the main body of the monitoring plan in Chapter 1.0 and Sections 2.7, 3.1, 3.2, and 4.2. Background information on monitoring is also provided in the main body of this plan in Sections 2.2, 2.5, and 3.3.

A2.3 Project/Task Description

The project description is provided in Chapters 2, 3, and 4 of this monitoring plan and includes the parameter indicators as required by 40 CFR 265.92 for establishing groundwater quality and groundwater contamination detection, evaluation of the monitoring network, interpretation of analytical results, and reporting. The parameter indicators to be monitored, along with the monitoring wells and frequency of sampling, are provided in Chapter 3. Information on the collection and analyses of groundwater from the monitoring network is provided in this appendix and in Appendix B. In addition to the required parameter indicators of 40 CFR 265.92, a selection of site-specific constituents to be monitored is included in Chapter 3.

A2.4 Quality Assurance Objectives and Criteria

The QA objective of this plan is to ensure that the generation of analytical data of known and appropriate quality is acceptable and useful in order to meet the evaluation requirements stated in the monitoring plan. In support of this objective, statistics and data descriptors known as data quality indicators (DQIs) are used to help determine the acceptability and utility of data to the user. The principal DQIs are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These DQIs are defined for the purposes of this document in Table A-1.

Data quality is defined by the degree of rigor in the acceptance criteria assigned to the DQIs. The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. DQIs are evaluated during the data quality assessment (DQA) process (Section A5.3).

Table A-1. Data Quality Indicators

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

Table A-1. Data Quality Indicators

DQI	Definition	Determination Methodologies	Corrective Actions
	which one data set can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	handling methods, sample preparation and analytical methods, holding times, and QA protocols.	• Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Qualify the data as appropriate • Resample and/or reanalyze if needed • Revise sampling/analysis protocols to ensure future comparability
Completeness	Completeness is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered to be valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/ acceptance criteria).	If data set does not meet completeness objective: • Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Resample and/or reanalyze if needed • Revise sampling/analysis protocols to ensure future completeness
Bias	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (MS).	For sampling bias: • Properly select and use sampling tools • Institute correct sampling and subsampling procedures to limit preferential selection or loss of sample media • Use sample handling procedures, including proper sample preservation, that limit the loss or gain of constituents to the sample media • Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias • Laboratories that are known to generate biased data for a specific analyte are asked to

Table A-1. Data Quality Indicators

DQI	Definition	Determination Methodologies	Corrective Actions
			correct their methods to remove the bias as best as practicable. Otherwise, samples are sent to other labs for analysis.
Sensitivity	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation[a] is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet objective: • Request reanalysis or re-measurement using methods or analytical conditions that will meet required detection or limit of quantitation • Qualify/reject the data before use

Source: SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, as amended.

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

DQI = data quality indicator

MS = matrix spike

QA = quality assurance

A2.5 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, "Dangerous Waste Regulations," "Personnel Training." The FWS, in coordination with line management, will ensure that special training requirements for field personnel are met.

Training has been instituted by the contractor management team to meet training and qualification programs to satisfy multiple training drivers imposed by the applicable CFR and WAC requirements. For example, the environmental, safety, and health training program provides workers with the knowledge and skills necessary to execute assigned duties safely.

Training records are maintained for each employee in an electronic training record database. The contractor's training organization maintains the training records system. Line management confirms that an employee's training is appropriate and up-to-date prior to performing any field work.

A2.6 Documents and Records

The S&GRP RCRA groundwater manager (or designee) is responsible for ensuring that the current version of the groundwater monitoring plan is used and providing any updates to field personnel. Version control is maintained by the administrative document control process. Table A-2 defines the types of changes that may impact the groundwater monitoring plan and the associated approvals, notifications, and documentation requirements. Changes to elements of the monitoring plan that are required by 40 CFR 265.92 are not allowed, except as unintentional changes as described in Table A-2.

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 FWS, SMR, and any field crew supervisors are responsible for ensuring that field instructions are maintained and aligned with any revisions or approved changes to the groundwater monitoring plan. The SMR group will ensure that any deviations from the plan are reflected in revised field sampling documents for the samplers and analytical laboratory. The FWS or appropriate field crew supervisors will ensure that deviations from the plan or problems encountered in the field are documented appropriately (e.g., in the field logbook).

Table A-2. Change Control for Monitoring Plans

Type of Change*	Action	Documentation
Temporary addition of wells or site-specific constituents, or increased sampling frequency that do not impact the requirements of 40 CFR 265.92.	S&GRP RCRA groundwater manager approves temporary change; provides informal notice to Ecology.	SMR group's integrated groundwater monitoring schedule
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, and loss of samples in transit.	S&GRP RCRA groundwater manager provides electronic notification to DOE-RL.	Annual groundwater monitoring report
Planned change to groundwater monitoring activities, including addition or deletion of site-specific constituents, change of sampling frequency for site-specific constituents, or changes to well network.	S&GRP RCRA groundwater manager obtains DOE-RL approval; revise monitoring plan.	Revised RCRA groundwater monitoring plan
Anticipated unavoidable changes (e.g., dry wells).	S&GRP RCRA groundwater manager provides electronic notification to DOE-RL; revise monitoring plan.	Annual groundwater monitoring report and revised RCRA groundwater monitoring plan

Note: 40 CFR 265.93, "Preparation, Evaluation, and Response," contains additional sampling and notification requirements should indicator parameter results demonstrate a significant increase (or pH decrease).

* "Site-specific constituents" are any constituents that may be included in this monitoring plan as additional analytes that are not required by 40 CFR 265.92, "Sampling and Analysis."

CFR = *Code of Federal Regulations*

DOE-RL = U.S. Department of Energy, Richland Operations Office

Ecology = Washington State Department of Ecology

RCRA = *Resource Conservation and Recovery Act of 1976*

S&GRP = Soil and Groundwater Remediation Project

SMR = Sample Management and Reporting

The S&GRP RCRA groundwater manager, FWS, or designee is responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities. The S&GRP RCRA groundwater manager is also responsible for ensuring that project files are setup, as appropriate, and/or maintained. The project files will contain project records or references to their storage locations. Project files generally include, as appropriate, the following information:

- Operational records and logbooks
- Data forms
- Global positioning system data (a copy will be provided to the SMR group)
- Inspection or assessment reports and corrective action reports
- Field summary reports
- Interim progress reports
- Final reports
- Forms required by WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the master drilling contract

The following records are managed and maintained by SMR personnel:

- Field sampling logbooks
- Groundwater sample reports and field sample reports
- Chain-of-custody forms
- Sample receipt records
- Laboratory data packages
- Analytical data verification and validation reports
- Analytical data "case file purges" (i.e., raw data purged from laboratory files) provided by offsite analytical laboratories

The laboratory is responsible for maintaining, and having available upon request, the following items:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Convenience copies of laboratory analytical results are kept in the HEIS database. Records may be stored in either electronic (e.g., in the managed records area of the Integrated Document Management System) or hard copy format (e.g., DOE Records Holding Area). 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.

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 the annual groundwater monitoring reports.

A3 Data Generation and Acquisition

This chapter 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. The requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed.

A3.1 Analytical Method Requirements

Analytical method requirements for samples collected are presented in Table A-3. Updated U.S. Environmental Protection Agency (EPA) methods may be substituted for analytical methods identified in Table A-3.

