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Revision 1

Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Pacific Northwest National Laboratory for the
U.S. Department of Energy under Contract DE-AC05-76RL01830

United States
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Concurrence Page

Title: Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit

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Summary

The 200-PO-1 Operable Unit comprises the groundwater beneath a large area in the southeast portion of the Hanford Site loosely defined by the extent of the tritium plume in groundwater. The operable unit is bound by the 200-BP-5 Operable Unit in the 200 East Area and the 300-FF-5 Operable Unit to the south in the 300 Area. The Columbia River forms the east boundary.

The 200-PO-1 Operable Unit has the largest contaminant plumes beneath the Hanford Site. Groundwater remediation is not currently being performed in the 200-PO-1 Operable Unit, and a record of decision is not yet in place. Therefore, the current goal is to monitor the contaminants of concern until final cleanup decisions are made.

The objective of this sampling and analysis plan is to provide groundwater data necessary to track the extent and concentration of groundwater contaminant plumes. The data will be used to meet the requirements for remedial investigation/feasibility study (RI/FS) scoping under the *Comprehensive Environmental Response, Compensation, and Liability Act* [CERCLA; 40 CFR 300.430(b)] and site-wide surveillance monitoring under the *Atomic Energy Act of 1954*. The sampling and analysis plan for this operable unit may be modified and resubmitted as part of the RI/FS work plan.

This document describes groundwater sampling and analysis requirements for the 200-PO-1 Operable Unit. It specifies wells and aquifer sampling tubes to be monitored, constituents to be analyzed, and frequency of sampling. This monitoring plan differs from the previous plan slightly in the wells and constituents monitored and format changes in the well tables. The changes were based on evaluation of data collected under previous monitoring plans and the need for standardizing well sampling schedules.

This sampling and analysis plan organizes the wells by their proximity to the sources of the major contaminant plumes in the 200 East Area. Wells located near the plume sources are termed "near-field" wells, and wells farther from sources are "far-field" wells. The contaminants of concern for the near-field wells are iodine-129, nitrate, tritium, arsenic, chromium, manganese, strontium-90, technetium-99, and vanadium. Far-field wells are generally sampled for iodine-129, nitrate, and tritium. Some of these and other groundwater constituents such as cyanide, cobalt-60, and volatile organic compounds are monitored for additional support at "transect" wells near the 200 East Area, along the Columbia River, or near specific waste site such as the BC cribs. The overall well network includes 121 wells (43 near-field and 78 far-field) that are sampled annually to triennially. Fifteen aquifer sampling tubes at six sites along the Columbia River near the Hanford town site are sampled annually.

The results of sampling and analysis will be reported in the annual report prepared by the Groundwater Performance Assessment Project. This sampling and analysis plan will be evaluated annually to determine whether it should be revised.

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1.0 Introduction

The 200-PO-1 Operable Unit is located in the southeast portion of the Hanford Site and is bounded by 2,000 pCi/L tritium contamination plume isopleths as they extend eastward and southward from groundwater contamination sources located in the south portion of the 200 East Area (Figure 1.1). The east boundary is the Columbia River, and the south boundary is the 300-FF-5 Operable Unit in the 300 Area. The operable unit is bounded in part on the north by the 200-BP-5 Operable Unit.

The purpose of this document is to identify sampling and analysis requirements for monitoring groundwater at the 200-PO-1 Operable Unit. This sampling and analysis plan summarizes what is currently known about groundwater contamination in the 200-PO-1 Operable Unit area and describes a revised monitoring well network, constituents to be analyzed, sampling frequency, sampling protocol and waste management requirements, groundwater level measurement, and reporting and quality assurance requirements associated with these activities.

The objective of this sampling and analysis plan is to provide groundwater data necessary to track groundwater contaminant plume extent and concentration in the 200-PO-1 Groundwater Operable Unit. The data will be used to meet the requirements for remedial investigation/feasibility study (RI/FS) scoping under the *Comprehensive Environmental Response, Compensation, and Liability Act* [CERCLA; 40 CFR 300.430(b)] and site-wide surveillance monitoring under the *Atomic Energy Act of 1954* (AEA). This sampling and analysis plan updates sampling frequency and constituents to be analyzed (at some wells) that reflect data collected and evaluated since publication of the first plan (DOE 2003a; see Section 1.4). It also describes an integrated monitoring program that meets the objectives of CERCLA and AEA. AEA information is provided for completeness and to fully integrate monitoring. Groundwater monitoring for contaminants under the AEA is implemented under U.S. Department of Energy (DOE) Order 450.1. Monitoring data are also collected within the 200-PO-1 Operable Unit in accordance with the *Resource Conservation and Recovery Act* (RCRA) as contained in 40 CFR 265 and administered under the *Washington Administrative Code* (WAC) 173-303 and as described in Section 4.1 of the Hanford Groundwater Strategy (DOE 2003b). However, monitoring data to support RCRA are collected under separate groundwater monitoring plans. Sampling and analysis activities are coordinated with RCRA monitoring within the operable unit to avoid duplication and to provide supplementary data about contaminant distribution.

Groundwater remediation is not currently being performed in the 200-PO-1 Operable Unit, and a record of decision (ROD) is not yet in place. Therefore, the long-term goal is to monitor the contaminants of concern until final cleanup decisions are made. The sampling and analysis plan for this operable unit may be modified and resubmitted as part of the RI/FS work plan.

The Groundwater Performance Assessment Project[a] (groundwater project) has defined a series of "groundwater interest areas" (Figure 1.2) within the Hanford Site for the purposes of interpreting all

(a) The Groundwater Performance Assessment Project is the project name used by the groundwater monitoring contractor to DOE (currently Pacific Northwest National Laboratory).

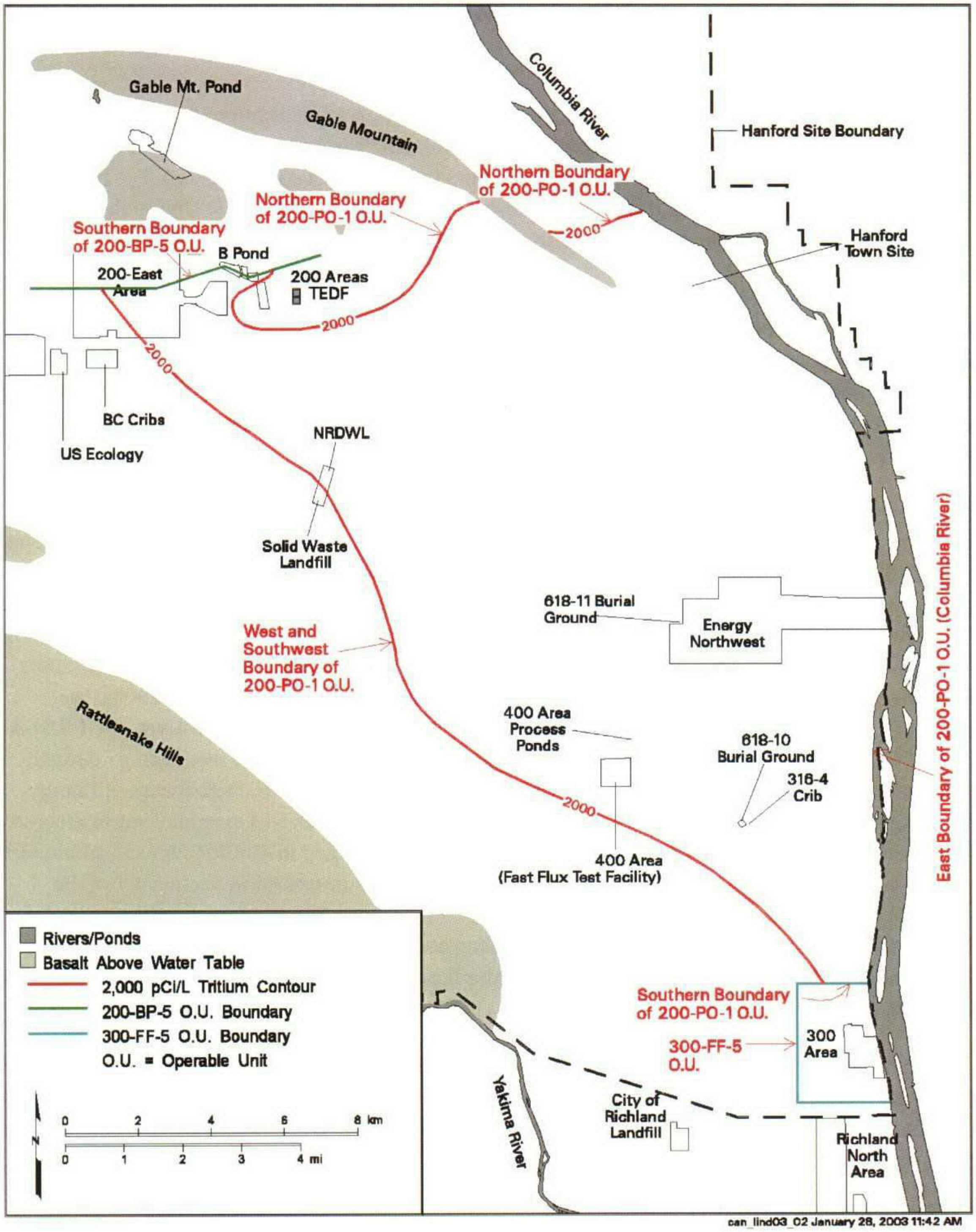

Figure 1.1. 200-PO-1 Operable Unit Boundary as Defined by the Extent of Tritium Plume

