S

DOE/RL-2008-59
Revision 0

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

P.O. Box 550
Richland, Washington 99352

DOE/RL-2008-59
Revision 0

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

Date Published
September 2010

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

J.E. Bratton 9/20/2010
Release Approval Date

Printed in the United States of America

Executive Summary

This document presents a revision to the 2005 groundwater monitoring plan (PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*) for the 216-B-3 Main Pond (hereafter referred to as the B Pond). The groundwater monitoring plan is based on requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA) and the *Revised Code of Washington* (RCW) 70.105, "Public Health and Safety," "Hazardous Waste Management."

The B Pond is a non-operational treatment, storage, and disposal (TSD) unit in the 200-CW-1 Chemical Sewer Operable Unit (OU). The B Pond is regulated as a surface impoundment and has been designated as a TSD unit because it received nonradioactive dangerous waste regulated by 40 *Code of Federal Regulations* (CFR) 261, "Identification and Listing of Hazardous Waste," after November 19, 1980.

This groundwater monitoring plan presents a groundwater contamination indicator evaluation monitoring program that will detect any adverse impact from past B Pond operations on groundwater quality in the uppermost aquifer beneath the TSD unit.
This document addresses the operational history, current hydrogeology, and groundwater monitoring results for the site and incorporates the sum of knowledge regarding the potential for contamination originating from the B Pond. A site conceptual model is developed based on these attributes of the B Pond and the data quality objectives (DQO) process.

The B Pond is located approximately 1,600 m (5,249 ft) east of the 200 East Area fence (Figure ES-1). The main pond is located in a natural topographic depression, diked on the eastern margin, and covers approximately 14.2 ha (35 ac). The B Pond began receiving effluent in 1945 at the site of the main pond (initially referred to as the B-3 Pond). The last recorded discharge to any of ponds was 1997. With the exception of the B-3C Pond, all ponds and ditches associated with this unit have been backfilled to grade.

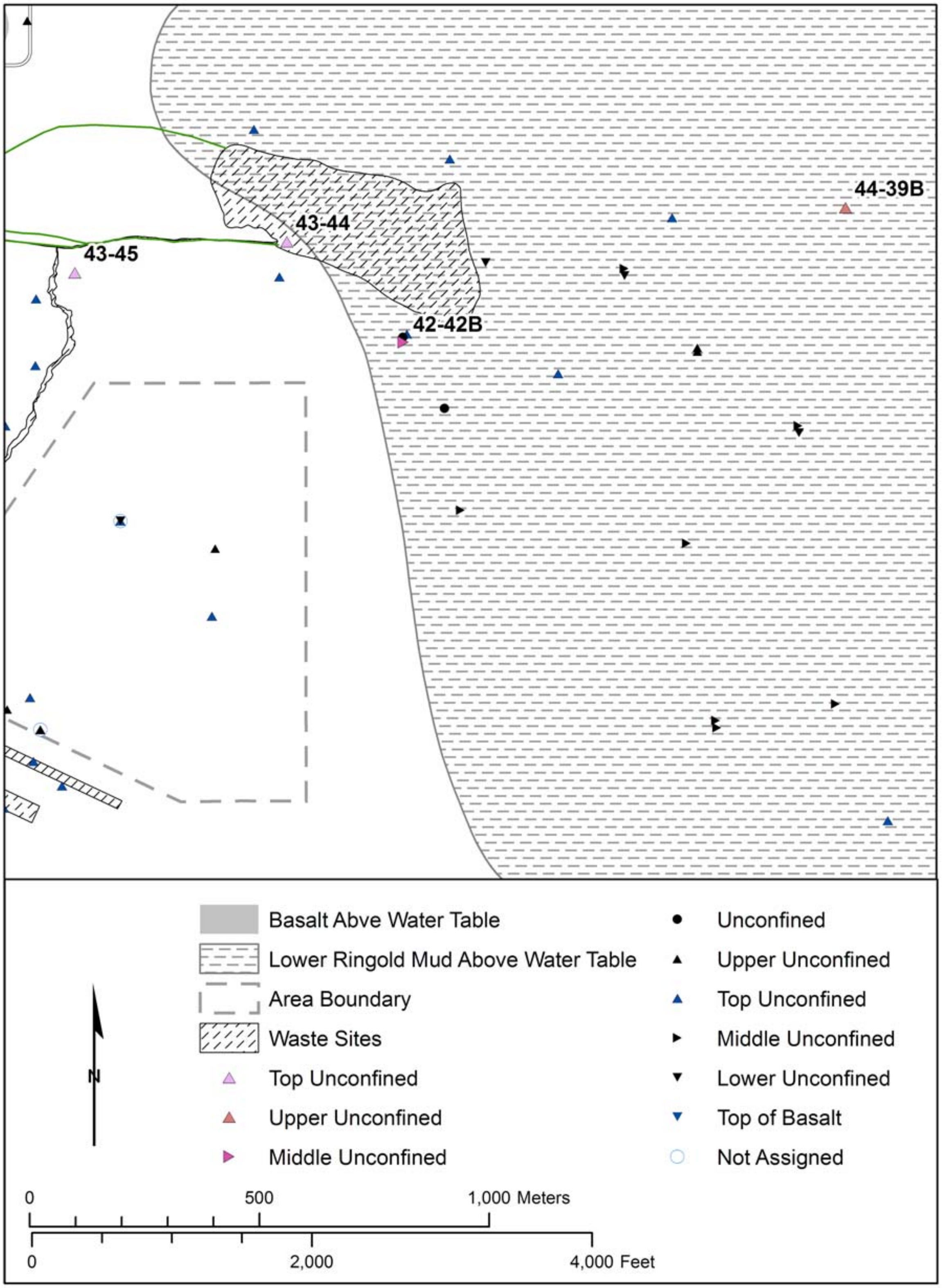

Figure ES-1. Current RCRA Monitoring Well Network

To date, no dangerous waste or dangerous waste constituents subject to *Washington Administrative Code* (WAC) 173-303, “Dangerous Waste Regulations,” and associated with releases to the B Pond have been detected in groundwater beneath the unit. Therefore, the site remains under indicator evaluation monitoring for indicator parameters, as specified in 40 CFR 265.92, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.”

The B Pond began receiving effluent in 1945 at the site of the main (B-3) pond (Figure ES-1). In April 1994, discharges to the main pond and the 3A expansion pond ceased, and all effluents were re-routed to the 3C expansion pond. In addition, at that time, the main pond and 216-B-3-3 Ditch were filled with clean soil. Prior to diversion of effluent from the main pond, the 3A, 3B, and 3C expansion ponds were clean-closed under RCRA. This determination indicates that no identifiable waste remains in the closed facilities. In June 1995, portions of the effluent stream were re-routed from the 3C expansion pond to the permitted 200 Areas Treated Effluent Disposal Facility (TEDF). The remaining streams were diverted from the 3C expansion pond to the TEDF by August 1997. The 3C expansion pond is still maintained as an overflow contingency for the TEDF.

The B Pond received effluent from several 200 East Area facilities, including the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, A Tank Farm, 242-A evaporator, 244-AR vault, and the 284-E power plant. Dangerous waste associated with these operations came from two primary sources: (1) corrosive and dangerous waste resulting from regeneration of demineralizer columns at the PUREX Plant, (2) spills of dangerous or mixed waste at other facilities, and (3) off-specification chemical make-ups at the PUREX Plant. The dangerous waste consists of toxicity characteristic waste (D006), discarded chemical products (U133), and state-only waste (WT02 and WT01). The last known reportable discharge of chemical waste, sodium nitrite, occurred in 1987.

Because the B Pond received wastewater potentially contaminated with dangerous waste/dangerous waste constituents, a contamination indicator groundwater monitoring program was implemented in 1988. In 1990, statistical evaluation of total organic halides (TOX) and total organic carbon (TOC) showed that concentrations in two downgradient wells were statistically greater than background levels. Resampling verified the elevated TOC and TOX levels, and a required groundwater quality assessment plan for the B Pond was prepared and initiated (WHC-SD-EN-AP-030, *Groundwater Quality Assessment Plan for the 216-B-3 Pond System*).

In 1997, the results of the groundwater quality assessment program concluded that the increased concentrations of TOC and TOX were isolated occurrences (PNNL-11604, *Results of RCRA Groundwater Quality Assessment at the 216-B-3 Pond Facility*). Because these constituents could not be correlated to any dangerous waste/dangerous waste constituent that was released to the B Pond system, it was concluded that the groundwater had not been adversely impacted.

The site was returned to indicator parameter monitoring in 1998. Through 2009, TOX or TOC results still occasionally spike, sometimes above the critical mean. The reason for these spikes remains unclear.

The geologic units present beneath the B Pond and their orientation have a significant effect on groundwater flow and contaminant migration in this area. In the southern and eastern portions of the 200 Areas, a particularly persistent layer of clay and silt within the lowermost Ringold Formation allows for further subdivision of this unit into a lower confined sand unit, a middle confining unit, and an upper gravel/sand unit. Overlying the lowermost Ringold Formation units is the lower mud unit. The Ringold lower mud unit is not present in the northwestern portion of the B Pond but is up to 24 m (approximately 80 ft) thick near the southern extreme of the B-3C expansion pond and generally thickens south and southeast of the main pond.

Because of the dipping beds of the Ringold Formation and the unconformable contact between them and the overlying Hanford formation, groundwater beneath the B Pond occurs in both confined and unconfined states, depending on the specific location. The uppermost aquifer is unconfined to the west, southwest, and north of the main pond where the Ringold Formation confining units are absent. The aquifer becomes progressively more confined to the east and southeast of the facility. Observations of water levels and aquifer testing data indicate that the change from unconfined to confined conditions is apparently gradational in most of the areas around B Pond. Water from below the Ringold lower mud unit discharges to the unconfined aquifer along this boundary.

The Ringold lower mud unit and the lowermost middle confining unit are believed to have intercepted infiltrating effluent in some areas around the B Pond, diverting water down-dip along the surface of the units. Near the western end of the main pond, these fine-grained units are thin or absent, thus allowing effluent to reach the lower most Ringold sands and gravels. This artificial recharge has resulted in an increase in the confined hydrostatic pressure observed in wells completed below the fine-grained units east and southeast of the facility, and some distance away from the point of infiltration (i.e., at the TEDF).

In general, groundwater moves west to southwest within the confined Ringold Formation units beneath the B Pond complex before entering the unconfined aquifer south and west of the main pond (Figure ES-2). From that point, flow within the unconfined aquifer is dominantly west southwest for a short distance before turning southeastward to flow over the top of the same units (e.g., lower mud unit). This is possible because of the south-trending structural dip of the Ringold Formation strata.

The monitoring network consists of one upgradient well (699-44-39B) and three downgradient wells (699-43-45, 699-43-44, and 699-42-42B). All network monitoring wells were constructed to meet resource protection well standards of WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells.” None of these wells are anticipated become dry within the foreseeable future.

The groundwater at the B Pond monitoring wells will be sampled in compliance with WAC 173-303-400(3), “Dangerous Waste Regulations,” “Interim Status Facility Standards.” The B Pond network groundwater wells will be sampled semiannually for indicator parameters TOC, TOX, pH, and specific conductance. Additional parameters (i.e., dissolved oxygen, temperature, and turbidity) will be measured as indicators of sample quality and general aquifer/well environmental conditions. Alkalinity, major anions, and water levels will also be collected semiannually. Wells will be monitored annually for metals and phenols.

Arsenic and nitrate have been identified as constituents of interest in the groundwater that could be associated with B Pond operations. Because these constituents are also associated with existing sitewide plumes, they will be monitored on a regional scale as part of the 200-PO-1 OU and are not specifically included as constituents for B Pond.