Table A-3. Analytical Requirements for Groundwater Analysis

Constituent	Analytical Method[a]	Highest Allowable PQL[b] (µg/L)
Groundwater Quality Parameters (40 CFR 265.92[b][2])		
Chloride	EPA/600 Method 300.0	400
Sulfate		550
Iron	SW-846 Method 6010B/C	50
Manganese		5
Sodium		500
Phenols	SW-846 Method 8270D	5
Contamination Indicator Parameters (40 CFR 265.92[b][3])		
pH	Field measurement Instrument/meter	N/A
Specific Conductance		N/A
Total Organic Carbon	SW-846 Method 9060	1,000
Total Organic Halogen	SW-846 Method 9020	10
Site-Specific Constituents[c]		
Alkalinity	EPA/600 Method 310.1	5,000
Arsenic	SW-846 Method 6010B/C, SW 846 Method 6020, or EPA/600 Method 200.8	10
Calcium		1,000
Magnesium		750
Potassium		4,000
Nitrate	EPA/600 Method 300.0	250
Dissolved Oxygen	Field measurement Instrument/meter	N/A
Temperature		N/A

Table A-3. Analytical Requirements for Groundwater Analysis

Constituent	Analytical Method[a]	Highest Allowable PQL[b] (µg/L)
Turbidity		N/A

Reference: 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis"

Note: The information in this table does not represent EPA requirements but is intended solely as guidance.

a. For EPA Method 300.0, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final V*. Equivalent methods may be substituted.

b. Highest allowable practical quantitation limits are specified in contracts with analytical laboratories. Actual quantitation limits vary by laboratory and may be lower than required contractually. Method detection limits are three to five times lower than quantitation limits.

c. Site Specific Constituents not required by RCRA but used to support interpretation.

CFR = *Code of Federal Regulations*
EPA = U.S. Environmental Protection Agency
N/A = not applicable
PQL = practical quantitation limit
RCRA = *Resource Conservation and Recovery Act of 1976*

A3.2 Field Analytical Methods

Field screening and survey data will be measured in accordance with HASQARD (DOE/RL-96-68) requirements (as applicable). Field analytical methods may also be performed in accordance with manufacturer manuals. Appendix B provides the parameters identified for field measurements.

A3.3 Quality Control

QC requirements specified in the plan must be followed in the field and analytical laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects of the analytical data. Field and laboratory QC sample requirements are summarized in Table A-4. Acceptance criteria for field and laboratory QC are shown in Table A-5. Data will be qualified and flagged in HEIS, as appropriate.

Table A-4. Project Quality Control Requirements

Sample Type	Frequency	Characteristics Evaluated
Field Quality Control		
Field Duplicates	One in 20 well trips	Precision, including sampling and analytical variability
Field Splits	As needed When needed, the minimum is one for every analytical method, for analyses performed where detection limit and precision and accuracy criteria have been defined in the Analytical Performance Requirements table (Table A-3)	Precision, including sampling, analytical, and interlaboratory

Table A-4. Project Quality Control Requirements

Sample Type	Frequency	Characteristics Evaluated
Full Trip Blanks	One in 20 well trips	Cross-contamination from containers or transportation
Equipment Blanks	As needed If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment blank is not required Otherwise, one for every 20 samples[a]	Adequacy of sampling equipment decontamination and contamination from nondedicated equipment
Analytical Quality Control[b]		
Laboratory Duplicates	1 per analytical batch[c]	Laboratory reproducibility and precision
Matrix Spikes	1 per analytical batch[c]	Matrix effect/laboratory accuracy
Post-Preparation Spike	1 per analytical batch[c]	Matrix effect/laboratory accuracy
Matrix Spike Duplicates	1 per analytical batch[c]	Laboratory accuracy and precision
Laboratory Control Samples	1 per analytical batch[c]	Laboratory accuracy
Method Blanks	1 per analytical batch[c]	Laboratory contamination
Surrogates	1 per analytical batch[c]	Recovery/yield

Note: The information in this table does not represent EPA requirements but is intended solely as guidance.

a. For portable pumps, equipment blanks are collected one for every 10 well trips. Whenever a new type of nondedicated equipment is used, an equipment blank will be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination methods for the nondedicated equipment.

b. Batching across projects is allowed for similar matrices (e.g., all Hanford groundwater).

c. Unless not required by, or different frequency is called out in, laboratory analysis methods.

EPA = U.S. Environmental Protection Agency

Table A-5. Laboratory Quality Control and Acceptance Criteria

Analyte	Quality Control	Acceptance Criteria	Corrective Action
General Chemical Analyses			
Alkalinity	MB	< MDL < 5% Sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	Laboratory Duplicate	≤ 20% RPD[b]	Data reviewed[a]
	MS	75–125% recovery	Flagged with "N"

Table A-5. Laboratory Quality Control and Acceptance Criteria

Analyte	Quality Control	Acceptance Criteria	Corrective Action
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"
Total Organic Carbon	MB	< MDL < 5% Sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	Laboratory Duplicate or MS/MSD	≤ 20% RPD[b]	Data reviewed[a]
	MS or PS, and MSD	75–125% recovery	Flagged with "N"
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"
Total Organic Halogen	MB	< MDL < 5% Sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	Laboratory Duplicate or MS/MSD	≤ 20% RPD[b]	Data reviewed[a]
	MS and MSD	75–125% recovery	Flagged with "N"
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"
Anions			
Anions by IC (Chloride, Sulfate, Nitrate)	MB	< MDL < 5% sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	Laboratory Duplicate or MS/MSD	≤ 20% RPD[b]	Data reviewed[a]
	MS or PS, and MSD	75–125% recovery[a]	Flagged with "N"
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"
Metals			
ICP Metals (Arsenic, Calcium, Iron, Magnesium, Manganese, Potassium, Sodium)	MB	< RDL < 5% Sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	MS or PS, and MSD	75–125% recovery	Flagged with "N"
	MS/MSD	≤ 20% RPD	Data reviewed[a]
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"

Table A-5. Laboratory Quality Control and Acceptance Criteria

Analyte	Quality Control	Acceptance Criteria	Corrective Action
Semivolatile Organic Compounds			
Phenols by GC or GC/MS	MB	< MDL < 5% sample concentration	Flagged with "B"
	LCS	Statistically derived[c]	Data reviewed[a]
	MS and MSD	%Recovery statistically derived[c]	Flagged with "T" if analyzed by GC/MS, otherwise "N" based on FEAD
	MS/MSD	%RPD statistically derived[c]	Data reviewed[a]
	SUR	Statistically derived[c]	Data reviewed[a]
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"

Notes: The information in this table does not represent EPA requirements but is intended solely as guidance.

This table only applies to laboratory analyses. Specific conductance, pH, dissolved oxygen, temperature, and turbidity are not listed as they are measured in the field.

a. After review, corrective actions are determined on a case-by-case basis.

b. Applies only in cases where both results are greater than 5 times the minimum detectable concentration.

c. Determined by the laboratory based on historical data or statistically derived control limits. Limits are reported with the data. Where specific acceptance criteria are listed, those acceptance criteria may be used in place of statistically derived acceptance criteria.

