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**Groundwater Monitoring Plan for
the Hanford Site 216-B-3 Pond
RCRA Facility**

D. B. Barnett
R. M. Smith
C. J. Chou
J. P. McDonald

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Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

The 216-B-3 Pond (B Pond) system was a series of ponds used for disposal of liquid effluent from past Hanford production facilities. In operation from 1945 to 1997, the B Pond system has been a *Resource Conservation and Recovery Act (RCRA)* facility since 1986; RCRA interim status groundwater monitoring has been in place since 1988. In 1994, the expansion ponds of the facility were clean closed, leaving only the main pond and a portion of the 216-B-3-3 ditch as the currently regulated facility.

In 2001, the Washington State Department of Ecology (Ecology) issued a letter providing guidance for a 2-year trial evaluation of an alternate intrawell statistical approach to contaminant detection monitoring at the B Pond system. This temporary variance was allowed because the standard indicator-parameters evaluation (pH, specific conductance, total organic carbon, and total organic halides) and accompanying interim status statistical approach is ineffective for detecting potential B-Pond-derived contaminants in groundwater, primarily because this method fails to account for variability in the background data and because B Pond leachate is not expected to affect the indicator parameters. In July 2003, the final samples were collected for the 2-year variance period. An evaluation of the results of the alternate statistical approach is currently in progress. While Ecology evaluates the efficacy of the alternate approach (and/or until B Pond is incorporated into the Hanford Facility RCRA Permit), the B Pond system will return to contamination-indicator detection monitoring. Total organic carbon and total organic halides were added to the constituent list beginning with the January 2004 samples.

Under this plan, the following wells will be monitored for B Pond: 699-42-42B, 699-43-44, 699-43-45, and 699-44-39B. The wells will be sampled semiannually for the contamination indicator parameters (pH, specific conductance, total organic carbon, and total organic halides) and annually for water quality parameters (chloride, iron, manganese, phenols, sodium, and sulfate). This plan will remain in effect until superseded by another plan or until B Pond is incorporated into the Hanford Facility RCRA Permit.

Acknowledgments

The authors extend their appreciation to reviewers M. J. Hartman, S. P. Luttrell, and J. A. Winterhalder for their valuable contribution to the quality of the document, and to L. F. Morasch for editing and overseeing final publication. Thanks are also extended to K. R. Neiderhiser for final preparation of the document, and to J. T. Rieger, D. E. Brunson, and C. A. Newbill for graphics support.

Acronyms and Abbreviations

AEA	<i>Atomic Energy Act of 1954</i>
B Pond	216-B-3 pond system
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act</i>
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HEIS	Hanford Environmental Information System
MTCA	<i>Model Toxics Control Act</i>
PNNL	Pacific Northwest National Laboratory
POC	point of compliance
PUREX	Plutonium-Uranium Extraction (plant)
RCRA	<i>Resource Conservation and Recovery Act</i>
RPD	relative percent difference
TEDF	200 Area Treated Effluent Disposal Facility
TOC	total organic carbon
TOX	total organic halides
WAC	<i>Washington Administrative Code</i>
WHC	Westinghouse Hanford Company
WTP	Waste Treatment Plant

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1.0 Introduction

The 216-B-3 pond system (B Pond) is a regulated wastewater disposal facility in the 200 East Area of the Hanford Site (Figure 1.1). The B Pond has been a *Resource Conservation and Recovery Act* (RCRA) hazardous waste facility since 1986, when a RCRA (Part A) permit application was submitted to the Washington State Department of Ecology (Ecology). Groundwater monitoring has been conducted in accordance with RCRA interim status requirements since 1988. Groundwater monitoring was changed to an assessment program in 1990 because of elevated levels of total organic halides (TOX) and total organic carbon (TOC) in two downgradient wells. The assessment report concluded that no hazardous waste could be correlated to the TOX or TOC results (Barnett and Teel 1997). The site was returned to detection monitoring in 1998. Also in that year, the *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility* (Barnett and Chou 1998, later revised in Barnett et al. 2000) was released to address a change in monitoring strategy derived from the assessment program work. This strategy included a plan for intrawell monitoring and more appropriate statistical methods for evaluating groundwater data, because the standard indicator-parameters evaluation and accompanying interim status statistical approach is believed to be ineffective for detecting potential B-Pond-derived contaminants in groundwater at this facility.

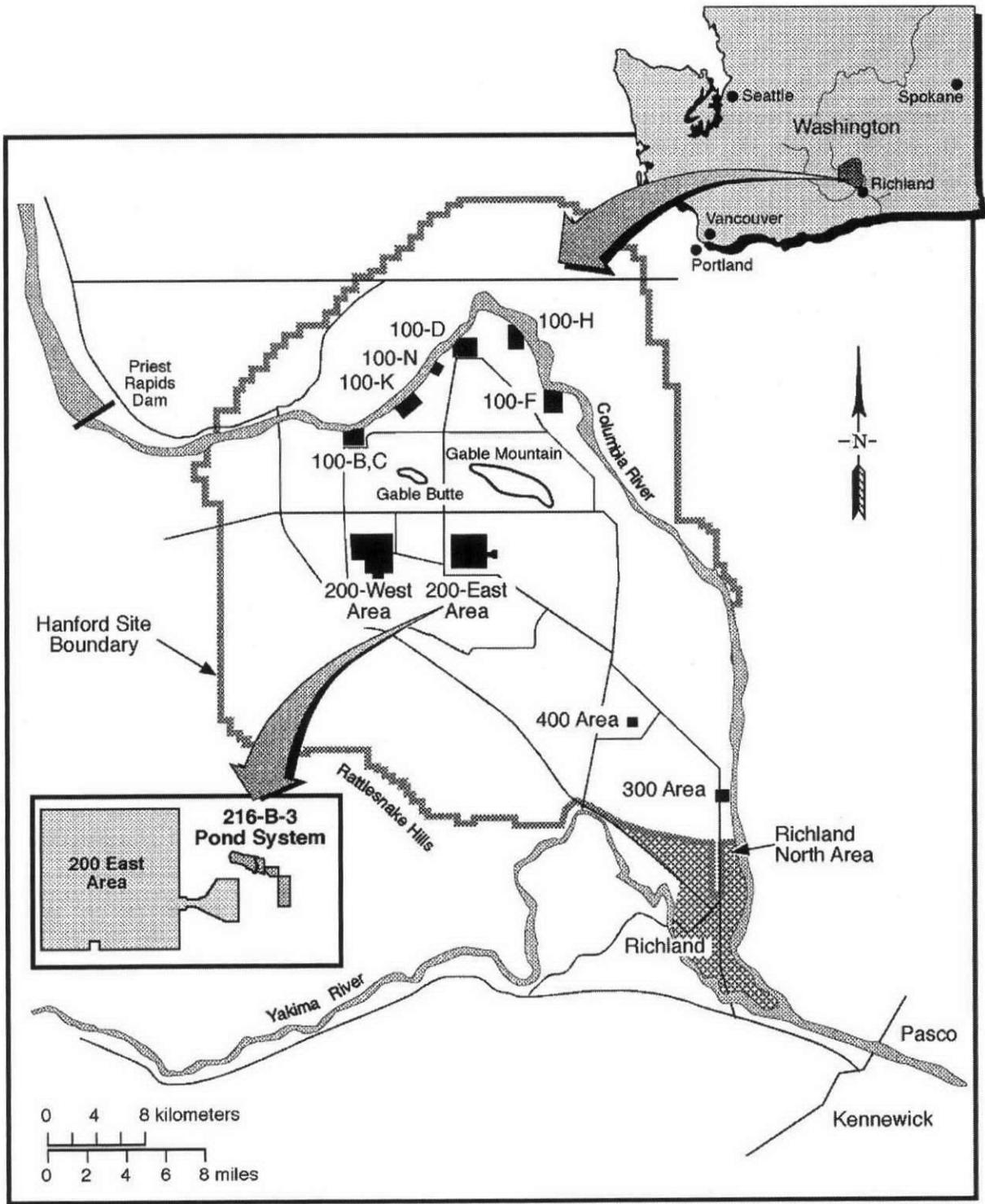
In May 2001, Ecology issued a letter¹ allowing intrawell monitoring at B Pond and the alternate statistical approach for a 2-year trial period, once certain criteria were met. During this trial period, TOX and TOC were removed from the groundwater sampling constituent list for the B Pond. In July 2003, the final samples were collected for this 2-year trial period. An evaluation of the results of the alternate statistical approach is currently in progress, as documented in Chou (2004).

The purpose of this document is to re-establish a groundwater contamination-indicator detection monitoring program for the B Pond, while Ecology evaluates the efficacy of the alternate approach. The groundwater monitoring plan in Section 4.0 supersedes the plan of Barnett et al. (2000) as amended by Interim Change Notice (Barnett 2002) (TOX and TOC were added to the constituent list beginning with the January 2004 samples). This document addresses the current hydrogeologic conceptual model for the site, and incorporates the sum of knowledge about the potential for contamination originating from the facility.

Data collected under this work plan will also help to meet *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) groundwater data needs. The miscellaneous solid waste generated during these activities may be handled under the respective waste management plan or waste control plan.

Please note that source, special nuclear and by-product materials, as defined in the *Atomic Energy Act of 1954* (AEA), are regulated at U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. These materials are not subject to regulation by the state of

¹ Letter from Dib Goswami (Washington State Department of Ecology, Olympia, Washington) to Marvin Furman (U.S. Department of Energy, Richland, Washington), *Statistical Assessment for the 300 Area Resource Conservation and Recovery Act of 1976 (RCRA) Ground Water Monitoring Plan*, dated May 7, 2001.



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Figure 1.1. Location of the 216-B-3 Pond Facility and the Hanford Site

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1.1 Site Characteristics

The B Pond is located east of the 200 East Area and consisted of a main pond and three expansion ponds, all constructed for wastewater disposal (Figure 1.2). The 200 Area Treated Effluent Disposal Facility (TEDF) is located about 700 meters (2,297 feet) east of the 216-B-3-C expansion pond. This is a permitted disposal facility for treated effluent from various Hanford Site programs and projects, and has been in operation since 1995. To the south and southwest of the main pond, construction of a high-level radioactive Waste Treatment Plant (WTP) began in 2001. The northern and eastern boundaries of this construction site are about 200 meters (656 feet) away from some of the B Pond groundwater monitoring wells. Permitted liquid effluent releases to ground are occurring as part of the construction activities.

1.1.1 History of Facility Operations

The B Pond began receiving effluent in 1945 at the site of the main pond (initially termed the "B-3 Pond"). The main pond was located in a natural topographic depression, diked on the eastern margin, covered approximately 14.2 hectares (35 acres), and had a maximum depth of approximately 6.1 meters (20 feet). Three expansion ponds (216-B-3-A [3A], 216-B-3-B [3B], and 216-B-3-C [3C]) were placed into service in 1983, 1984, and 1985, respectively. The 3A and 3B expansion ponds are about 4.5 hectares (11 acres) in size, and the 3C expansion pond is approximately 16.6 hectares (41 acres). 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 producing facilities in the 200 East Area to the main pond, where the water then infiltrated into the ground. These ditches were decommissioned and stabilized (backfilled) over a period of time, mostly as a result of unplanned releases of dangerous waste (DOE-RL 1993b). Details of the operation of these ponds and ditches are presented in DOE-RL (1993a).

Discharge volumes to the B Pond were at a maximum during 1988 (Figure 1.3). Total discharge to the facility since 1945 is estimated to have exceeded 1.0×10^{12} liters (260 billion gallons). Beginning in April 1994, discharges to the main pond and 3A expansion pond ceased, and all effluents were rerouted to the 3C expansion pond via a pipeline. Also during 1994, the main pond and 216-B-3-3 ditch (B-3-3 ditch) were filled with clean soil, and all vegetation was removed from the perimeter and included with the fill soil, as part of interim stabilization activities. Just prior to the diversion of the 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. Hence, only the main pond and an adjoining part of the B-3-3 ditch require groundwater monitoring under RCRA requirements.

In June 1995, portions of the effluent stream were rerouted to the 200 Areas TEDF. The remaining streams were diverted from the 3C expansion pond to the TEDF in August 1997, thus ending all