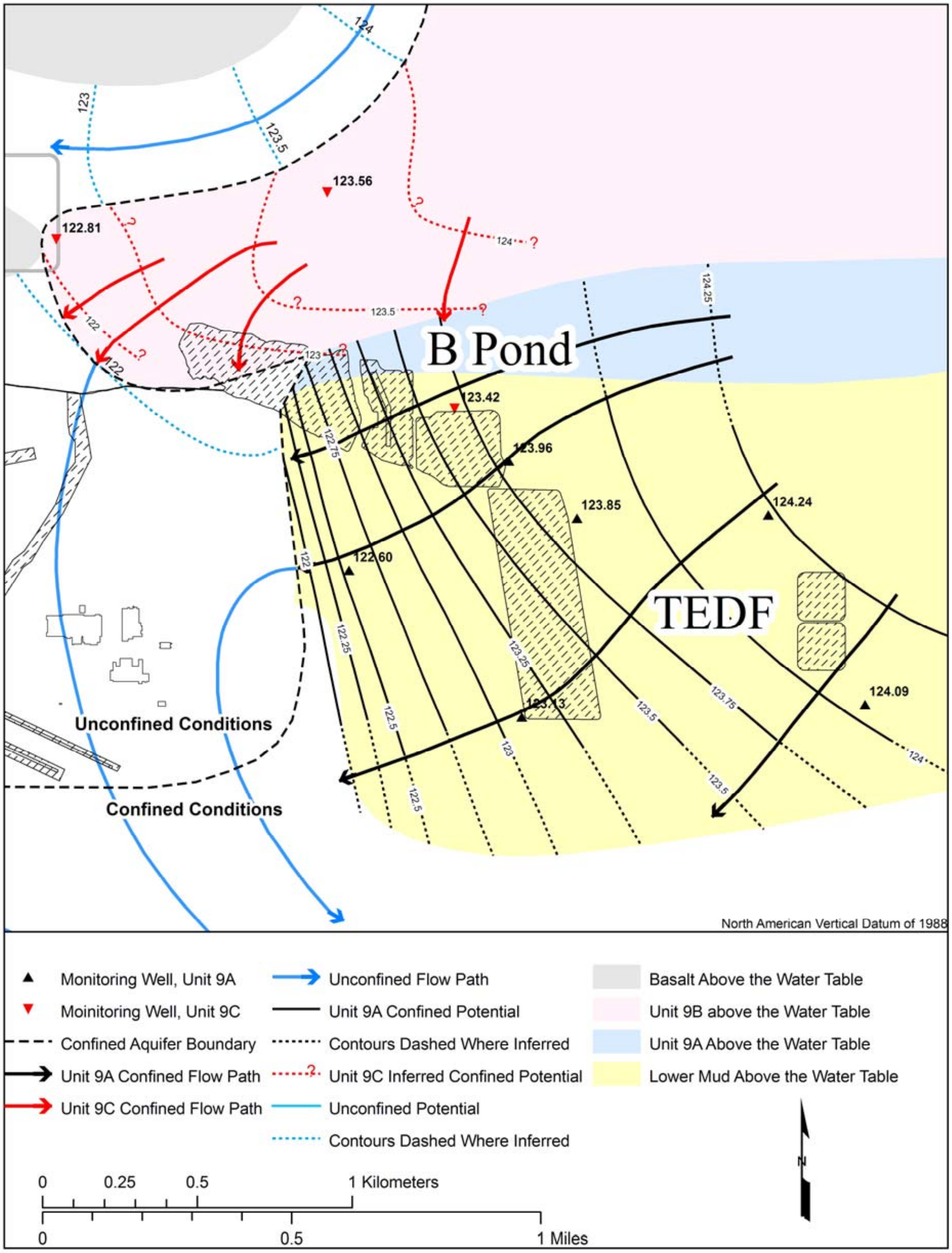

Figure ES-2. March 2004 Potentiometric Surface for the Confined and Unconfined Aquifers near B Pond and Geometry of Significant Hydrostratigraphic Units

Contents

Appendix

Figures

Tables

Terms

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DQO	data quality objective
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
OU	operable unit
PUREX	Plutonium-Uranium Extraction (Plant)
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	*Revised Code of Washington*
TEDF	Treated Effluent Disposal Facility
TOC	total organic carbon
TOX	total organic halides
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*
WTP	Waste Treatment Plant

1 Introduction

This document revises the 2005 groundwater monitoring plan (PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*) for the 216-B-3 Main Pond (hereafter referred to as B Pond). This groundwater monitoring plan is based on requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA) and amended by *Revised Code of Washington* (RCW) 70.105, "Hazardous Waste Management Act." These regulations are promulgated by the Washington State Department of Ecology (Ecology) under *Washington Administrative Code* (WAC) 173-303-400 ("Dangerous Waste Regulations," "Interim Status Facility Standards") and, by reference, 40 *Code of Federal Regulations* (CFR) 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring").

The B Pond is a non-operational treatment, storage, and disposal (TSD) units in the 200-CW-1 Chemical Sewer Operable Unit (OU). The B Pond is regulated as a surface impoundment, as defined in WAC 173-303-040, "Definitions." The B Pond has been a designated TSD unit because it received nonradioactive dangerous waste regulated by 40 CFR 261, "Identification and Listing of Hazardous Waste," after November 19, 1980. For regulatory purposes, the TSD unit boundary of the B Pond is identified in the current Dangerous Waste Permit Application Part A Form (WA7890008967, *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*).

The B Pond closure is coordinated with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) as part of the 200-CW-1 OU (vadose zone) for future OU groupings under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989). The B Pond is located within the 200-PO-1 Groundwater OU.

The B Pond is located approximately 1,600 m (5,249 ft) east of the 200 East Area fence. Figure 1-1 shows the location of the B Pond system. The main pond is located in a natural topographic depression, diked on the eastern margin, and covers approximately 14.2 ha (35 ac). The B Pond had a maximum depth during operational use of approximately 6.1 m (20 ft) and began receiving effluent in 1945 at the site of the main pond (initially referred to as the B-3 Pond).

The purpose of this RCRA groundwater monitoring plan is to detail a groundwater contamination indicator evaluation monitoring program for the B Pond. This document addresses the operational history, current hydrogeology, and groundwater monitoring results for the site, and it incorporates the sum of knowledge regarding the potential for contamination originating from B Pond. A conceptual site model is developed based on these attributes of the B Pond and the data quality objectives (DQO) process.

The groundwater contamination indicator evaluation monitoring program detailed in this monitoring plan provides continued semiannual sampling for the indicator parameters at one upgradient and three downgradient wells. Annual sampling of groundwater quality parameters is also performed at these wells.

Chapter 2 of this plan presents background information on historical and present facility operations, waste characteristics, geology, hydrology, previous monitoring results, and a site conceptual model. Chapters 3 and 4 present details of the monitoring program and data evaluation and reporting, respectively. A list of the references cited is provided in Chapter 5. Appendix A provides the quality assurance project plan (QAPjP).

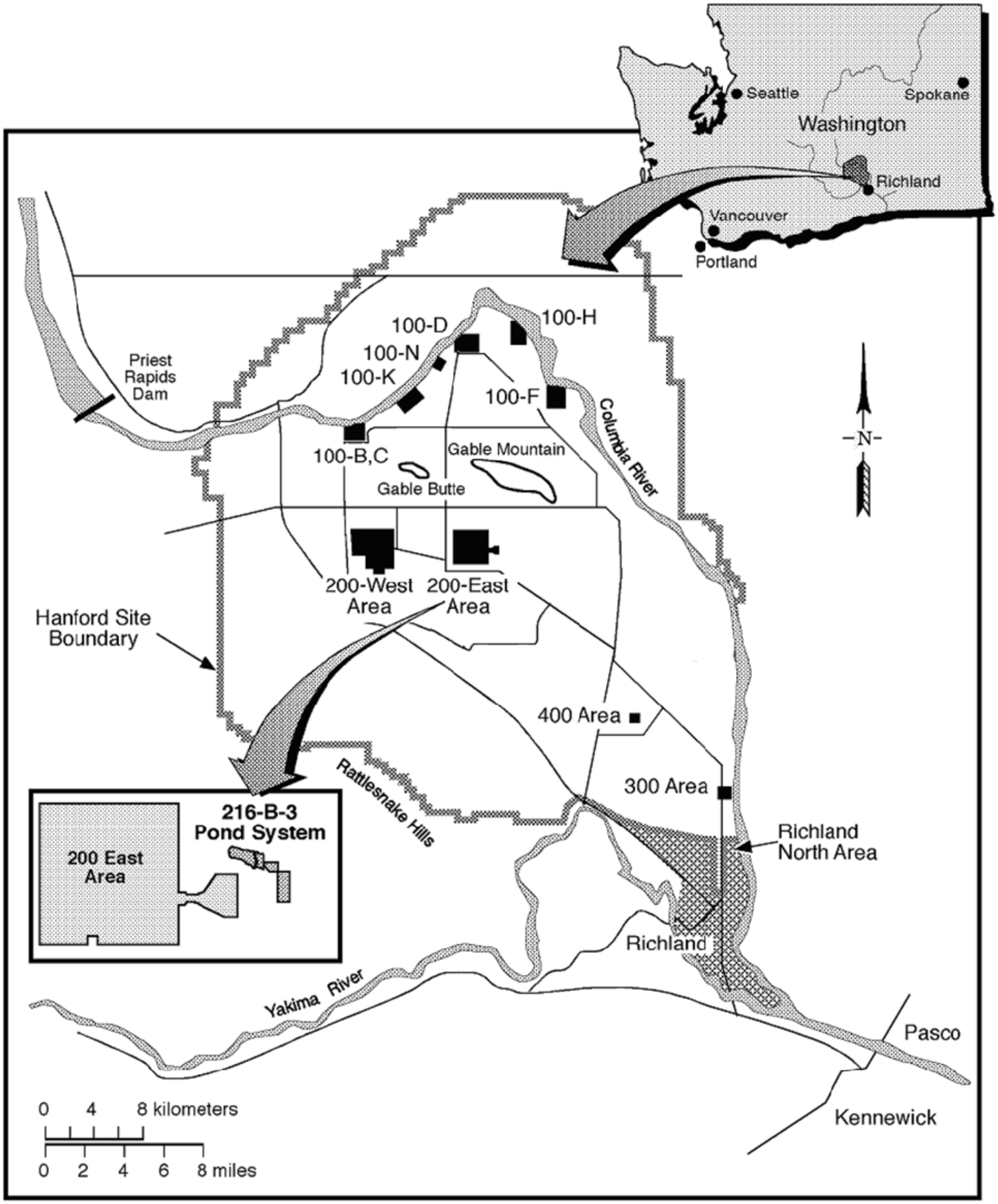

Figure 1-1. Location of the 216-B-3 Main Pond

2 Background

This chapter provides a description of B Pond and its operational history, the regulatory requirements for groundwater monitoring, and waste characteristics. It also summarizes the hydrogeology beneath B Pond, outlines a conceptual model for contaminant migration, describes groundwater contamination in the uppermost aquifer, and addresses the DQOs.

2.1 Facility Description and Operational History

The B Pond began receiving effluent in 1945 at the site of the main pond (B-3). 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. 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 (Figure 2-1). The 3A and 3B expansion ponds are approximately 4.5 ha (11 ac) in size, and the 3C expansion pond is approximately 16.6 ha (41 ac). The 216-B-3-1, 216-B-3-2, 216-B-3-3, and 216-A-29 Ditches were used to convey effluent from the production facilities in the 200 East Area to the main pond, where the water then evaporated and infiltrated into the ground. 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, *216-B-3 Expansion Ponds Closure Plan*, Rev. 1). DOE/RL-92-05, *B Plant Source Aggregate Area Management Study Report*, presents operational details for these ponds and ditches.

Discharge volumes to the B Pond averaged around 1.0×10^{10} L/year (2.6 billion gal/year), except for a short period in the mid-1980s. From 1986 to 1991, discharges to the B Pond 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 (260 billion gal). Figure 2-2 shows the annual and cumulative discharges to B Pond.

Beginning in April 1994, discharges to the main pond and the 3A expansion pond ceased, and all effluents were re-routed to the 3C expansion pond via a pipeline. Also during 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. This determination 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 require groundwater monitoring under WAC 173-303 requirements.

In June 1995, portions of the effluent stream were re-routed to the permitted 200 Areas Treated Effluent Disposal Facility (TEDF). The remaining streams were diverted from the 3C expansion pond to the TEDF by August 1997, thus ending all routine operation of the B Pond system. The 3C expansion pond is still maintained as an overflow contingency for the TEDF. Historic effluent feeds are further described in DOE/RL-92-05 and WHC-EP-0813, *Groundwater Impact Assessment Report for the 216-B-3 Pond System*.