EB = equipment blank
EPA = U.S. Environmental Protection Agency
FEAD = format for electronic analytical data
FTB = full trip blank
GC = gas chromatography
GC/MS = gas chromatography/mass spectrometry
IC = ion chromatography
ICP = inductively coupled plasma
LCS = laboratory control sample
MB = method blank
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
PS = post-digestion spike
QC = quality control
RDL = required detection limit
RPD = relative percent difference
SUR = surrogate

Data Flags:

B (organics)= analyte was detected in both the associated QC blank and the sample

C (inorganics) = the analyte was detected in both the sample and the associated QC blank and the blank value exceeds 5% of the measured concentration present in the associated sample

N = all except GC/MS – matrix spike outlier

T = volatile organic analysis and semivolatile organic analysis GC/MS – matrix spike outlier

Q = associated QC sample is out of limits

A3.3.1 Field Quality Control Samples

Field QC samples are collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability and laboratory performance to help ensure that reliable data are obtained. Field QC samples include field duplicates, field split (SPLIT) samples, and two types of field blanks (full trip blanks [FTBs] and equipment blanks [EBs]). Field blanks are typically prepared using high-purity reagent water. QC sample definitions and their required frequency for collection are described in this section:

- **Field Duplicates:** independent samples collected as close as possible to the same time and same location as the scheduled sample, and are intended to be identical. Field duplicates are placed in separate sample containers and analyzed independently. Field duplicates are used to determine precision for both sampling and laboratory measurements.
- **Field Splits:** two samples collected as close as possible to the same time and same location and are intended to be identical. SPLITs will be stored in separate containers and analyzed by different laboratories for the same analytes. SPLITs are interlaboratory comparison samples used to evaluate comparability between laboratories.
- **Full Trip Blanks:** bottles prepared by the sampling team prior to traveling to the sampling site. The preserved bottle set is either for volatile organic analysis only or identical to the set that will be collected in the field. It is filled with high-purity reagent water, and the bottles are sealed and transported (unopened) to the field in the same storage containers used for samples collected that day. Collected FTBs are typically analyzed for the same constituents as the samples from the associated sampling event. FTBs are used to evaluate potential contamination of the samples attributable to the sample bottles, preservative, handling, storage, and transportation.
- **Equipment Blanks:** reagent water passed through or poured over the decontaminated sampling equipment identical to the sample set collected and placed in sample containers, as identified on the SAF. EB sample bottles are placed in the same storage containers with the samples from the associated sampling event. EB samples will be analyzed for the same constituents as the samples from the associated sampling event. EBs are used to evaluate the effectiveness of the decontamination process. EBs are not required for disposable sampling equipment.

A3.3.2 Laboratory Quality Control Samples

Internal QA/QC programs are maintained by the laboratories utilized by the project. Laboratory QA includes a comprehensive QC program that includes the use of matrix spikes (MSs), matrix duplicates, matrix spike duplicates (MSDs), laboratory control samples (LCSs), surrogates (SURs), post-digestion spikes (PSs), and method blanks (MBs). These QC analyses are required by EPA methods (e.g., those in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*), and will be run at the frequency specified in the respective references unless superseded by agreement. QC checks outside of control limits are documented in analytical laboratory reports during DQAs, if performed. Laboratory QC and their typical frequencies are listed in Table A-4. Acceptance criteria are shown in Table A-5. The following text describes the various laboratory QC samples:

- **Laboratory Duplicate:** an intralaboratory replicate sample that is used to evaluate the precision of a method in a given sample matrix.
- **Matrix Spike:** an aliquot of a sample spiked with a known concentration of target analyte(s). MS is used to assess the bias of a method in a given sample matrix. Spiking occurs prior to sample preparation and analysis.
- **Matrix Spike Duplicate:** a replicate spiked aliquot of a sample that is subjected to the entire sample preparation and analytical process. MSD results are used to determine the bias and precision of a method in a given sample matrix.
- **Laboratory Control Sample:** a control matrix (e.g., reagent water) spiked with analytes representative of the target analytes or a certified reference material that is used to evaluate laboratory accuracy.

- **Method Blank:** an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in the sample processing. The MB is carried through the complete sample preparations and analytical procedure and is used to quantify contamination resulting from the analytical process.
- **Post-Digestion Spike:** the same as MS; however, the spiking occurs after sample preparation and before analysis.
- **Surrogate:** a compound added to all samples in the analysis batch (field samples and QC samples) prior to preparation. SURs are typically similar in chemical composition to the analyte being determined, yet are not normally encountered. SURs are expected to respond to the preparation and measurement systems in a manner similar to the analytes of interest. Because SURs are added to all standards, samples, and QC samples, they are used to evaluate overall method performance in a given matrix. SURs are used only in organic analyses.

Laboratories are required to analyze samples within the holding time specified in Table A-6. In some instances, constituents in the samples not analyzed within the holding times may be compromised by volatilizing, decomposing, or other chemical changes. Data from samples analyzed outside the holding times are flagged in the HEIS database with an "H."

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

Constituent/ Parameter	Minimum Volume	Container Type[a]	Preservation[b]	Holding Time
Alkalinity	500 mL	Narrow mouth poly or glass	Store ≤ 6°C	14 days
Total Organic Carbon	250 mL	Narrow mouth amber glass with Teflon®-lined lid	Store ≤ 6°C, Adjust pH to < 2 with H_2SO_4 or HCl	28 days
Total Organic Halogen	1 L	Narrow mouth glass with Teflon®-lined lid	Store ≤ 6°C, Adjust pH to < 2 with H_2SO_4	28 days
Anions by IC (Chloride, Sulfate, Nitrate)	60 mL	Poly or glass	Store ≤ 6°C	48 hours
ICP Metals (Arsenic, Calcium, Iron, Magnesium, Manganese, Potassium, Sodium)	250 mL	Narrow mouth poly or glass	Adjust pH to < 2 with nitric acid	6 months
Phenols by GC or GC/MS	4 × 1L	Narrow mouth amber glass with Teflon®-lined lid	Store ≤ 6°C	7 days before extraction 40 days after extraction

Notes: Teflon is a registered trademark of E.I. du Pont de Nemours and Company, Wilmington, Delaware.

The information in this table does not represent EPA requirements but is intended solely as guidance.

This table only applies to laboratory analyses. Specific conductance, pH, dissolved oxygen, temperature, and turbidity are not listed as they are measured in the field

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

Constituent/ Parameter	Minimum Volume	Container Type[a]	Preservation[b]	Holding Time

a. Under the Container heading, the term poly stands for EPA clean polyethylene bottles.

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

EPA	=	U.S. Environmental Protection Agency
GC	=	gas chromatography
GC/MS	=	gas chromatography/mass spectrometry
H_2SO_4	=	sulfuric acid
HCl	=	hydrochloric acid
IC	=	ion chromatography
ICP	=	inductively coupled plasma

A3.4 Measurement Equipment

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

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

Collection, measurement, and testing equipment will meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or will have been evaluated as acceptable and valid in accordance with instrument-specific methods, requirements, and specifications. Software applications will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory will be subject to preventive maintenance measures to ensure minimization of downtime. Laboratories must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization's QA plan or operating protocols, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with applicable Hanford Site requirements.

A3.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Appendix B. Analytical laboratory instruments are calibrated in accordance with the laboratory's QA plan and applicable Hanford Site requirements.

A3.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed in accordance with test methods in SW-846 and will be appropriate for their use. Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes. Responsibilities and interfaces necessary to ensure that items procured/acquired for the contractor meet the specific technical and quality requirements must be in place. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

A3.8 Nondirect Measurements

Data obtained from sources, such as computer databases, programs, literature files, and historical databases, will be technically reviewed to the same extent as the data generated as part of any sampling and analysis QA/QC effort. All data used in evaluations will be identified by source.

A3.9 Data Management

The SMR group, in coordination with the S&GRP RCRA groundwater manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management methods.

Electronic data access, when appropriate, will be through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to the SMR group on a routine basis. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with applicable methods. This process is used to document analytical errors and establish their resolution with the S&GRP RCRA groundwater manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and records management.

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A4 Assessment and Oversight

Assessment and oversight activities address the effectiveness of project implementation and associated QA/QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

A4.1 Assessments and Response Actions

Random surveillances and assessments verify compliance with the requirements outlined in this plan, project field instructions, the QAPjP, methods, and regulatory requirements. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project's line management chain coordinates the corrective actions/deficiencies resolutions in accordance with the QA program, corrective action management program, and associated methods implementing these programs. When appropriate, corrective actions will be taken by the S&GRP RCRA groundwater manager.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with laboratory QA plans. The contractor oversees offsite analytical laboratories and verifies that laboratories are qualified for performing Hanford Site analytical work.