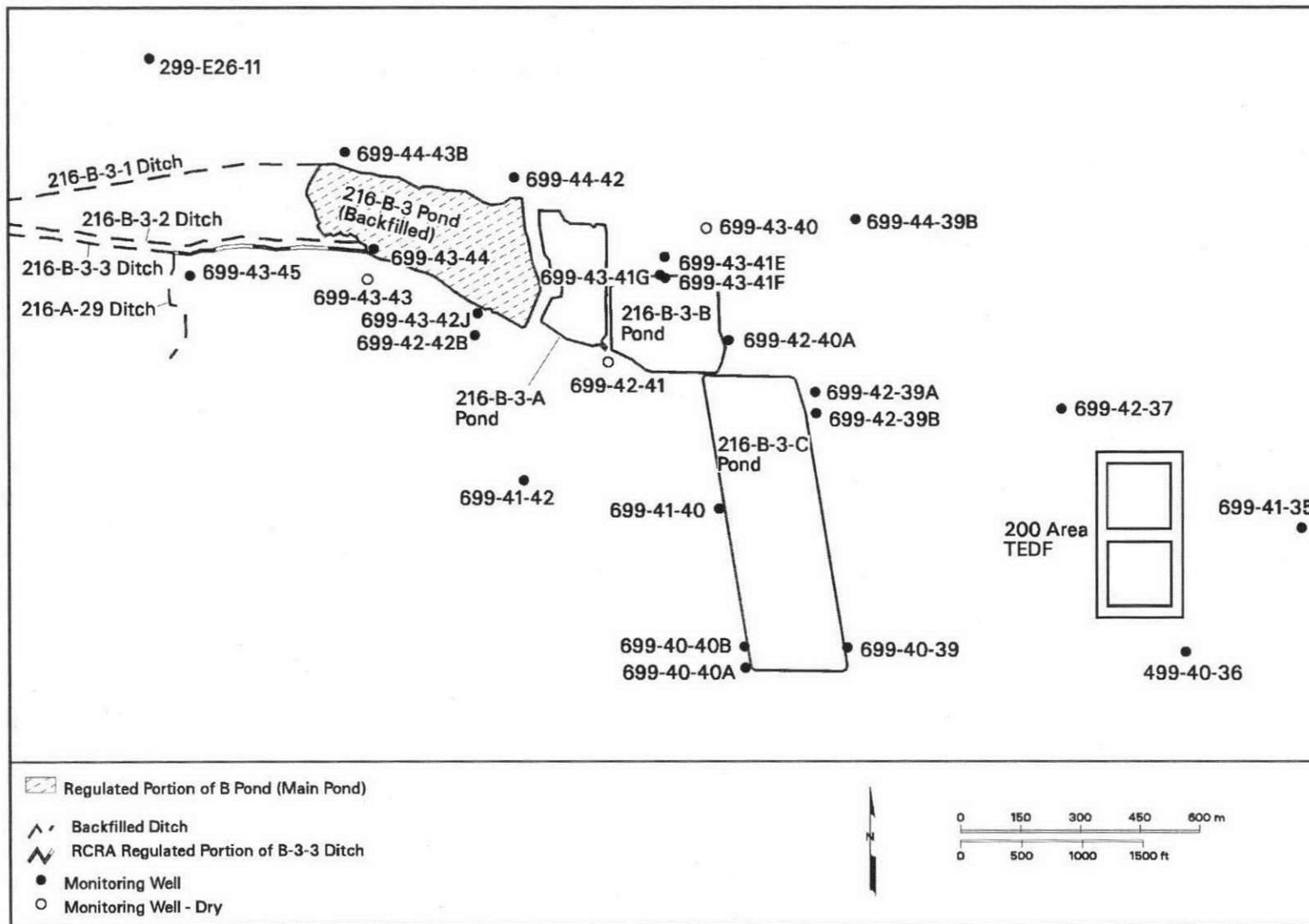
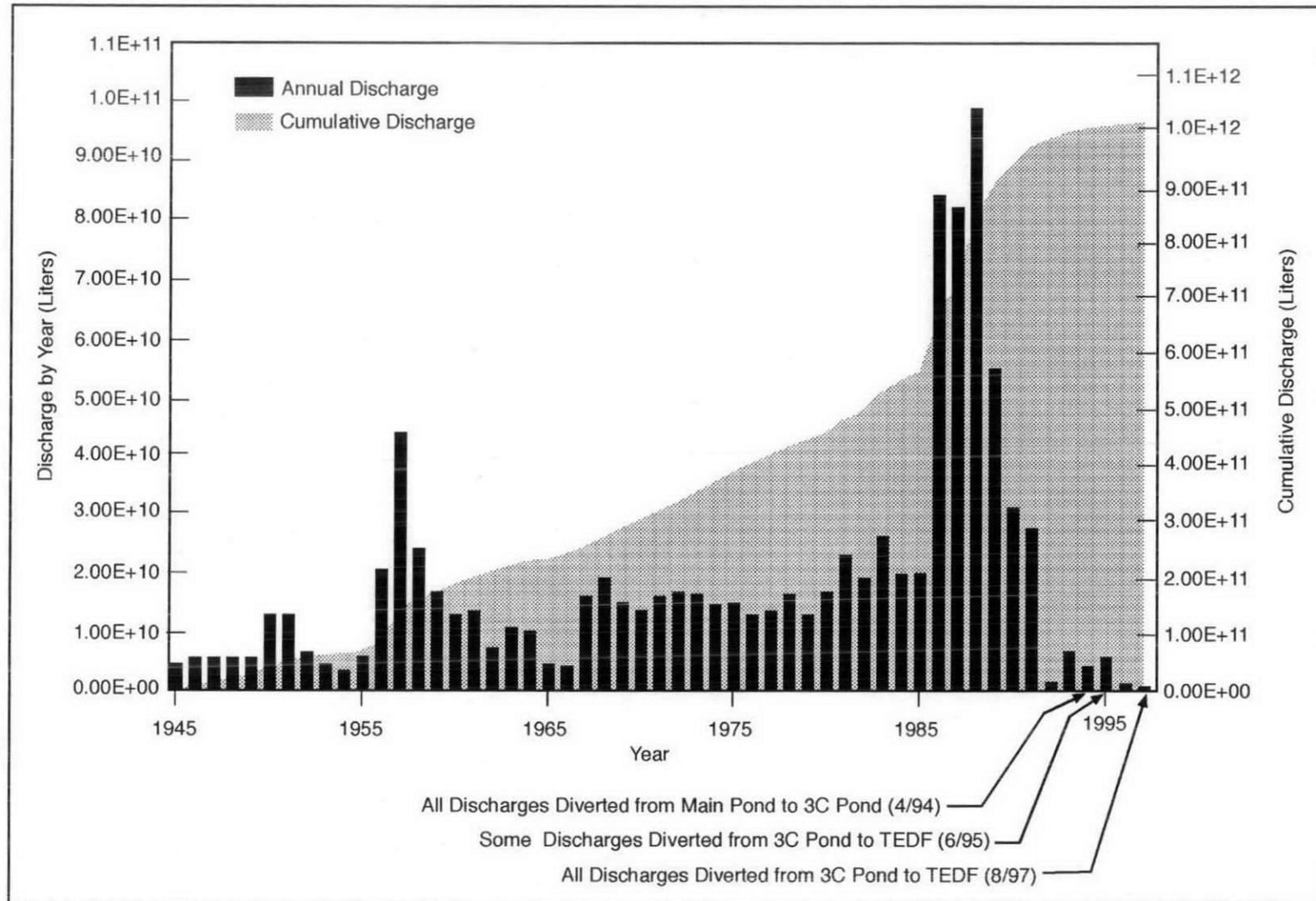


Figure 1.2. Location and Configuration of the B Pond Facility and Associated Groundwater Monitoring Wells Used During the History of Monitoring at the Facility



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Figure 1.3. Annual and Cumulative Discharge Volumes to the B Pond System, 1945 to 1997

operation of the B Pond. The 3C Pond is still maintained as an overflow contingency facility for the TEDF. Historic effluent feeds are described in greater detail by DOE-RL (1993a) and Johnson et al. (1995).

Descriptions of waste sources, waste streams, process information, and unplanned releases involving the B Pond are described in several documents (e.g., WHC 1989, WHC 1990a, DOE-RL 1993a, DOE-RL 1993b, DOE-RL 1994, DOE-RL 2000, and Barnett et al. 2000). 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. Corrosive hazardous waste, such as nitric and sulfuric acid, were routinely discharged to the B Pond via the ditches, although attempts were made to neutralize these wastes before they were discharged. Other volumetrically important chemicals discharged to the B Pond include cadmium nitrate, ammonium fluoride, ammonium nitrate, and sodium hydroxide. Sulfuric acid and sodium hydroxide were the most frequently discharged hazardous waste. An unplanned release of cadmium nitrate from the PUREX chemical sewer was sent to the B Pond in 1977 (DOE-RL 1994). Records of dangerous waste discharges to the B Pond are poor prior to 1983, and information concerning chemical (non-radioactive) releases is sketchy prior to 1987 (DOE-RL 1993b). The last known reportable discharge of chemical waste (sodium nitrate) occurred in 1987.

1.1.2 Soil Sampling Results

Because of the history of known and potential contaminants discharged to the B Pond, a series of evaluations of soil contamination was conducted for the main pond, expansion ponds, and nearby portions of the B-3-3 ditch from 1989 through 1992. This work involved shallow soil sampling and analysis of sediments from the main pond, expansion ponds, and B-3-3 ditch (Kramer 1991), and deep vadose zone sampling in the expansion ponds (DOE-RL 1993b). 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 *Model Toxics Control Act* (MTCA) (WAC 173-340) cleanup standards. Organic constituents were below detection or contractually required quantitation limits, except for a few compounds at low levels associated with laboratory or blank contamination.

A more recent vadose zone characterization effort was performed in 1999 in support of the 200-CW-1 Operable Unit remedial investigation, which involved only the main pond and the B-3-3 ditch (Cearlock et al. 2000). This investigation found that contamination of soil in the 216-B-3 main pond and B-3-3 ditch appears to be relatively limited, both in depth and magnitude. The greatest concentrations of hazardous constituents were found at the main pond bottom (1.5 to 4 meters [4.9 to 13.1 feet] below ground surface). Cadmium (maximum concentration of 7.3 mg/kg), lead (maximum 592 mg/kg), mercury (maximum 11.9 mg/kg), and silver (maximum 9.6 mg/kg) were above MTCA Method B cleanup levels in the northwest portion of the pond. Contaminant distribution in the B-3-3 ditch was similar to the pattern in the main pond, such that 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 hazardous constituents at the B-3-3 ditch were below MTCA method B cleanup levels. More details on the soil sampling results at the B Pond can be found in Barnett et al. (2000).

1.2 History of RCRA Groundwater Monitoring

RCRA groundwater monitoring of the B Pond began in 1988 with an interim status detection level program. The initial program is described by Luttrell (1989). Groundwater monitoring was changed from a RCRA detection program to an assessment program in 1990 because of elevated levels of TOX and TOC in two downgradient wells. A groundwater quality assessment plan (Harris 1990) was submitted to Ecology in May 1990. An assessment report issued in 1997 concluded that these occurrences were mostly isolated and that no hazardous waste could be correlated to TOX or TOC results (Barnett and Teel 1997). Other than radionuclides, 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. The groundwater monitoring program at the B Pond was returned to contamination detection level monitoring in 1998.

The groundwater monitoring well network for B Pond has undergone several changes since detection-level monitoring was first initiated. The initial network consisted of 25 wells that were installed around the B Pond facility between 1988 and 1992, when groundwater was interpreted to flow radially away from the pond. Two upgradient wells were selected to be as near the B Pond as possible, yet outside the hydrologic influence of the facility (299-E18-1 at the 2101-M Pond, and 299-E32-4 at Low-Level Waste Management Area 1). The number of wells in the network was reduced to 13 in 1995 to eliminate redundancy and focus resources on additional hydrochemical analyses in the remaining wells. In 1996, one well (299-E18-1) of two upgradient wells was dropped from the network to reduce redundancy.

From late 1998 through early 2000, the network was restructured (existing wells were dropped or added) to 1) adjust for changes in the groundwater flow direction caused by the cessation of effluent disposal to the facility, 2) to compensate for the drying of some wells due to declining water levels, and 3) to further reduce redundancy in monitoring locations. The site-specific constituent list of groundwater analyses was also amended to more accurately address the potential contaminants at this site. The current monitoring well network for the B Pond consists of one upgradient well and three downgradient wells (see Section 4.1). A more detailed summary of the initial network and subsequent changes can be found in Barnett et al. (2000).

In July 2001, an alternate intrawell statistical approach to contaminant detection monitoring was implemented at B Pond for a 2-year trial evaluation. This temporary variance was allowed because the standard indicator-parameters evaluation (specific conductance, pH, TOC, and TOX) and accompanying interim status statistical approach is ineffective for detecting potential B-Pond-derived contaminants in groundwater, primarily because this method fails to account for variability in the background data and because B Pond leachate is not expected to affect the indicator parameters. In July 2003, the final samples were collected for the 2-year trial period (Chou 2004). Beginning with the January 2004 sampling event, the site has returned to contamination-indicator detection monitoring.

1.2.1 Groundwater Sampling Results

Sampling and analysis of groundwater beneath the B Pond system has been conducted under RCRA requirements since 1988. During this time, there have been no measured concentrations of a dangerous waste constituent exceeding a drinking water standard (DWS) that has been definitely attributed to groundwater contamination from the B Pond facility. Chromium, iron, and manganese have been found

above their respective DWSs, but these results are attributed to well construction and have no significance as groundwater or soil contaminants at the B Pond. Arsenic has also been detected above the DWS, mostly in wells in the western part of the B Pond area. While the arsenic may have originated from B Pond, it is also possible that it originates from cribs and ditches in the 200 East Area.

Table 1.1 gives the maximum concentrations of nitrate, antimony, arsenic, cadmium, copper, lead, mercury, silver, and zinc measured in groundwater wells in the B Pond vicinity. These constituents were chosen because nitrate occurs in the groundwater above background levels, and the metals have significance as soil contaminants. Table 1.1 shows that B Pond has had only a minimal effect on groundwater quality (with respect to non-radioactive constituents). Nitrate and arsenic are the most significant constituents, but the maximum nitrate concentration since 1988 is only half the DWS, and arsenic has not been detected above the DWS since 1995. For most constituents, the maximum concentration occurred in the early 1990s. For selected wells in the B Pond area, groundwater concentration trends for nitrate and arsenic since RCRA monitoring began in 1988 are shown in Figures 1.4 and 1.5, respectively.

Table 1.1. Maximum Constituent Concentrations in Groundwater for the B Pond Facility Since 1988

Constituent	Maximum Result ^(a)	Drinking Water Standard	Well Name	Date	Overall Trend and Comments
Nitrate	22.5 mg/L	45 mg/L	699-41-40	1/25/1990	Downward trends in most wells, some upward. Only a few wells above background
Antimony (dissolved)	5.2 µg/L	6 µg/L	699-41-35	9/2/2003	Almost all non-detect
Arsenic (dissolved)	28 µg/L	10 µg/L	699-43-42J	6/25/1992	Downward or no obvious trends in most. No results above DWS since 1995
Cadmium (dissolved)	3.0 µg/L	5 µg/L	699-43-42J	4/13/1994	Most results non-detect
Cadmium (total)	3.0 µg/L	5 µg/L	699-42-40A	8/10/1989	Most results non-detect
Copper (dissolved)	29 µg/L	1,000 µg/L	699-40-39	9/11/1991	Most results non-detect
Lead (dissolved)	9.0 µg/L	15 µg/L	699-43-45	7/8/1991	Most results non-detect
Lead (total)	9.4 µg/L	15 µg/L	699-41-42	7/28/1993	Most results non-detect
Mercury (dissolved)	ND	2 µg/L	--	--	No unqualified detections
Mercury (total)	0.2 µg/L 0.2 µg/L	2 µg/L	699-41-35 699-40-36	4/19/1999 4/13/1998	Almost all non-detect
Silver (dissolved)	4.1 µg/L	100 µg/L	699-42-37	2/4/2003	Almost all non-detect
Silver (total)	ND	100 µg/L	--	--	No unqualified detections
Zinc (dissolved)	200 µg/L	5,000 µg/L	699-40-40B	1/26/1993	Downward for some wells, no obvious trend for most

(a) Maximum, unqualified analytical result.
DWS = Drinking water standard.
ND = Not detected.

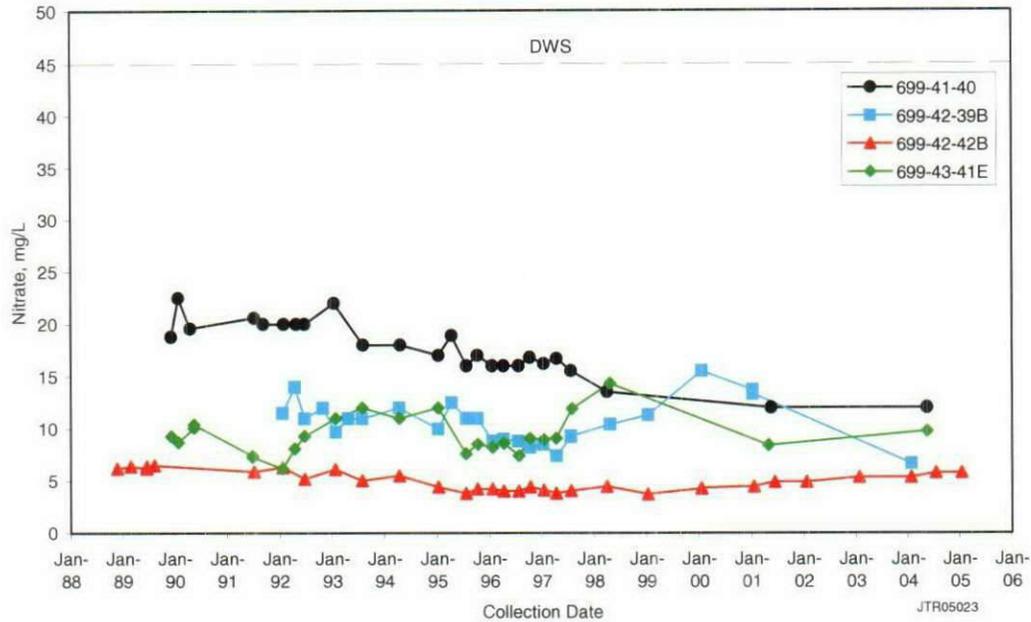


Figure 1.4. Nitrate Concentrations in Groundwater for Selected Wells Near the B Pond Facility

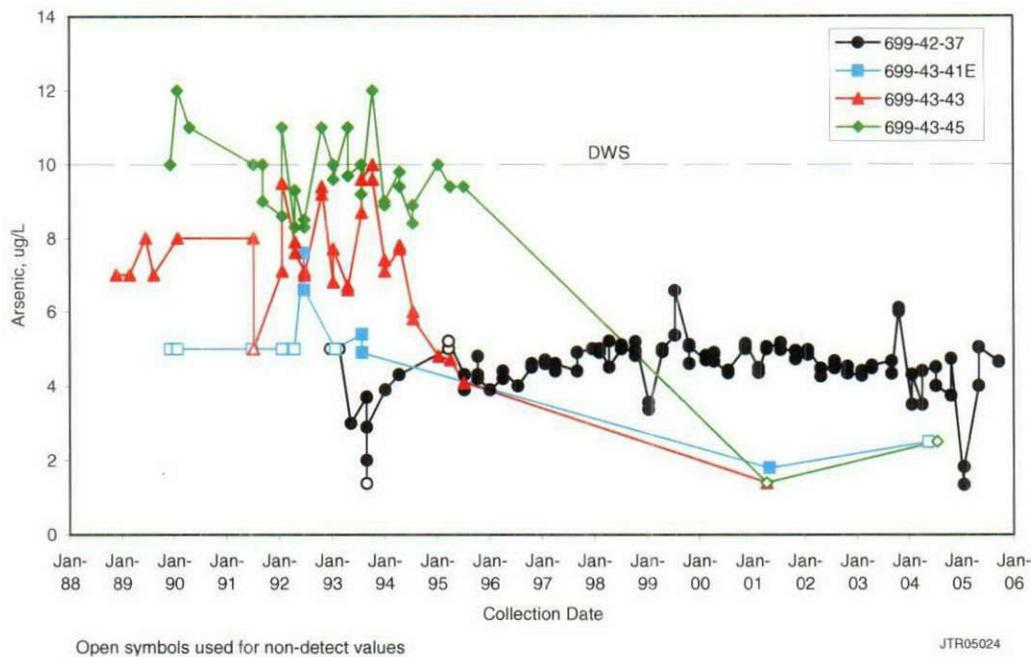


Figure 1.5. Arsenic Concentrations in Groundwater for Selected Wells Near the B Pond Facility

Since 1998, when the site was returned to detection-level monitoring after an assessment period (1990 to 1997), there have been no confirmed exceedances of a critical mean value for an indicator parameter (pH, specific conductance, TOC, and TOX) in a downgradient monitoring well. Although low levels of nitrate and arsenic have been detected in groundwater samples at B Pond, the site remains in detection-level monitoring. Nitrate is not a dangerous waste constituent, and arsenic was evaluated

during the assessment period and could not be specifically attributed to B Pond. As mentioned above, arsenic has not been detected above the DWS since 1995.