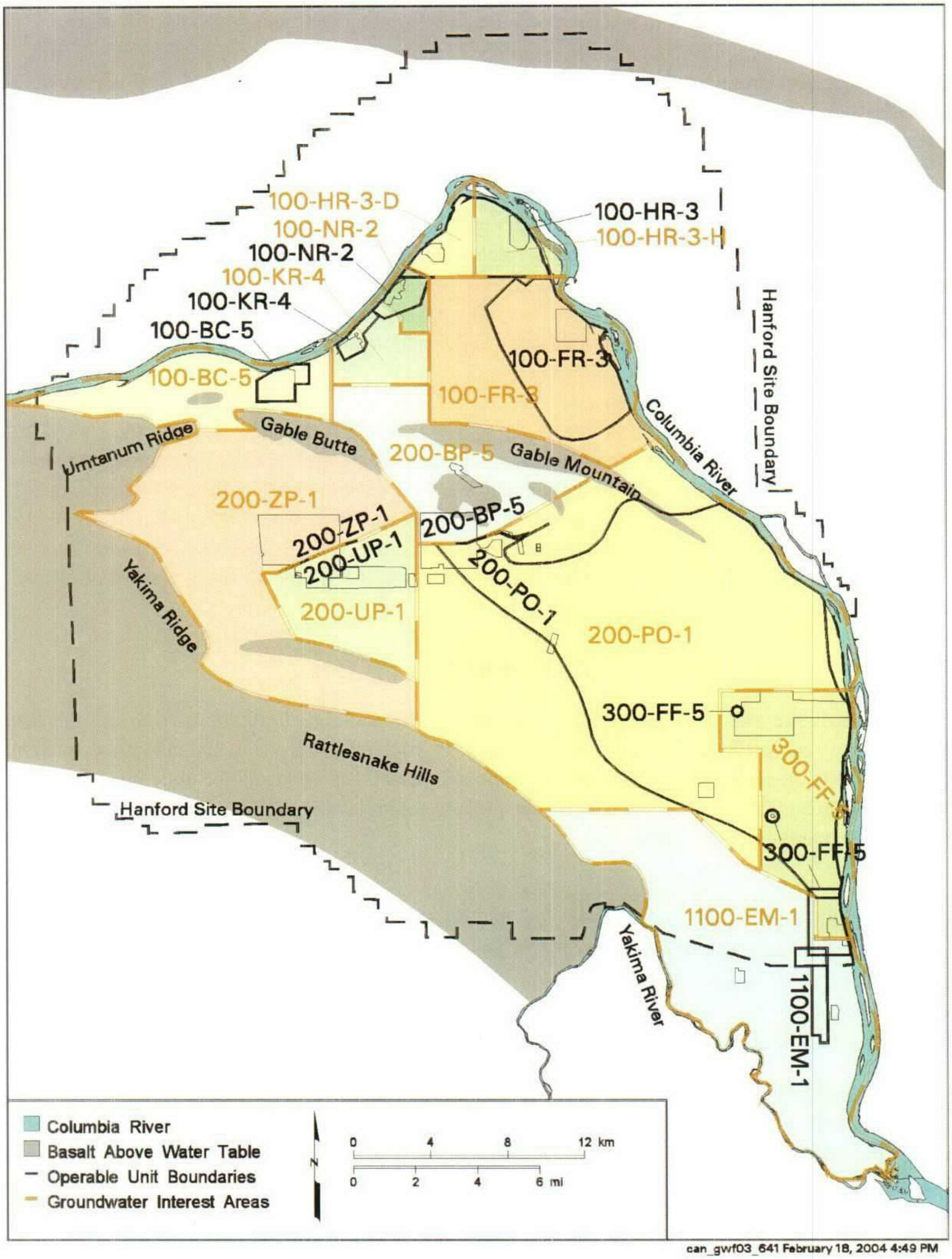

Figure 1.2. Hanford Site Groundwater Interest Areas and Operable Units

groundwater data that may relate to an operable unit and scheduling and sampling wells efficiently. Consequently, this sampling and analysis plan addresses an area slightly larger than the operable unit, termed the 200-PO-1 groundwater interest area. It extends farther west and slightly farther north that the 200-PO-1 Operable Unit based on the 2,000 pCi/L tritium contours. The 200-PO-1 interest area overlaps with part of the 300-FF-5 interest area north of the 300 Area (see Figure 1.2).

The remainder of Section 1.0 provides background information about the 200-PO-1 Operable Unit including a summary of the sources of groundwater contamination, groundwater flow and contamination plumes, monitoring well networks within the operable unit, groundwater contaminants of concern, data quality objectives, and changes from the previous plan. The discussion about data quality objectives is a summary of *Data Quality Summary Report – Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units* (Thornton and Lindberg 2002).

1.1 Background Information

Known contaminant plumes, groundwater flow, and the existing groundwater monitoring networks are summarized here as background information that was used for the selection of the contaminants of concern and developing the data quality objectives. More detailed information is found in *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit* (DOE 1996), *RCRA Corrective Measures Study for the 200-PO-1 Operable Unit* (DOE 1997), and annual reports of the groundwater project (e.g., Hartman et al. 2004).

1.1.1 Sources of Groundwater Contamination

Operations in the 200 Areas were related to the chemical separation of plutonium from spent nuclear fuel. Operations in the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, and U Plant resulted in liquid disposal to the soil column in the operable unit area, which contaminated the underlying groundwater. Waste streams included steam condensate, process cooling water, chemical sewer waste, and acid fractionator condensate (DOE 1996).

The PUREX process used tributyl phosphate in normal paraffin hydrocarbon solvent to recover uranium and plutonium from irradiated fuel rods dissolved in nitric acid solutions. The plant operated from 1955 to 1972 and again from 1983 to 1992 when it was officially terminated. Low-level PUREX waste was disposed to liquid waste disposal units such as cribs (e.g., 216-A-36B, 216-A-10, 216-A-37-1, and 216-A-45), trenches, and french drains. Figure 1.3 shows the location of facilities in the 200 East Area. High-level PUREX waste was diverted to the tank farms.

B Plant used a bismuth phosphate process to extract plutonium from irradiated fuel rods from 1945 to 1952. From 1968 to 1985, the plant was used to recover cesium and strontium from tank farm waste. Process cooling water and steam condensate from B Plant was sent to the 216-B-3 Pond Complex (B Pond). The large volumes of wastewater discharged to B Pond are known to have affected both the northward and southward groundwater flow in the 200 East Area.

Wastewater from U Plant (in the 200 West Area) was transported from the plant to the 200 East Area by underground pipelines. The plant used a tributyl phosphate in kerosene dilutant process to recover

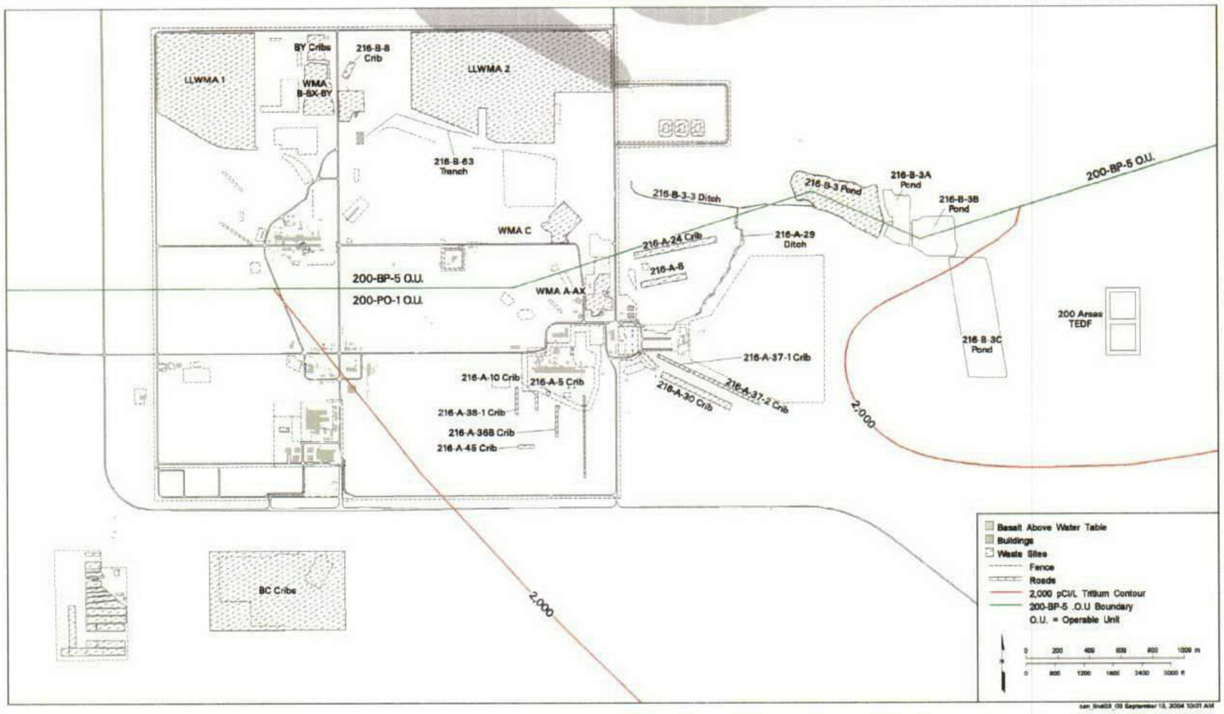

Figure 1.3. 200 East Area Facilities

uranium metal from bismuth phosphate process waste stored in the tank farms. The aqueous portion of the waste stream was neutralized with sodium hydroxide and transferred to the tank farm. Overflow from these tanks was disposed to the 200 East Area soil column to various cribs including the BC cribs and trenches.

1.1.2 Groundwater Flow and Contaminant Plumes

Groundwater within the 200-PO-1 Operable Unit generally flows within an upper unconfined aquifer within the Hanford or underlying Ringold formations, within portions of the lower Ringold Formation that are locally confined beneath Ringold Formation muds, and confined aquifers within the Columbia River Basalts below the Ringold Formation (see Hartman 2002, Williams et al. 1999, and DOE 2002 for more detailed discussions of area hydrogeology). Groundwater flow direction is predominantly south-eastward and eastward toward the Columbia River. Evidence suggests that there is no significant communication between the unconfined or locally confined aquifers above the Columbia River Basalts and the confined aquifers within the basalts. A large flood channel filled with Hanford formation sediment (deposited during cataclysmic Pleistocene floods) extends across the 200 East Area from northwest to the southeast. This flood channel cuts completely through the Ringold Formation in the northern part of the 200 East Area such that Hanford formation sediment rest directly upon basalt. In the southeast portion the 200 East Area (within the 200-PO-1 Operable Unit), the flood channel extends through the Ringold Formation lower mud unit, a major locally confining layer, such that the sand and gravel of the Hanford formation lie directly upon the sand and gravel of the lower portions of the Ringold

Formation. Therefore, within and near the large flood channel there is hydraulic communication between the uppermost, unconfined aquifer and any partially or locally confined aquifers in the lower portions of the Ringold Formation.