A4.2 Reports to Management

Management will be made aware of deficiencies identified by self-assessments, corrective actions from ECOs, and findings from QA assessments and surveillances. Issues reported by the laboratories are communicated to the SMR group, which then initiates a sample issue resolution form. This process is used to document analytical or sample issues and establish resolution with the S&GRP RCRA groundwater manager.

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A5 Data Review and Usability

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

A5.1 Data Review and Verification

Data review and verification are performed to confirm that sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific sampling locations, reviewing sample collection dates and sample preparation and analysis dates to assess whether holding times, if any, have been met, and reviewing QC data to determine whether analyses have met the data quality requirements specified in this plan.

The criteria for verification include, but are not limited to, review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Field QA/QC results also will be reviewed to ensure that they are usable.

The project scientist, assigned by the S&GRP RCRA groundwater manager, will perform a data review to help determine if observed changes reflect improved/degraded groundwater quality or potential data errors and may result in submittal of a request for data review (RDR) on questionable data. The laboratory may be asked to check calculations or re-analyze the sample, or the well may be resampled. Results of the RDR process are used to flag the data appropriately in the HEIS database and/or to add comments.

A5.2 Data Validation

Data validation activities may be performed at the discretion of the S&GRP RCRA groundwater manager and under the direction of the SMR group. If performed, data validation activities will be based on EPA functional guidelines.

A5.3 Reconciliation with User Requirements

The DQA 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 DQA is to determine whether quantitative data are of the correct type and are of adequate quality and quantity to meet the project data quality needs. For routine groundwater monitoring undertaken through this groundwater monitoring plan, which evaluates field and laboratory QC and the usability of data. Further DQAs will be performed at the discretion of the S&GRP RCRA groundwater manager and documented in a report overseen by the SMR group.

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A6 References

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

265.92, "Sampling and Analysis."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

Atomic Energy Act of 1954, as amended, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at: http://epw.senate.gov/atomic54.pdf.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE/RL-96-68, 2015, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD), Rev. 4, *Volume 1, Administrative Requirements; Volume 2, Sampling Technical Requirements; Volume 3, Field Analytical Technical Requirements; and Volume 4, Laboratory Technical Requirements*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:

http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL1-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL2-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL4-04.pdf.

Ecology Publication No. 04-03-030, 2004, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studie*s, Environmental Assessment Program, Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/biblio/0403030.html.

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

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/QUALITY/qs-docs/r5-final.pdf.

EPA/240/R-02/009, 2002, *Guidance for Quality Assurance Project Plans*, EPA QA/G-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/QUALITY/qs-docs/g5-final.pdf.

EPA/600/R-93/100, 1993, *Methods for the Determination of Inorganic Substances in Environmental Samples*, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: http://monitoringprotocols.pbworks.com/f/EPA600-R-63-100.pdf.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm.

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

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

303-330, “Personnel Training.”

303-400, “Interim Status Facility Standards.”

Appendix B

Sampling Protocol

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Contents

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Terms

CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
FWS	Field Work Supervisor
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document* (DOE/RL-96-68)
IATA	International Air Transport Association
NTU	nephelometric turbidity unit
RCRA	*Resource Conservation and Recovery Act of 1976*
S&GRP	Soil and Groundwater Remediation Project
SMR	Sampling Management and Reporting

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B1 Introduction

Resource Conservation and Recovery Act of 1976 (RCRA) groundwater monitoring at the Hanford Site has been conducted since the mid 1980's. Hanford Site groundwater sampling methods contain extensive requirements for sampling precautions to be taken, equipment and its use, cleaning and decontamination, records and documentation, and sample collection, management, and control activities. Appendices A and B, together, provide the sampling and analysis essentials (sample collection, sample preservation, chain of custody control, analytical procedures, and field and laboratory quality assurance/quality control) necessary for the groundwater monitoring plan.

This appendix provides more specific elements of the sampling protocols and techniques used for the RCRA groundwater monitoring plan. Chapter 3 of the groundwater monitoring plan identifies the monitoring wells that will be sampled, the constituents to be analyzed for, and the sampling frequency for the groundwater monitoring at the B Pond.

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B2 Sampling Methods

Sampling methods may include, but are not limited to, the following:

- Field screening measurements
- Groundwater sampling
- Water level measurements

Groundwater samples will be collected according to the current revision of applicable operating methods. Groundwater samples are collected after field measurements of purged groundwater have stabilized:

- pH – two consecutive measurements agree within 0.2 pH units
- Temperature – two consecutive measurements agree within 0.2°C
- Conductivity – two consecutive measurements agree within 10 percent of each other
- Turbidity – less than 5 nephelometric turbidity units (NTUs) prior to sampling (or project scientist's recommendation)

Dissolved oxygen will also be measured in the field in this plan, but it is not required to demonstrate concentration stability before field measurement.

Absent any special requirements from project scientists, wells are purged utilizing the three borehole volume method. Stable field readings are also required as specified above. The default pumping rate is 7.6 to 45.4 L/min (2 to 12 gal/min), depending on the pump, although this is not practical at every well. On occasions when the purge volume is extraordinarily large, wells are purged a minimum of 1 hour and then sampled once stable field readings are obtained.

Field measurements (except for turbidity) are obtained through the use of a flow through cell. Groundwater is pumped directly from the well and to the flow through cell. At the beginning of the sample event, field crews attach a clean stainless steel sampling manifold to the riser discharge. The manifold has two valves and two ports: one port is used only for purgewater, and the other is used to supply water to the flow through cell. Probes are inserted into the flow through cell for measurement of pH, temperature, conductivity, and dissolved oxygen. Turbidity is measured by inserting a sample vial into a turbidimeter. The purgewater is then discharged to the purgewater truck.

Once field measurements have stabilized, the hose supplying water to the flow through cell is disconnected, and a clean stainless steel drop leg is attached for sampling. The flow rate is reduced during sampling to minimize loss of volatiles, if any, and prevent overfilling of bottles. Sample bottles are filled in a sequence designed to minimize loss of volatiles, if any. Filtered samples are collected after the unfiltered samples. For some constituents, like metals, both filtered and unfiltered samples are analyzed. If additional samples require filtration (e.g., at turbidity greater than 5 NTUs), an inline disposable 0.45 µm filter is used.

Typically, three types (i.e., Grundfos, Hydrostar, and submersible electrical pumps) of environmental grade sampling pumps are used for groundwater sampling at Hanford Site monitoring wells. Individual pumps are selected based on the unique characteristics of the well and the sampling requirements. A small number of wells will not support a pumped sample because of yield or the physical characteristics of the well. In these cases, a grab sample may be obtained.

For certain types of samples, preservatives are required. While the preservative may be added to the collection bottles before their use in the field, it is allowable to add the preservative at the sampling vehicle immediately after collection. Samples may require filtering in the field, as noted on the chain-of-custody form.

To ensure sample and data usability, the sampling associated with this plan will be performed according to DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD), pertaining to sample collection, collection equipment, and sample handling.

Suggested sample container, preservation, and holding time requirements are specified in Appendix A (Table A-6) for groundwater samples. These requirements are in accordance with the analytical method specified in Appendix A (Table A-3). The final container type and volumes will be identified on the chain-of-custody form. This groundwater monitoring plan defines a “sample” as a filled sample bottle for starting the clock for holding time restrictions.