Analyses for total and dissolved concentrations of cadmium, lead, mercury, and silver were performed over a 4-year period from January 2002 through January 2005. All four of these metals were found to exceed MTCA Method B cleanup levels in soil samples collected from the northwest portion of the main pond during 1999 (see Section 1.1.2). Because no anomalous concentrations or trends were found in groundwater, it is no longer required that these constituents be sampled for. Analyses for these metals was discontinued after the January 2005 sample.

2.0 Hydrogeologic Summary

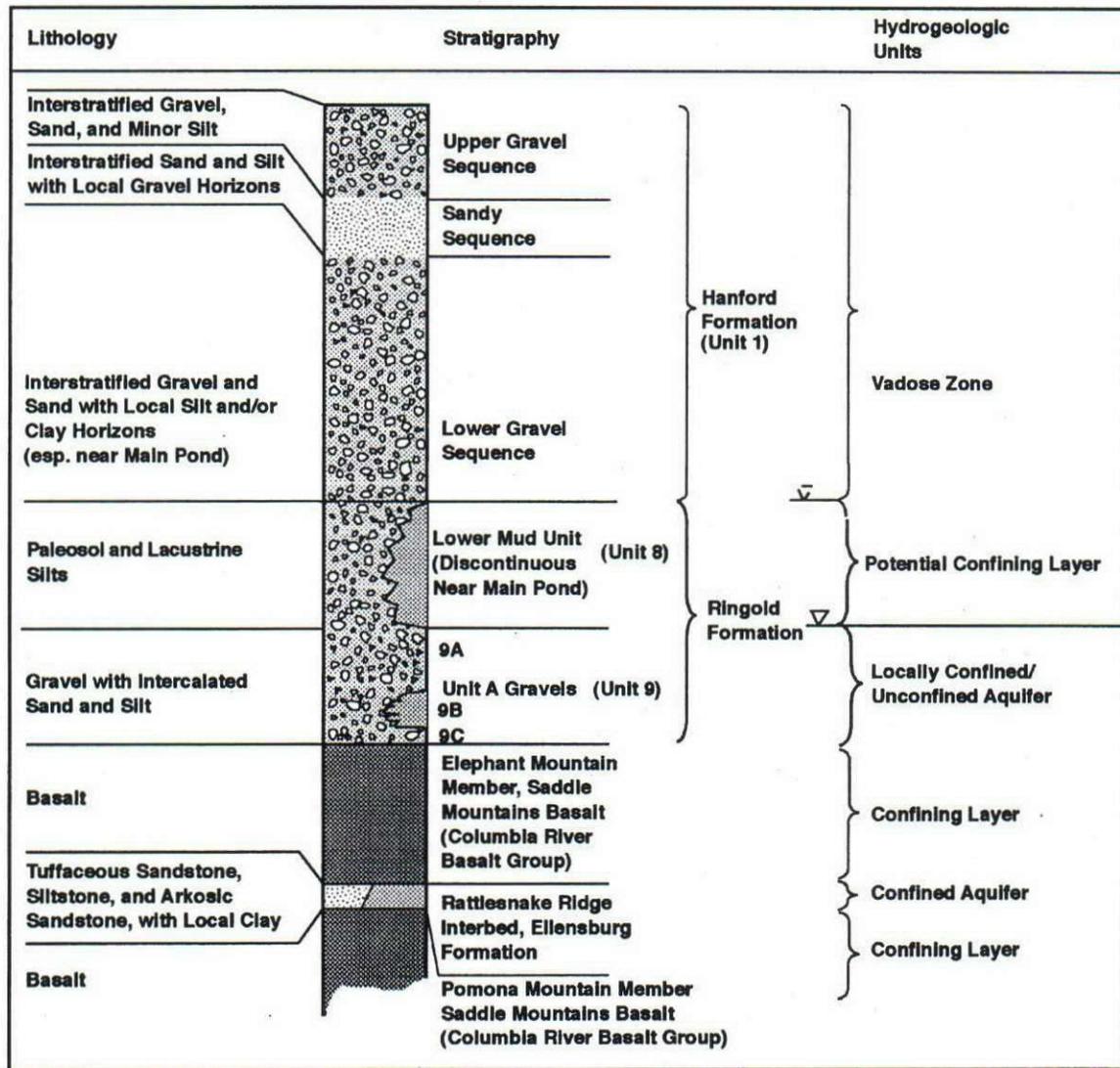
The geologic units present beneath the B Pond vicinity, and their orientation, have a significant effect on groundwater flow and contaminant migration in this area. Stratigraphy and groundwater hydrology of the B Pond have been described in several previous studies. The brief description given in this section is a summary of information derived from these earlier reports. The focus of this summary is the Hanford and Ringold Formations because these strata comprise the uppermost aquifer and vadose zone in the area of the B Pond. The most detailed description of stratigraphic relationships at the B pond facility is presented in DOE-RL (1993a) and DOE-RL (1994). A description of groundwater hydrology and groundwater contamination in the region of the Hanford Site surrounding the B Pond is presented most recently by Hartman et al. (2005). A reinterpretation of well logs and hydrostratigraphy in the 200 East Area and vicinity by Williams et al. (2000) has allowed a more accurate portrayal of groundwater movement beneath the B Pond facility, upon which much of the groundwater monitoring program presented in Section 4.0 is based.

2.1 Stratigraphy

The principal geologic units beneath the B Pond include the Miocene/Pliocene Ringold Formation and the Pleistocene Hanford formation. As a tool for constructing a three-dimensional groundwater flow conceptual model, Thorne et al. (1994) describe and assign numbers to these strata that overlie the Columbia River Basalt on the Hanford Site. Williams et al. (2000) refine this nomenclature in the vicinity of the 200 East Area and the B Pond. A representative stratigraphic column based on these descriptions for the vicinity of the B Pond is shown in Figure 2.1. The orientation of these units is shown along a northwest-southeast trending cross section through the B Pond area in Figure 2.2. The uppermost aquifer beneath the B Pond occurs primarily within sediment of the Ringold Formation, with the Hanford formation comprising the vadose zone. The Columbia River Basalt acts as the regional lower boundary for the uppermost aquifer system.

Overlying the Columbia River Basalt is the Ringold Formation fluvio-lacustrine sediment of the Unit A gravels (Unit 9 of Thorne et al. 1994, and Units 9A and 9C of Williams et al. 2000) and the lower mud unit (Unit 8 of Thorne et al. 1994). The Ringold Unit A ranges in thickness from ~12 meters (~40 feet) in the area northwest of the main pond to ~30 meters (~100 feet) in the southern portion. This unit is mainly composed of a silty sandy gravel with secondary lenses and interbeds of gravely sand, sand, and muddy sands to clay/silt (DOE-RL 1994). A particularly persistent layer of clay and silt within the Ringold Unit A is designated Unit 9B by Williams et al. (2000), and essentially separates the Ringold Unit A gravels into upper and lower components in the vicinity of the B Pond. The Ringold lower mud sequence is not present in the northwestern portion of the B Pond but is ~24 meters (~80 feet) thick near the southern extreme of the 3C expansion pond, and generally thickens south and southeast of the main pond. The lower mud unit consists mostly of various mixtures of silt and clay (DOE-RL 1994). This unit is particularly important to effluent infiltration and groundwater flow patterns near the B Pond (see Section 2.2). The Ringold Formation units dip to the south in the B Pond area, and were eroded in the north part of the area forming an angular unconformity with the overlying Hanford formation sediment

(see Figure 2.2). The lateral extent of these units to the west is limited – much of this sediment was eroded from the 200 East Area by the ancestral Columbia River and Pleistocene cataclysmic flooding (see Figure 2.3).



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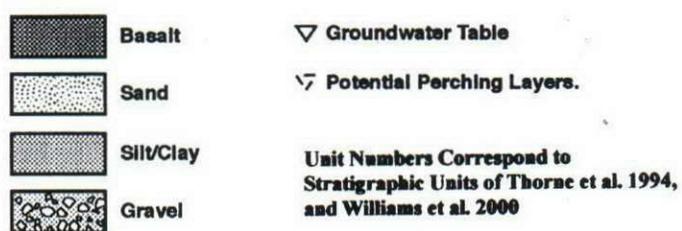
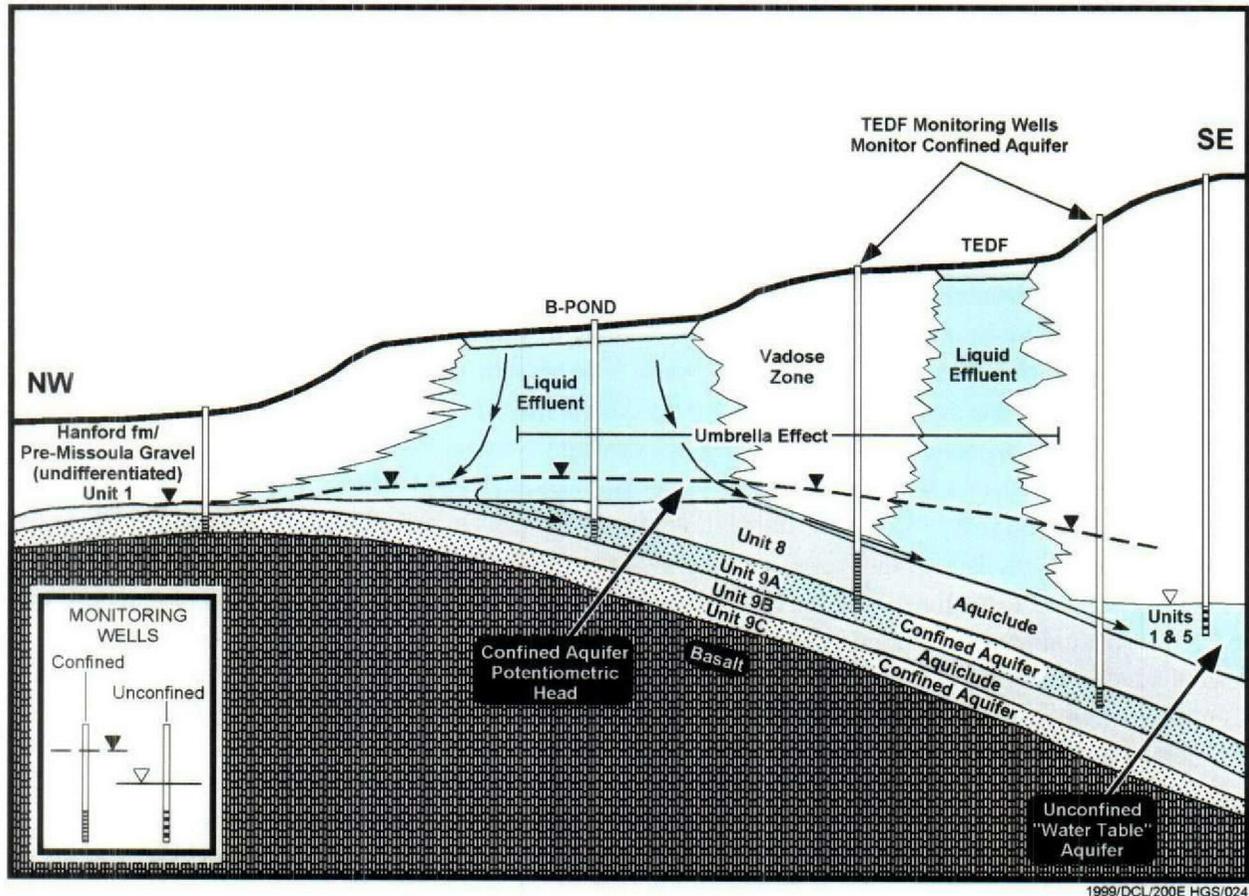


Figure 2.1. Generalized Stratigraphic Column for the B Pond Area



1999/DCL/200E HGS/024

Figure 2.2. Schematic Cross Section of the B Pond Area Showing General Hydrostratigraphic Relationships and the Effects of Historical Discharges by B Pond and TEDF. The “umbrella effect” refers to the interception and diversion of effluent by the relatively impermeable Units 8 and 9B. The confined aquifer of Unit 9A is locally unconfined beneath the B Pond. See text for discussion of flow potential (after Williams et al. 2000).

Overlying the Ringold Formation sediment is the Hanford formation (Unit 1 of Thorne et al. 1994), which ranges in thickness from ~40 meters (~130 feet) beneath the 216-B-3-C pond to ~50 meters (~160 feet) at the northwestern corner of the main pond (Davis et al. 1993). The Hanford formation is represented by three facies, in ascending stratigraphic order: 1) lower gravel sequence, 2) sandy sequence, and 3) upper gravel sequence (subdivisions after Lindsey et al. 1992). The upper and lower gravel sequences are not differentiated in those areas where the intervening sandy sequence is absent. The gravel units 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 are notably rich in clay near the western portion of the main pond, as indicated in well logs from this area. The sandy sequence is dominated by sand to gravelly sand with minor sandy gravel or silt/clay interbeds. The sandy sequence is present mainly in the vicinity of the main pond of the B Pond, but has a significant silt/clay component in the extreme western portion of the main pond near the 216-B-3-3 ditch.