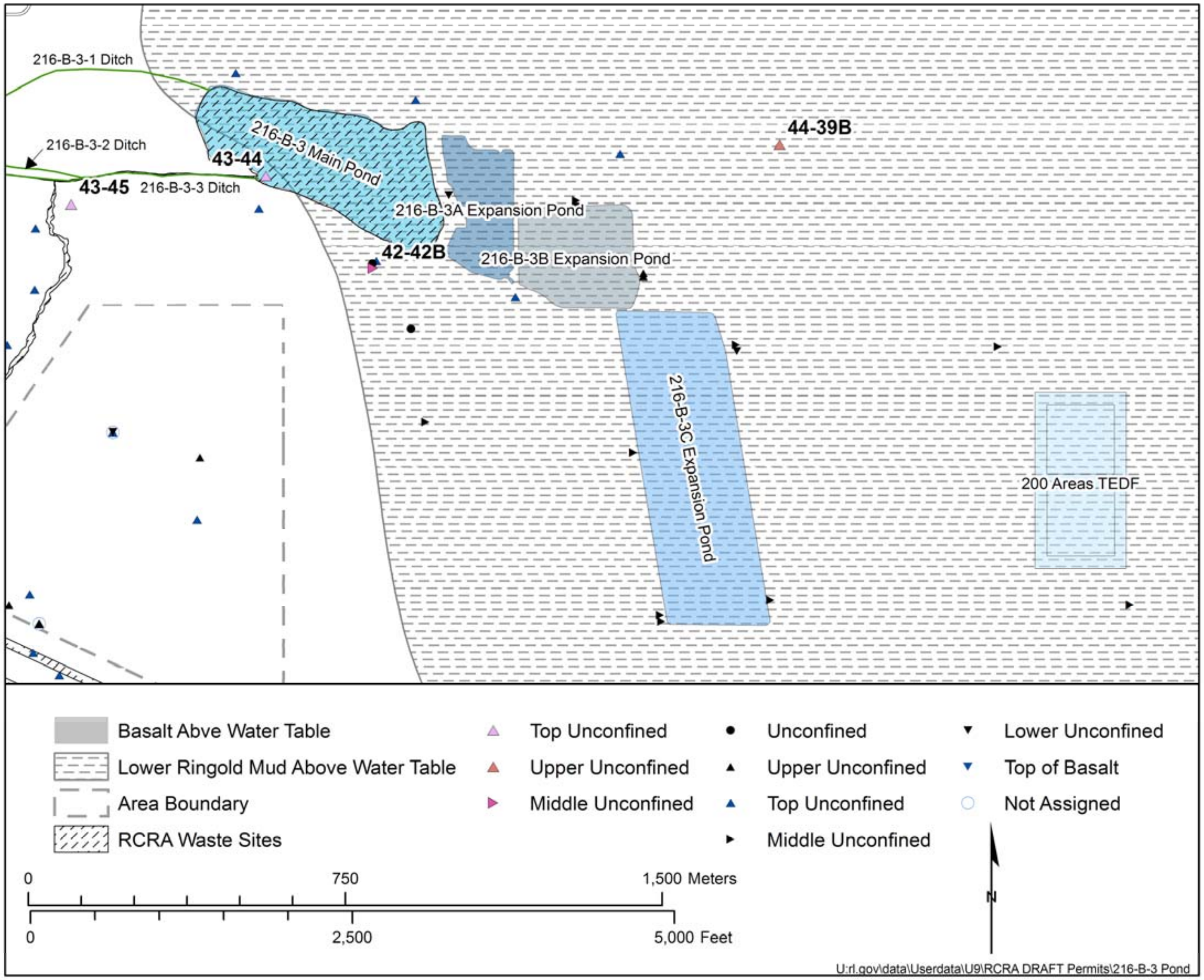

Figure 2-1. 216-B-3 Pond System and 200 Area TEDF

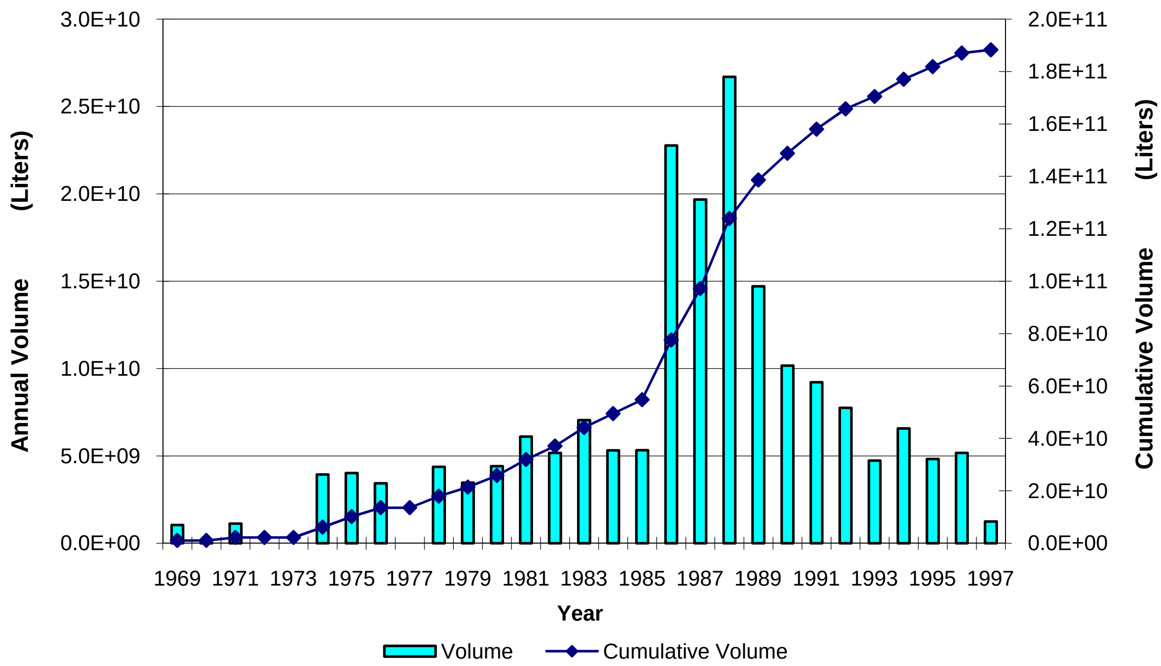

Figure 2-2. Annual and Cumulative Discharges to the 216-B-3 Main Pond

2.2 Regulatory Basis

The B-3 Pond is classified as a TSD unit because it received dangerous waste after one of two effective dates. The effective date for nonradioactive dangerous waste discharges is November 19, 1980, for dangerous waste regulated by 40 CFR 261; or March 10, 1982, for dangerous waste regulated by WAC 173-303 only (e.g., state-only dangerous waste). Since the corrosive waste (D002) discharged to the B-3 Pond is regulated under 40 CFR 261, the effective date of regulation for this unit is November 19, 1980 (see definition of “active portion” in WAC 173-303-040).

The B Pond is currently subject to the regulations of WAC 173-303-400 and those portions of 40 CFR 265, Subpart F, as incorporated by reference in WAC 173-303-400.

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

Groundwater monitoring has been conducted in accordance with the above-referenced RCRA requirements since 1988. Interim status monitoring was performed from 1988 to 1990, when monitoring was changed to an assessment program (40 CFR 65.93[d], “Preparation, Evaluation, and Response”) due to elevated levels of total organic halides (TOX) and total organic carbon (TOC) in two downgradient wells. The assessment report concluded that no hazardous waste or hazardous waste constituents associated with the B Pond site could be correlated to the elevated TOX or TOC results (PNNL-11604, *Results of RCRA Groundwater Quality Assessment at the 216-B-3 Pond Facility*), and the site was returned to indicator parameter monitoring in 1998.

2.3 Waste Characteristics

The B Pond received effluent from several 200 East Area facilities, including the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, A Tank Farm, 242-A evaporator, 244-AR vault, and the

284-E power plant. 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 make-ups 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 nitrite, occurred in 1987. 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 nitrite, occurred in 1987.

The results of PUREX chemical sewer effluent analyses for dangerous and radioactive components are provided in WHC-EP-0052, *Preliminary Evaluation of Hanford Liquid Discharges to Ground*, and additional data can be found in WHC-EP-0367, *Liquid Effluent Study Final Project Report*. The identity and quantity of dangerous waste disposed at the B Pond are outlined in the RCRA Part A Form. Dangerous wastes disposed included corrosive waste, cadmium, hydrazine, and dangerous waste/toxic dangerous waste.

2.4 Geology and Hydrology

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

- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- 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*

The most detailed descriptions of stratigraphic relationships at the B Pond are presented in DOE/RL-92-05 and DOE/RL-93-74, *200-BP-11 Operable Unit and 216-B-3 Main Pond Work/Closure Plan, Hanford Site, Richland, Washington*. A description of groundwater hydrology and groundwater contamination in the region of the Hanford Site surrounding B Pond is presented in DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*. 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 the B Pond, upon which much of the groundwater monitoring program is based (Chapter 3).

2.4.1 Stratigraphy

The principal geologic units beneath the B Pond include (from youngest to oldest) the Pleistocene Hanford formation, the Miocene/Pliocene Ringold Formation, and Elephant Mountain Member of the Saddle Mountains Basalt. PNNL-12261 (upon which much of this section is based) uses the nomenclature first described in PNNL-10195, *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1994 Status Report*, near the 200 East Area and B Pond. The nomenclature in PNNL-12261 is also referenced to the more recent descriptions in BHI-00184, *Miocene-to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*.

In PNNL-12261, the sediments in the 200 East Area above the Columbia River Basalt Group are divided into four distinct hydrostratigraphic units. The lowermost unit is the Ringold Formation Unit A of document BHI-00184 (Unit 9 in PNL-10195). In the southern and eastern portions of the 200 Areas, a particularly persistent layer of clay and silt within this unit allows for further subdivision of this unit into a lower confined unit (Unit 9C), a middle confining unit (Unit 9B), and an upper gravel/sand unit (Unit 9A).

Overlying Ringold Units 9A through 9C is the lower mud unit (Unit 8 in PNL-10195). The Ringold lower mud sequence is not present in the northwestern portion of the B Pond but is up to 24 m (approximately 80 ft) thick near the southern extreme of the 3C expansion pond, generally thickening south and southeast of the main pond. 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 near B Pond (Section 2.4.2).

Above the lower mud unit lie the fluvial gravels and sands of Ringold Unit E (Unit 5 in PNL-10195). Unit E has been removed from Gable Gap and most of the 200 East Area to approximately the May Junction Fault 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. As described in PNNL-12261, Unit E comprises the uppermost unconfined aquifer south and west of the 200 East Area.

The majority of the vadose zone above the Ringold Formation units is the Hanford formation (Unit 1 in PNL-10195). The Hanford formation ranges in thickness from approximately 40 m (about 130 ft) beneath the 216-B-3-C Pond to about 50 m (160 ft) at the northwestern corner of the main pond (WHC-SD-EN-ES-004, *Site Characterization Report: Results of Detailed Evaluation of the Suitability of the Site Proposed for Disposal of 200 Areas Treated Effluent*). The Hanford formation is represented by three facies, in descending stratigraphic order (with subdivisions as provided in WHC-SD-EN-TI-012): upper gravel sequence, designated as “H1”; sandy sequence designated as “H2”; and lower gravel sequence, designated as “H3.”

The 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 the main 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. The sandy H2 sequence is present mainly near the main pond of the B Pond system but has a significant silt/clay component in the extreme western portion of the main pond near the 216-B-3-3 Ditch.

The orientation of the stratigraphic units is shown along a northwest-southeast trending cross-section through the B Pond area in Figure 2-3.

2.4.2 Physical Hydrogeology

Figure 2-3 also shows the interpreted hydrostratigraphic relationships in the B Pond/TEDF area. Because of the dipping beds of the Ringold Formation and the unconformable contact between them and the overlying Hanford formation, groundwater beneath the B Pond occurs in both confined and unconfined states, depending on the specific location. The uppermost aquifer is unconfined to the west, southwest, and north of the main pond where the Ringold Formation confining units are absent. The aquifer becomes progressively more confined to the east and southeast of the facility. Actual observations of water levels during drilling and monitoring, as well as aquifer testing data, indicate that the change from unconfined to confined conditions is apparently gradational in most of the areas around B Pond. Figure 2-4 illustrates the hydrologic effects of the complex stratigraphy near B Pond. The heavy dashed line demarcates the approximate boundary between confined and unconfined conditions. Water from Units 9A and 9C discharges to the unconfined aquifer along this boundary.

The Ringold Formation gravels (Units 9A and 9C) comprise the bulk of the uppermost aquifer in the B Pond area. In the extreme western portion of the facility (western end of the main pond and portions of the 216-B-3-3 Ditch), the unconfined aquifer occurs in the Hanford formation, as well as Unit 9A. Except for the western portion of the main pond area, most of the Hanford formation near the B Pond is coarse-grained and highly permeable. Estimates of the saturated thickness of the uppermost aquifer at the B Pond range from less than 10 m (33 ft) in the northwest portion of the main pond to greater than 30 m (98 ft) near the southern end of the 216-B-3-C Pond. Hydraulic conductivities in the B Pond area have been calculated at 1 to 640 m/day (3 to 2,100 ft/day), depending on the unit (Ringold Formation and Hanford formation, respectively) where this property is measured (WHC-SD-EN-EV-002, PNL-10195).

2.4.3 Groundwater Flow Interpretation

Groundwater beneath the B Pond was historically interpreted to flow radially outward in the unconfined aquifer from a hydraulic mound, the apex of which was located near the 216-B-3-B Pond. This mound was a result of discharges to B Pond and remained a major influence on flow direction even after discharges ended in 1997. Continued well drilling, aquifer testing, and a re-examination of the hydrostratigraphy in PNNL-12261 indicate that groundwater flow is more complicated than suggested by earlier interpretations.