Holding time is the maximum allowable time period between sample collection and analysis. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the constituent and are listed in analytical method compilations such as APHA et al., 2012, *Standard Methods for the Examination of Water and Wastewater*, and SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition; Final Update V*. Recommended holding times are also provided in HASQARD (DOE/RL-96-68).

B2.1 Decontamination of Sampling Equipment

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

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

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

B2.2 Water Levels

Each time a sample is obtained, measurement of the ground water surface elevation at each monitoring well is required by Title 40 *Code of Federal Regulations* (CFR) 265.92(e) “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” “Sampling and Analysis.” A measurement of depth to water is recorded in each well prior to sampling, using calibrated depth measurement tapes. Two consecutive measurements are taken that agree within 6 mm (0.02 ft); these are recorded along with the date, time, measuring tape number, and other pertinent information. The depth to groundwater is subtracted from the elevation of a reference point (usually the top of casing) to obtain the water level elevation. Tops of casings are known elevation reference points because they have been surveyed to local reference data.

B3 Documentation of Field Activities

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

Data forms may be used to collect field information; however, the information recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

A summary of information to be recorded in logbooks is as follows:

- The day and date, time the task started, weather conditions, and the names, titles, and organizations of personnel performing the task.
- The purpose of the visit to the task area.
- Site activities in specific detail (e.g., maps and drawings) or the forms used to record such information (e.g., soil boring log or well completion log). Details of any field tests that were conducted. Reference any forms that were used, other data records, and the methods followed in conducting the activity.
- Details of any field calibrations and surveys that were conducted. Reference any forms that were used, other data records, and the methods followed in conducting the calibrations and surveys.
- Details of any samples collected and indicate the preparation, if any, of splits, duplicates, matrix spikes, or blanks. Reference the methods followed in sample collection or preparation. List location of sample collected, sample type, all label or tag numbers, sample identification, sample containers and volume, preservation method, packaging, chain-of-custody form number, and the analytical request form number pertinent to each sample or sample set. Note the time and the name of the individual to whom custody of samples was transferred.
- The time, equipment type, and serial or identification number, and the methods followed for decontaminations and equipment maintenance performed. Reference the page number(s) of any logbook (if any) where detailed information is recorded.
- Any equipment failures or breakdowns that occurred, with a brief description of repairs or replacements.

B3.1 Corrective Actions and Deviations for Sampling Activities

The Soil and Groundwater Remediation Project (S&GRP) RCRA groundwater manager, FWS, appropriate field crew supervisors, and Sampling Management and Reporting (SMR) personnel must document deviations from protocols, problems pertaining to sample collection, chain-of-custody forms, target analytes, contaminants, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected because of field conditions.

As appropriate, such deviations or problems will be documented (e.g., in the field logbook) in accordance with internal corrective action methods. The S&GRP RCRA groundwater manager, FWS, field crew supervisors, or SMR personnel will be responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities.

Changes in sample activities that require notification, approval, and documentation will be performed as specified in Appendix A (Table A-2).

B4 Calibration of Field Equipment

Field instrumentation, calibration, and quality assurance checks will be performed as follows:

- Prior to initial use of a field analytical measurement system.
- At the frequency recommended by the manufacturer or methods, or as required by regulations.
- Upon failure to meet specified quality control criteria.
- Daily calibration checks will be performed and documented for each instrument. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.
- Standards used for calibration will be traceable to a nationally recognized standard agency source or measurement system.

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B5 Sample Handling

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

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

B5.1 Containers

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

Containers shall be capped and stored in an environment which minimizes the possibility of contamination of the sample containers. If contamination of the stored sample containers occurs, corrective actions shall be implemented to prevent reoccurrences. Contaminated sample containers cannot be used for a sampling event. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. Container types and sample amounts/volumes are identified in Appendix A (Table A-6).

B5.2 Container Labeling

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

B5.3 Sample Custody

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

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility for custody of the sample changes, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to the SMR group within 48 hours of shipping.

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

- Project name
- Collectors' names
- Unique sample number

- Date and time of collection
- Matrix
- Preservatives
- Chain of possession information (i.e., signatures and printed names of all individuals involved in the transfer of sample custody and storage locations, and dates of receipt and relinquishment)
- Requested analyses (or reference thereto)
- Shipped-to information (i.e., analytical laboratory performing the analysis)

Samplers should note any anomalies with the samples. If anomalies are found, samplers should inform the SMR group so that special direction for analysis may be provided to the laboratory if deemed necessary.

B5.4 Sample Transportation

All packaging and transportation instructions shall be in compliance with applicable transportation regulations and U.S. Department of Energy (DOE) requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT) as described in 49 CFR 171, "General Information, Regulations, and Definitions," through 49 CFR 177, "Carriage by Public Highway." Carrier specific requirements defined in the International Air Transport Association (IATA) *Dangerous Goods Regulations* (IATA, current edition) shall also be used when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents shall be considered hazardous material in transportation and transported according to DOT/IATA requirements. If the sample material is known or can be identified, then it will be classified, described, packaged, marked, labeled, and shipped according to the specific instructions for that material and appropriate laboratory notifications will be made, if necessary, through the SMR project coordinator.

B6 Management of Waste

Waste materials are generated during sample collection, processing, and subsampling activities. Waste will be managed in accordance with DOE/RL-2004-18, *Waste Control Plan for the 200-PO-1 Operable Unit*. For waste designation purposes, the wells listed in Table 3-1 will be surveyed in the Hanford Environmental Information System and the maximum concentration for each analyte within the most recent 5 years evaluated for use in creating a waste profile, if required. Offsite analytical laboratories are responsible for disposal of unused sample quantities. Pursuant to 40 CFR 300.440, “National Oil and Hazardous Substances Pollution Contingency Plan,” “Procedures for Planning and Implementing Off-Site Response Actions,” approval from the DOE Richland Operations Office is required before returning unused samples or waste from offsite laboratories.

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B7 Health and Safety

DOE established the hazardous waste operations safety and health program pursuant to the *Price-Anderson Amendments Act of 1988* to ensure the safety and health of workers involved in mixed waste site activities. The program was developed to comply with the requirements of 10 CFR 851, "Worker Safety and Health Program," which incorporates the standards of 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," and 10 CFR 830, "Nuclear Safety Management," through 10 CFR 835, "Occupational Radiation Protection." The health and safety program defines the chemical, radiological, and physical hazards and specifies the controls and requirements for daily work activities on the overall Hanford Site. Personnel training, control of industrial safety and radiological hazards, personal protective equipment, site control, and general emergency response to spills, fire, accidents, injury, site visitors, and incident reporting are governed by the health and safety program.

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B8 References

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.830&rgn=div5.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations.* Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=57ef404ac6f4734a67fd97302b2d7f7f&node=pt10.4.835&rgn=div5.

10 CFR 851, "Worker Safety and Health Program," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.851&rgn=div5.

29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title29-vol5/xml/CFR-2010-title29-vol5-sec1910-120.xml.

40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol25/xml/CFR-2010-title40-vol25-sec265-92.xml.

40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-Site Response Actions," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-sec300-440.xml.

49 CFR, "Transportation," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol2/xml/CFR-2009-title49-vol2.xml.

49 CFR 171, "General Information, Regulations, and Definitions."

49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans."

49 CFR 173, "Shippers-General Requirements for Shipments and Packagings."

49 CFR 174, "Carriage by Rail."

49 CFR 175, "Carriage by Aircraft."

49 CFR 176, "Carriage by Vessel."

49 CFR 177, "Carriage by Public Highway."

APHA/AWWA/WEF, 2012, *Standard Methods for the Examination of Water and Wastewater*, 22nd Edition, American Public Health Association, American Water Works Association, and Water Environment Federation, Washington, D.C.