2.2 Groundwater Hydrology

Lithologic and hydrologic data collected from drilling and groundwater monitoring reveal that the uppermost aquifer 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, and becomes progressively more confined to the east and southeast of the facility. Actual observations of water levels during drilling and monitoring, and aquifer testing data indicate that the change from unconfined to confined conditions is apparently gradational in most of the areas around B Pond. Figure 2.3 illustrates the hydrologic effects of the complex stratigraphy in the vicinity of B Pond. The potentiometric surface for Units 9A and 9C is mapped separately in this figure, but beneath the B Pond facility, the flow direction is generally the same in both units toward the west-southwest. The heavy dashed line demarcates the approximate boundary between confined and unconfined conditions. Water from Units 9A and 9C discharge to the unconfined aquifer along this boundary. However, the high gradient in Units 9A and 9C, which is indicated by close packing of equipotentials near the western end of the main pond (Figure 2.3), suggests an impediment to flow in the Hanford formation along the boundary. This may be due to the fine-grained component of the Hanford formation identified in this area. Figure 2.2 is a schematic cross section of the same general area depicted in Figure 2.3 along a northwest-southeast line. This figure also shows the emergent nature of units above the water table, the confining strata, and the effects associated with discharges from historical B Pond operations and current T EDF operation.

The Ringold Unit A gravels (Units 9A and 9C) comprises 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 parts of the 216-B-3-3 ditch), the aquifer occurs in the Hanford formation as well as the Ringold Unit A. Except for the western portion of the main pond area, most of the Hanford formation in the vicinity of the B Pond is coarse-grained and highly permeable. Estimates of the saturated thickness of the uppermost aquifer at the B Pond range from <10 meters (<33 feet) in the northwest portion of the main pond to >30 meters (>98 feet) 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 meters/day (3 to 2,100 feet/day) depending on which unit (Ringold Formation and Hanford formation, respectively) this property is measured (WHC 1990b; Thorne et al. 1994).

The Ringold lower mud unit (Unit 8 in Figures 2.2 and 2.3) forms both a confining horizon and potential perching layer for groundwater in the B pond area. An interpretation of the geometry of this stratum where it occurs in the vadose zone is shown in Figure 2.2. The surface of the lower mud unit is interpreted to dip gently to the south and southwest in the area immediately south of the main pond and 216-B-3-C pond. Saturated hydraulic conductivity of this unit averaged 5.5×10^{-7} cm sec⁻¹ (4.8×10^{-4} m/d) (Davis et al. 1993). The presence and configuration of this unit probably explains the lack of hydraulic response in some monitoring wells in the uppermost aquifer near the 216-B-3-C pond to large volumes of effluent diverted to this pond in 1994. The lower mud unit probably acted as an umbrella and intercepted a large portion of this infiltrating effluent. Farther east and southeast of the main pond, the lower mud unit also confines groundwater and isolates portions of the aquifer from surface contamination. From the configuration of units above the water table in Figures 2.2 and 2.3, it is apparent that

much of the effluent infiltrating from the surface could have been diverted away from the underlying aquifers by the intervening fined-grained Units 8 and 9B (i.e., an umbrella effect). This scenario is developed further in Section 3.0 to form a conceptual model for continued groundwater monitoring at the B Pond facility.

2.3 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 apparently located in the vicinity of the 216-B-3-B pond. This mound was a result of past discharges to the B Pond, which ended in 1997. Continued well drilling, aquifer testing, and a reexamination of the hydrostratigraphy by Williams et al. (2000) indicate that groundwater flow is more complicated than earlier interpretations suggested. Fine-grained units (Units 8 and 9B of Figures 2.2 and 2.3) are assumed to have intercepted infiltrating effluent in some areas around the facility, diverting this water mostly to the south along the surface of the units—primarily Unit 8. In the vicinity of the main pond these units are thin or absent, thus allowing effluent to reach Units 9A and 9C. This artificial recharge has resulted in increased 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. However, calculations of hydraulic conductivity, stratigraphic relationships recently recognized in distal southeast portions of the area (e.g., south of the TEDF—see Figure 1.2), and groundwater geochemistry (see Section 3.2) all 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 to flow may exist immediately west of the main pond. Hence, the relatively uniform radial flow pattern envisioned in earlier reports (e.g., Barnett and Teel 1997) was probably oversimplified.

In general, Figure 2.3 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., Unit 8) that are responsible for the confinement in the B Pond/TEDF region. This is possible because of the south-trending structural dip (exaggerated in Figure 2.2) of the Ringold Formation strata.

The horizontal component of hydraulic gradient near B pond varies from ~0.003 east of the mound apex to 0.006 west-southwest of the former location of the main pond. The relationship:

$$\bar{v} = Ki/n_e$$

is used to estimate average linear flow velocities (\bar{v}); where gradient values (i) are in the range noted above, hydraulic conductivity (K) ranges from 1 to 640 meters/day (3 to 2,100 feet/day), and an effective porosity value (n_e) of 0.25 is assumed. This calculation results in a range of average linear groundwater flow velocities of 0.01 to 15.36 meters/day (0.03 to 50.07 feet/day), with the lower rate occurring within the Ringold Formation Unit A (9A and 9C) and the higher rate in the Hanford formation (Unit 1).

It should be emphasized that the water table and potentiometric surface represented in Figure 2.3 indicate flow potential. Although the hydraulic gradient around the B Pond clearly indicates a potential

for west to southwest groundwater flow, actual flow may be limited. The increased gradient indicated in the vicinity of the main pond suggests a constraint to flow in a west-southwest direction.

Well pairs in the network, representing shallow and deep completions are occasionally used to estimate the magnitude and direction of the vertical hydraulic gradient. Recent water-level measurements indicate a downward-directed component of hydraulic gradient, which is possibly a reflection of a residual groundwater mound from remnant discharge effects. Hydraulic head measurements indicate a downward-directed gradient of ~ 0.03 to ~ 0.04 in well pair 699-43-42J (Units 8 and 9A) and 699-42-42B (Unit 9A), as well as in wells 699-43-41E (Unit 9A) and 699-43-41G (Unit 9C). Because the screens in each of these wells are open to several meters of aquifer thickness, estimates of the vertical hydraulic gradient should be considered gross approximations.

3.0 Conceptual Model

Soil and groundwater analyses in the B Pond area have not revealed any substantial contamination in these media by dangerous waste (see Sections 1.1.2 and 1.2.1). Extensive sampling of soil in the vadose zone across the B Pond has shown very little contamination. Based on characterization and monitoring performed thus far, actual impacts to groundwater are minor. In addition, the risk that a B Pond derived leachate would significantly contaminate groundwater in the future is also believed to be minor. A conceptual model of contaminant transport is presented here to guide future groundwater monitoring. Because of the dynamic conditions at the B Pond (a receding groundwater mound and consequent alteration of groundwater flow patterns), this model will require periodic updates.

3.1 Hydrogeology

Figure 3.1 shows a schematic representation of the interpreted hydrostratigraphic relationships in the B Pond/TEDF area. The uppermost aquifers (Units 9A and 9C) in the B Pond/TEDF area appear to have been mostly isolated from a significant part of the B Pond effluent discharges, and probably all of the TEDF discharges. The effluent was mostly intercepted by the intervening lower mud unit (Unit 8) and diverted predominantly south along the upper surface of this fine-grained unit. 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 (see Figures 2.2 and 2.3). 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 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 (Units 8 and 9B) were removed by erosion. Groundwater sampling data indicate that the contamination associated with this effluent apparently did not migrate very far to the east and south (see Section 3.2) even though there was a hydraulic gradient in these directions due to groundwater mounding beneath the B Pond. Hydrostratigraphic research by Williams et al. (2000) 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. 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 in the B Pond vicinity, 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 south end of the 216-B-3-C pond and wells monitored for the TEDF indicate low hydraulic conductivities and low groundwater flow rates (≤ 0.004 meter/day [≤ 0.013 feet/day]) for Unit 9A in this area.

While there is a possibility that effluent releases associated with construction of the WTP may impact some of the B Pond groundwater monitoring wells, the probability of this occurring is believed to be low. These releases are occurring either hydraulically downgradient or cross-gradient from the

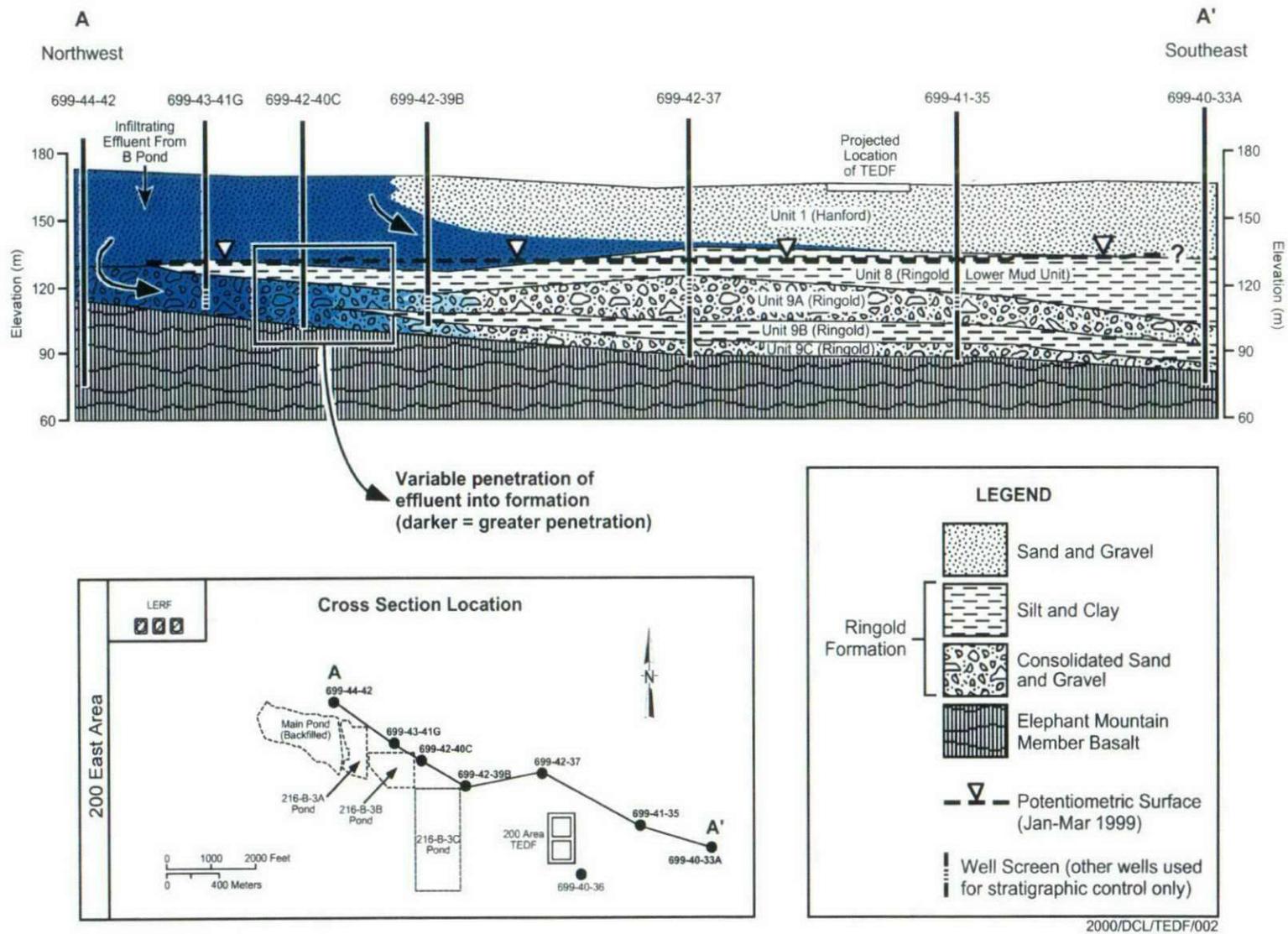


Figure 3.1. Hydrostratigraphic Relationships and Possible Effluent Flow Patterns in the Vicinity of B Pond

B Pond wells. The well having the highest probability of being impacted is well 699-43-45, located about 200 meters (656 feet) north of the construction site boundary (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 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 4.5×10^6 liters (1,200,000 gallons) (Fluor Hanford 2004). Should nitrate or other constituents significantly increase in well 699-43-45, a more quantitative assessment of effluent releases from the WTP site and their potential impacts would be warranted.

3.2 Groundwater Chemistry

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, and therefore it can be assumed to indicate the maximum extent that contaminants (including RCRA-regulated ones) may have moved through the groundwater. In effect, tritium serves as a tracer for the B Pond effluent. The distribution of tritium in groundwater at the B Pond is depicted by the map of maximum sampling results in Figure 3.2. The most striking feature of this illustration is the apparent southwest-northeast line demarcating the limit of tritium occurrence in the aquifer. This feature suggests that tritium, and presumably effluent from the B Pond, may not have migrated southeast of this line. In fact, low level analyses for tritium from wells at the TEDF indicate levels of tritium below natural background for the uppermost aquifer (Barnett 1998), 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 the B Pond (see Section 4.0).

Major ion chemistry for confined-aquifer groundwater in the vicinity of the B Pond also supports a southwest-northeast demarcation between groundwater chemistry (Figure 3.3). Wells east of the 3C pond are dominated by sodium bicarbonate groundwater, suggesting a more evolved groundwater chemistry and greater age, whereas wells closer to the main pond, 3A and 3B expansion ponds, and the northern wells around the 3C pond show either a less evolved (e.g., less sodium and more calcium) or dilute chemistry. The low ionic strength of groundwater from well 699-42-40A most closely resembles the ionic character of the effluent sent to the 3C pond until 1997 (thereafter diverted to the TEDF). This supports the tritium-related evidence, which indicates that wells east to southeast of the B Pond are unaffected by discharges from the facility. Had effluent reached these areas southeast of B Pond, the water chemistry would more closely resemble that of wells around the main pond and northern portion of the 3C expansion pond. As explained in Section 3.1, hydraulic barriers toward the east and south are postulated to explain the lack of groundwater flow and contaminant migration in these directions.