The uppermost unconfined aquifers in the B Pond/TEDF area appear to have been mostly isolated from a significant part of the B Pond effluent discharges, and likely all of the TEDF discharges. The effluent was mostly intercepted by the intervening lower mud unit (Unit 8) and diverted along the upper surface of this fine-grained unit, predominantly to the south. Where the lower mud unit dips below the water table, the effluent entered the more permeable Hanford formation, south and west of the main pond (Figure 2-4). This interpretation is supported by the fact that no hydrologic response to TEDF discharges has thus far been observed in the TEDF wells (completed in Unit 9A) since the facility began operating in 1995. Wells in this region, including those near the southern extreme of the 216-B-3-C Pond, have shown only a general decline in head since TEDF installation in the early 1990s, with only a brief period of stasis in 1995, prior to TEDF operation.

Some of the B Pond effluent apparently did enter Units 9A and 9C where the overlying confining layers (lower mud unit and Unit 9B) were absent. Groundwater sampling data indicate that the contamination 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 the B Pond. Hydrostratigraphic research indicates that a stratigraphic “trap” could exist near the south and southeast extremities of the facility (e.g., south of the TEDF and 216-B-3-C Pond) that may have prevented any appreciable groundwater movement in this direction (PNNL-12261). However, calculations of hydraulic conductivity, stratigraphic relationships recently recognized in distal southeast portions of the area (e.g., south of the TEDF), and groundwater geochemistry suggest that actual movement of groundwater in a southeast direction has been more limited than depicted by historical interpretations of the water table around B Pond. Similar limitations of flow may exist immediately west of the main pond; thus, the relatively uniform radial flow pattern envisioned in earlier reports (e.g., PNNL-11604) was likely oversimplified.

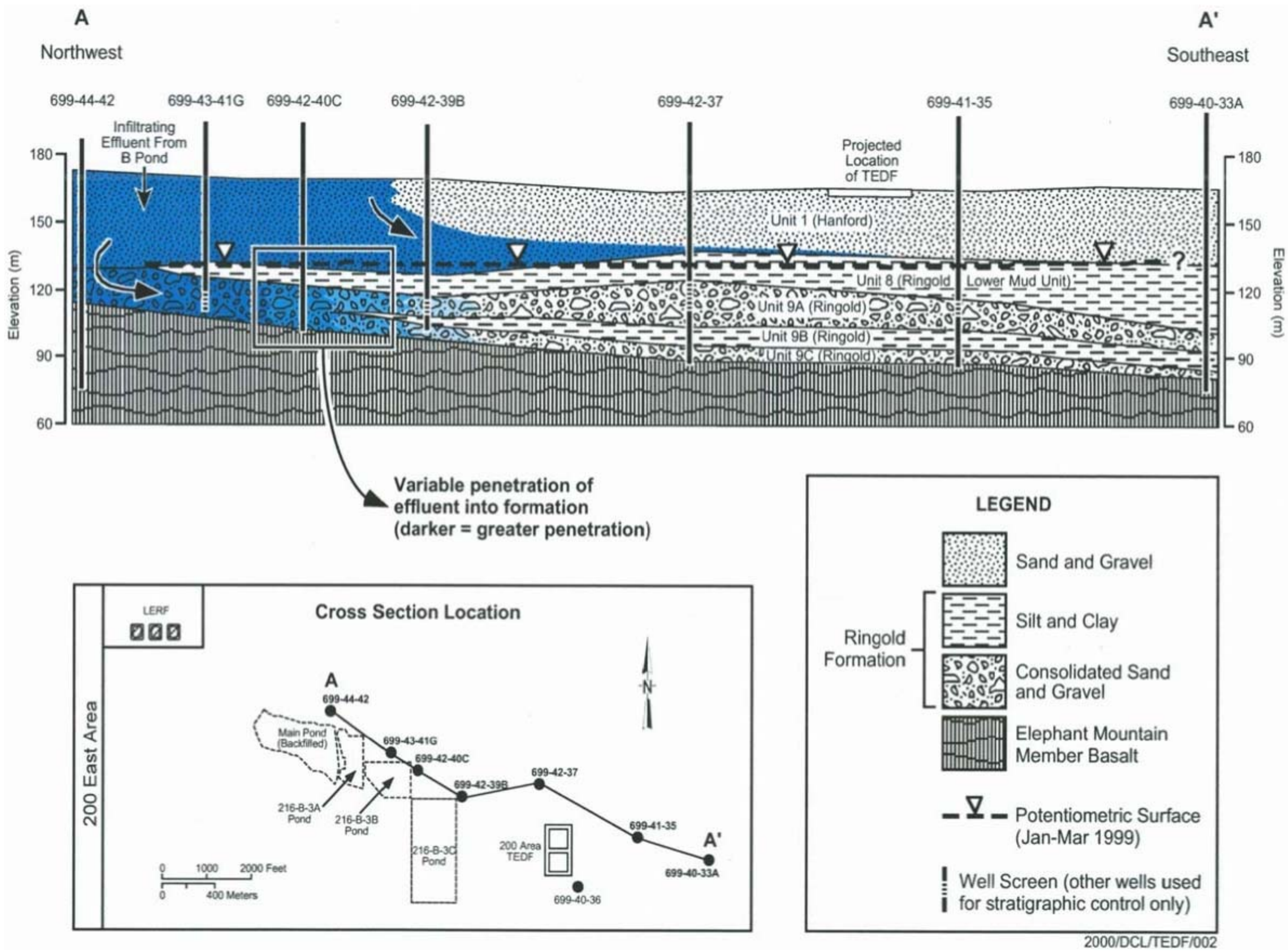

Figure 2-3. Cross-Section of the B Pond Area Showing General Hydrostratigraphic Relationships and Possible Subsurface Effluent Flow Patterns

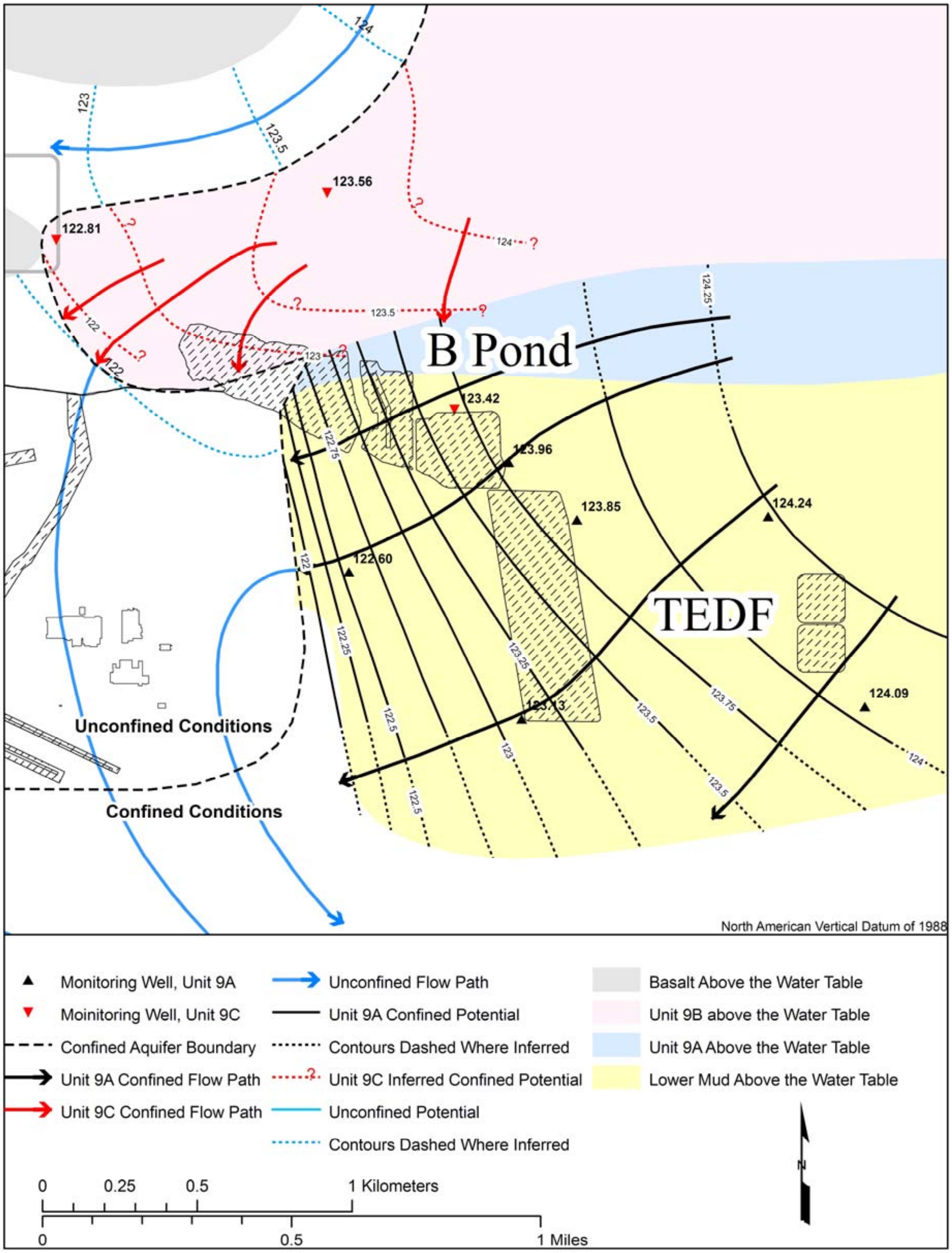

Figure 2-4. March 2004 Potentiometric Surface for the Confined and Unconfined Aquifers near B Pond and Geometry of Significant Hydrostratigraphic Units

In addition, it is postulated that the north-south trending May Junction Fault (located to the east of the B Pond area) may represent a barrier to groundwater flow in Units 9A and 9C, preventing any appreciable flow to the east. Within these units near the B Pond, groundwater currently flows to the west-southwest and discharges to the unconfined aquifer along the erosional boundary of the confining units. Aquifer tests from B Pond wells near the southern end of the 216-B-3-C Pond and wells monitored for the TEDF indicate low hydraulic conductivities and low groundwater flow rates (less than or equal to 0.004 m/day [0.013 ft/day]) for Unit 9A in this area.

In general, Figure 2-4 illustrates that groundwater moves west to southwest within the Ringold Formation units beneath the B Pond complex before entering the unconfined aquifer south and west of the main pond. From that point, flow within the unconfined aquifer (Hanford formation) is also dominantly west-southwest before turning southeastward to flow over the top of the same units (e.g., lower mud unit) that are responsible for the confinement in the B Pond/TEDF region. This is possible because of the south-trending structural dip (which is exaggerated in Figure 2-3) of the Ringold Formation strata. As stated previously, discharges from the TEDF have little effect on groundwater flow beneath the B Pond due to the southerly dip of the Ringold sediments.

The horizontal component of the hydraulic gradient near B Pond varies with location, being lower near the former mound apex and steeper west-southwest of the main pond. An average gradient of 0.0036 is used here. An estimate of the average linear flow velocity with a hydraulic conductivity of 1 m/day (3 ft/day) and an effective porosity value of 0.25 yields a groundwater flow velocity 0.0015 m/day (0.03 ft/day).

The water table and potentiometric surface represented in Figure 2-4 indicate flow potential not actual flow. Although the hydraulic gradient around B Pond clearly indicates a potential for west to southwest groundwater flow, actual flow may be limited. However, the increased gradient indicated near the main pond suggests a limitation to flow in a west-southwest direction.

2.5 Summary of Previous Groundwater Monitoring

A RCRA-compliant monitoring network has been used to monitor the groundwater beneath the B Pond system since 1988. The groundwater monitoring well network for B Pond has undergone several changes since the initiation of indicator evaluation monitoring. The initial network consisted of 25 wells installed around the B Pond facility between 1988 and 1992.

The number of wells in the network was reduced to 13 wells in 1995 because of clean closure of the 3A, 3B, and 3C expansion ponds in order to eliminate redundancy and to focus resources on additional hydrochemical analyses in the remaining wells. From late 1998 through early 2000, the network was restructured again to (1) adjust for changes in the groundwater flow direction caused by the cessation of effluent disposal to the facility, (2) compensate for the declining water levels that had led to some wells going dry, and (3) further reduce redundancy in monitoring locations. The site-specific constituent list of groundwater analyses was also amended to more accurately address potential contaminants at this site. The current monitoring well network for the B Pond consists of one upgradient well and three downgradient wells. A more detailed summary of the initial network and subsequent changes is provided in *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility* (PNNL-13367).

2.5.1 Groundwater Contamination

In 1990, the groundwater monitoring program changed from a RCRA indicator evaluation program to an assessment program due to elevated levels of TOC and TOX in downgradient well 699-43-41E. A groundwater quality assessment plan was submitted to Ecology in May 1990 (WHC-SD-EN-AP-030). In 1997, the final assessment report was issued, concluding that the occurrences of elevated TOC and TOX were mostly isolated and that no dangerous waste could be correlated to the TOC or TOX results

(PNNL-11604). The only contaminant that could be attributed with any degree of certainty to the B Pond system was nitrate, with arsenic possibly originating from B Pond. Certain radionuclides were also tied to discharges to the B Pond system but are not subject to regulation under RCRA. With the issuance of the final assessment report in 1998, the groundwater monitoring program reverted to indicator evaluation monitoring.