Groundwater contamination within the 200-PO-1 Operable Unit occurs in minor and major plumes. The minor plumes are confined to areas near their sources and include groundwater constituents such as strontium-90, arsenic, and manganese near the PUREX Plant cribs. Technetium-99, cobalt-60, cyanide, and chromium are known constituents of the waste discharged to the BC cribs and are monitored at that location to determine whether they have entered the groundwater. Some of these minor plumes or potential minor plumes are located near RCRA treatment, storage, and/or disposal (TSD) units (e.g., PUREX cribs), which are monitored separately from this sampling and analysis plan. Many of the wells monitored under these RCRA units also are monitored for some of the same groundwater constituents (co-sampled) under this sampling and analysis plan to maintain regional consistency and continuity. There was only one reverse/injection well located in the 200-PO-1 Operable Unit (well 299-E24-111 located southwest of the PUREX facility and west of the 216-A-38-1 crib). The well was used for experimental purposes, and liquid waste was never routinely disposed there. Major plumes are those that extend beyond the 200 East Area boundary and, as in the case of tritium, reach as far as the Columbia River to the east and southeast. The major plumes are tritium, iodine-129, and nitrate.

The plumes move as a response to groundwater flow. The groundwater flow system is characterized by measuring the depth to water at wells screened within the aquifers beneath the operable unit and constructing water-table elevation maps. Where water-table maps are inadequate to delineate flow directions because of extremely low gradients, flow direction can be estimated by tracking plumes.

Depth of contaminated groundwater within each of the contaminant plumes varies with plume and with location, but the most concentrated portions of the plumes have been shown to be generally in the upper portion of the unconfined aquifer. There are exceptions to this general rule, of course, such as in the area near the 216-B-3 Pond (B Pond) where localized groundwater contamination occurs in a portion of the uppermost aquifer that is locally confined. It is locally confined there because the water table (or in this case the potentiometric surface) occurs within the lower mud unit of the Ringold Formation.

The occurrence of greater concentration of contaminants near the water table with decreasing concentration with depth is documented in several previous studies at the Hanford Site. Two are provided here as examples. Eddy et al. (1978) reported that the Hanford Site groundwater monitoring network in the 600 Area, which comprised primarily wells open to the upper part of the aquifer, was appropriate. The monitoring wells in the upper portions of the unconfined groundwater flow system contained the most concentrated levels of contaminants. The reason for the higher concentrations in the upper portion of the unconfined aquifer is that the preferred path appears to be a horizontal, radial flow pattern rather than vertical flow. In some areas, the increased potentiometric head with depth may prevent the downward migration of contaminants being introduced at the mound locations. Hanford-originated contaminants do exist occasionally at lower levels at greater depths in the flow system and should be sampled. However, because of the lower levels of contaminants, these deeper wells need not be sampled as frequently as the upper unconfined flow system; therefore, fewer deep wells are needed.

Groundwater was sampled while drilling a well at the southeast corner of the 200 East Area (Lindberg et al. 1996). Three samples were collected above the Ringold Formation lower mud unit in unit E (unconfined) and three below the mud in unit A (confined). The highest concentration of tritium was discovered in the most shallow sample below the water table (17,700 pCi/L) and decreased in concentration with depth to 14,200 pCi/L just above the lower mud unit. Below the lower mud unit, tritium concentrations were within the counting error in all three groundwater samples. Similar results were discovered with iodine-129 and nitrate, the two other major plumes in the area.

1.1.2.1 Minor Plumes

Arsenic – Reported results for arsenic no longer exceed the maximum contaminant level (10 μg/L) in the 200-PO-1 Operable Unit. Exceedances were reported previously in the vicinity of the 216-A-37-1 crib and near Waste Management Area A-AX. The source of the arsenic may be past discharges of chemical waste in which arsenic was present as a contaminant (e.g., the 216-A-29 ditch) or associated with chemical carryover from the 242-A evaporator waste discharged to the 216-A-37-1 crib. In addition, arsenic-contaminated wastewater is known to have been discharged to the 216-A-10 and 216-A-36B cribs. Arsenic is also a suspected groundwater contaminant at the Solid Waste Landfill (see Figure 1.1) where it is detected in the leachate collection system.

Manganese – Manganese in recent years has exceeded the maximum contaminant level (50 μg/L) at three wells at isolated locations at the 216-A-37-1 crib, 216-A-36B crib, and at Waste Management Area A-AX. Although it is possible that manganese-contaminated wastewater was discharged at the PUREX cribs (or leaked from the single-shell tanks), it is more likely that manganese in these instances is due to corrosion of the well casings (Hartman et al. 2002, p. 2.237 and p. 2.239). Elevated levels of manganese are sometimes associated with elevated levels of chromium and nickel, which provide additional evidence that the contamination is due to well-related effects.

Strontium-90 – Although strontium-90 is detected at several wells near the 216-A-36B and 216-A-10 cribs, concentrations exceed the maximum contaminant level (8 pCi/L) at only one well downgradient of the 216-A-36B crib. In general, the concentration has been rising slightly or holding steady in this well since 1997. The impact is localized because of the lower mobility of strontium-90 compared to iodine-129, nitrate, and tritium. This result is consistent, in part, with elevated gross beta in the same well (strontium-90 is a beta-emitter). In addition to the PUREX cribs, strontium-90 is also a suspected groundwater contaminant at the BC cribs and Waste Management Area A-AX.

Technetium-99 – Although technetium-99 is known as a groundwater contaminant, technetium-99 is no longer routinely sampled in the vicinity of the PUREX cribs. Results from previous groundwater monitoring efforts were significantly lower than the drinking water standard (900 pCi/L), and gross beta analysis could be used as a screening tool for technetium-99 and other beta emitters (see more on technetium-99 later in this section). Technetium-99 is also a suspected groundwater contaminant at the BC cribs and Waste Management Area A-AX.

Vanadium – Vanadium was detected at levels above 100 μg/L only at two wells near the 216-A-37-2 crib in the 1980s. There is no maximum contaminant level defined for vanadium in the *Safe Drinking Water Act*. The *Model Toxic Control Act* (MTCA, WAC 173-340) limits are MTCA-A at 245 μg/L and

MTCA-B at 112 µg/L. These two wells have not been sampled and analyzed for vanadium since 1994. Vanadium was also sampled and analyzed continuously at one well near the 216-A-37-1 crib, but reported values in that well were never measured above 60 µg/L.

1.1.2.2 Major Plumes

Iodine-129 – The iodine-129 plume extends east and south from the southeast portion of the 200 East Area near the PUREX cribs (Figure 1.4). Concentrations exceed the drinking water standard (1.0 pCi/L) over an area greater than 70 km^2. The plume is shaped similarly to the tritium plume, although the portion greater than the standard does not extend as far as the tritium plume greater than the tritium standard. The maximum concentrations are near the 216-A-36B crib, where they exceed 12 pCi/L. Iodine-129 is a mobile, long-lived radionuclide with a 1.7×10^7 year half-life.

Nitrate – Nitrate has been detected in many wells at levels exceeding the 45 mg/L maximum contaminant level. As indicated in Figure 1.5, the plume with a concentration above 20 mg/L is a plume very similar in shape and extent to the tritium plume above 20,000 pCi/L. The nitrate concentrations above 45 mg/L tend to occur as small, isolated slugs and may represent slugs of contamination related to separate historical disposal events. Nitrate is a mobile contaminant and has reached the Columbia River in earlier years at concentrations above the maximum contaminant level. However, presently the nitrate has disseminated to the point that there are no portions of the plume over that level that are flowing into the Columbia River. The slugs of nitrate above 45 mg/L may eventually reach the Columbia River (DOE 1996).

Tritium – Concentrations of tritium exceed the drinking water standard (20,000 pCi/L) over an area exceeding 126 km^2. As shown in Figure 1.6, the large tritium plume extends beyond the 200 East Area and has reached the Columbia River. Separate tritium pulses associated with the two periods of PUREX Plant operations contributed to the plume. The first pulse, which resulted from discharges during 1956 to 1972, can be detected near the Columbia River. Elevated tritium concentrations measured immediately downgradient from the 200 East Area (within the 80,000 pCi/L isopleth line) represent the second pulse associated with the re-start of operations between 1983 and 1988. Tritium is a relatively short-lived radionuclide with a 12.3-year half-life.

Tritium also is detected in the basalt-confined aquifer, though it is not widespread. Only one well, 699-42-40C near the 216-B-3 Pond, contained elevated levels of tritium (5,080 pCi/L in October 2003). Concentrations have been decreasing in this well since 1996. Nearby wells completed in the overlying Ringold Formation contain tritium at levels exceeding the 20,000 pCi/L drinking water standard, with declining trends.

There is another tritium source at the 618-11 burial ground within the 300-FF-5 Operable Unit (see Figure 1.2). The plume from that source is small, but has high concentrations.

1.1.2.3 Groundwater Flow

Depth-to-water measurements are collected from all wells in the 200-PO-1 Operable Unit as they are sampled. In addition, a large selection of wells are measured during March of each year to make a