Comparisons of tritium results in four well clusters, containing two or more wells at the same location, and which monitor different portions of the uppermost aquifer, suggest a vertical distribution of

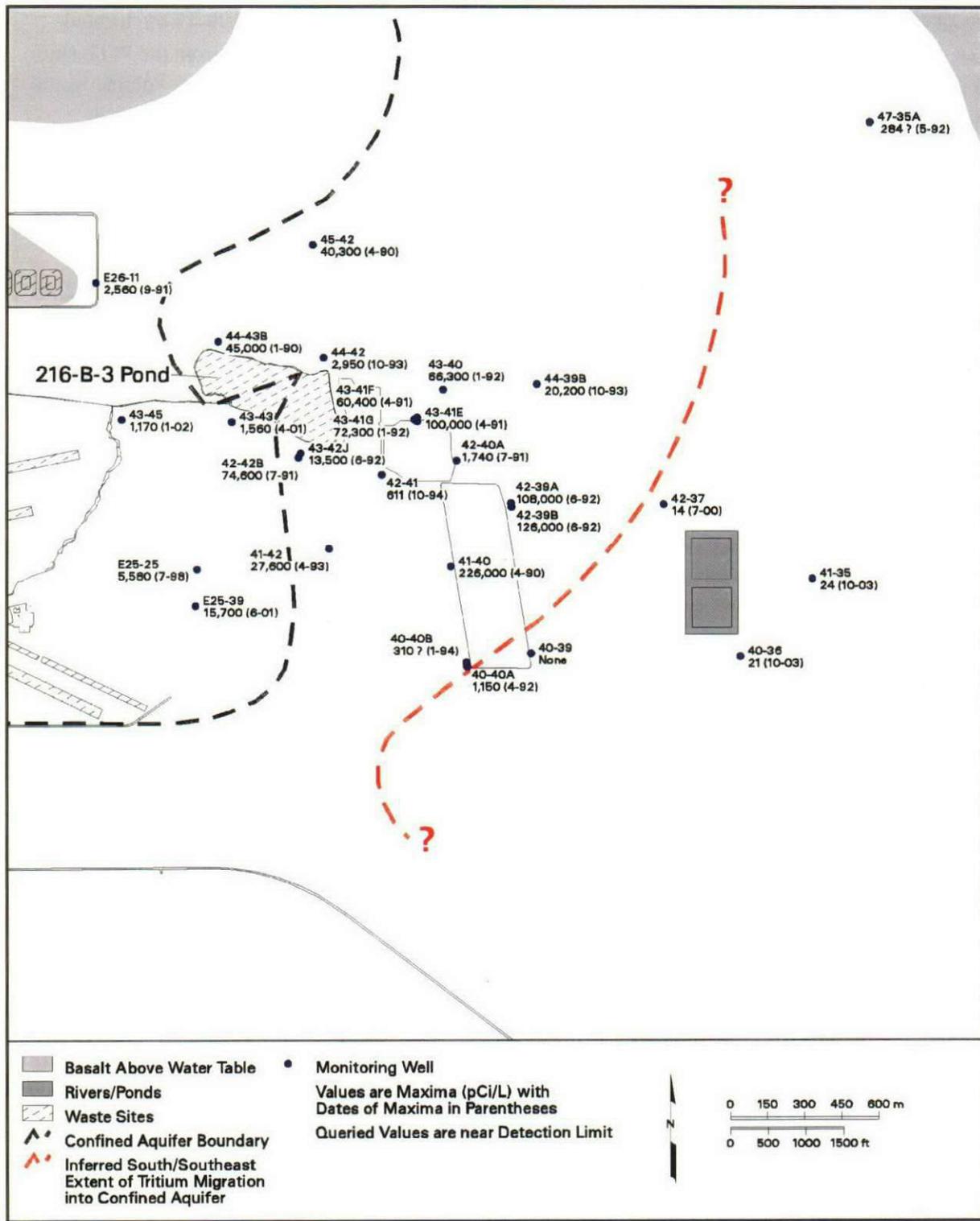


Figure 3.2. Tritium Maxima in B Pond and Vicinity Wells Showing Extent of Tritium Migration in the Confined Aquifer

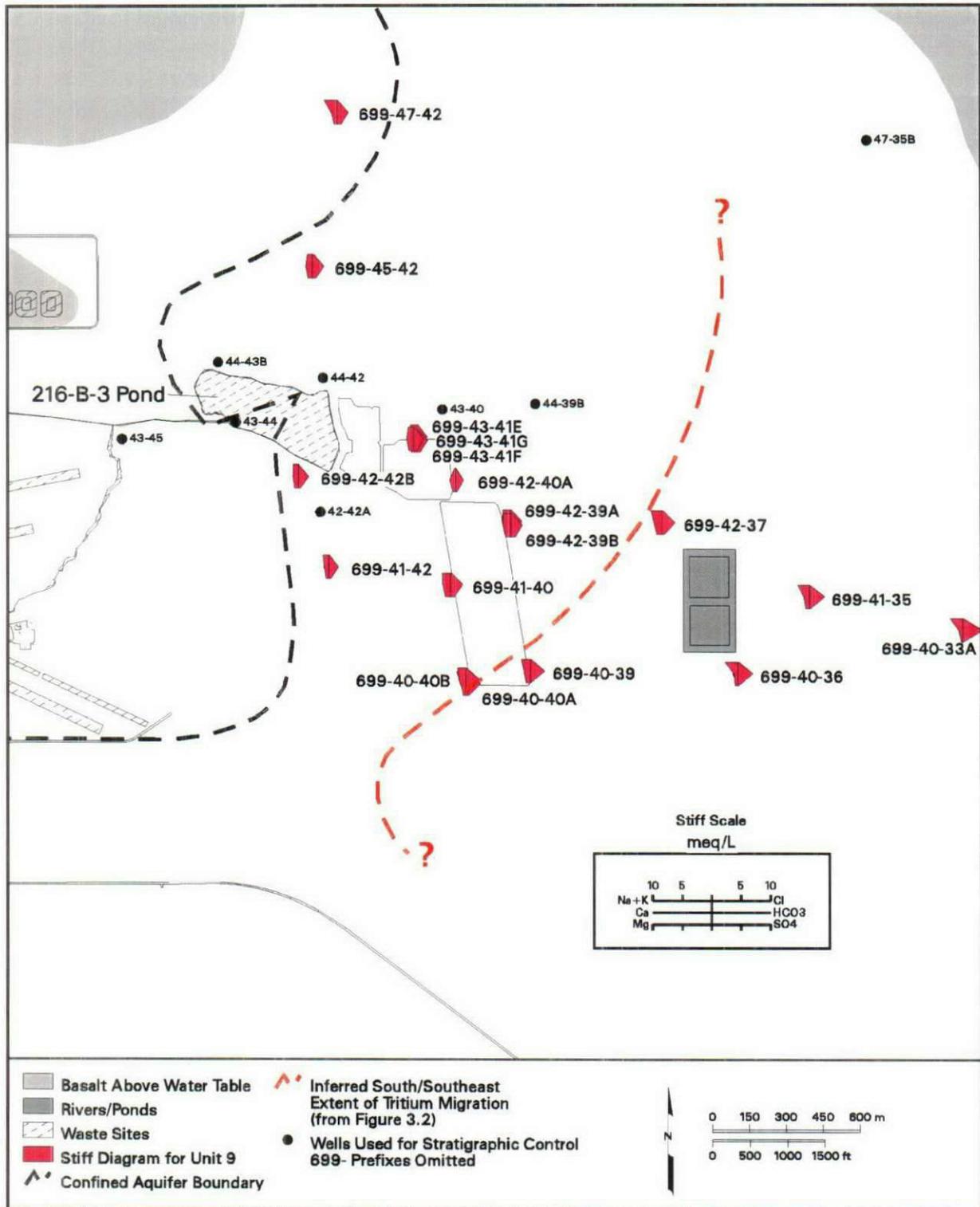


Figure 3.3. Major Ion Chemistry in Wells Completed in the Ringold Unit 9 in the Vicinity of B Pond (modified from Williams et al. 2000)

concentrations of constituents. With the exception of one group, deeper wells in the groups have produced historically higher concentrations of tritium. This trend is reversed in wells 699-43-41E, F, and G, with the shallow well having higher concentrations. Concentrations of other constituents, such as iron, nitrate, manganese, pH, and conductivity, display differences between deep/shallow well pairs, but no consistent pattern is recognizable across all four clusters of wells. No obvious differences between shallow/deep well companions were observed for concentrations of total organic carbon or total organic halides. Reasons for vertical differences in concentrations of constituents are undetermined, but may be due to an interplay of factors such as well construction, aquifer heterogeneities, variables in transport characteristics, and varying concentrations of constituents in effluent. In the case of tritium, later discharges of effluent were lower in tritium concentrations than earlier discharges, thus possibly accounting for higher concentrations being observed mostly lower in the aquifer.

3.3 Implications for Groundwater Monitoring

Conceptual models of contaminant fate (DOE-RL 1994, 2000) and subsequent soil chemistry testing suggest that most of the contaminated effluent directed to the B Pond infiltrated in the ditches leading to the main pond, probably within the 200 East Area, with some 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 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 south of the main pond. Sampling of monitoring wells south to southwest of the main pond can detect both of these potential sources under the current groundwater flow regime.

Arsenic, nitrate, and specific conductance are constituents of interest for groundwater monitoring because they are most likely to serve as indicators for residual contamination beneath the B Pond reaching groundwater. Arsenic and nitrate are essentially the only non-radiological constituents that have been detected in groundwater that cannot be explained as anything but contamination. These constituents are also 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, although it has not been identified as a component of the B Pond waste stream. The arsenic may have originated from 200 East Area cribs and ditches. Arsenic and nitrate are constituents of regional interest, and are therefore monitored under AEA and CERCLA long-term monitoring and are not included specifically as constituents for RCRA monitoring.

Anionic species, often complexed with radionuclides, predominated the waste streams sent to the B Pond. Nitrate is still present in groundwater beneath the facility, so specific conductance should be measured as part of a B Pond monitoring program. However, monitoring specific conductance poses a special problem. Because of dilution by the large volume of raw river water discharged to the facility, values for this parameter have been artificially depressed below natural background and are not currently in equilibrium with the solid phase of the aquifer. However, this parameter may be a useful indicator for contamination if Hanford Site background levels are reattained in B Pond wells.

4.0 Groundwater Monitoring Program

This section describes an interim status, detection-level, groundwater monitoring program for the B Pond consisting of a monitoring well network, target constituents, and sampling and analysis methods. This plan will remain in effect until superseded by another plan or until B Pond is incorporated into the Hanford Facility RCRA Permit. The monitoring program presented here was modified from Barnett et al. (2000) (as amended by Interim Change Notice) by including TOC and TOX as indicator parameters and by incorporating changes to the method of statistical analysis. The peculiar history of effluent discharges to the B pond facility, 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 of Section 3.0 describes these peculiarities. The following elements of the plan are designed to detect contaminants with the greatest potential for occurrence in groundwater at the B Pond facility.

4.1 Monitoring Well Network

An effective groundwater monitoring well network for the B Pond must account for the peculiar groundwater flow conditions existing at this facility. To ensure interception of any potential contamination, it is important to consider the location of potential contamination in the vadose zone and aquifer (from operation of the main pond and 216-B-3-3 ditch), areal distribution of wells in relation to the facility, and the interpreted direction of groundwater flow in the confined and unconfined aquifers beneath and in the vicinity of the pond as prefaced by the conceptual model (Section 3.0).

Using these guidelines, the groundwater monitoring network for the B Pond was derived as shown in Table 4.1 and Figure 4.1. The network consists of one upgradient well (699-44-39B) and three downgradient wells (699-43-45, 699-43-44, and 699-42-42B). The construction details and lithologic logs of these wells are presented in Appendix A. The complex orientation of geologic strata beneath B Pond, and the unconfined and confined aquifers, makes well 699-44-39B the most logical selection for an upgradient monitoring location. This well is completed in Ringold Unit 9A, and is currently upgradient of the B Pond. Although groundwater flows under confined conditions in the vicinity of 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.

The point of compliance (POC) is defined in WAC 173-303-645(6)(a) as a "vertical surface" located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated unit. For the B Pond, the POC will consist of the downgradient monitoring wells 699-43-45, 699-43-44, and 699-42-42B. These wells are directly downgradient of the facility, including the regulated portion of the B-3-3 ditch.

4.2 Constituent List and Sampling Frequency

Table 4.2 lists the constituents to be analyzed under the B Pond facility groundwater monitoring program. Groundwater will be sampled for all constituents on a semiannual basis, except metals and the groundwater quality parameters, which will be sampled annually.

Table 4.1. B Pond Groundwater Monitoring Well Network

Well	Date of Construction	Units Monitored	Minimum Years of Service Left ^(a)
699-44-39B (upgradient)	September 1992	Ringold Unit A—completed below water table	22
699-42-42B	August 1988	Ringold Unit A—completed below water table	Well is not expected to go dry
699-43-44	September 1999	Hanford formation—completed at water table	Well is not expected to go dry
699-43-45	May 1989	Hanford formation—completed at water table	33

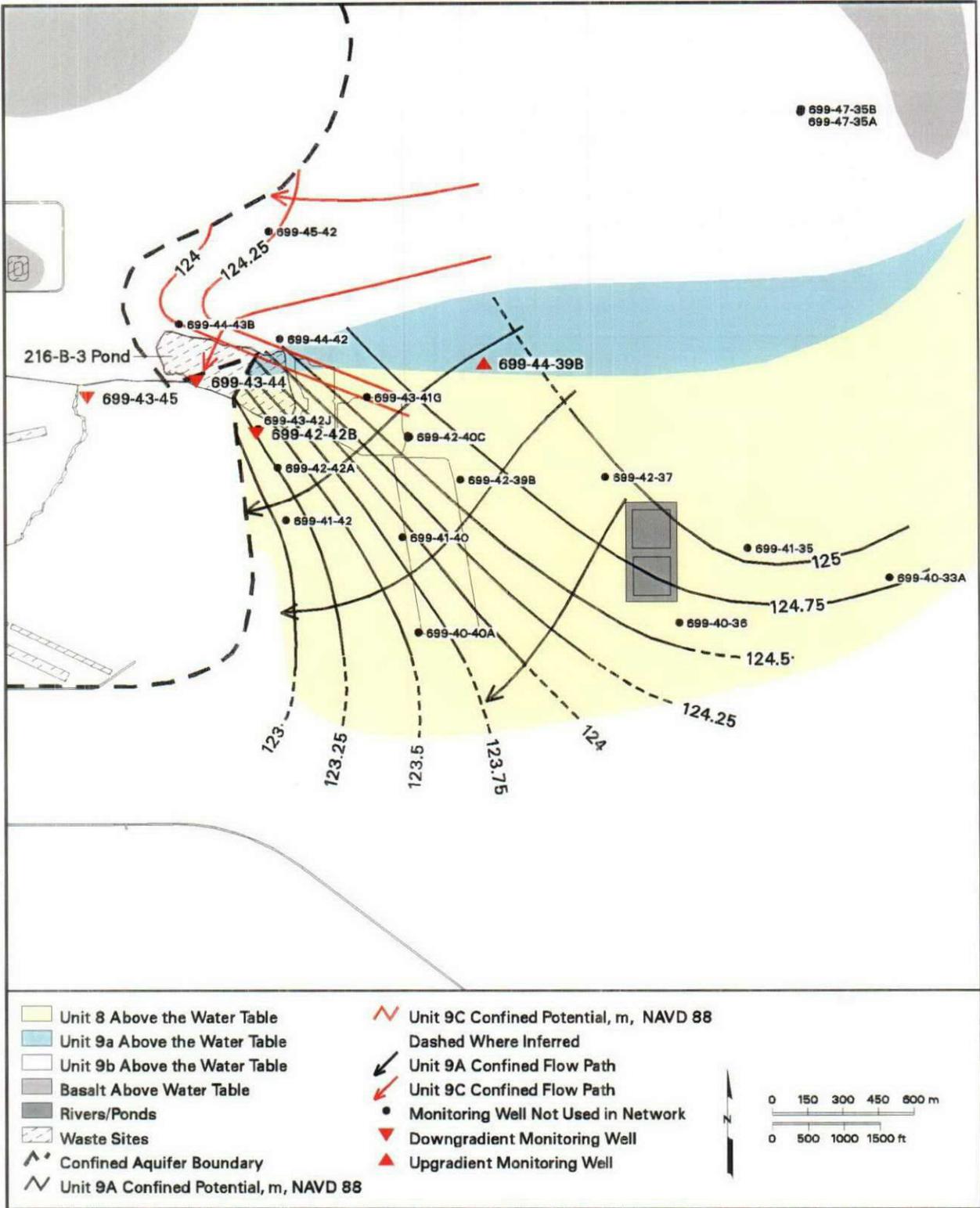
(a) Computed as the amount of water remaining in the well divided by the average rate of water-level decline from January 2002 to December 2003 (determined by linear regression). The values listed are a minimum, because the rate of water-level decline is expected to become smaller over time resulting in a longer service life.

The B Pond facility will be monitored semiannually for the contamination indicator parameters required under 40 CFR 265, Subpart F, 92(b)(3): specific conductance, pH, TOC, and TOX. Quadruplicate samples will be analyzed for the indicator parameters each semiannual period. Annual sampling will occur for the water quality parameters required under 40 CFR 265, Subpart F, 92(b)(2): chloride, iron, manganese, phenols, sodium, and sulfate. Additional parameters (i.e., alkalinity, dissolved oxygen, temperature, and turbidity) will be measured as indicators of sample quality and general aquifer/well environmental conditions.