During the entire period of monitoring, no measured concentrations of a dangerous waste/waste constituent exceeding drinking water standards (DWSs) have been conclusively attributed to discharges from the B Pond. Chromium, iron, and manganese have been found above their respective DWSs in network wells, but the results are attributed to well construction and have no significance as groundwater contaminants at B Pond (PNNL-15479). Arsenic has also been detected above the DWS, mostly in wells in the western portion of the B Pond area. While arsenic may have originated from B Pond, it is also possible that originated from cribs and ditches in the 200 East Area.

Nitrate and arsenic are the most significant constituents, but the maximum nitrate concentration since 1988 is much below the DWS (Figure 2-5), while arsenic has not been detected above the DWS since 1995. For most constituents, the maximum concentrations occurred in the early 1990s.

Since 1998, when the site was returned to indicator evaluation monitoring after an assessment period, there have been no confirmed exceedances of a critical mean value for any of the indicator parameters (i.e., pH, specific conductance, TOC, and TOX) in downgradient monitoring wells

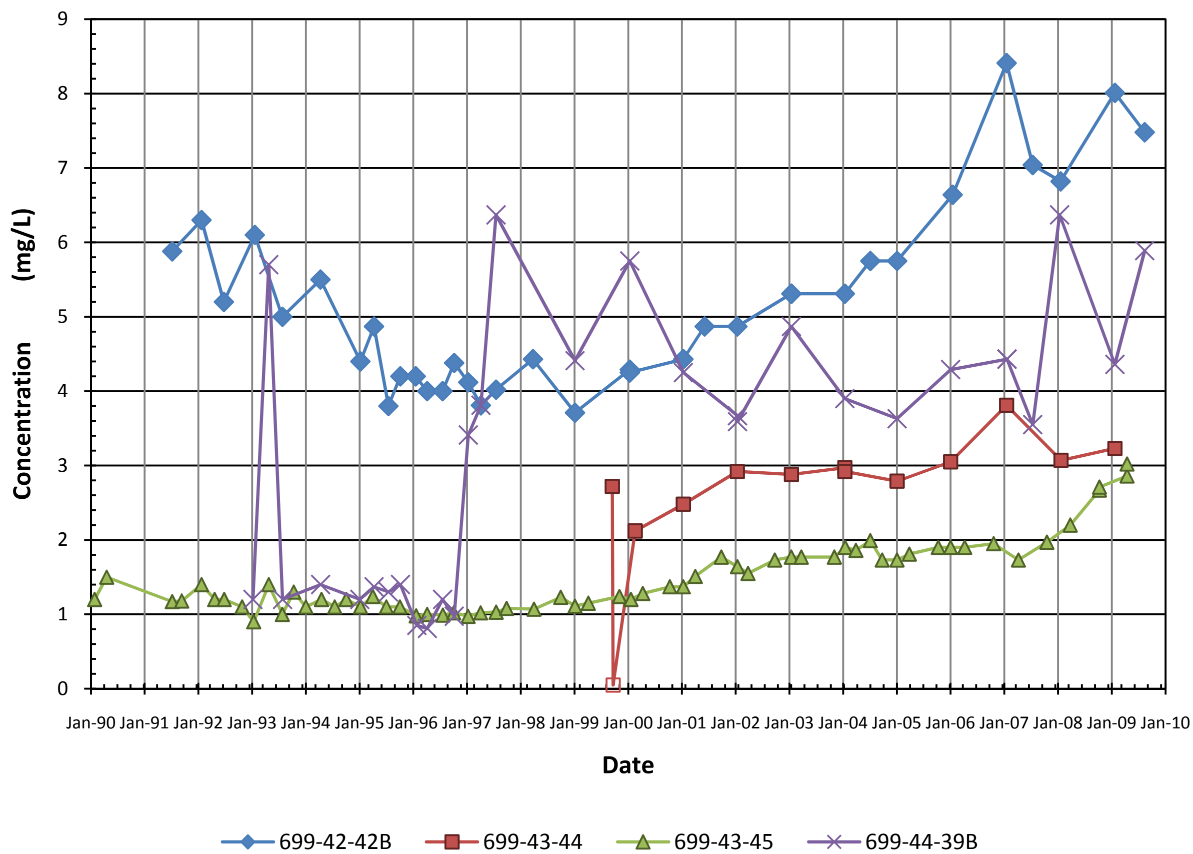

Figure 2-5. Nitrate Concentrations in Groundwater for Selected B Pond Network Wells

2.5.2 Vadose Zone Contamination

Based on the history of known and potential contaminants discharged to the B Pond system, a series of soil contamination evaluations were conducted for the main pond, expansion ponds, and nearby portions of the 216-B-3-3 Ditch between 1989 and 1992. This evaluation 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), as well as deep vadose zone sampling in the expansion ponds (DOE/RL-89-28). The results indicated minimal amounts of contamination. Antimony, cadmium, copper, lead, mercury, and zinc were found above background levels but were below toxic levels or the cleanup standards of WAC 173-340, "Model Toxics Control Act – Cleanup." Organic constituents were below detection or contract-required quantitation limits, except for a few compounds found at low levels that were associated with laboratory or blank contamination.

A more recent vadose zone characterization effort for the main pond and the 216-B-3-3 Ditch was performed in 1999 to support the 200-CW-1 OU remedial investigation (BHI-01367, *200-CW-1 Operable Unit Borehole/Test Pit Summary Report*). This investigation found that contamination of soil in the B-3 Main Pond and 216-B-3-3 Ditch appears to be relatively limited, in both depth and magnitude. The greatest concentrations of dangerous constituents were found at the main pond bottom (1.5 to 4 m [4.9 to 13.1 ft] below ground surface). Cadmium, lead, and mercury were above the WAC 173-340 Method B cleanup levels in soils collected from the northwestern portion of the pond.

Contaminant distribution in the 216-B-3-3 Ditch was similar to the pattern in the main pond, so most of the contamination was found at or slightly below the ditch bottom. Low concentrations of several organic constituents were found in the ditch sediment, and the metals arsenic and mercury were found at maximum concentrations of 14.7 and 0.51 mg/kg, respectively. All results for dangerous constituents at the 216-B-3-3 Ditch were below WAC 173-340 Method B cleanup levels. PNNL-13367 provides additional information on the soil sampling results for B Pond.

These soil results resulted in analyses for total and dissolved concentrations of these metals over a 4-year period, from January 2002 through January 2005. No anomalous concentrations or trends of these constituents were found in groundwater; thus, sampling is no longer required for these constituents. Specific analyses for these metals were discontinued after the January 2005 sampling.

2.6 Conceptual Model

Soil and groundwater analyses in the B Pond area have not revealed any substantial contamination by dangerous waste/dangerous waste constituents (Sections 2.5.1 and 2.5.2). Extensive sampling of vadose zone soil across the B Pond area has indicated very little contamination of any kind. Based on characterization and monitoring performed to date, the actual impact to groundwater is minor.
A conceptual model of contaminant transport is presented in this section to guide future groundwater monitoring. Because of the dynamic conditions at B Pond (i.e., a receding groundwater mound and consequent alteration of groundwater flow patterns), this model will require periodic updates.

2.6.1 Contaminant Source

As discussed in Section 2.4.2, the uppermost unconfined aquifers in the B Pond/TEDF area appear to have been mostly isolated from a significant part of the B Pond effluent discharges, and likely all of the TEDF discharges. The intervening, fine-grained units (lower mud unit and Unit 9B) intercepted infiltrating effluent in some areas around the facility, diverting the wastewater down along the surface of the units, predominantly to the south. Where these fine-grained 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 the contamination 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 the B Pond. This artificial recharge has resulted in an increase in the confined hydrostatic pressure observed in wells completed below the fine-grained units east and southeast of the facility, some distance away from the point of infiltration.

While there is a possibility that effluent releases associated with construction of the Waste Treatment Plant (WTP) may impact some of the B Pond groundwater monitoring wells, there is low probability of this occurring. This is due to the releases are occurring either hydraulically downgradient or cross-gradient from the B Pond wells. The well with the highest probability of being impacted is 699-43-45, which is located about 200 m (656 ft) north of the construction site boundary and cross-gradient from the WTP site. For any effluents released from the WTP construction site to reach this well, a sufficient volume would have to be released to significantly alter the groundwater flow direction in this area. The effluent releases are small in comparison to the aquifer volume and are mostly associated with concrete mixing, dust control, and a sanitary/septic system. There are no permit limits on the volume of concrete mixing releases, so the volume of actual releases is not monitored. However, only a few very small ponds exist at the site, so the release volume is expected to be low. The estimated volume of sanitary releases at the WTP construction site for calendar year 2003 was 6.4×10^7 L (1.7 million gal) (HNF-EP-0527-17, *Environmental Releases for Calendar Year 2007*).

Arsenic and nitrate are associated with widespread (sitewide) contamination plumes. Nitrate has an areal distribution that suggests it originated, at least in part, from the B Pond. Arsenic has been detected primarily in wells at the western extremity of the B Pond network and may have originated from 200 East Area cribs and ditches. Arsenic and nitrate are constituents of regional interest and are therefore monitored under the *Atomic Energy Act of 1954* and CERCLA long-term monitoring, and they are not included specifically as constituents for RCRA monitoring.

Anionic species, often complexed with radionuclides, were predominant in the waste streams sent to B Pond. Nitrate is still present in groundwater beneath the facility, so specific conductance will be measured as part of the B Pond monitoring program. Specific conductance was depressed because of the dilution of groundwater from B Pond effluents, and it has been returning to equilibrium with aquifer materials. Therefore, the specific conductance background values continue to be evaluated and revised as necessary to provide a useful indicator of contamination.

2.6.2 Driving Force

In general, the two ways that contaminants can migrate to groundwater are (1) the volume of the wastewater discharged was large enough to reach groundwater through gravity drainage and/or capillary action, or (2) an external source of water or other liquid may act to drive residual contamination downward. As shown in Section 2.1, discharges over the lifetime of the B Pond system were clearly sufficient for wastewater to reach groundwater.

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 due to the lack of any water lines 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 current mean annual precipitation rate is 17.2 cm (6.8 in.), with most annual accumulation occurring between November and February (PNNL-18807, *Soil Water Balance and Recharge Monitoring at the Hanford Site – FY09 Status Report*). Recharge in the B Pond area is estimated to be between 26 and 52 mm (1.02 and 2.05 in.) annually based on PNNL-14702, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*. The range of recharge rates depends on a variety of factors, such as soil texture and vegetation cover.

The risk of infiltration by snowmelt and the potential for vertical migration of contaminants, however, is considered low because of low annual precipitation.

2.6.3 Migration

Though not regulated under RCRA, tritium provides a good indication of the influence of B Pond effluent on the underlying groundwater. Tritium was present in the B Pond effluent and is mobile in the subsurface; therefore, it can be assumed to indicate the maximum extent that contaminants (including those that are RCRA-regulated) may have moved through the groundwater. In effect, tritium serves as a tracer for B Pond effluent. The distribution of tritium in groundwater at B Pond is depicted by the map of maximum sampling results presented in Figure 2-6. The most striking feature of this illustration is the apparent southwest-northeast line demarcating the limit of tritium occurrence in the confined aquifer. This feature suggests that tritium (and other effluent from B Pond) has not migrated southeast of this line. Low-level analyses for tritium from wells at the TEDF indicate levels of tritium below natural background for the uppermost aquifer (PNNL-11986, *Evaluation of Groundwater Monitoring Results at the Hanford Site 200 Area Treated Effluent Disposal Facility*), thus suggesting a relatively old age for groundwater at this location. Analyses for tritium in these wells have been performed since 1992 or earlier. This feature has important implications for groundwater monitoring at B Pond.

2.6.4 Implications for Groundwater Monitoring

Conceptual models of 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 B Pond infiltrated into the ditches leading to the main pond, probably within the 200 East Area, with some of the effluent reaching as far as the main pond itself. The possible pathways for contamination reaching groundwater are from remobilization of existing contamination in the vadose zone beneath the main pond or from effluent that has been intercepted in the vadose zone by the Ringold lower mud unit (Unit 8), which may then move laterally along this perching layer to enter the unconfined aquifer. Sampling of monitoring wells south to southwest of the main pond can detect both of these potential sources under the current groundwater flow regime.

2.7 Data Quality Objectives

The DQO process ensures that data gathered during an investigation are of the appropriate quantity and quality to meet specific objectives. The DQOs for the groundwater indicator monitoring are presented in SGW-34011, *Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit*.

The current groundwater monitoring network for B Pond is a result of previous investigations and DQOs. Table 2-1 provides a matrix of the data requirements that are typically determined in a DQO process, the associated interim status regulations applicable to these requirements, and the current and historical documentation specifying how the monitoring program for B Pond complies with requirements.