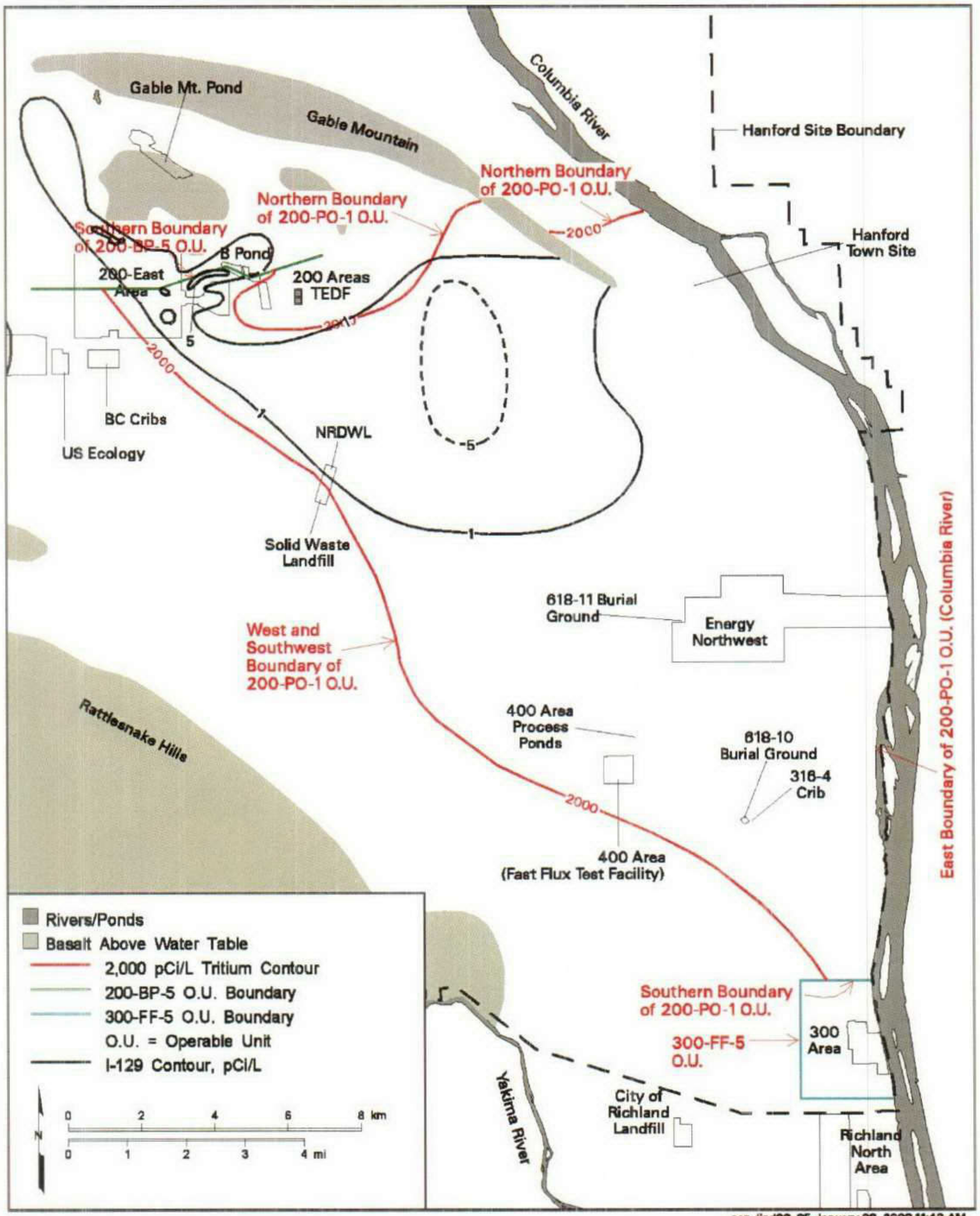

Figure 1.4. Iodine-129 Concentrations in the 200-PO-1 Operable Unit

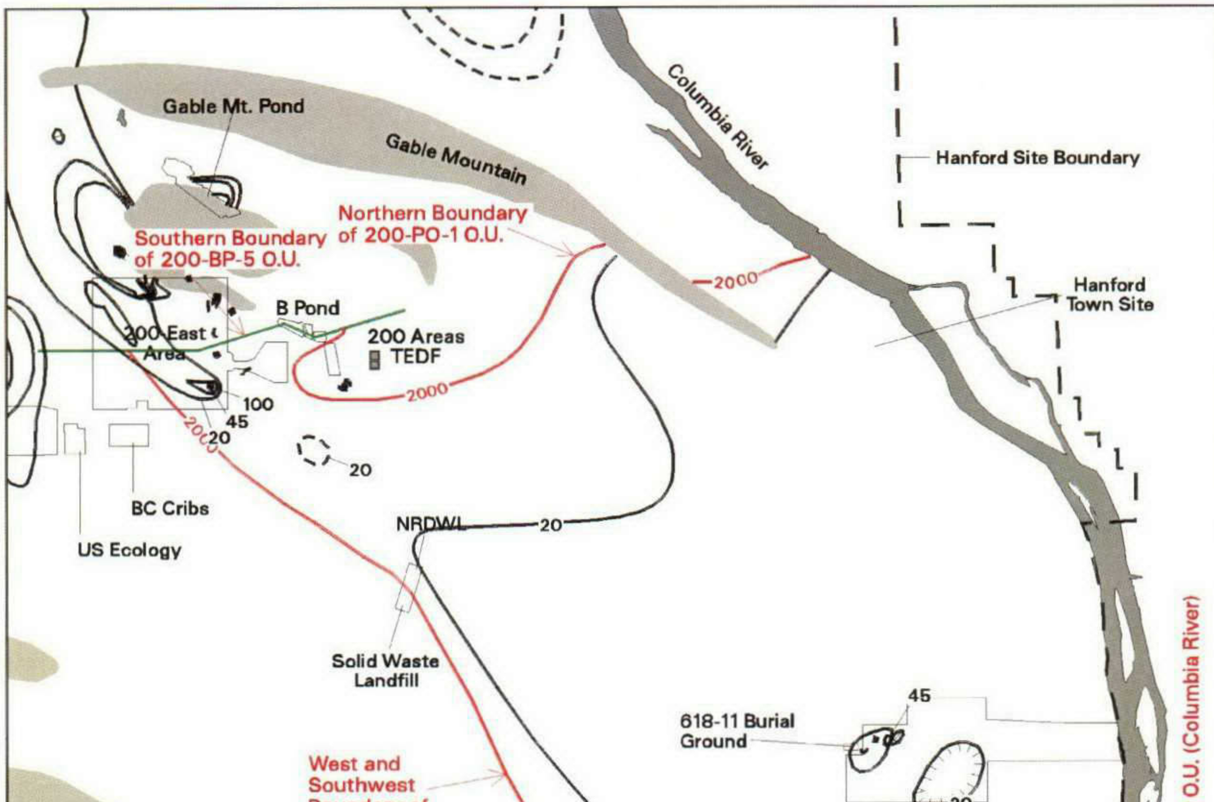

Figure 1.5. Nitrate Concentrations in the 200-PO-1 Operable Unit

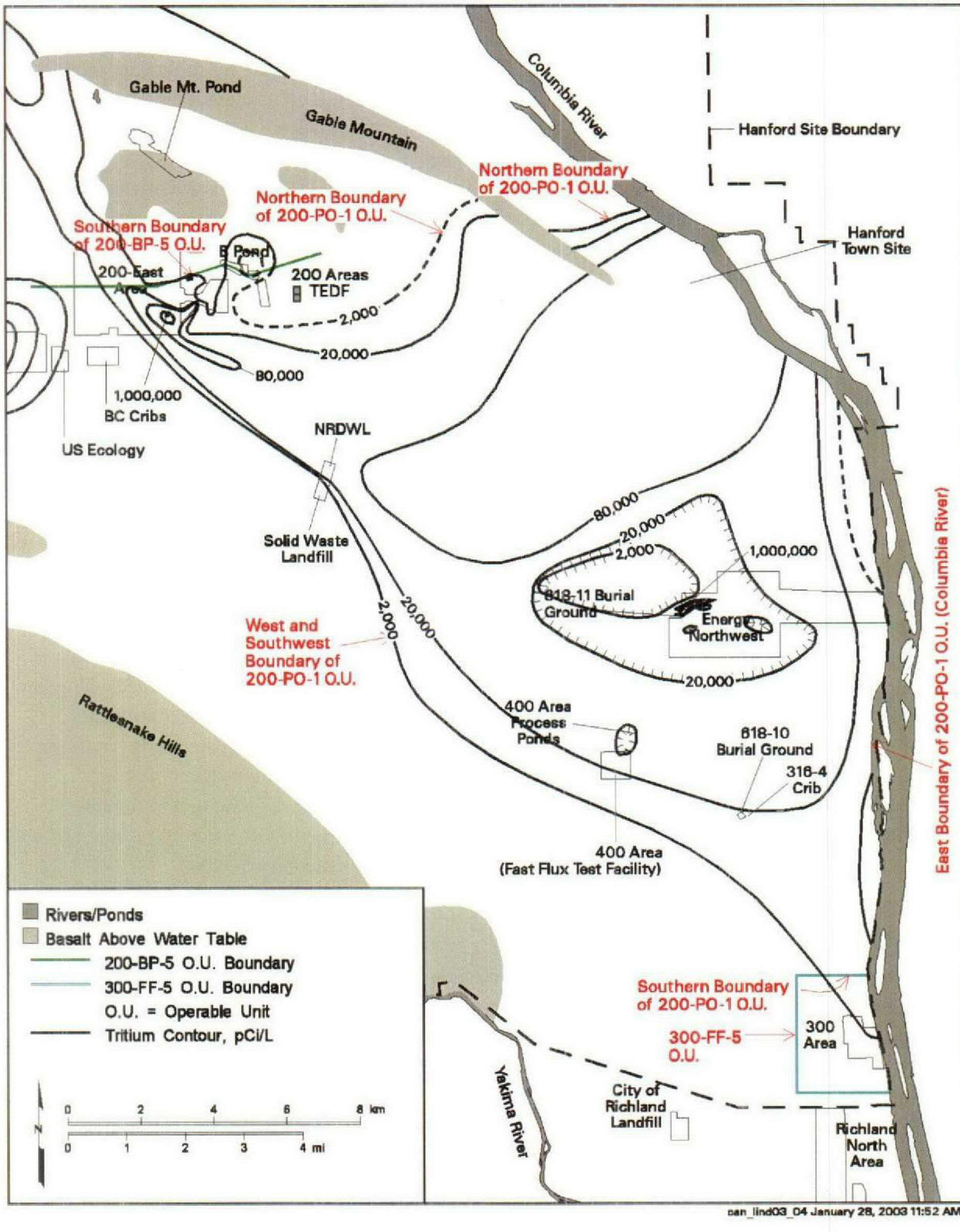

Figure 1.6. Tritium Concentrations in the 200-PO-1 Operable Unit

comprehensive water-table map. Depth-to-water measurements may also be collected from wells monitored for RCRA units as directed by individual RCRA groundwater monitoring plans. Water-table maps from these depth-to-water measurements are used to construct water-table maps that are included in the groundwater project's annual report. Figure 1.7 shows the water table throughout the Hanford Site during March 2004. Throughout most of the 200-PO-1 area, the groundwater flow direction interpreted from water-table maps is southeastward to eastward. However, estimates of flow direction from water-table maps are difficult in the southeast portion of the 200 East Area and southeastward toward the Central Landfill because of the low water-table gradient. In this area, the groundwater flow direction (southeastward to eastward) is interpreted by tracking the major groundwater plumes of tritium, nitrate, and iodine-129 (see Figures 1.4 to 1.6).

1.1.3 Monitoring Networks

This sampling and analysis plan organizes the wells within the 200-PO-1 Operable Unit by their proximity to the sources of the major contaminant plumes in the southeast portion of the 200 East Area. Wells located close to the contaminant sources (e.g., near the PUREX cribs) are called "near-field" wells. The other wells located further from the contaminant sources (e.g., outside of the 200 East Area) are hereby termed "far-field" wells. In addition to the near-field and far-field wells, aquifer sampling tubes monitor groundwater along the Columbia River near the Hanford town site.

There are several smaller groundwater monitoring networks within the 200-PO-1 Operable Unit area besides the larger network described in this sampling and analysis plan. These subsidiary networks include six RCRA TSD facilities, one liquid waste disposal facility, and one solid waste landfill, all regulated by the state of Washington under authority of the Washington Administrative Code. They are monitored under separate groundwater monitoring plans, which describe monitoring requirements specific to those sites. Groundwater sampling at these smaller networks is coordinated with sampling for the 200-PO-1 Operable Unit under this sampling and analysis plan to avoid duplication of effort. Furthermore, reported data from these networks are used as supplementary information to the data reported for this sampling and analysis plan. The wells, constituents monitored, sampling frequency and other details of the smaller networks are listed in Appendix A (Supplementary Wells).