Arsenic and nitrate are also identified as constituents of interest in groundwater that could be associated with B pond operations. Because these constituents are also associated with existing, widespread sitewide plumes, they will be monitored on a *regional* scale for AEA and CERCLA to the extent possible, and are not specifically included as constituents for B Pond.

4.3 Statistical Evaluation

Under this plan, sampling procedures and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference into WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general contamination indicator parameters (i.e., pH, specific conductance, TOC, and TOX) to background levels to test for potential impacts 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. For each well, the arithmetic mean and variance of these results are compared with the background arithmetic mean determined from previous sampling of the upgradient well. The comparison must consider individually each of the wells in the monitoring system (i.e., each well, including the upgradient well, is compared separately with background values from the upgradient well), and must use the Student's t-test at the 0.01 level of significance to determine statistically significant increases (and decreases in the case of pH) over background values.



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Figure 4.1. Location of Monitoring Wells in the B Pond Network

Table 4.2. Monitoring Well Network, Constituent List, and Sampling Frequency for the B Pond Facility

Well ID	Well Name	Purpose	WAC Compliant	RCRA Required Constituents (a)											Supporting Constituents (b)					
				Water Level (c)	Contamination Indicator Parameters				Groundwater Quality Parameters						Alkalinity	Dissolved Oxygen (c)	Temperature (c)	Turbidity (c)	Anions (d)	Metals (filtered) (e)
					pH (c)	Specific Conductance (c)	Total Organic Carbon	Total Organic Halides	Chloride	Iron (filtered)	Manganese (filtered)	Phenols	Sodium (filtered)	Sulfate						
A5185	699-44-39B	Upgradient	C	S	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	A	A
A5171	699-42-42B (f)	Downgradient	C	S	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	A	A
B8758	699-43-44	Downgradient	C	S	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	A	A
A5180	699-43-45	Downgradient	C	S	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	A	A
Footnotes																				
(a)	Constituents and parameters required by 40 CFR 265.92																			
(b)	Constituents not required by RCRA but needed to support interpretation.																			
(c)	Field measurement																			
(d)	Anions - Analytes include but not limited to chloride, sulfate, and nitrate for charge balance computations.																			
(e)	Metals - Analytes include but not limited to calcium, magnesium, potassium, and sodium for charge balance computations.																			
(f)	Deeper well																			
Codes																				
C = Well is constructed as a WAC 173-160, Part 2 resource protection well A = To be sampled annually S = To be sampled semiannually S4 = To be sampled semiannually with quadruplicate samples taken																				
Notes																				
Arsenic and nitrate are constituents of Hanford sitewide concern. Therefore, they will be monitored on a regional scale by sitewide groundwater surveillance to the extent possible, and are not included specifically as constituents for B Pond. However, nitrate is requested as a supporting constituent needed for charge balance computations.																				

The implementation of the statistical test method at the Hanford Site, including the B Pond system, is described in more detail in Hartman (2000) and Chou (1991). Critical mean values (i.e., concentrations that would be a statistically significant increase [and decrease for pH] above background values) for each of the indicator parameters are calculated by applying the statistical test method to the sampling results for the upgradient well. If the statistical critical mean comparison value calculated from the upgradient well is lower than the quantitation limit (which is calculated each quarter), then the quantitation limit is used as the statistical comparison value. The B Pond system indicator parameter critical mean values for fiscal year 2005 are shown in Table 4.3. Critical mean values are recalculated periodically if there are changes in upgradient groundwater chemistry, flow direction, or detection limits, and are published in the groundwater annual report (e.g., Appendix B of Hartman et al. 2005).

Table 4.3. Critical Means for the 216-B-3 Pond for Fiscal Year 2005 Comparisons^(a)

Constituent, unit	n	df	t_c	Average Background d	Standard Deviation	Critical Mean	Upgradient/Downgradient Comparison Value
Specific conductance, $\mu\text{S}/\text{cm}$	5	4	8.1216	254.8	7.2	318	318
Field pH	5	4	9.7291	8.16	0.030	[7.83, 8.48]	[7.83, 8.48]
Total organic carbon, $\mu\text{g}/\text{L}$	5	4	8.1216	414.2	228.4	2,446	2,450 ^(b)
Total organic halides, ^(c) $\mu\text{g}/\text{L}$	5	4	8.1216	NC	NC	NC	21.1

(a) For upgradient well 699-44-39B based on semiannual sampling events from June 2002 to July 2004 for specific conductance and field pH, and from June 2000 to July 2004 for total organic carbon and total organic halides.
(b) Rounded to the nearest 10 $\mu\text{g}/\text{L}$.
(c) Critical mean cannot be calculated because essentially all measurements are below vendor's specified method detection limit. Upgradient/downgradient comparison value is the most recently determined limit of quantitation determined by the contract laboratory (updated quarterly).
df = Degrees of freedom (n-1).
n = Number of background replicate averages.
NC = Not calculated.
 T_c = Bonferroni critical t-value for appropriate df and 16 comparisons.

If comparisons for the upgradient well show a statistically significant increase (or pH decrease) the information must be submitted in the groundwater annual report. If the comparisons for a downgradient well show a significant increase (or pH decrease) then the well could be resampled and split samples sent to different laboratories to determine if the exceedance of the comparison value was the result of laboratory error. In addition, the original samples may be reanalyzed if laboratory error is suspected.

If the exceedance of the statistical comparison value is confirmed by the resampling, then written notice is provided to the regulatory agency within seven days that the facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program must 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 and an assessment program is not instituted.

4.4 Water-Level Monitoring

Field personnel measure depth to water in each well before sampling, or at other times as specified by project staff (e.g., annual water-level measurements). The measuring tapes used to make depth to water measurements are periodically standardized to a calibrated measuring tape. Field personnel obtain two consecutive measurements that agree within 6 millimeters (0.02 feet) and record them along with the date, time, measuring tape number, and other pertinent information. The depth to water is subtracted from the elevation of a reference point (usually top of casing) to obtain water-level elevation. Water-level elevations from the RCRA wells and from other B Pond wells are used to construct water-table and potentiometric surface maps of the B Pond Area. Groundwater flow direction is inferred from these maps as well as plume maps. Rate of flow is estimated from hydraulic gradient, hydraulic conductivity, and porosity, or from rates of contaminant movement.

4.5 Sampling and Analysis Protocol

RCRA groundwater monitoring for the B Pond is part of the Groundwater Performance Assessment Project (groundwater project) conducted by Pacific Northwest National Laboratory (PNNL). Groundwater monitoring for B Pond will follow the requirements of the project's quality assurance protocols; this monitoring plan need not be revised to cite future revisions of those protocols.

This section describes the groundwater project's protocols for sample collection and analysis. Project staff schedule sampling, initiate paperwork, and oversee sample collection, shipping, and analysis. Quality requirements for any work subcontracted are specified in statements of work or contracts. Groundwater project staff conduct laboratory audits and field surveillances to assess the quality of subcontracted work and initiate corrective action if needed.

The statement of work for sampling activities specifies those activities will be conducted in accordance with a quality assurance project plan that meets the requirements defined in *EPA Requirements for Quality Assurance Project Plans* (EPA/240/B-01/003, EPA QA/R-5, March 2001 as revised). Additional requirements are specified in the statement of work.

4.5.1 Scheduling Groundwater Sampling

The groundwater project schedules well sampling. Many Hanford Site wells are sampled for multiple objectives and requirements, such as RCRA, CERCLA, and AEA. Scheduling activities help manage the overlap, eliminating redundant sampling, and meeting the needs of each sampling objective. Scheduling activities include the following:

- Each fiscal year, project scientists provide well lists, constituent lists, and sampling frequency. Each month, project scientists review the sampling schedule for the following month. Changes are requested via change request forms and approved by the sampling and analysis task lead and the monitoring project manager.
- Project staff track sampling and analysis through an electronic schedule database, stored on a server at PNNL. Quality control samples also are managed through this database. A scheduling program

generates unique sample numbers and a special user interface generates sample authorization forms, field services reports, groundwater sample reports, chain-of-custody forms, and sample container labels.

- Sampling and analysis staff verify that well name, sample numbers, bottle sizes, preservatives, etc. are indicated properly on the paperwork, which is transmitted to the sample collector. Staff verify that the paperwork was generated correctly.
- At each month's end, project staff use the schedule database to determine if any wells were not sampled as scheduled. If the wells or sampling pumps require maintenance, sampling is rescheduled following repair. If a well can no longer be sampled, it is cancelled, and the reason is recorded in the database. DOE will notify Ecology if sampling is delayed past the end of the scheduled quarter or if a well cannot be sampled.

4.5.2 Chain of Custody

The sample collector uses chain-of-custody forms to document the integrity of groundwater samples from the time of collection through data reporting. The forms are generated during scheduling (see Section 4.5.1) and managed by the sample collector. Samplers enter required information on the forms, including the following:

- Sampler's name(s)
- Method of shipment and destination
- Collection date and time
- Sample identification numbers
- Analysis methods
- Preservation methods.

When samples are transferred from one custodian to another (e.g., from sampler to shipper or shipper to analytical laboratory), the receiving custodian inspects the form and samples and notes any deficiencies. Each transfer of custody is documented by the printed names and signatures of the custodian relinquishing the samples and the custodian receiving the samples, and the time and date of transfer.

4.5.3 Sample Collection

Field personnel measure water levels in each well prior to sampling (see Section 4.4), then purge stagnant water from the well. Groundwater samples generally are collected after three casing volumes of water have been purged from the well and after field measured parameters (pH, temperature, specific conductance, and turbidity) have stabilized. For routine groundwater samples, preservatives are added to the collection bottles, if necessary, before their use in the field.

Samples for metals analyses are filtered in the field with 0.45 micrometer, in-line, disposable filters. After sampling, pH, temperature and specific conductance are measured again. Sample bottles are sealed with evidence tape and placed in a cooler with ice for shipping. The samplers record the date, time, personnel, field measurements, and other pertinent information and complete the chain of custody form as described in Section 4.5.2.

4.5.4 Analytical Protocols

Instruments for field measurements (e.g., pH, specific conductance, temperature, and turbidity) are calibrated using standard solutions prior to use and are operated according to manufacturer's instructions. Each instrument is assigned a unique number that is tracked on field documentation and calibrated and controlled. Laboratory analytical methods are specified in contracts with the laboratories, and most are standard methods from *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* (SW-846, EPA 1986c, as revised).

5.0 Quality Assurance

The groundwater project's quality assurance protocols meet *EPA Requirements for Quality Assurance Project Plans* (EPA/240/B-01/003, EPA QA/R-5, March 2001 as revised). A quality control protocol is included in the groundwater project quality documentation, and quality control sampling requirements for subcontracted work are discussed in the statement of work with the subcontractor.

The groundwater project's quality control program is designed to assess and enhance the reliability and validity of groundwater data. This is accomplished through evaluating the results of quality control samples, conducting audits, and validating groundwater data. This section describes the quality control program for the entire groundwater project, which includes the B Pond facility.

The quality control practices of the groundwater project are based on EPA guidance cited in the *Tri-Party Agreement Action Plan*, Section 6.5 (Ecology et al. 1989, as amended). Accuracy, precision, and detection are the primary parameters used to assess data quality (Mitchell et al. 1985). Data for these parameters are obtained from two categories of quality control samples: those that provide checks on field and laboratory activities (field quality control) and those that monitor laboratory performance (laboratory quality control). Table 5.1 summarizes the types of samples in each category along with the sample frequencies and characteristics evaluated.

5.1 Quality Control Criteria

Quality control data are evaluated based on established acceptance criteria for each quality control sample type. For field and method blanks, the acceptance limit is generally two times the instrument detection limit (metals), method detection limit (other chemical parameters), or minimum detectable activity (radiochemistry parameters). However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, and phthalate esters, the limit is five times the method detection limit. Groundwater samples that are associated (i.e., collected on the same date and analyzed by the same method) with out-of-limit field blanks are flagged with a "Q" in the Hanford Environmental Information System (HEIS) database to indicate a potential contamination problem.

Field duplicates must agree within 20%, as measured by the relative percent difference (RPD) to be acceptable. Only those field duplicates with at least one result greater than five times the appropriate detection limit are evaluated. Unacceptable field duplicate results are also flagged with a "Q" in the HEIS database.

The acceptance criteria for laboratory duplicates, matrix spikes, matrix spike duplicates, surrogates, and laboratory control samples are generally derived from historical data at the laboratories in accordance with *Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods, 3rd ed.* (SW-846, EPA 1986c, as revised). Typical acceptance limits are within 25% of the expected values, although the limits may vary considerably with the method and analyte. Current values for laboratory duplicates, matrix spikes, and laboratory control samples are 20% RPD, 60% to 140%, and 70% to 130%, respectively. These values are subject to change if the contract is modified or replaced.

Table 5.1. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field Quality Control		
Full trip blank	Contamination from containers or transportation	1 per 20 well trips
Field transfer blank	Airborne contamination from the sampling site	1 each day volatile organic compound samples are collected
Equipment blank	Contamination from non-dedicated sampling equipment	1 per 10 well trips or as needed ^(a)
Duplicate samples	Reproducibility	1 per 20 well trips
Laboratory Quality Control		
Method blank	Laboratory contamination	1 per batch
Lab duplicates	Laboratory reproducibility	Method/contract specific ^(b)
Matrix spike	Matrix effects and laboratory accuracy	Method/contract specific ^(b)
Matrix spike duplicate	Laboratory reproducibility and accuracy	Method/contract specific ^(b)
Surrogates	Recovery/yield	Method/contract specific ^(b)
Laboratory control sample	Accuracy	1 per batch
Double blind standards	Accuracy and precision	Varies by constituent ^(c)
<p>(a) When a new type of non-dedicated sampling equipment is used, an equipment blank should be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the equipment's decontamination procedure.</p> <p>(b) If called for by the analytical method, duplicates, matrix spikes, and matrix spike duplicates are typically analyzed at a frequency of 1 per 20 samples. Surrogates are routinely included in every sample for most gas chromatographic methods.</p> <p>(c) Double blind standards containing known concentrations of selected analytes are typically submitted in triplicate or quadruplicate on a quarterly, semiannual, or annual basis.</p>		

Table 5.2 lists the acceptable recovery limits for the double blind standards. These samples are prepared by spiking background well water (currently wells 699-19-88 and 699-49-100C) 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. Double blind standard results that are outside the acceptance limits are investigated and appropriate actions are taken if necessary.

Holding time is the elapsed time period between sample collection and analysis. Exceeding recommended 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 *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* (SW-846, EPA 1986c, as revised) or *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020, 1983). These holding times are specified in laboratory contracts. Data associated with exceeded holding times are flagged with an "H" in the HEIS database.

Additional quality control 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. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report (e.g., Hartman et al. 2005).

Table 5.2. Recovery Limits for Double Blind Standards

Constituent	Frequency	Recovery Limits	Precision Limits (RSD)
Specific conductance	Quarterly	75%–125%	25%
Total organic carbon ^(a)	Quarterly	75%–125%	Varies with spiking compound
Total organic halides ^(b)	Quarterly	75%–125%	Varies with spiking compound
<p>(a) The spiking compound generally used for total organic carbon is potassium hydrogen phthalate. Other spiking compounds may also be used.</p> <p>(b) Two sets of spikes for total organic halides will be used. The first should be prepared with 2,4,5-trichlorophenol. The second set will be spiked with a mixture of carbon tetrachloride, chloroform, and trichloroethene.</p> <p>RSD = Relative standard deviation.</p>			

5.2 Groundwater Data Validation Process

The groundwater project's data validation process provides requirements and guidance for validation of groundwater data that are routinely collected as part of the groundwater project. Validation is a systematic process of reviewing data against a set of criteria to determine whether the data are acceptable for their intended use. This process applies to groundwater data that have been verified (see Section 6.1) and loaded into HEIS. The outcome of the activities described below is an electronic data set with suspect or erroneous data corrected or flagged. Groundwater monitoring project staff document the validation process quarterly. Documentation is stored in the project file.