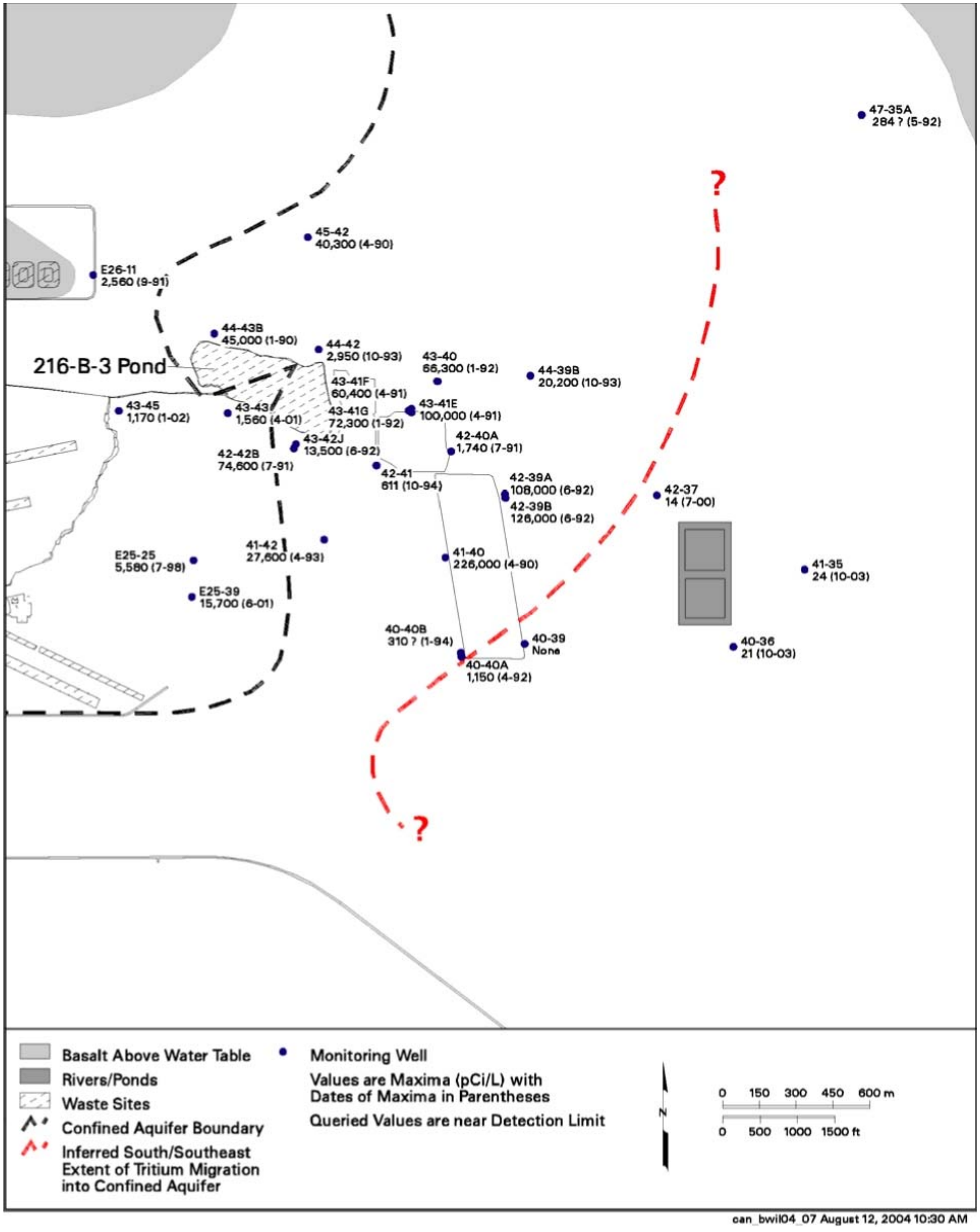

Figure 2-6. Tritium Maxima in the 216-B-3 Pond and Vicinity Wells
Showing Extent of Tritium Migration in the Confined Aquifer

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

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Scope	RCRA interim status ground-water monitoring at sites where no impact to ground-water has been identified. Requirements are found in WAC 173-303-400(3) and 40 CFR 265.90 through 265.94, as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).	
Number and location of wells Point(s) of compliance	**40 CFR 265.91, Ground-Water Monitoring System.** (a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of: (1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are: (i) Representative of background ground-water quality in the uppermost aquifer near the facility; and (ii) Not affected by the facility; and (2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer.	This plan, Sections 2.4, 2.5, 2.6, and 3.2 PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility* CP-15329, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*
Well configuration (depth and length of screened interval; well construction)	**40 CFR 265.91, Ground-Water Monitoring System.** (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand, where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.	This plan, Section 3.2 and Appendix A PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility* BHI-01239, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report* BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* CP-15329, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*

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

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
	Additional Requirements from WAC 173-303-400(3)(c)(v)(C). Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells.	
Frequency of sampling Types of analysis or measurement Method detection limits or accuracy and precision	**40 CFR 265.92, Sampling and Analysis.** (b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section: (1) Parameters characterizing the suitability of the ground-water as a drinking water supply, as specified in Appendix III. *[Note: Have not listed these because, in accordance with 40 CFR 265.92(c)(1) below, these analyses are only conducted for the first year. None of the RCRA sites are in the first year of monitoring.]* (2) Parameters establishing ground-water quality: (i) Chloride (ii) Iron (iii) Manganese (iv) Phenols (v) Sodium (vi) Sulfate *[Comment: These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required under 40 CFR 265.93(d).]*	This plan, Sections 3.1, 3.3, and 3.4; Appendix A PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility* BHI-01239, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report* SGW-34011*, Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit* CP-15329, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*

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

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
	40 CFR 265.92, Sampling and Analysis. (cont'd.) (3) Parameters used as indicators of ground-water contamination: (i) pH (ii) Specific Conductance (iii) Total Organic Carbon (iv) Total Organic Halogen (c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in paragraph (b) of this section. The owner or operator must do this quarterly for one year. (2) For each of the indicator parameters specified in paragraph (b)(3) of this section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples, obtained from upgradient wells during the first year. (d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies: (1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually. (2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semiannually. (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	

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

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Methods used to evaluate the collected data	**40 CFR 265.93, Preparation, Evaluation, and Response.** (b) For each indicator parameter specified in 40 CFR 265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with 40 CFR 265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the student's t-test at the 0.01 level of significance (see Appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background.	This plan, Section 3.2 and Appendix A PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility* BHI-01239, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report* BHI-01276, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report* SGW-34011, *Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit* CP-15329, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*

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

CFR = *Code of Federal Regulations*

DQO = data quality objective

RCRA = *Resource Conservation and Recovery Act of 1976*

WAC = *Washington Administrative Code*

3 Groundwater Monitoring Program

This chapter describes the interim status indicator evaluation groundwater monitoring program for the B Pond facility, including the monitoring well network, target constituents, and sampling and analysis methods. The monitoring program is unchanged from that previously presented in PNNL-15479.

3.1 Special Conditions at the 216-B-3 Pond

The atypical history of effluent discharges to the B Pond, the complex geologic formations in which the aquifer beneath the facility is found, and the resulting hydrologic and hydrochemical conditions require special consideration in the formulation of an appropriate groundwater monitoring program. The conceptual model discussed in Section 2.6 describes these special conditions. The following elements of the plan are designed to detect contaminants with the greatest potential for occurrence in groundwater at the B Pond facility.

3.2 Constituent List and Sampling Frequency

Table 3-1 lists the constituents to be analyzed under the B Pond facility groundwater monitoring program. In compliance with 40 CFR 265.92, as incorporated by reference by WAC 173-303-400(3), the B Pond network groundwater wells will be sampled semiannually for the indicator parameters TOX, TOC, pH, and specific conductance. Water levels will be measured semiannually. Wells will be monitored annually for alkalinity, major anions, metals, and phenols. Anions are included to detect potential nitrate contamination and to provide input for charge balance calculations. Alkalinity will be used to calculate a groundwater charge balance. The major ions will also be evaluated for geochemical relationships (e.g., stiff diagrams). Groundwater quality parameters (i.e., dissolved oxygen, temperature, and turbidity) will be measured as indicators of sample quality and general aquifer/well environmental conditions.

Arsenic and nitrate have been identified as constituents of interest in the groundwater that could be associated with B Pond operations. Because these constituents are also associated with existing sitewide plumes, they will be monitored on a regional scale as part of the 200-PO-1 OU; however, they are included in this plan as constituents of interest for the purpose of continuity.

Cadmium is known to have been a constituent discharged to the B Pond as cadmium nitrate. Since cadmium has the potential to be mobile in the subsurface, it will be analyzed for as a contaminant of interest.

Hydrazine was also discharged as a constituent to the B Pond. Because hydrazine was discharged as an “off-specification chemical,” it is considered a listed waste (U133). During the investigation of the 216-B-3-3 Ditch and B-3 Main Pond, a “contained-in” determination was requested and approved by Ecology for soils associated with investigation derived waste and any future B Pond and ditch contaminated soil designations (“Approval of the Contained-In Determination Request for Hydrazine” [Hedges, 2000]). 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”; “Sampling and Analysis Instruction for Hydrazine Sampling in Groundwater Associated with the 216-B-3 Main Pond and 216-A-29 Ditch” [Becker-Khaleel, 2001]). However, based on review of the results from the sampling effort, hydrazine is not being considered as a contaminant of interest at B Pond due to the rapid oxidation in the environment to nitrogen and water.

3.3 Monitoring Well Network

Figure 3-1 shows the location of the wells in the monitoring network. The network consists of one upgradient well (699-44-39B) and three downgradient wells (699-43-45, 699-43-44, and 699-42-42B). Table 3-2 summarizes well construction information, including the current depth of water (as of 2009) in each well.

PNNL-15479 provides the construction details and lithologic information for the B Pond network wells. All network monitoring wells were constructed to meet resource protection well standards of WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells.” None of these wells are anticipated become dry within the foreseeable future.

Because of the complex orientation of geologic strata beneath B Pond and the unconfined and confined aquifers, well 699-44-39B is the most logical selection for an upgradient monitoring location. This well is completed in Ringold Unit 9A and it is currently upgradient of B Pond. Although groundwater flows beneath the Ringold lower mud unit confining layer near well 699-44-39B, this water discharges to the unconfined portion of the aquifer southwest and south of the main pond and 216-B-3-3 Ditch.

3.4 Sampling and Analysis Protocol

Groundwater monitoring at B Pond is part of the Soil and Groundwater Remediation Project’s routine network. Sampling and analysis protocols follow the conventions of the project and are described in the QAPjP (Appendix A).

Table 3-1. Monitoring Well Network, Constituent List and Sampling Frequency for the 216-B-3 Pond Facility

			RCRA Required Constituents[a]											Contaminants of Interest			Supporting Constituents[b]					
				Indicator Parameters				Groundwater Quality Parameters									Field			Laboratory		
Well	Position in Groundwater Gradient	WAC-Compliant	Water Level	pH[c]	Specific Conductance[c]	TOC	TOX	Chloride	Iron (Unfiltered)	Manganese (Unfiltered)	Phenols	Sodium (Unfiltered)	Sulfate	Arsenic (Filtered and Unfiltered)	Nitrate	Cadmium (Filtered and Unfiltered)	Dissolved Oxygen[c]	Temperature[c]	Turbidity[c]	Alkalinity	Anions[d]	Metals[e] (Unfiltered)
699-44-39B	Upgradient	C	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	A	S	S	A	A	A
699-42-42B[f]	Downgradient	C	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	A	S	S	A	A	A
699-43-44	Downgradient	C	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	A	S	S	A	A	A
699-43-45	Downgradient	C	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	A	S	S	A	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 measurement.

d. Anions; analytes include, but are not limited to, chloride, fluoride, sulfate, nitrate, and nitrite for charge-balance computations.

e. Metals; analytes include, but are not limited to, common soil minerals; calcium, magnesium, potassium, and sodium for charge-balance computations.

f. Deeper well.