1.1.3.1 Near-Field Wells

Near-field wells at the 200-PO-1 Operable Unit include 43wells located close to sources of the major groundwater contamination plumes in the southeast portion of the 200 East Area. These wells are important because they monitor groundwater near otherwise unregulated facilities or between the regulated ones. These wells are discussed further in Section 2.0. Samples from these wells are generally analyzed for arsenic, chromium, manganese, strontium-90, vanadium, technetium-99 (or gross beta), as well as iodine-129, nitrate, and tritium. Included in the near-field wells are five RCRA TSD facilities (with separate groundwater monitoring plans). Some of the wells in these subsidiary networks are co-sampled with the 200-PO-1 Operable Unit, and the rest provide supplementary data. The RCRA TSD facilities include the RCRA PUREX cribs, Waste Management Area A-AX, 216-A-29 ditch, 216-B-3 pond (B Pond), and the Integrated Disposal Facility (see Appendix A).

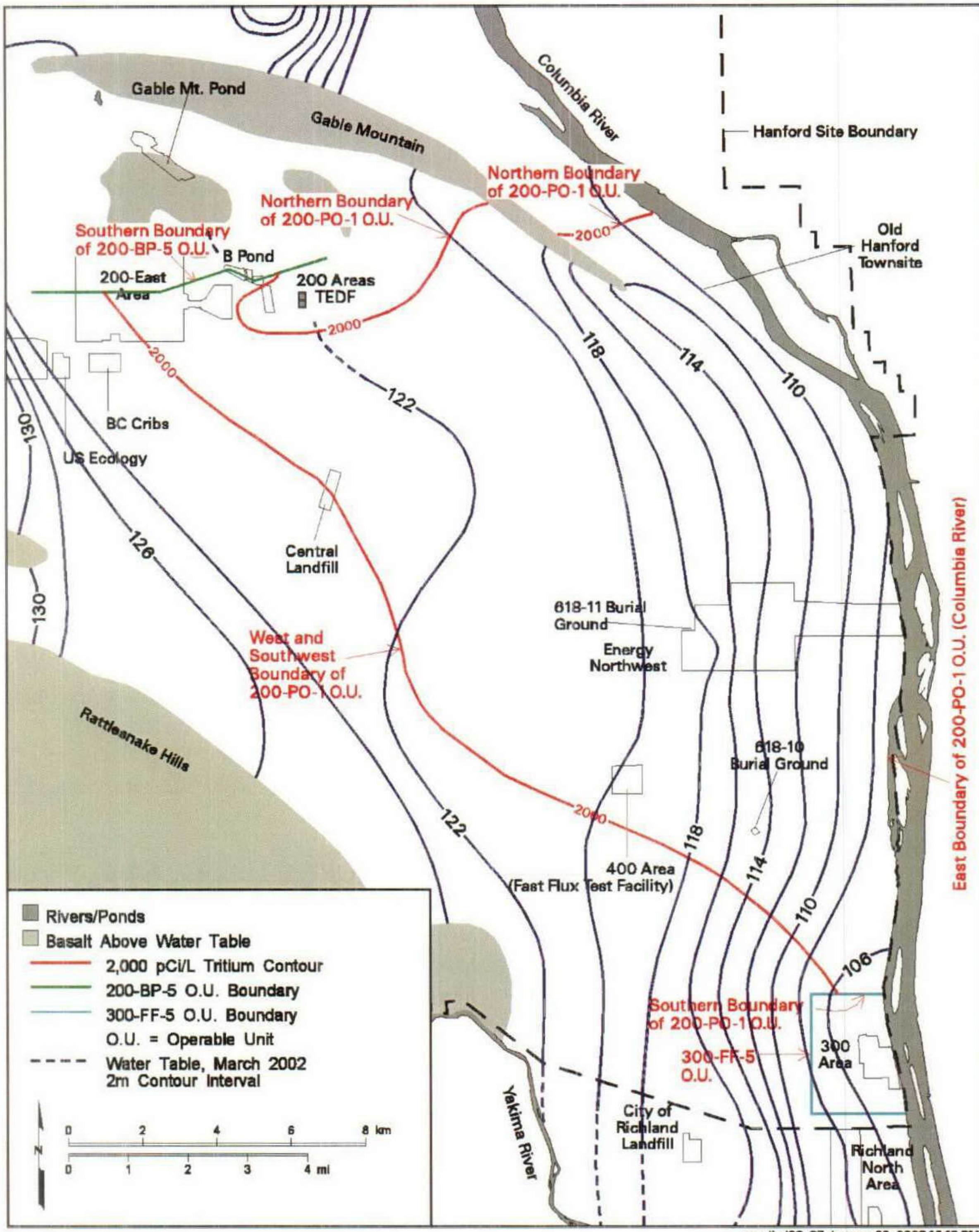

Figure 1.7. Hanford Site Water-Table Map, March 2004

1.1.3.2 Far-Field Wells

Far-field wells (78 total) monitor groundwater beyond the 200 East Area with the primary objective to track the major groundwater contaminant plumes, determine if minor plume constituents are detected beyond the 200 East Area, characterize groundwater waste constituents near the Columbia River, monitor a small number of deep wells screened in confined basalt aquifers, and monitor groundwater near the BC cribs. Depending on location and proximity to other localized areas of contaminated groundwater, samples from far-field wells may also be analyzed for other groundwater constituents. Wells to the southwest that are not influenced by Hanford groundwater contamination (outside the 2,000-pCi/L contour of the tritium plume) are monitored to determine background groundwater quality. Far-field wells are generally sampled once every 3 years, and the samples are analyzed for major groundwater contaminant plumes constituents (e.g., iodine-129, nitrate, and tritium). Far-field wells that monitor groundwater for other than the just the three major contaminant plumes are discussed below.

200-PO-1 Operable Unit Transect Wells – Two "bands" of guard wells are sampled annually rather than every 3 years for a list of potential groundwater constituents to assure that groundwater flowing away from the 200 East Area and entering the Columbia River is fully characterized. One band has a southwest-northeast trend and is located southeast of the 200 East Area. This line of guard wells is the "southeast transect" and is composed of eight wells. The other band is along the Columbia River, is composed of six wells, and is called the "river transect." Constituents for both transects include anions; gross alpha, beta, and gamma; inductively coupled plasma (ICP) metals; strontium-90; volatile organic compounds; as well as iodine-129, nitrate, and tritium.

200-PO-1 Operable Unit Basalt-Confined Aquifer Wells – Six basalt-confined aquifer wells within the 200-PO-1 Operable Unit monitor groundwater beneath the uppermost aquifer. They are wells 299-E16-1, 699-42-40C, 699-32-22B, 699-24-1P, 699-13-1C, and 699-S11-E12AP. These wells are sampled every 3 years, and samples are analyzed for anions, ICP metals, gross alpha and beta, iodine-129, and tritium.

BC Cribs and Trenches – These cribs and trenches were used from 1956 to 1958 to dispose of waste from uranium recovery. A composite analysis for low-level waste disposal in the 200 Areas (Kincaid et al. 1998) and the initial assessment completed with the System Assessment Capability (Bryce et al. 2002) both make the point that the majority of tank waste inventory sent to the liquid discharge sites was disposed at the BC cribs and trenches. Groundwater collected from an exploratory borehole (C4191) drilled (near the B-26 trench) during fiscal year (FY) 2004 showed that the only groundwater constituent exceeding drinking water standards was manganese with a concentration of 208 μg/L. The secondary drinking water standard for manganese is 50 μg/L. Elevated levels of manganese are often discovered immediately after well or borehole installation. However, elevated levels (100 pCi/g) of technetium-99 (a highly mobile waste constituent) were discovered at a depth of 28.9 meters, which is immediately above a fine-grained layer (the water table is at 103 meters). Most likely the 30 million gallons of liquid waste disposed at the BC cribs and natural recharge have not been significant enough to push water (containing waste constituents) to the water table due to the effects of alternating fine- and coarse-grained sediment layers. The constituents of interest remain cyanide and chromium and various radionuclides, specifically technetium-99 and cobalt-60. Currently there are two wells at the BC cribs, which are sampled annually for anions, gross alpha and beta, gamma scan, ICP metals, strontium-90, technetium-99, tritium, and uranium. Two new wells are proposed for installation during FY 2005.

Three smaller well networks are included in the far-field wells, but are monitored under separate groundwater monitoring plans (see Appendix A). These include the Nonradioactive Dangerous Waste Landfill (a RCRA TSD), Solid Waste Landfill (a solid waste landfill regulated by Washington State under the authority of WAC 173-304), and 200 Area Treated Effluent Disposal Facility (regulated by Washington State waste discharge permit – WAC 173-216). Some of the wells in these smaller networks are co-sampled with the 200-PO-1 Operable Unit network and the rest provide supplementary data.

1.1.3.3 Aquifer Tubes at Hanford Town Site

Six aquifer sampling tube locations along the Columbia River at the Hanford town site (see Figure 1.1) monitor groundwater at the river bank. Sampling tubes are sampled at shallow, medium, and deep zones for hexavalent chromium, nitrate, gross alpha, gross beta, and tritium. Sampling frequency is, at minimum, annually. These aquifer sampling tubes are part of the 200-PO-1 Operable Unit network and are included with the far-field wells. Additional information about aquifer tubes is provided in the *Sampling and Analysis Plan for Aquifer Sampling Tubes* (DOE 2000).

1.2 Contaminants of Concern

The rationale for selecting the contaminants of concern was explained in detail in the data quality objectives summary report (Thornton and Lindberg 2002). The rationale was based largely on data from many years of groundwater monitoring throughout the 200-PO-1 Operable Unit area and results reported in *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit* (DOE 1996), *RCRA Corrective Measures Study for the 200-PO-1 Unit* (DOE 1997), and annual reports of the groundwater project (e.g., Hartman et al. 2004). Near-field contaminants of concern continue to be arsenic, chromium, iodine-129, manganese, nitrate, strontium-90, technetium-99, tritium, and vanadium. General far-field contaminants of concern continue to be iodine-129, nitrate, and tritium. At the BC cribs, the contaminants of concern are chromium, cobalt-60, cyanide, nitrate, technetium-99, tritium, and uranium. For the transect wells, the groundwater samples are screened for anions; gross alpha, beta, and gamma; ICP metals; strontium-90; volatile organic compounds; as well as iodine-129, nitrate, and tritium.