Responsibilities for data validation are divided among project staff. Each RCRA unit or geographic region is assigned to a project scientist, who is familiar with the hydrogeologic conditions of that site. The data validation process includes the following elements:

- **Generation of data reports:** Twice each month, data management staff provide tables of newly loaded data to project scientists for evaluation (biweekly reports). Also, after laboratory results from a reporting quarter have been loaded into HEIS, staff produce tables of water-level data and analytical data for wells sampled within that quarter (quarterly reports). The quarterly data reports include any data flags added during the quality control evaluation or as a result of prior data review.
- **Project scientist evaluation:** As soon as practical after receiving biweekly reports, project scientists review the data to identify changes in groundwater quality or potential data errors. Evaluation techniques include comparing key constituents to historical trends or spatial patterns. Other data checks may include comparison of general parameters to their specific counterparts (e.g., conductivity to ions) and calculation of charge balances. Project scientists request data reviews if appropriate (see Section 6.2). If necessary, the lab may be asked to check calculations or reanalyze the sample, or the well may be resampled. After receiving quarterly reports, project scientists review sampling summary tables to determine whether network wells were sampled and analyzed as scheduled. If

not, they work with other project staff to resolve the problem. Project scientists also review quarterly reports of analytical and water-level data using the same techniques as for biweekly reports. Unlike the biweekly reports, the quarterly reports usually include a full data set (i.e., all the data from the wells sampled during the previous quarter have been received and loaded into HEIS).

- Staff report results of quality control evaluations informally to project staff, DOE, and Ecology each quarter. Results for each fiscal year are described in the annual groundwater monitoring report (e.g., Hartman et al. 2005).

6.0 Data Management and Reporting

This chapter describes how groundwater data are stored, retrieved, and interpreted. Reporting requirements are also described.

6.1 Loading and Verifying Data

The contract laboratories report analytical results both electronically and in hard copy. The electronic results are loaded into HEIS. Hard copy data reports and field records are maintained as part of the Hanford Facility operating record, unit specific file for the B Pond treatment, storage, and disposal unit. Project staff perform an array of computer checks on the electronic file for formatting, allowed values, data flagging (qualifiers), and completeness. Verification of the hard copy results includes checks for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems that arose during the analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff members work with the laboratory to correct the problems. Notes on condition of samples or problems during analysis may be used to support data reviews (see Section 6.2).

Field data such as specific conductance, pH, temperature, turbidity, and depth-to-water are recorded on field records. Data management staff enter these into HEIS manually through data entry screens, verify each value against the hard copy, and initial each value on the hard copy.

6.2 Data Review

The groundwater project conducts special reviews of groundwater analytical data or field measurements when results are in question. Groundwater project staff document the process on a review form and results are used to flag the data appropriately in HEIS. Various staff may initiate a review, e.g., project scientists, data management, quality control. The data review process includes the following steps:

- The initiator fills out required information on a review form, such as sample number, constituent, and reason for the request (e.g., “result is two orders of magnitude greater than historical results and disagrees with duplicate.”). The initiator recommends an action, such as a data re-check, sample re-analysis, well re-sampling, or simply flagging the data as suspect in HEIS.
- The data review coordinator determines that the review form does not duplicate a previously submitted form, then assigns a unique review number and records it on the form. A temporary flag is assigned to the data in HEIS, indicating the data are undergoing review (“F” flag).
- If laboratory action is required, the data review coordinator records the laboratory’s response on the review form. Other documentation also may be relevant, such as chain-of-custody forms, field records, calibration logs, or chemist’s sheets.
- A project scientist assigned to evaluating review forms determines and records the appropriate response and action on the form, including changes to be made to the data flags in HEIS. Actions may include updating HEIS with corrected data or result of re-analysis, flagging existing data (e.g.,

“R” for reject, “Y” for suspect, “G” for good), and/or adding comments. Data management updates the temporary “F” flag to the final flag in HEIS.

- The data review coordinator signs the review form to indicate its closure.
- If a review form is filed on data that are not “owned” by the groundwater project, the data review coordinator forwards a copy of the partially filled form to the appropriate contact for their action. The review is then closed.

6.3 Interpretation

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

- Hydrographs – graph water levels vs. 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 to be perpendicular to lines of equal potential.
- Trend plots – graph concentrations of constituents vs. 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 aid in determining movement of plumes and direction of flow.
- Contaminant ratios – can sometimes be used to distinguish between different sources of contamination.

6.4 Reporting

Chemistry and water-level data are reviewed after each sampling event and are available in HEIS. Formal, interpretive reports are issued annually in March (e.g., Hartman et al. 2005). Results of RCRA monitoring also are summarized in informal, quarterly reports sent to Ecology via e-mail.

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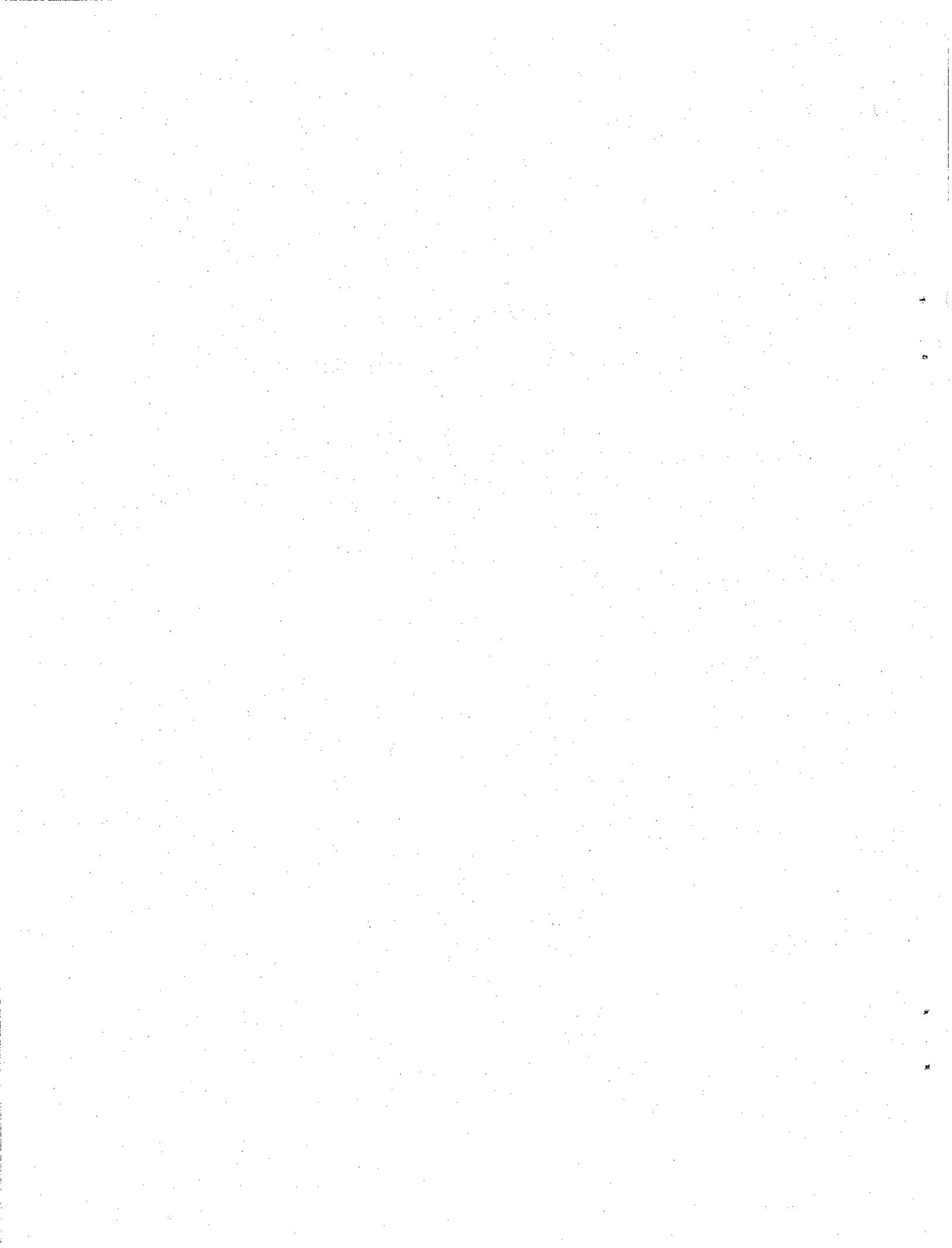
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Appendix A

Well Lithologic Logs and Construction Details

The following diagrams illustrate specifications of well construction and the general lithologic records from the drilling of each of the four wells included in the B Pond groundwater monitoring network. All depths and distances are in feet, as they were recorded during the drilling of the wells.



Pacific Northwest National Laboratory
AS-BUILT DIAGRAM

Boring or Well Number 699-43-44 (B8758)

Sheet 1 of 1

Location 200 East Area / B-Pond

Project 200-CW-1 / RCRA

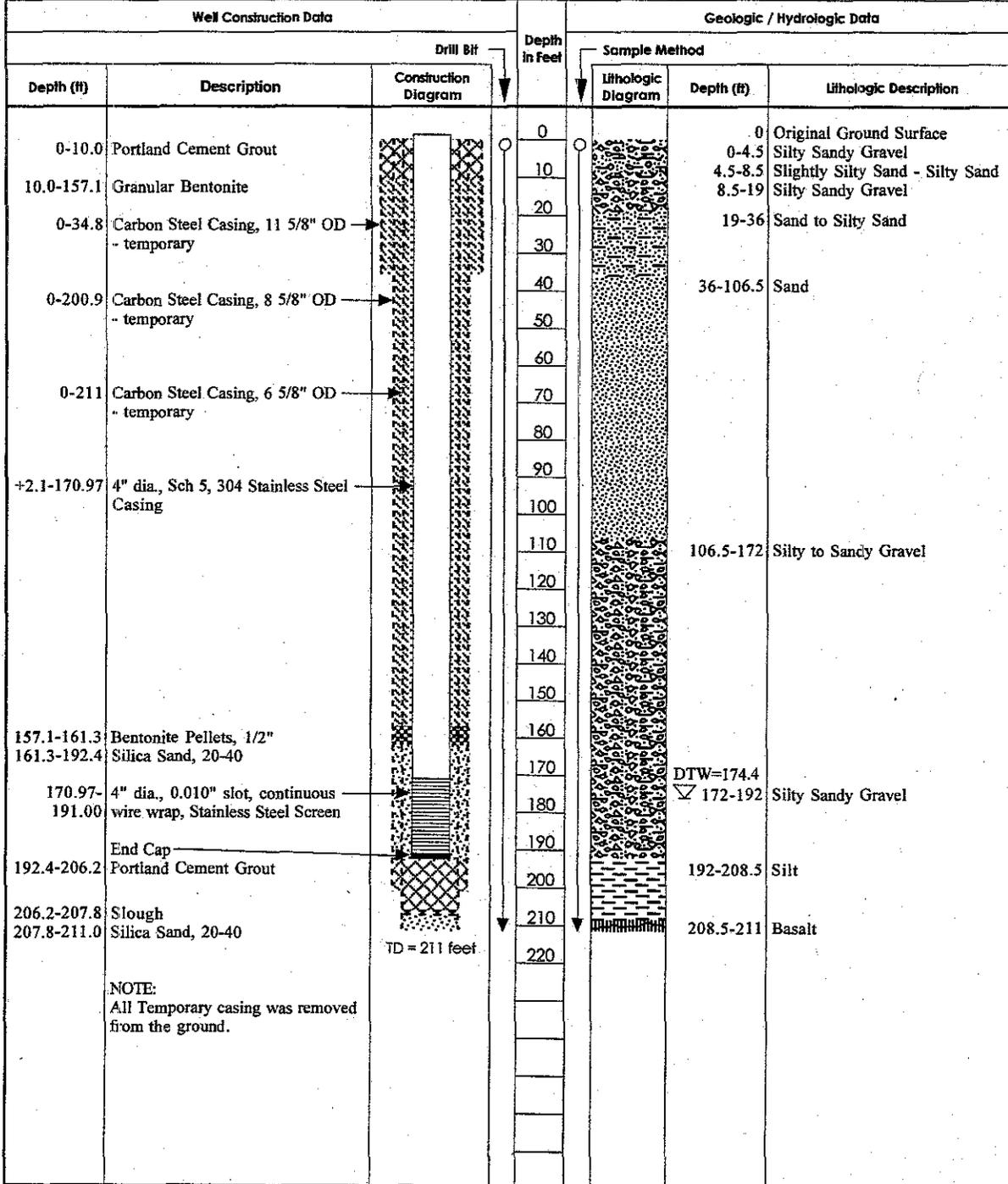
Logged by K. Singleton, L.D. Walker

Date Well Started 09-13-99

Reviewed by D.C. Weekes

Date 10/06/99

Date Well Completed 09-27-99



Drill Bit / Sample Method Used:

Rotary
 Air Rotary
 Mud Rotary
 Air Percussion
 Back Hoe
 Auger
 Drive Sampler
 Hard Tool
 Split-Barrel

2000/DCL/200CW1QP/001

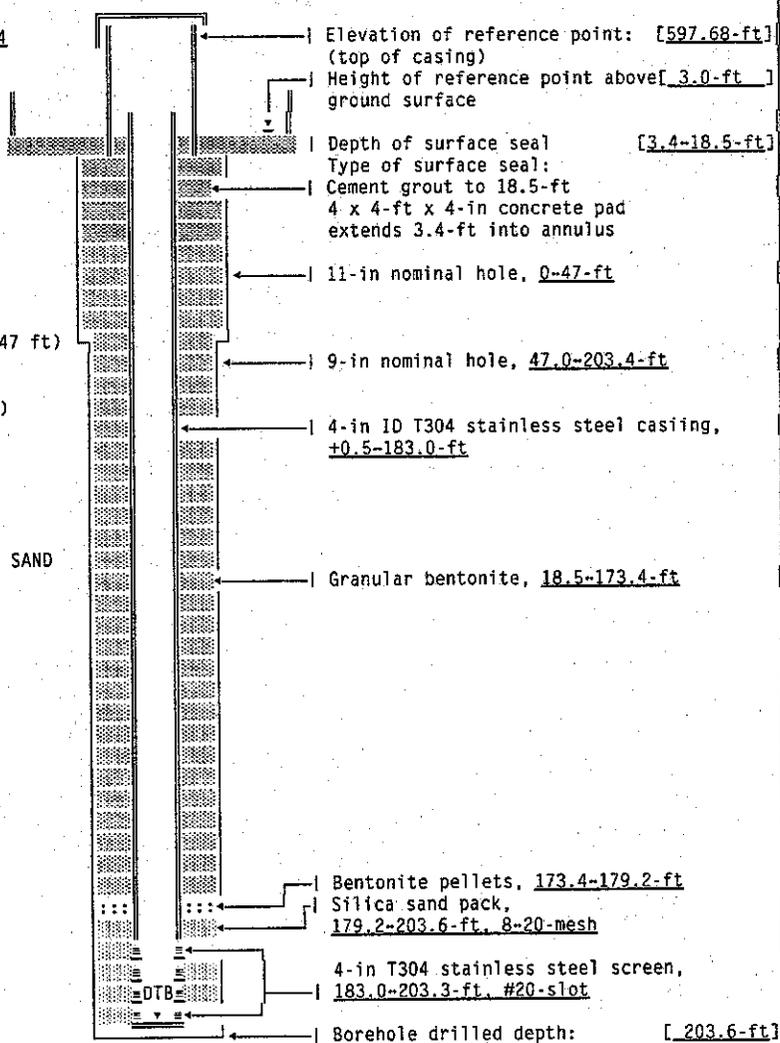
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: <u>Cable tool</u>	Sample Drive barrel & Method: <u>Hard tool</u>	WELL NUMBER: <u>699-43-45</u> A5180	TEMPORARY WELL NO: <u>BP-1</u>
Drilling Fluid Used: <u>Water</u>	Additives Used: <u>Not documented</u>	Hanford	
Driller's Name: <u>L. Watkins</u>	WA State Lic Nr: <u>Not documented</u>	Coordinates: N/S <u>N 42.977.4</u>	E/W <u>W 44.643.6</u>
Drilling Company: <u>KEH</u>	Location: <u>Hanford</u>	State Coordinates: N <u>448.164.7</u>	E <u>2.250.571.2</u>
Date Started: <u>02May89</u>	Date Complete: <u>02Jun89</u>	Card #: <u>011453</u>	T <u>12N</u> R <u>26E</u> S <u>1NW4</u>
		Elevation	Ground surface: <u>594.70-ft Brass cap</u>