A = to be sampled annually

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

RCRA = *Resource Conservation and Recovery Act of 1976*

S = to be sampled semiannually

S4 = to be sampled semiannually with quadruplicate samples taken

TOC = total organic carbon

TOX = total organic halides

WAC = *Washington Administrative Code*

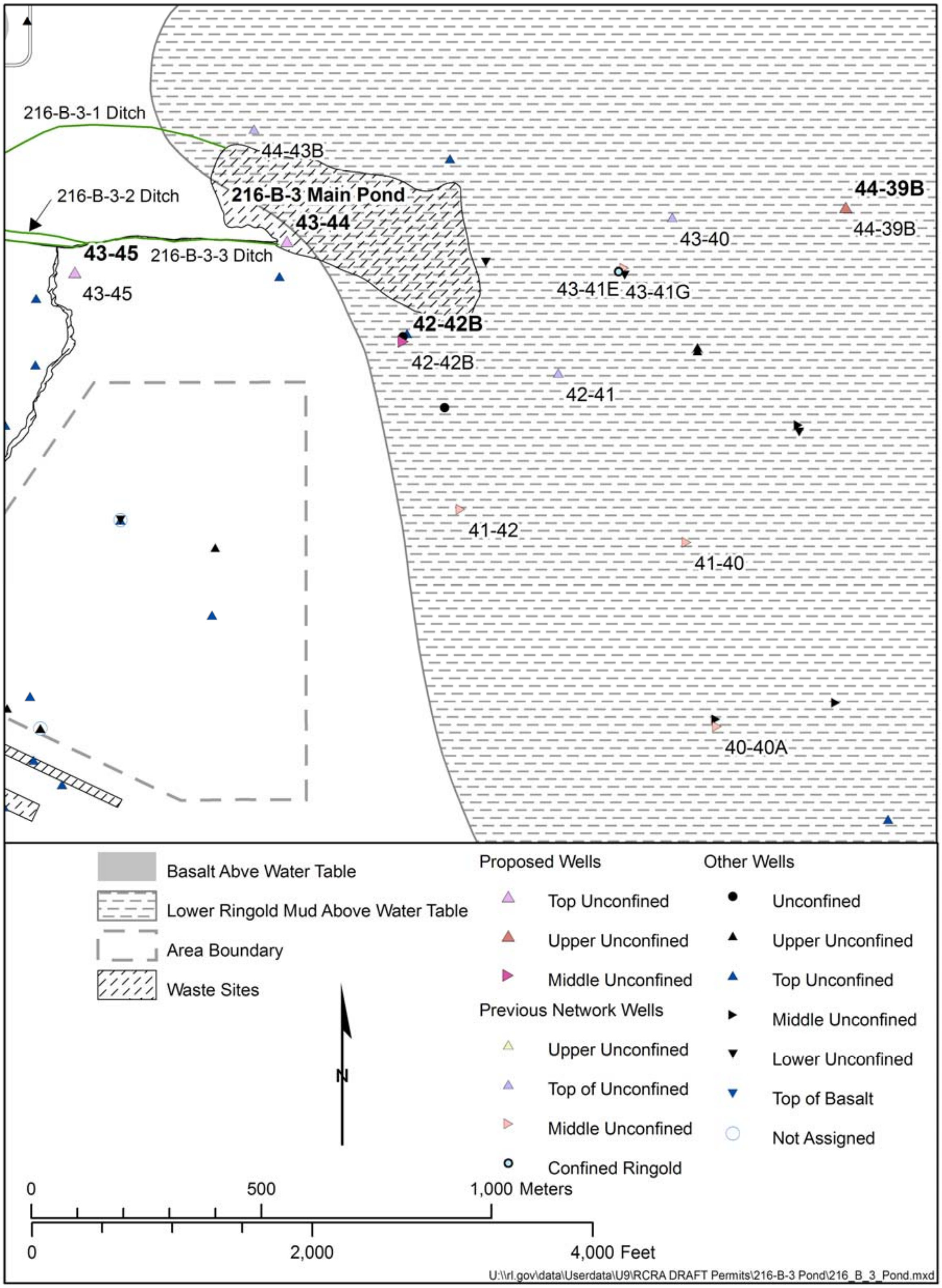

Figure 3-1. Current RCRA Monitoring Well Network

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

Well	Year Drilled	Construction Notes[a]	Units Monitored	Water Table Elev.[b] (NAVD88) (m)	Top of Casing (m) (NAVD88)	Bottom Elev.[c] (m) (NAVD88)	Water Left (m)
699-44-39B (upgradient) (confined)	1992	4-in., 304 stainless steel, wire-wrap screen	Ringold Unit A; completed below water table	124.11	157.51	120.13	3.99
699-42-42B (confined)	1988	4-in., 304 stainless steel, wire-wrap screen	Ringold Unit A; completed below water table	122.51	178.75	115.69	6.4
699-43-44	1999	4-in., 304 stainless steel, wire-wrap screen	Hanford formation; completed at water table	122.20	177.37	118.40	3.93
699-43-45	1989	4-in., 304 stainless steel, wire-wrap screen	Hanford formation; completed at water table	121.94	183.15	120.28	1.66

Notes: Well construction details and lithologic information for the B Pond network wells are provided in PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*.

a. Includes (when available) well casing/screen material, screen type, and well seal type.

b. Water table elevation in February 2008.

c. Bottom elevation from most recently available source (e.g., well inspection depth-to-bottom measurement or bottom of screen from as-built diagram).

NAVD88 = *North American Vertical Datum of 1988*

4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for the B Pond facility.

4.1 Data Review

The data review, validation, and the verification process are discussed in the QAPjP in Appendix A.

4.2 Statistical Evaluation

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

The implementation of the statistical test method at the Hanford Site, including the B Pond system, is described in further detail in PNNL-13116, *Hanford Site Groundwater Monitoring for Fiscal Year 1999* and WHC-SA-1124-FP, *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site*. Twice each year, monitoring data from downgradient wells are compared to the upgradient (background) results to determine if there is any indication that contamination may have occurred using a t-test to make this determination (40 CFR 265.93[b]). Critical mean values are recalculated annually, and the limits of quantitation are recalculated for each sample event.

4.3 Interpretation

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

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

4.4 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the monitoring network to determine if it remains adequate to monitor the area. The network must include upgradient and downgradient wells in the uppermost aquifer. The gradient beneath the B Pond is extremely flat but is estimated to be southwest. The network includes both upgradient and downgradient wells based on current estimates of flow direction.

No new wells are currently planned for the B Pond monitoring network. Any new RCRA wells installed at the Hanford Site are negotiated annually by Ecology, the U.S. Department of Energy (DOE), and the U.S. Environmental Protection Agency (EPA) and are approved under Tri-Party Agreement Milestone M-24-00.

Water-level measurements will continue to be collected before each sampling event, and more comprehensive measurements will continue to be made annually in selected wells in the 200 East Area. The wells used for this task have very exacting controls, allowing contractor staff to correct the measurements to account for borehole deviation from vertical and barometric effects. The resulting data are used in trend analyses, with statistical evaluation of the significance of a trend on the water table.

4.5 Reporting and Notification

Chemistry and water-level data are reviewed after each sampling event and are available in the Hanford Environmental Information System database. The data are presented in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2008-66).

If comparisons for the upgradient well show a statistically significant increase (and/or pH decrease), the information is reported in the annual groundwater report. If the comparisons for a downgradient well show a significant increase (and/or pH decrease), then one or both of the following actions are taken:

- The well is resampled and split samples are sent to different laboratories to determine if the exceedance of the comparison value was the result of laboratory error.
- The original samples may be re-analyzed if laboratory error is suspected.

If resampling confirms exceedance of the statistical comparison value, then written notice is provided to the regulatory agency within 7 days that the monitored facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program will be developed and submitted. In some instances, it is possible to determine immediately that the statistical finding is not the result of contamination from the facility. In that case, the regulatory agency is notified but an assessment program is not instituted.

5 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.Hedges, Washington State Department of Ecology, from J.G. Morse), U.S. Department of Energy, Richland Operations Office, Richland, Washington, March 13.

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_09/40cfr261_09.html.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/40cfr265_08.html.

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

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."

Atomic Energy Act of 1954, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

Becker-Khaleel, B., 2001, "Sampling and Analysis Instruction 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), Administrative Record Accession #D8818746, dated August 27, 2001, Washington State Department of Ecology, Kennewick, Washington.

BHI-00184, 1995, *Miocene-to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI-01239, 1999, *200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-01276, 1999, *200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D199159404.

BHI-01367, 2000, *200-CW-1 Operable Unit Borehole/Test Pit Summary Report*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq. Available at: http://uscode.house.gov/download/pls/42C103.txt.

CP-15329, 2003, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*, Rev. 0, Fluor Hanford, Inc., Richland, Washington. Available at: http://www5.hanford.gov/pdwdocs/fsd0001/osti/2003/I0040342.pdf.

DOE/RL-2008-66, 2009, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0905131281. http://www2.hanford.gov/arpir/?content=findpage&AKey=0905131282.

DOE/RL-89-28, 1993, *216-B-3 Expansion Ponds Closure Plan*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196105282.

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://www5.hanford.gov/arpir/?content=findpage&AKey=D196125912. http://www5.hanford.gov/arpir/?content=findpage&AKey=D196125952.

DOE/RL-93-74, 1995, *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: Field Investigation and Sampling Strategy*, Draft B, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=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://www5.hanford.gov/arpir/?content=findpage&AKey=D8434692.

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.

Hedges, J., 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, Kennewick, Washington, June 22.

HNF-EP-0527-17, 2008, *Environmental Releases for Calendar Year 2007*, Rev. 0, Fluor Hanford, Inc., Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0903110443.

NAVD88, 1988, *North American Vertical Datum of 1988*, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland.

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://www5.hanford.gov/arpir/?content=findpage&AKey=D199061222.

PNNL-11604, 1997, *Results of RCRA Groundwater Quality Assessment at the 216-B-3 Pond Facility*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-11986, 1998, *Evaluation of Groundwater Monitoring Results at the Hanford Site 200 Area Treated Effluent Disposal Facility*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/676987-I7hYjy/webviewable/676987.pdf.

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. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0906180659.

PNNL-13116, 2000, *Hanford Site Groundwater Monitoring for Fiscal Year 1999*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D2736610. http://www5.hanford.gov/arpir/?content=findpage&AKey=D2736978.

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://www5.hanford.gov/arpir/?content=findpage&AKey=D1662819.

PNNL-14702, 2006, *Vadose Zone Hydrogeology Data Package for Hanford Assessments*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/ PNNL-147022rev1.pdf.

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.

PNNL-18807, 2009, *Soil Water Balance and Recharge Monitoring at the Hanford Site – FY09 Status Report*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

RCW 70.105, "Public Health and Safety," "Hazardous Waste Management," *Revised Code of Washington*, Washington State, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www4.law.cornell.edu/uscode/42/6901.html.

SGW-34011, 2007, *Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

WA7890008967, 1994, *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended, effective September 28, 1994, Washington State Department of Ecology, Olympia, Washington.

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=173-303-400.

303-040, "Definitions."

303-400, "Interim Status Facility Standards."

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-EP-0052,1988, *Preliminary Evaluation of Hanford Liquid Discharges to Ground*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0367, 1990, *Liquid Effluent Study Final Project Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196021662.

WHC-EP-0813, 1995, *Groundwater Impact Assessment Report for the 216-B-3 Pond System*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196047719.

WHC-SA-1124-FP, 1991, *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-AP-030, 1990, *Groundwater Quality Assessment Plan for the 216-B-3 Pond System*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-AP-042, 1991, *Phase I Characterization of the 216-B-3 Pond System*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-ES-004, 1993, *Site Characterization Report: Results of Detailed Evaluation of the Suitability of the Site Proposed for Disposal of 200 Areas Treated Effluent*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-EV-002, 1990, *Interim Hydrogeologic Characterization Report for the 216-B-3 Pond*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-012, 1992, *Geologic Setting of the 200 East Area: An Update*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Appendix A