DOE/RL-96-68, 2014, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD), Rev. 4, *Volume 1, Administrative Requirements*; *Volume 2, Sampling Technical Requirements*; *Volume 3, Field Analytical Technical Requirements*; and *Volume 4, Laboratory Technical Requirements*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:

http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL1-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL2-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf.
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL4-04.pdf.

DOE/RL-2004-18, 2008, *Waste Control Plan for the 200-PO-1 Operable Unit*, Rev 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0807010321.

IATA, *Dangerous Goods Regulations*, Current Edition, International Air Transport Association, Montreal, Quebec, Canada. Available at: http://www.iata.org/publications/dgr/Pages/index.aspx.

Price-Anderson Amendments Act of 1988, Pub. L. 100-408, Aug. 20, 1988, 102 Stat. 1066, 42 USC 2010, et seq. Available at: http://www.gpo.gov/fdsys/pkg/STATUTE-102/pdf/STATUTE-102-Pg1066.pdf.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

SW-846, 2015, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm.

Appendix C

Well Construction

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Contents

Figures

Tables

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C1 Introduction

This appendix provides the following information for the B Pond groundwater monitoring wells:

- Well name
- Hydrogeologic unit to be monitored – the portion of the aquifer that is located at the well screen or perforated casing (Table C-1)
- The following sampling interval information, as shown in Table C-2:
  - Elevation at top of the screen or perforated interval
  - Elevation at the bottom of the screen or perforated interval
  - Open interval length (i.e., difference between elevations of top and bottom of the screen or perforated interval)

Figures C-1 through C-5 provide the well construction and completion summaries for Wells 699-42-42B, 699-43-44, 699-43-45, 699-44-39B, and 699-45-42.

Table C-1. Hydrogeologic Monitoring Unit Classification Scheme

Unit	Description
CR	**Confined Ringold.** Wells for which the open interval does not extend more than a approximately 3 m (10 ft) below the top of basalt. Typically open to the lower mud (unit 8) and basal gravel (unit 9) of the Ringold Formation. This classification is not used for wells completed in the Ringold Formation upper mud (RUM).
TU	**Top of Unconfined.** Screened across the water table or the top of the open interval is within 1.5 m (5 ft) of the water table, and the bottom of the open interval is no more than 10.7 m (35 ft) below the water table.

Table C-2. Sampling Interval Information for Wells within the B Pond Network

Well Name	Hydrogeologic Unit Monitored	Elevation Top of Open Interval (m [ft] NAVD88)	Elevation Bottom of Open Interval (m [ft] NAVD88)	Open Interval Length (m [ft])
699-42-42B	CR	121.6 (399.0)	115.5 (379.0)	6.1 (20.0)
699-43-44	TU	124.5 (408.5)	118.4 (388.5)	6.1 (20.0)
699-43-45	TU	126.5 (415.0)	120.3 (394.7)	6.2 (20.3)
699-44-39B	TU	126.2 (414.0)	120.1 (394.0)	6.1 (20.0)
699-45-42	CR	128.4 (421.3)	121.7 (399.3)	6.7 (22.0)

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

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

WELL CONSTRUCTION AND COMPLETION SUMMARY

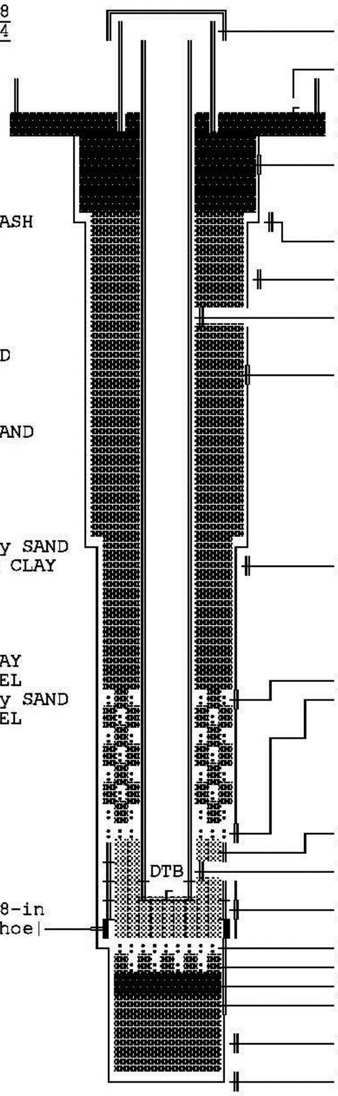
Drilling Method: Cable tool	Sample Method: Drive barrel & Hard tool
Drilling Fluid Used: 200E Area Water	Additives Used: Not documented
Driller's Name: R Vance	WA State Lic Nr: Not documented
Drilling Company: Onwego Drilling Co	Company Location: Kennewick, WA
Date Started: 15Aug88	Date Complete: 15Oct88

WELL NUMBER: 699-42-42B A5171 TEMPORARY WELL NO: BP-10
Hanford Coordinates: N/S N 42,472.9 E/W W 42,301.3
State Coordinates: N 447,666 E 2,252,915
Start Card #: Not documented T____ R____ S________
Elevation Ground surface: 579.83-ft Brass cap

Depth to water: 160.8-ft 07Oct88
(Ground surface) 162.1-ft 06Sep94

GENERALIZED STRATIGRAPHY Geologist's Log
Sl=Slightly

0-15: Cse SAND
15-25: Sl gravelly SAND
25-35: Fine SAND
35-40: Med-fine SAND
38 : 1-2-in layer of volcanic ASH
40-50: Fine SAND
50-65: Med-fine SAND
65-70: Med SAND
70-85: Fine SAND
85-90: Med SAND
90-95: Fine SAND
93 : 2-in lens SILT w/some SAND
95-105: Cse-med SAND
105-109: Med SAND
109-159: Silty, sandy GRAVEL
159-160: Gravelly silty clayey SAND
160-182: Split spoon sampled
No field description
182-190: Silty sandy GRAVEL
190-195: Gravelly SAND
195-204: Sandy GRAVEL
204-210: Sl gravelly silty clayey SAND
210-215: Sl gravelly sandy silty CLAY
215-220: Sandy silty CLAY
220-225: Silty CLAY
225-230: Sl gravelly silty CLAY
230-235: Silty CLAY
235-240: Gravelly sandy silty CLAY
240-243: Silty clayey sandy GRAVEL
243-248: SL gravelly silty clayey SAND
248-250: Silty clayey sandy GRAVEL



Elevation of reference point: [583.23-ft] (top of casing)
Height of reference point above ground surface [4.0-ft]
Depth of surface seal [0-18.2-ft]
Type of surface seal:
Cement grout to 16.7-ft
4 x 4-ft x 4-in concrete pad extends 2.0-ft into annulus
13-in nominal hole, 0-20.0-ft
11-in nominal hole, 20.0-110.0-ft
4-in ID T304 stainless steel casing, +3.5-192.9-ft
Granular bentonite, 18.2-150.5-ft
9-in nominal hole, 110.0-208.1-ft
Bentonite plug seal, 150.5-177.5-ft
Bentonite pellet seal,
1/2-in, 177.5-181.8-ft
1/4-in, 181.8-184.9-ft
Colorado silica sand pack,
184.9-202.8-ft, 20-40-mesh
202.8-207.2-ft, 10-20-mesh
4-in T304 stainless steel screen, 192.9-203.2-ft, #10-slot
8-in telescoping screen, T304 stainless 183.5-203.5-ft, #20-slot
Bentonite pellet seal, 207.2-212.0-ft
Bentonite plug seal, 212.0-219.2-ft
Cement grout seal, 219.2-~222-ft
Volclay grout seal, ~222-250-ft
8-in nominal hole, 208.1-250-ft
Borehole drilled depth: [250.0-ft]