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

GENERALIZED Geologist's STRATIGRAPHY Log

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



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

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

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 699-43-45

WELL DESIGNATION : 699-43-45
 RCRA FACILITY : 216-B-3 Pond
 CERCLA UNIT : Not applicable
 HANFORD COORDINATES : N 42,977 W 44,644 [28Sep89-200E]
 LAMBERT COORDINATES : N 448,165 E 2,250,571 [HANCONV]
 N 136,585.7m E 576,284.2m [28Sep89-NAD83]
 DATE DRILLED : Jun89
 DEPTH DRILLED (GS) : 203.6-ft
 MEASURED DEPTH (GS) : 203.9-ft, 08Apr93
 DEPTH TO WATER (GS) : 187.7-ft, Jun89,
 192.1-ft, 22Jul94
 CASING DIAMETER : 4-in, stainless steel, +0.5-183.0-ft,
 6-in, stainless steel, +3.0--0.5-ft
 ELEV TOP CASING : 597.68-ft (6-in) [28Sep89-UNK]
 595.2-ft, (4-in) [28Sep89-UNK]
 ELEV GROUND SURFACE : 594.70-ft, Brass cap [28Sep89-UNK]
 PERFORATED INTERVAL : Not applicable
 SCREENED INTERVAL : 183.0-203.3-ft, 4-in stainless steel, #20-slot
 COMMENTS : FIELD INSPECTION, 08Apr93;
 4 and 6-in stainless steel casing.
 4-ft by 4-ft concrete pad, 4 posts, 1 removable.
 Capped and locked, brass cap in pad with well ID.
 Not in radiation zone.
 OTHER;
 AVAILABLE LOGS : Geologist, Driller
 TV SCAN COMMENTS : Not applicable
 DATE EVALUATED : Not applicable
 EVAL RECOMMENDATION : Not applicable
 LISTED USE : B-Pond monthly water level measurement, 24Oct89-22Jul94,
 CURRENT USER : WHC ES&M w/l monitoring and RCRA sampling,
 PNL sitewide w/l monitoring
 PUMP TYPE : Hydrostar,
 MAINTENANCE :

WELL CONSTRUCTION AND COMPLETION SUMMARY

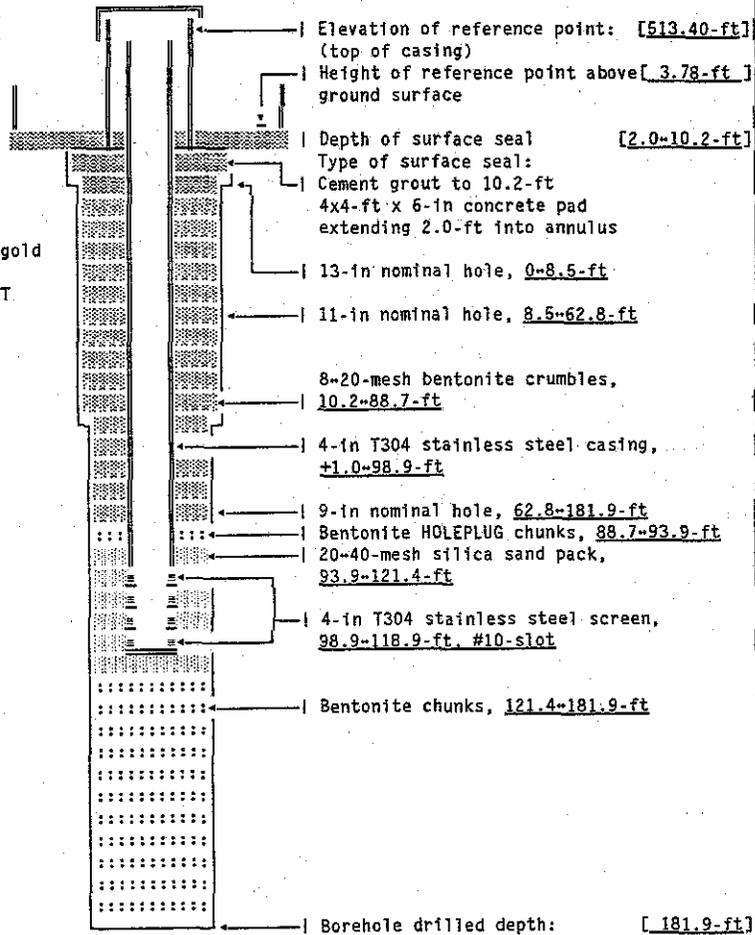
Drilling Backhoe to 8.8-ft Sample Drive barrel
 Method: Cable tool/air rotary Method: Air returns
 Drilling Additives
 Fluid Used: Raw water Used: None
 Driller's WA State
 Name: S. McKinnon Lic Nr: Not documented
 Drilling Company
 Company: Jensen Drilling Co Location: Not documented
 Date Date
 Started: 08Sep92 Complete: 03Nov92

WELL TEMPORARY
 NUMBER: 699-44-39B A5185 WELL NO:
 Hanford
 Coordinates: N/S N 43,426.3 E/W W 39,140.4
 State NAD83 N 136,727.61m E 577,960.30m
 Coordinates: N 448.628 E 2,256.073
 Start
 Card #: Not documented T R S
 Elevation
 Ground surface: 509.62-ft Brass cap

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

GENERALIZED Geologist's
 STRATIGRAPHY Log
 S1=slightly

0-5: SAND-Eolian
 5-69: S1 silty SAND
 69-71: Sandy GRAVEL
 71-92: S1 sandy GRAVEL
 (Hanford/Lower Coarse Ringold
 contact @ 92-ft)
 92-95: Gravelly SAND w/trace SILT
 95-120: SAND
 120-135: S1 sandy GRAVEL
 135-140: Gravelly SAND
 140-155: SAND
 155-172: Gravelly SAND
 172-181.9: BASALT
 (Elephant Mt Member)



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

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 699-44-39B

WELL DESIGNATION : 699-44-39B
 CERCLA UNIT : Not applicable
 RCRA FACILITY : 216 B-3 Pond
 HANFORD COORDINATES : N 43,426.3 W 39,140.4 [200E-30Dec92]
 LAMBERT COORDINATES : N 448,628 E 2,256,073 [HANCONV]
 N 136,727.61m E 577,960.30m [NAD83-30Dec92]
 DATE DRILLED : Nov92
 DEPTH DRILLED (GS) : 181.9-ft
 MEASURED DEPTH (GS) : Not documented
 DEPTH TO WATER (GS) : 93.3-ft, 03Nov92
 89.1-ft, 22Ju194
 CASING DIAMETER : 4-in stainless steel, +1.0-98.9-ft;
 6-in stainless steel, +3.78--0.5-ft
 ELEV TOP CASING : 513.40-ft, [NGVD'29-30Dec92]
 ELEV GROUND SURFACE : 509.62-ft, Brass cap [NGVD'29-30Dec92]
 PERFORATED INTERVAL : Not applicable
 SCREENED INTERVAL : 98.9-118.9-ft, 4-in #10-slot stainless steel;
 COMMENTS : FIELD INSPECTION, 05Nov92;
 4 and 6-in stainless steel casing.
 4-ft by 4-ft concrete pad, 4 posts, 1 removable.
 Capped and locked, brass cap in pad with well ID.
 Not in radiation zone.
 OTHER:
 AVAILABLE LOGS : Geologist
 TV SCAN COMMENTS : Not applicable
 DATE EVALUATED : Not applicable
 EVAL RECOMMENDATION : Not applicable
 LISTED USE : B-Pond monthly water level measurement, 23Feb93-22Ju194,
 CURRENT USER : WHC ES&M w/1 monitoring and RCRA sampling,
 PUMP TYPE : Hydrostar,
 MAINTENANCE :

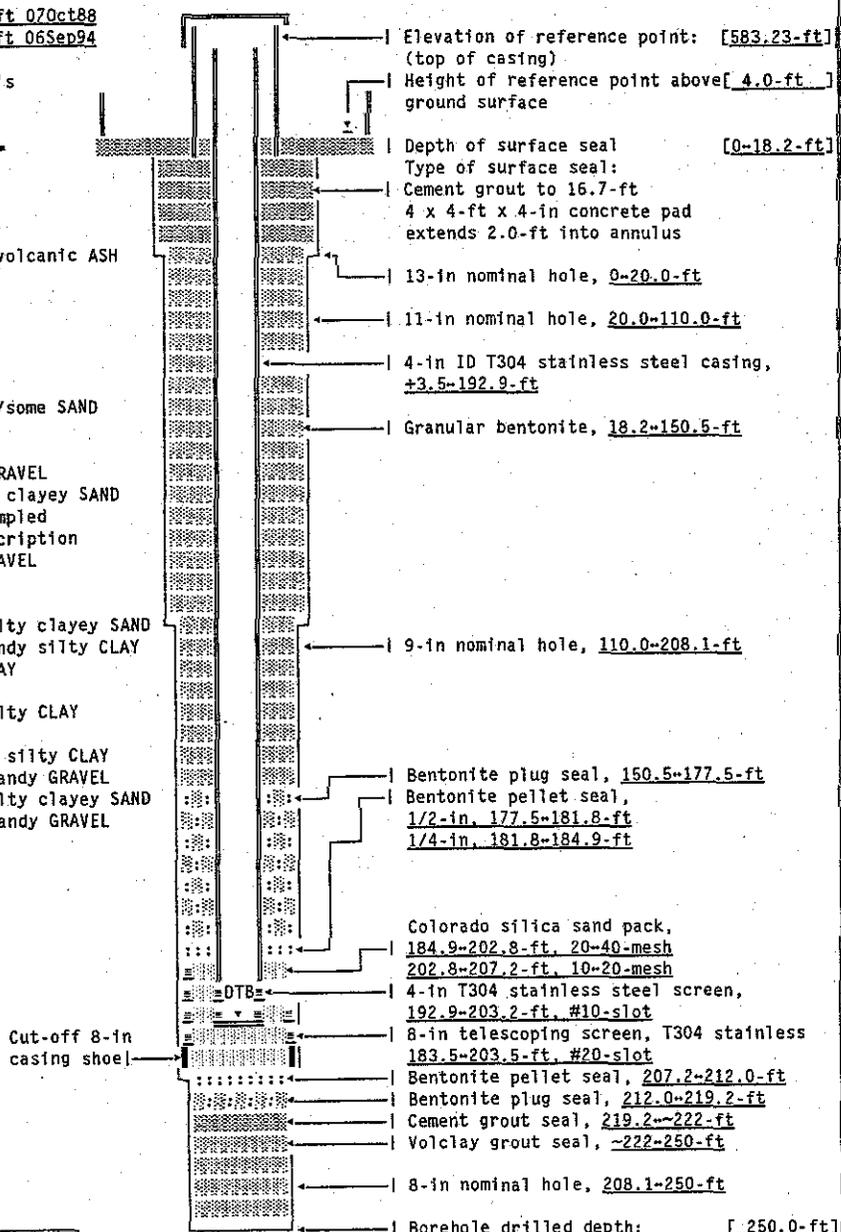
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: <u>Cable tool</u>	Sample Drive barrel & Method: <u>Hard tool</u>	WELL NUMBER: <u>699-42-42B</u> A5171	TEMPORARY WELL NO: <u>BP-10</u>
Drilling Fluid Used: <u>Water</u>	Additives Used: <u>Not documented</u>	Hanford	
Driller's Name: <u>R Vance</u>	WA State Lic Nr: <u>Not documented</u>	Coordinates: N/S <u>N 42,472.9</u>	E/W <u>W 42,301.3</u>
Drilling Company: <u>Onwego Drilling Co</u>	Location: <u>Kennewick, WA</u>	State	Coordinates: N <u>447,666</u> E <u>2,252,915</u>
Date Started: <u>15Aug88</u>	Date Complete: <u>15Oct88</u>	Start Card #: <u>Not documented</u>	T <u> </u> R <u> </u> S <u> </u>
		Elevation	Ground surface: <u>579.83-ft Brass cap</u>

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

GENERALIZED Geologist's STRATIGRAPHY Log
S1=Slightly

0-15: Cse SAND
15-25: S1 gravelly SAND
25-35: Fine SAND
35-40: Med-fine SAND
38 : 1-2-in layer of volcanic ASH
40-50: Fine SAND
50-65: Med-fine SAND
65-70: Med SAND
70-85: Fine SAND
85-90: Med SAND
90-95: Fine SAND
93 : 2-in lens SILT w/some SAND
95-105: Cse-med SAND
105-109: Med SAND
109-159: Silty, sandy GRAVEL
159-160: Gravelly silty clayey SAND
160-182: Split spoon sampled
No field description
182-190: Silty sandy GRAVEL
190-195: Gravelly SAND
195-204: Sandy GRAVEL
204-210: S1 gravelly silty clayey SAND
210-215: S1 gravelly sandy silty CLAY
215-220: Sandy silty CLAY
220-225: Silty CLAY
225-230: S1 gravelly silty CLAY
230-235: Silty CLAY
235-240: Gravelly sandy silty CLAY
240-243: Silty clayey sandy GRAVEL
243-248: SL gravelly silty clayey SAND
248-250: Silty clayey sandy GRAVEL



Elevation of reference point: [583.23-ft]
(top of casing)
Height of reference point above [4.0-ft]
ground surface

Depth of surface seal [0-18.2-ft]
Type of surface seal:
Cement grout to 16.7-ft
4 x 4-ft x 4-in concrete pad
extends 2.0-ft into annulus

13-in nominal hole, 9-20.0-ft

11-in nominal hole, 20.0-110.0-ft

4-in ID T304 stainless steel casing,
+3.5-192.9-ft

Granular bentonite, 18.2-150.5-ft

9-in nominal hole, 110.0-208.1-ft

Bentonite plug seal, 150.5-177.5-ft
Bentonite pellet seal,
1/2-in, 177.5-181.8-ft
1/4-in, 181.8-184.9-ft

Colorado silica sand pack,
184.9-202.8-ft, 20-40-mesh
202.8-207.2-ft, 10-20-mesh

DTB ← 4-in T304 stainless steel screen,
192.9-203.2-ft, #10-slot

Cut-off 8-in casing shoe ← 8-in telescoping screen, T304 stainless
183.5-203.5-ft, #20-slot

Bentonite pellet seal, 207.2-212.0-ft
Bentonite plug seal, 212.0-219.2-ft
Cement grout seal, 219.2-222-ft
Volclay grout seal, ~222-250-ft

8-in nominal hole, 208.1-250-ft

Borehole drilled depth: [250.0-ft]

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

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