Quality Assurance Project Plan

Contents

Figure

Tables

Terms

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

A Quality Assurance Project Plan

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

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

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

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

A1 Project Management

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

A1.1 Project/Task Organization

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

A1.1.1 Regulatory Project Manager

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

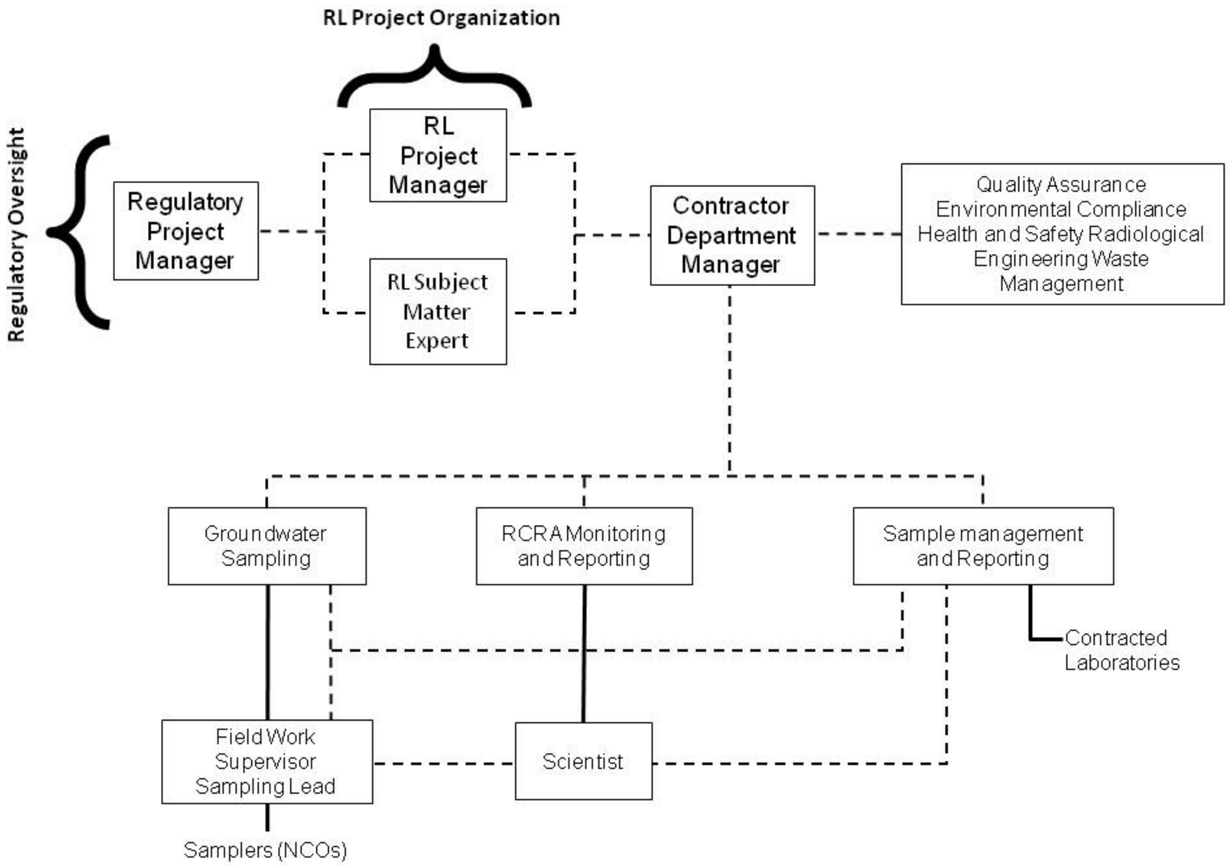

Figure A-1. Project Organization

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

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

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

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

A1.1.4 Contractor Groundwater Remediation Department Manager

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

A1.1.5 Groundwater Sampling Operations

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

A1.1.6 RCRA Monitoring and Reporting

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

A1.1.7 Sample Management and Reporting Organization

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

A1.1.8 Contract Laboratories

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

A1.1.9 Quality Assurance

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

A1.1.10 Environmental Compliance Officer

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

A1.1.11 Health and Safety

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

A1.1.12 Waste Management

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

A1.2 Problem Definition/Background

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

A1.3 Project/Task Description

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

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

A1.4 Quality Objectives and Criteria

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

A1.5 Special Training/Certification

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

A1.6 Documents and Records

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

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

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

Table A-1. Actions and Documentation for Regulatory Notification

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

RCRA = *Resource Conservation and Recovery Act of 1976*

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

A2 Data Generation and Acquisition

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

A2.1 Sampling Process Design (Experimental Design)

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

A2.1.1 Regulatory Requirements

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

A2.1.2 Judgmental Sampling

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

A2.2 Sampling Methods

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

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

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

A2.3 Sample Handling and Custody

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

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

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

A2.4 Analytical Methods

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

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for the 216-B-3 Pond Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Contamination Indicator Parameters			
Total organic carbon	G/P, HCL to pH <2	SW-846[d] Method 9060	1,000
Total organic halides	G, H_2SO_4 to pH <2, no head space	SW-846[d] Method 9020	20
Metals Analyzed by Inductively Coupled Plasma Method – Unfiltered/Filtered			
Calcium	P, HNO_3 to pH <2	SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e]	1,000
Cadmium			5
Sodium			500
Manganese			5
Potassium			4,000
Iron			50
Magnesium			750
Trace Metals – Unfiltered/Filtered			
Antimony	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	6
Barium			5
Beryllium			5
Chromium, (total)			10
Cobalt			20
Copper			10
Nickel			40
Silver			10
Strontium			10
Vanadium			25
Zinc			10
Anions by Ion Chromatography			
Chloride	P	EPA/600 Method 300.0[f]	200
Fluoride			500
Nitrate			250
Nitrite			250
Sulfate			500

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for the 216-B-3 Pond Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Other			
Alkalinity	G/P	Standard Method[g] 2320, EPA/600 Method 310.1 EPA/600 Method 310.2	5,000
Conductivity, field	Field measurement	Instrument/meter	1 µohm
Dissolved oxygen, field	Field measurement	Instrument/meter	0 mg/L
pH, field measurement	Field measurement	Instrument/meter	0.1
Phenol	G	SW-846 Method 8040, SW-846 Method 8041, SW-846 Method 8270D	5 5 10
Temperature	Field measurement	Instrument/meter	
Turbidity, field measurement	Field measurement	Instrument/meter	0.1 NTU

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

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

c. Detection limit units, unless otherwise indicated.

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

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

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

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

EPA = U.S. Environmental Protection Agency

N/A = not applicable

NTU = nephelometric turbidity unit

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

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

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

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Trace Metals – Unfiltered/Filtered			
Antimony	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	6
Aluminum			50
Boron			20
Bismuth			100
Hexavalent chromium	G/P, cool to 4°C	SW-846 Method 7196	10
Lead	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	5
Mercury	G, HNO_3 to pH <2	SW-846 Method 7470A, EPA/600 Method 200.8	0.5
Lithium	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	25
Molybdenum			20
Selenium			10
Silicon			20
Thallium			5
Tin			100
Titanium			5
Zirconium			25
Anions by Ion Chromatography			
Bromide	P	EPA/600 Method 300.0[d]	250
Phosphate			500
Pesticides			
Endrin	G	SW-846 Method 8081B	0.1
Lindane (four isomers)			0.05
Methoxychlor			0.5
Toxaphene			2
Herbicides			
2,4-D	G	SW-846 Method 8151A	20
2,4-5-TP silvex			1
2,4,5-T			1

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

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Volatile Organic Analyses			
Acetone (by volatile organic analysis)	G, no headspace	SW-846 Method 8260B	20
Benzene			5
Carbon tetrachloride			5
Chloroform			5
1,1,1-trichloroethane			5
1,1,2-trichloroethane			5
1, 1-dichloroethane			10
1, 2-dichloroethane			5
Methylene chloride			5
Methyl ethyl ketone			10
Methyl isobutyl ketone			10
P-dichlorobenzene			5
Trichloroethylene			5
Tetrachloroethylene			5
Tetrahydrofuran			50
Toluene			5
Trans-1, 2-dichloroethylene			5
Vinyl chloride			10
Xylene-m			10
Xylene-o, p			10
Semivolatile Organic Analyses			
Benzo(a)pyrene	Amber glass	SW-846 Method 8270D	10
Bis(2ethylhexyl)phthalate (DEHP)			10
Cresol (o,p,m)			10
n-nitrosodimethylamine			10

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

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Polychlorinated Biphenyls			
Aroclor-1016	G	SW-846 Method 8082	0.5
Aroclor-1221			0.5
Aroclor-1232			0.5
Aroclor-1242			0.5
Aroclor-1248			0.5
Aroclor-1254			0.5
Aroclor-1260			0.5
Other			
Ammonium ion	P, H_2SO_4 to pH <2	EPA/600 Method 350.1, EPA/600 Method 300.7	50
Coliform bacteria	P	Standard Method[e] 9223[f]	2.2[g]
Conductivity, laboratory	P	Instrument/meter	1 µohm
Cyanide	P, NaOH to pH >12	SW-846 Method 9012, Standard Method[e] 4500, EPA/600 Method 335.2	5
Hydrazine	G, HCl	ASTM D1385	100
pH, laboratory measurement	P	Instrument/meter	0.1
Oxidation-reduction potential, field	Field measurement	Instrument/meter	
Total dissolved solids	P	EPA/600 Method 160.1	10,000
Total organic halogen	G, H_2SO_4 to pH <2, no headspace	SW-846 Method 9020	20
Total organic carbon	G, HCL or H_2SO_4 to pH <2	SW-846 Method 9060	1,000

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

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

c. Detection limit units, unless otherwise indicated.

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

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

f. Enzyme substrate test.

g. Most probable number.

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

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

ASTM = American Society for Testing and Materials
EPA = U.S. Environmental Protection Agency
NTU = nephelometric turbidity unit

A2.5 Quality Control

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

Table A-4. Quality Control Samples

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

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

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

QC = quality control

A2.5.1 Field Quality Control Samples

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

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

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

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

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

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

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

A2.5.2 Laboratory Quality Control Samples

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

A2.5.3 Quality Control Requirements

Table A-5 lists the acceptance criteria for QC samples, and Table A-6 lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking Hanford Site background well water with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper limit of concentration determined in groundwater on the Hanford Site.

Investigations shall be conducted for double-blind standards that are outside of acceptance limits. The results from these standards are used to determine the acceptability of the associated parameter data.

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

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

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

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

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

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

b. Does not apply to pH.

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

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

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

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

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

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

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

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

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

Abbreviations:

CRDL = contract-required detection limit

DUP = laboratory matrix duplicate

EB = equipment blank

FTB = full trip blank

FXR = field transfer blank

GC = gas chromatography

IC = ion chromatography

ICP = inductively coupled plasma

ICP/MS = inductively coupled plasma/mass spectrometry

LCS = laboratory control sample

MB = method blank

MDA = minimum detectable activity

MDL = method detection limit

MS = matrix spike

MSD = matrix spike duplicate

QC = quality control

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
RPD = relative percent difference			
SUR = surrogate			

Table A-6. Blind Standard Constituents and Schedule

Constituents	Frequency	Accuracy (%)	Precision (% RSD)[a]
Fluoride	Quarterly	±25%	≤25%
Nitrate	Quarterly	±25%	≤25%
Chromium	Annually	±20%	≤25%
Total organic carbon[b]	Quarterly	Varies according to spiking compound	Varies according to spiking compound
Total organic halides[c]	Quarterly	Varies according to spiking compound	Varies according to spiking compound

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

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

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

RSD = relative standard deviation

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

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

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

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

A2.7 Instrument/Equipment Calibration and Frequency

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

A2.8 Inspection/Acceptance of Supplies and Consumables

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

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

A2.9 Non-Direct Measurements

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

A2.10 Data Management

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

All field activities will be recorded in the field logbook.

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

A3 Assessment and Oversight

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

A3.1 Assessments and Response Actions

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

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

A3.2 Reports to Management

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

A4 Data Validation and Usability

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

A4.1 Data Review, Verification, and Validation

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

A4.2 Verification and Validation Methods

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

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

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

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

A4.3 Reconciliation with User Requirements

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

A5 References

10 CFR 830, Subpart A, "Nuclear Safety Management," "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:4.0.2.5.26.1&idno=10.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_09/40cfr265_09.html.

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

ANSI/ASQ E4, 2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*, American National Standards Institute/American Society for Quality, Milwaukee, Wisconsin.

AWWA, APHA, and WEF, 2005, *Standard Methods for the Examination of Water and Wastewater*, 21st ed., American Water Well Association, Denver, Colorado; American Public Health Association, Washington, D.C.; and Water Environment Federation, Alexandria, Virginia.

Atomic Energy Act of 1954, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq. Available at: http://uscode.house.gov/download/pls/42C103.txt.

DOE O 414.1C, 2005, *Quality Assurance*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/414.1-BOrder-c/view.

DOE/RL-96-68, 2007, *Hanford Analytical Services Quality Assurance Requirements Document*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/orp/?page=141&parent=14.

DOE/RL-2008-66, 2009, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0905131281. http://www5.hanford.gov/arpir/?content=findpage&AKey=0905131282.

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*, 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-600/4-79-020, 1983, *Methods for Chemical Analysis of Water and Wastes*, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196019611.

EPA-600/4-84-017, 1984, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*, EPA Method 300.0, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.resintech.com/products/frm_ProductInfo.aspx?qProductId=133.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www4.law.cornell.edu/uscode/42/6901.html.

SW-846, 2007, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: www.epa.gov/SW-846/main.htm.

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, "Personal Training."

303-400, "Interim Status Facility Standards."

Distribution

	MS	Quantity
U.S. Department of Energy, Richland Operations Office		
R.D. Hildebrand	A6-38	1
J.G. Morse	A5-11	1
DOE Public Reading Room	H2-53	1
CH2M HILL Plateau Remediation Company		
C.J. Martin	R3-50	1
G.D. Cummins	H8-15	1
S.C. Davis	R3-50	1
G. LeBaron	S4-42	1
J.W. Lindberg	R3-50	1
S.P. Luttrell	R3-50	1
J.P. McDonald	R3-50	1
A.G. Miskho	H8-45	1
D.L. Norman	T1-41	1
R.W. Oldham	R6-30	1
L.C. Swanson	R3-50	1
W.R. Thackaberry	R3-60	1
J.A. Winterhalder	R3-60	1
C.D. Wittreich	H8-15	1
Publications Technical Library	H3-21	1
Administrative Record	H6-08	1
Document Clearance	H6-08	1