Drawing By: RKL/6N42W42B.ASB
Date : 20Oct94
Reference : HANFORD WELLS

DTB=Depth to bottom, 203.2-ft, 08Apr93

Figure C-1. Well 699-42-42B Construction and Completion Summary

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method:	CT-AR-Sonic	Sample Method:	Grab/Split Spoon	WELL NUMBER:	699-43-44 B8758
Drilling Fluid Used:	N/A	Additives Used:	None	TEMPORARY WELL NO:	Not Allowed
Driller's Name:	M. Wraspir	WA State Lic Nr:	1909	Coordinates: N	Not documented
Drilling Company:	Resonant Sonic Intl.	Company Location:	Woodland, Ca.	Coordinates: E	Not documented
Date Started:	13Sep99	Date Completed:	05Oct99	Start Card #:	R43389
				Elevation Ground Surface:	Brass Marker

Depth to Water: 176.1 ft 20Sep99
(Ground surface) 174.4 ft 05Oct99

GENERALIZED STRATIGRAPHY — **Geologist's Log**

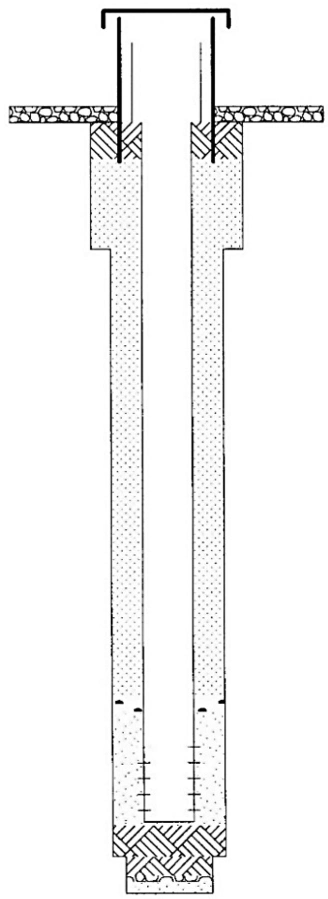
Elevation of Reference Point: m

Height of Reference Point Above Ground Surface:

Depth of Surface Seal: **10 ft.**

Type of Surface Seal: **4x4 Concrete Pad**

0 - 0.6 ft : Gravel drl. pad
0.6 - 4.5 ft : Silty Sandy Gravel
4.5 - 8.5 ft : SLIGHTLY Silty Sand
8.5 - 9.5 ft : Silty Sandy Gravel
9.5 - 19 ft : Sandy Gravel - Gravelly Sand
19 - 24.5 ft : Sand
24.5 - 36 ft : Sand - Slightly Silty Sand
36 - 75 ft : SAND
75 - 106.5 ft : SAND
106.5 - 112.5 ft : SANDY Gravel
112.5 - 113 ft : Silty Sandy GRAVEL
113 - 142 ft : SANDY GRAVEL
142 - 160 ft : Silty Sandy GRAVEL
160 - 161 ft : Sandy Gravel
161 - 164 ft : Silty Sandy Gravel
164 - 166 ft : Sand Gravel
166 - 167 ft : SAND
167 - 172 ft : Sandy GRAVEL
172 - 192 ft : Silty Sandy GRAVEL
192 - 208.5 ft : Silt
208.5 - 211 ft : Basalt (possible flow top breccia)



Fill	*Casing*	*Screen*
0 - 10 ft : 11.62-inch hole Cement Surface Seal	0 - 170.97 ft : 4 inch 4" SS Well Csg.	
10 - 34.8 ft : 11.62-inch hole Granular Bentonite		
34.8 - 157.1 ft : 8.62-inch hole Granular Bentonite		
157.1 - 161.3 ft : 8.62-inch hole 1/2" Bentonite Pellets		170.97 - 191 ft : 4 inch 4" SS Wire Wrap .010 Slot Scrn.
161.3 - 191.41 ft : 8.62-inch hole 20-40 Silica Sand		
191.41 - 192.4 ft : 8.62-inch hole 20-40 Silica Sand	191 - 191.41 ft : 4 inch 4" SS End Cap	
192.4 - 200.9 ft : 8.62-inch hole Portland Cement		
200.9 - 206.2 ft : 6.62-inch hole Portland Cement		
206.2 - 207.8 ft : 6.62-inch hole Slough		
207.8 - 211 ft : 6.62-inch hole 20-40 Silica Sand		

211 ft : Borehole drilled depth

0 - 34.8 ft : 11.62-in. 11-5/8" CS Temporary Csg.
34.8 - 200.9 ft : 8.62-in. 8-5/8" CS Temporary Csg.
200.9 - 211 ft : 6.62-in. 6-5/8" CS Temporary Csg.

Drawing By: JEA
Reference: Hanford Wells
Revision: 0
Revision Date: 29Feb00
Print Date: 01Mar00

BECHTEL

Figure C-2. Well 699-43-44 Construction and Completion Summary

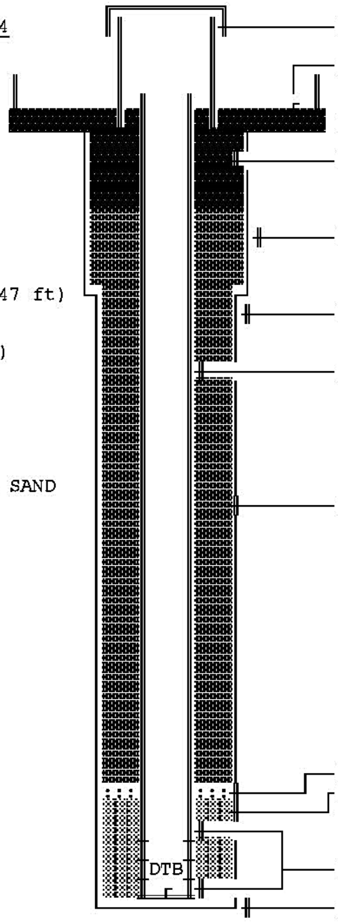
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel & Hard tool	WELL NUMBER: 699-43-45 A5180
Drilling Fluid Used: 200E Area Water	Additives Used: Not documented	TEMPORARY WELL NO: BP-1
Driller's Name: L. Watkins	WA State Lic Nr: Not documented	Hanford Coordinates: N/S N 42,977.4 E/W W 44,643.6
Drilling Company: KEH	Company Location: Hanford	State Coordinates: N 448,164.7 E 2,250,571.2
Date Started: 02May89	Date Complete: 02Jun89	Start Card #: 011453 T 12N R 26E S 1NW4
		Elevation Ground surface: 594.70-ft Brass cap

Depth to water: 187.7-ft Jun89
(Ground surface) 192.1-ft 22Jul94

GENERALIZED STRATIGRAPHY Geologist's Log

5-10: Muddy SAND
10-15: Gravelly SAND
15-20: SAND (medium)
20-25: Slightly gravelly SAND
25-40: Gravelly SAND
40-43: SAND
43-45: Slightly muddy med to very fine SAND
45-50: Muddy SAND(Perched water-47 ft)
50-60: SAND
60-70: Slightly gravelly SAND
70-85: SAND (COBBLES at 72-73 ft)
85-115: Sandy GRAVEL
115-135: Muddy sandy GRAVEL
135-146: Slightly sandy GRAVEL
146-150: Muddy GRAVEL
150-155: Sandy GRAVEL
155-195: Muddy sandy GRAVEL
195-200: Slightly muddy gravelly SAND
200-203: Gravelly SAND