1.3 Data Quality Objectives

In 2003, Pacific Northwest National Laboratory (PNNL) conducted a data quality objectives planning process for the 200-PO-1 and 200-BP-5 Operable Units, following guidance from the U.S. Environmental Protection Agency (EPA/600/R-96/055, QA/G-4, 2000 as revised). The results of that process were documented in *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units* (Thornton and Lindberg 2002). As described in that summary report (Thornton and Lindberg 2002), the data quality objectives process for the 200-PO-1 Operable Unit established a framework to answer the following questions:

- Does the monitoring network adequately define the extent of the contaminant of concern groundwater plumes?

- Will the monitoring network adequately measure water-table elevations and define groundwater flow directions?

- Do the sampling frequencies permit tracking of plume movement?

The results of the data quality objectives process for the 200-PO-1 Operable Unit provided the basis for the monitoring network and design, which were implemented in the original sampling and analysis plan for the 200-PO-1 Operable Unit (DOE 2003a).

1.4 Changes from the Previous Plan

This document revises the previous sampling and analysis plan (DOE 2003a), which was published September 2003. While the overall approach to monitoring remains the same, changes in sampling frequency and constituents have been made to reflect data collected and evaluated after publication of the first plan. Eighteen of the near-field wells were changed to an annual sampling frequency from triennial in order to more rapidly detect changes in groundwater chemistry in areas near the sources of 200-PO-1 Operable Unit groundwater contamination. Eleven of these wells that were changed to annual sampling status were already sampled annually or semiannually under RCRA groundwater monitoring plans. Total organic carbon and total organic halides analyses were replaced with volatile organic analyses (VOAs) in transect well samples in order to provide more reliable screening for volatile organic compounds. Miscellaneous analyses such as gross alpha and beta, arsenic, gamma scan, lead, mercury, ICP metals, strontium-90, and technetium-99 of groundwater samples from 22 general far-field wells were dropped because they are beyond what was determined necessary by the data quality objectives analysis (Thornton and Lindberg 2002). Another change from the previous plan is the difference in table format of the sampling matrices, which were made to provide a standardized format for sampling and analysis plans within the groundwater project.

Thirteen wells near the BC cribs and 11 wells near Waste Management Area A-AX were scheduled for decommissioning during FY 2005. These 24 wells will be sampled early in FY 2005. For the 13 wells at the BC cribs, this may be the last opportunity to sampling these wells. They are being decommissioned because they are in the way of an impermeable cover that is expected to be placed over the BC cribs area. The 11 wells at Waste Management Area A-AX will be sampled and evaluated for possible continued use to monitor cribs and to provide a monitoring location between Waste Management Areas A-AX and C.

2.0 Field Sampling Plan

This section lists the wells and aquifer tubes to be monitored and the sampling frequency and groundwater constituents. Protocol for sampling, analysis, and related activities are summarized.

2.1 Sampling Objectives

The objectives of groundwater monitoring in the 200-PO-1 Operable Unit are to define the extent of the groundwater contaminant plumes in the aquifer, determine groundwater flow rate and direction from water-table maps, and track the movement of the contaminant plumes in the aquifer. These objectives are accomplished in the field by sampling groundwater at designated wells and aquifer tubes, analyzing the samples for the contaminants of concern (and supporting constituents), and measuring depth to water in the wells.

2.2 Sampling Locations and Frequency

The groundwater wells and aquifer tubes to be sampled are listed in Tables 2.1 and 2.2, and the well locations are shown in Figures 2.1 to 2.3. Tables 2.1 and 2.2 also list the specific analytes and sampling frequency for each well. Appendix B lists the portion of the aquifer sampled, elevation of top and bottom of sampling interval, and the length of the sampling interval of each well. Tables 2.1 and 2.2 also include wells that are co-sampled with RCRA sites.

Two new wells are planned for installation during FY 2005 downgradient of the BC cribs. Well locations are shown on Figures 2.1 and 2.2. They are needed because the BC cribs area most likely will be covered by an impermeable cap as part of the remedial action for this facility. The cap will be installed to minimize precipitation infiltration and the downward movement of vadose zone water that may be transporting contaminants in the vadose zone downward to the water table and saturated zone. Both of these wells will be screened at the water table. However, one will be drilled deeper for the purpose of characterizing potential soil and groundwater contamination to the base of the unconfined aquifer. A more detailed suite of tests may be conducted in each well after well construction. (The detailed hydraulic tests are contingent on the budget level in FY 2005.) The tests may include slug tests, tracer-dilutions tests, tracer pump-back tests, constant-rate pumping tests, and vertical flow, in-well tracer tests. Vertical flow has been measured in existing wells, and it is important to know whether such vertical flow extends deeper in the aquifer.

Figure 2.4 shows the locations of aquifer sampling tubes near the Hanford town site. A typical aquifer tube site includes three tubes monitoring different depths: one just beneath the low river stage water table, a second near the bottom of the uppermost hydrologic unit, and the third at mid-depth between the other two ports. Field conditions may result in more or fewer tubes at a particular location. Specific conductance will be measured at each aquifer tube listed in Table 2.2. At each site, additional samples will be collected from the tube that is most representative of groundwater (generally the tube with highest specific conductance). If specific conductance is less than 160 μS/cm in all tubes, the site is considered not representative of groundwater, and no samples are collected for additional analyses.

Table 2.1. Sampling and Analysis Schedule for 200-PO-1 Operable Unit Near-Field Wells

Well ID	Well Number	Co-Sample	Comments	WAC Compliant	Contaminants of Concern							Supporting Constituents							
					Arsenic	Chromium, Manganese, and Vanadium (filtered)	Iodine-129	Nitrate	Strontium-90	Technetium-99	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Gross Beta	Metals[c]	Water Level[a]
200-PO-1 Near-Field Wells																			
A5878	299-E16-2			N/1960	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4730	299-E17-12			N/1986	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4731	299-E17-13			N/1986	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4732	299-E17-14	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4734	299-E17-16	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4736	299-E17-18	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4737	299-E17-19	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
C3827	299-E17-23	IDF		C	T	T	T	T			T	T	T	T	T	T	T	T	T
C3926	299-E17-25	IDF		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4743	299-E18-1	IDF		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4747	299-E23-1			N/1948	T	T	T	T			T	T	T	T	T	T	T	T	T
A4753	299-E24-18	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4756	299-E24-20	RCRA-A-AX		C	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
A5899	299-E24-5			N/1956	T	T	T	T			T	T	T	T	T	T	T	T	T
A6031	299-E25-17	RCRA-PUREX		N/1976	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4764	299-E25-18			N/1976	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4765	299-E25-19	RCRA-PUREX		N/1976	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4767	299-E25-20			N/1976	A	A	A	A	A		A	A	A	A	A	A	A	A	A

Table 2.1. (contd)

Well ID	Well Number	Co-Sample	Comments	WAC Compliant	Contaminants of Concern							Supporting Constituents							
					Arsenic	Chromium, Manganese, and Vanadium (filtered)	Iodine-129	Nitrate	Strontium-90	Technetium-99	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Gross Beta	Metals[c]	Water Level[a]
A6032	299-E25-22			N/1983	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4773	299-E25-28	RCRA-A-29	Deep unconfined	N/1986	T	T	T	T			T	T	T	T	T	T	T	T	T
A4774	299-E25-29P		piezometer	?	T	T	T	T			T	T	T	T	T	T	T	T	T
A4775	299-E25-29Q		piezometer	?	T	T	T	T			T	T	T	T	T	T	T	T	T
A6024	299-E25-3			N/1954	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4779	299-E25-32P	RCRA-A-29	piezometer	C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4780	299-E25-32Q		piezometer	C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4782	299-E25-34	RCRA-A-29		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4783	299-E25-35	RCRA-A-29		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4784	299-E25-36			C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4785	299-E25-37			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4790	299-E25-41	RCRA-A-AX		C	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
A4791	299-E25-42	RCRA-A-AX		C	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
A4792	299-E25-43			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A5448	299-E25-44			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4794	299-E25-47			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4796	299-E25-6			N/1956	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4804	299-E26-4			N/1958	A	A	A	A	A		A	A	A	A	A	A	A	A	A
B2822	699-37-47A	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A5150	699-39-39			N/1970	T	T	T	T			T	T	T	T	T	T	T	T	T

Table 2.1. (contd)

Well ID	Well Number	Co-Sample	Comments	WAC Compliant	Contaminants of Concern							Supporting Constituents							
					Arsenic	Chromium, Manganese, and Vanadium (filtered)	Iodine-129	Nitrate	Strontium-90	Technetium-99	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Gross Beta	Metals[c]	Water Level[a]
A5170	699-42-41			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A5171	699-42-42B	RCRA-B-Pond	Confined Ringold	C	T	T	T	T			T	T	T	T	T	T	T	T	T
A5179	699-43-43			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A5180	699-43-45	RCRA-A-29, B-Pond		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A5185	699-44-39B	RCRA-B-Pond	C	T	T	T	T			T	T	T	T	T	T	T	T	T	

(a) Field measurement.
(b) Anions - Analytes include but not limited to nitrate.
(c) Metals - Analytes include but not limited to chromium, manganese, and vanadium.
C =Well construction is compliant with WAC 173-160 resource protection requirements.
N =Well construction is not compliant with WAC 173-160 resource protection requirements.
T =To be sampled triennially (next scheduled in FY 2007).
A =To be sampled annually.