Elevation of reference point: (top of casing) [597.68-ft]
Height of reference point above ground surface [3.0-ft]
Depth of surface seal [3.4-18.5-ft]
Type of surface seal:
Cement grout to 18.5-ft
4 x 4-ft x 4-in concrete pad extends 3.4-ft into annulus
11-in nominal hole, 0-47-ft
9-in nominal hole, 47.0-203.4-ft
4-in ID T304 stainless steel casing, +0.5-183.0-ft
Granular bentonite, 18.5-173.4-ft
Bentonite pellets, 173.4-179.2-ft
Silica sand pack, 179.2-203.6-ft, 8-20-mesh
4-in T304 stainless steel screen, 183.0-203.3-ft, #20-slot
Borehole drilled depth: [203.6-ft]
DTB=Depth to bottom, 203.9-ft, 08Apr93

Drawing By: RKL/6N43W45.ASB
Date : 22Sep94
Reference : HANFORD WELLS

Figure C-3. Well 699-43-45 Construction and Completion Summary

WELL CONSTRUCTION AND COMPLETION SUMMARY

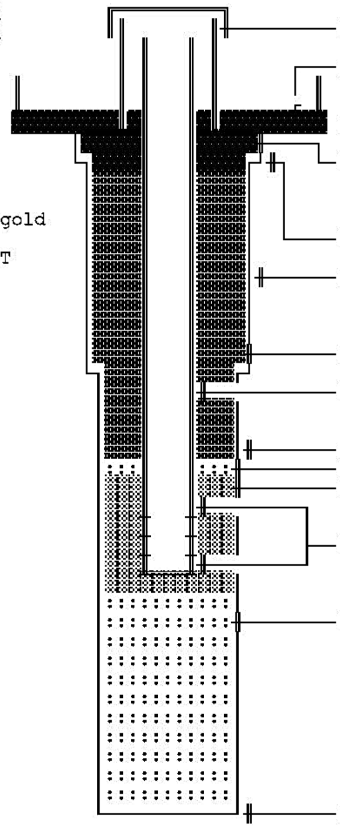
Drilling Method: Cable tool/air rotary	Sample Method: Drive barrel Air returns	WELL NUMBER: 699-44-39B A5185
Drilling Fluid Used: Raw water	Additives Used: None	TEMPORARY WELL NO:
Driller's Name: S. McKinnon	WA State Lic Nr: Not documented	Hanford Coordinates: N/S N 43,426.3 E/W W 39,140.4
Drilling Company: Jensen Drilling Co	Company Location: Not documented	State NAD83 Coordinates: N 136,727.61m E 577,960.30m; N 448,628 E 2,256,073
Date Started: 08Sep92	Date Complete: 03Nov92	Start Card #: Not documented T___ R___ S___
		Elevation Ground surface: 509.62-ft Brass cap

Backhoe to 8.8-ft

Depth to water: 93.3-ft 02Nov92
(Ground surface) 89.1-ft 22Jul94

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0-5: SAND-Eolian
5-69: Sl silty SAND
69-71: Sandy GRAVEL
71-92: Sl sandy GRAVEL
(Hanford/Lower Coarse Ringold contact @ 92-ft)
92-95: Gravelly SAND w/trace SILT
95-120: SAND
120-135: Sl sandy GRAVEL
135-140: Gravelly SAND
140-155: SAND
155-172: Gravelly SAND
172-181.9: BASALT
(Elephant Mt Member)



Elevation of reference point: [513.40-ft] (top of casing)
Height of reference point above ground surface [3.78-ft]
Depth of surface seal [2.0-10.2-ft]
Type of surface seal: Cement grout to 10.2-ft 4x4-ft x 6-in concrete pad extending 2.0-ft into annulus
13-in nominal hole, 0-8.5-ft
11-in nominal hole, 8.5-62.8-ft
8-20-mesh bentonite crumbles, 10.2-88.7-ft
4-in T304 stainless steel casing, +1.0-98.9-ft
9-in nominal hole, 62.8-181.9-ft
Bentonite HOLEPLUG chunks, 88.7-93.9-ft
20-40-mesh silica sand pack, 93.9-121.4-ft
4-in T304 stainless steel screen, 98.9-118.9-ft, #10-slot
Bentonite chunks, 121.4-181.9-ft
Borehole drilled depth: [181.9-ft]

Drawing By: RKL/6N44W39B.ASB
Date : 22Sep94
Reference : WHC-SD-EN-DP-053

Figure C-4. Well 699-44-39B Construction and Completion Summary

WELL CONSTRUCTION AND COMPLETION SUMMARY

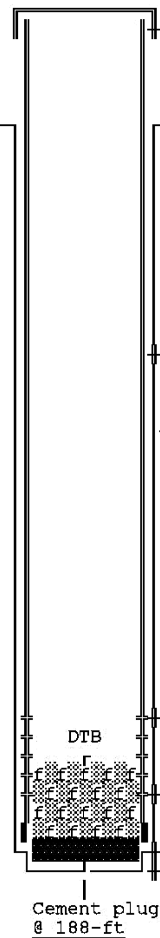
Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 699-45-42 A5195 TEMPORARY 699-46-42.5 WELL NO: 699-46-43
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 45,274 E/W W 42,099
Driller's Name: Baker	WA State Lic Nr: Not documented	State Coordinates: N 450,468 E 2,253,110
Drilling Company: Not documented	Company Location: Not documented	Start Card #: Not documented T 13N R 26E S 36R1
Date Started: 03Jun48	Date Complete: 23Jun48	Elevation Ground surface: 575.6-ft Estimated

Depth to water: 164-ft 18Jun48
(Ground surface) 159.2-ft 13Jun94

GENERALIZED STRATIGRAPHY Driller's Log

0-16: SAND & BOULDERS
16-25: BOULDERS
25-35: Black SAND and GRAVEL
35-40: Cse black SAND
40-55: Cse black SAND and small GRAVEL
55-65: SAND and GRAVEL w/some CLAY
65-90: Black SAND & GRAVEL w/some CLAY
90-95: Gray SAND w/some CLAY
95-120: SAND and SILT
120-125: SAND, GRAVEL and SILT
125-126: SAND and GRAVEL
126-132: BOULDERS
132-140: Gray SAND and SILT
140-141: Gray SAND and BOULDERS
141-143: Cse GRAVEL and BOULDERS
145-150: Gray SAND and BOULDERS
150-160: Gray SAND and cse GRAVEL
160-165: SAND, CLAY and GRAVEL
165-180: SAND and a lot of red CLAY
180-189: Volcanic ASH
189-190: Volcanic ASH and ROCK
190-195: Volcanic ASH and BASALT
195 : Black BASALT

REMEDIATIONS:
Sep56 by Row-Wall
Perforated 158-180-ft.
Nov 75 by M Bultena
Set cement plug
@ 188-ft.



Elevation of reference point: (top of casing) [577.33-ft]
Height of reference point above ground surface [1.7-ft]
Depth of surface seal [ND]
No surface seal documented:

8-in ID carbon steel casing, +1.7-187.5-ft

9-in nominal hole, 0-187.5-ft

8-in casing perforations, 158-180-ft, 6 holes/ft

8-in nominal hole, 187.5-195.0-ft

Borehole drilled depth: [195.0-ft]

DTB=Depth to bottom, 171.9-ft, 07Sep93

Drawing By: RKL/6N45W42.ASB
Date : 23Sep94
Reference : HANFORD WELLS

Figure C-5. Well 699-45-42 Construction and Completion Summary

C2 Reference

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

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