Table 2.2. Sampling and Analysis Schedule for 200-PO-1 Operable Far-Field Wells

					Contaminants of Concern			Supporting Constituents																			
Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[d]	Hg and Pb	ICP Metals (filtered)[c]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	VOA[e]	Other Constituents	Water Level[e]
200-PO-1 Far-Field Wells																											
BC Cribs																											
A4726	299-E13-14			N/1956		A	A	A	A	A	A	A		A		A	A		A	A	A			A			A
A5853	299-E13-5			N/1955		A	A	A	A	A	A	A		A		A	A		A	A	A			A			A
	Proposed Well		To be drilled in FY 2005			A	A	A	A	A	A	A		A		A	A		A	A	A			A			A
	Proposed Well		To be drilled in FY 2005			A	A	A	A	A	A	A		A		A	A		A	A	A			A			A
A5849	299-E13-1		Sample once before decommissioning	N/1955		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5851	299-E13-3		Sample once before decommissioning	N/1955		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5852	299-E13-4		Sample once before decommissioning	N/1955		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5854	299-E13-6		Sample once before decommissioning	N/1955		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5855	299-E13-7		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5856	299-E13-8		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5857	299-E13-9		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1

Table 2.2. (contd)

					Contaminants of Concern			Supporting Constituents																			
Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[d]	Hg and Pb	ICP Metals (filtered)[c]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	VOA[e]	Other Constituents	Water Level[a]
A5858	299-E13-11		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A4725	299-E13-12		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5861	299-E13-16		Sample once before decommissioning	N/1957		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5862	299-E13-17		Sample once before decommissioning	N/1957		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5863	299-E13-18		Sample once before decommissioning	N/1957		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5864	299-E13-19		Sample once before decommissioning	N/1957		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
Southeast Transect																											
A5063	699-10-54A			N/1950		A	A	A	A	A	A	A		A			A		A	A					A		A
A8457	699-24-46			N/1958	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5101	699-26-33			C	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5123	699-31-31			N/1956	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5126	699-32-22A			N/1971	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5127	699-32-43			N/1968	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5159	699-41-23			N/1948	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5197	699-46-21B			N/1955	A	A	A	A	A	A	A	A		A			A		A	A					A		A

Table 2.2. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																			
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[d]	Hg and Pb	ICP Metals (filtered)[c]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	VOA[e]	Other Constituents	Water Level[a]
River Transect																											
A5065	699-10-E12			N/1962		A	A	A	A	A	A	A		A			A		A	A					A		A
A9613	699-20-E12O			N/1961	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A8646	699-41-1A			N/1979	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A8726	699-46-4			N/1979	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5374	699-S3-E12			N/1960		A	A	A	A	A	A	A		A			A		A	A					A		A
A5370	699-S19-E13			N/1971		A	A	A	A	A	A	A		A			A		A	A					A		A
Basalt Confined Aquifer																											
A4727	299-E16-1[f]		Elephant Mt interflow[g]	N/1961	T	T	T	T	T	T	T	T		T					T								T
A8262	699-13-1C[f]		Elephant Mt interflow & Rattlesnake Ridge interbed[g]	?		T	T	T	T	T	T	T		T					T								T
A8453	699-24-1P[f]		Rattlesnake Ridge Interbed & Pomona basalt[g]	N/1966		T	T	T	T	T	T	T		T					T								T
A8512	699-32-22B[f]		Rattlesnake Ridge interbed[g]	C	T	T	T	T	T	T	T	T		T					T								T
A5169	699-42-40C[f]		Rattlesnake Ridge interbed[g]	N/1982	T	T	T	T	T	T	T	T		T					T								T
A9778	699-S11-E12AP		Levey Interbed (Spane and Webber 1995)	N/1962		T	T	T	T	T	T	T		T					T								T

Table 2.2. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																			
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[d]	Hg and Pb	ICP Metals (filtered)[c]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	VOA[e]	Other Constituents	Water Level[a]
Far-Field General																											
A8098	499-S0-7	400 Area		N/1972		T	T	T	T	T		T															T
A8252	699-12-4D			N/1982	T	T	T	T	T	T		T															T
A8260	699-13-1A			N/?	T	T	T	T	T	T		T															T
B2540	699-13-3A	300-FF-5		?		T	T	T	T	T		T															T
A5068	699-14-38			N/1958		T	T	T	T	T		T															T
A5073	699-17-5			N/1950	T	T	T	T	T	T		T															T
A5075	699-19-43			N1950	T	T	T	T	T	T		T															T
A5080	699-20-20			N/1948	T	T	T	T	T	T		T															T
A9617	699-20-E12S		Deep unconfined[g]	N/1962		T	T	T	T	T		T															T
A8428	699-20-E5A			N/1976		T	T	T	T	T		T															T
A8438	699-21-6			N/1979	T	T	T	T	T	T		T															T
A5078	699-2-3			N/1950	T	T	T	T	T	T		T															T
A8443	699-22-35			C	T	T	T	T	T	T		T															T
A5092	699-24-34C	SWL		C	T	T	T	T	T	T		T															T
A5100	699-26-15A			N/1958	T	T	T	T	T	T		T															T
A5101	699-26-33	RCRA-NRDWL		C		T	T	T	T	T		T															T
A5103	699-26-35A	RCRA-NRDWL, SWL		C	T	T	T	T	T	T		T															T
B8077	699-2-6A			C		T	T	T	T	T		T															T
A8122	699-2-7			N/1978		T	T	T	T	T		T															T
A5110	699-28-40			N/1956	T	T	T	T	T	T		T															T

Table 2.2. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																						
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[d]	Hg and Pb	ICP Metals (filtered)[c]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	VOA[e]	Other Constituents	Water Level[a]
A8490	699-29-4			N/1979	T	T	T	T	T	T		T															T
A8503	699-31-11			N/1980	T	T	T	T	T	T		T															T
A5132	699-33-42			N/1968	T	T	T	T	T	T		T															T
A5133	699-33-56			N/1958		T	T	T	T	T		T															T
A5135	699-34-41B			N/1970	T	T	T	T	T	T		T															T
A5136	699-34-42			N/1970	T	T	T	T	T	T		T															T
A5142	699-35-9			N/1950	T	T	T	T	T	T		T															T
A5146	699-37-43			N/1955	T	T	T	T	T	T		T															T
A8588	699-37-E4			N/1982	T	T	T	T	T	T		T															T
A8594	699-38-15			N/1979	T	T	T	T	T	T		T															T
A5152	699-40-1			N/1961	T	T	T	T	T	T		T															T
A5153	699-40-33A			N/1949	T	T	T	T	T	T		T															T
A5161	699-41-40		Confined Ringold[g]	C	T	T	T	T	T	T		T															T
A5163	699-42-12A			N/1957	T	T	T	T	T	T		T															T
A5165	699-42-39A			C	T	T	T	T	T	T		T															T
A5166	699-42-39B		Confined Ringold[g]	C	T	T	T	T	T	T		T															T
A8677	699-43-3			N/1979	T	T	T	T	T	T		T															T
A5173	699-43-40			C	T	T	T	T	T	T		T															T
A5174	699-43-41E		Confined Ringold[g]	C	T	T	T	T	T	T		T															T
A5195	699-45-42			N/1948	T	T	T	T	T	T		T															T
A8744	699-47-5			N/1979	T	T	T	T	T	T		T															T

Table 2.2. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																			
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[d]	Hg and Pb	ICP Metals (filtered)[c]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	VOA[e]	Other Constituents	Water Level[a]
A5213	699-48-7A			N/1943		T	T	T	T	T		T															T
A5215	699-49-13E			N/1944	T	T	T	T	T	T		T															T
A5222	699-50-28B			N/1971	T	T	T	T	T	T		T															T
A5233	699-52-19			N/1944		T	T	T	T	T		T															T
A5333	699-8-17			N/1950	T	T	T	T	T	T		T															T
A5334	699-8-25			N/1971	T	T	T	T	T	T		T															T
A5349	699-9-E2			N/1958	T	T	T	T	T	T		T															T
A5366	699-S12-3			N/1950		T	T	T	T	T		T															T
A5421	699-S19-E14			C		T	T	T	T	T		T															T
B8101	699-S2-34B		LIGO	N/?	A	A	A	A	A	A		A							A								A
A5373	699-S3-25			N/1971		T	T	T	T	T		T															T
A5405	699-S6-E14A			N/1962		T	T	T	T	T		T															T
A9152	699-S6-E4A	300-FF-5		N/1948		T	T	T	T	T		T															T
A9153	699-S6-E4B	300-FF-5		N/1953		T	T	T	T	T		T															T
A5408	699-S8-19			N/1950		T	T	T	T	T		T															T
Aquifer Sampling Tube Locations (Hanford Town Site)[h]																											
B8391, 2, 3	81-D, M, S		81-Deep, Medium, Shallow		A	A	A				A	A		A	A						A						
B8395, 6	82-M, S		82-Medium, Shallow		A	A	A				A	A		A	A						A						
B8397	83-D		83-Deep		A	A	A				A	A		A	A						A						

Table 2.2. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																			
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[d]	Hg and Pb	ICP Metals (filtered)[c]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	VOA[e]	Other Constituents	Water Level[a]
B8400, 1, 2	84-D, M, S		84-Deep, Medium, Shallow		A	A	A				A	A		A	A						A						
B8403, 4, 5	85-D, M, S		85-Deep, Medium, Shallow		A	A	A				A	A		A	A						A						
B8406, 7, 8	86-D, M, S		86-Deep, Medium, Shallow		A	A	A				A	A		A	A						A						

(a) Field measurement.
(b) Anions - Analytes include but not limited to nitrate. For the transect wells, analytes include but not limited to nitrate, sulfate, chloride, nitrite, and fluoride.
(c) Metals - Analytes include but not limited to chromium, manganese, and vanadium.
(d) Gamma Scan - Analytes include but not limited to cobalt-60.
(e) VOA - Analytes include but not limited to trichloroethene, 1,1-dichloroethene, 1,2-dichloroethene, tetrachloroethene, and vinyl chloride.
(f) Triennial sampling next scheduled for FY 2006.
(g) McDonald et al. (1999).
(h) Aquifer tube sites may include multiple depths: deep (D), medium (M), and shallow (S). Each aquifer tube will be sampled for field parameters if conditions permit. If specific conductance in at least one tube is >160 μS/cm, samplers will select the tube with the highest specific conductance for laboratory analyses.
C = Well construction is compliant with WAC 173-160 resource protection requirements.
N = Well construction is not compliant with WAC 173-160 resource protection requirements.
1 = One time sampling.
T = To be sampled triennially; next scheduled for FY 2007 except where noted.
A = To be sampled annually.

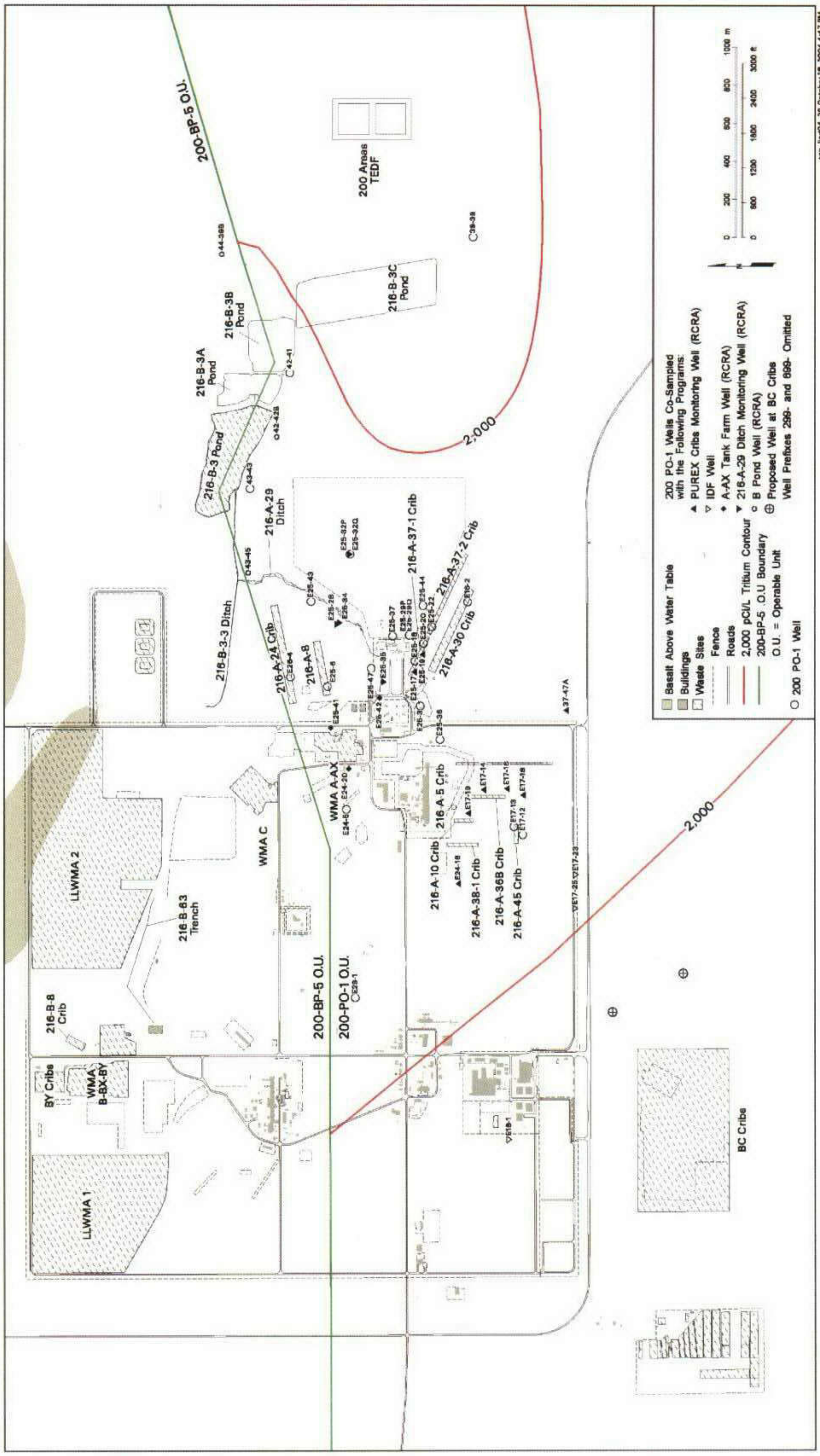

Figure 2.1. Near-Field Monitoring Wells

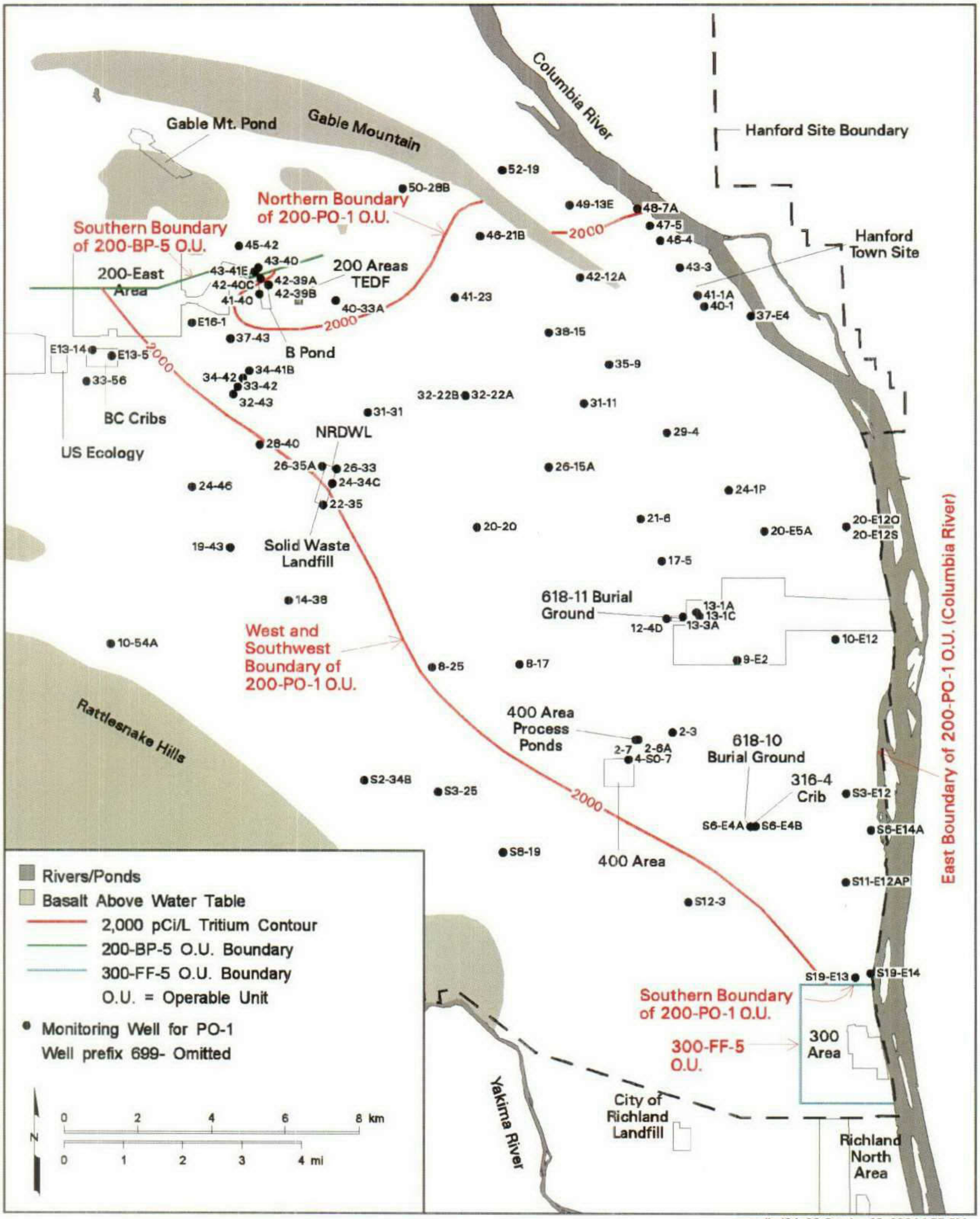

Figure 2.2. Far-Field Monitoring Wells

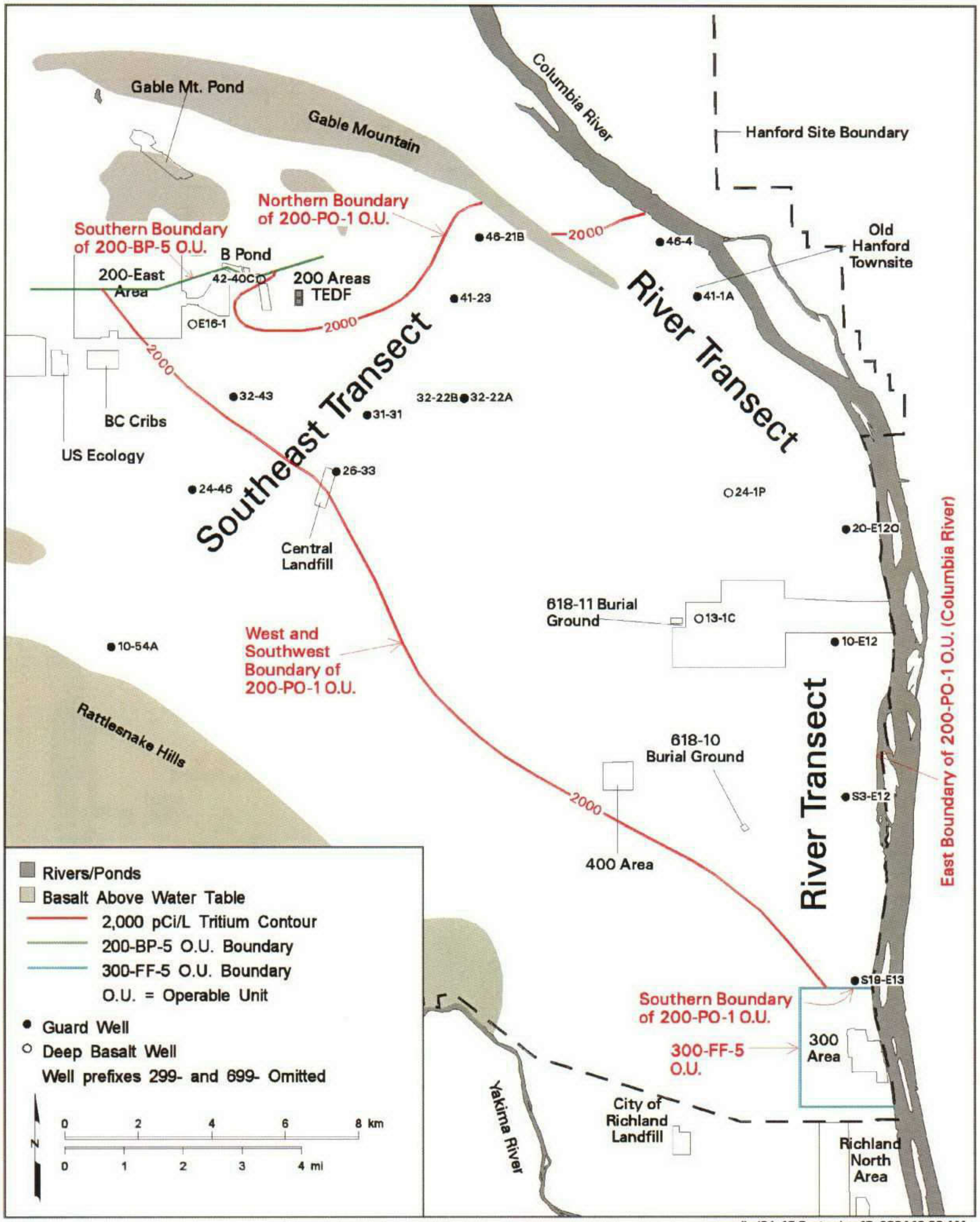

Figure 2.3. Location of the 200 East Area Southeast Transect Wells, River Transect Wells, and Basalt-Confined Aquifer Wells

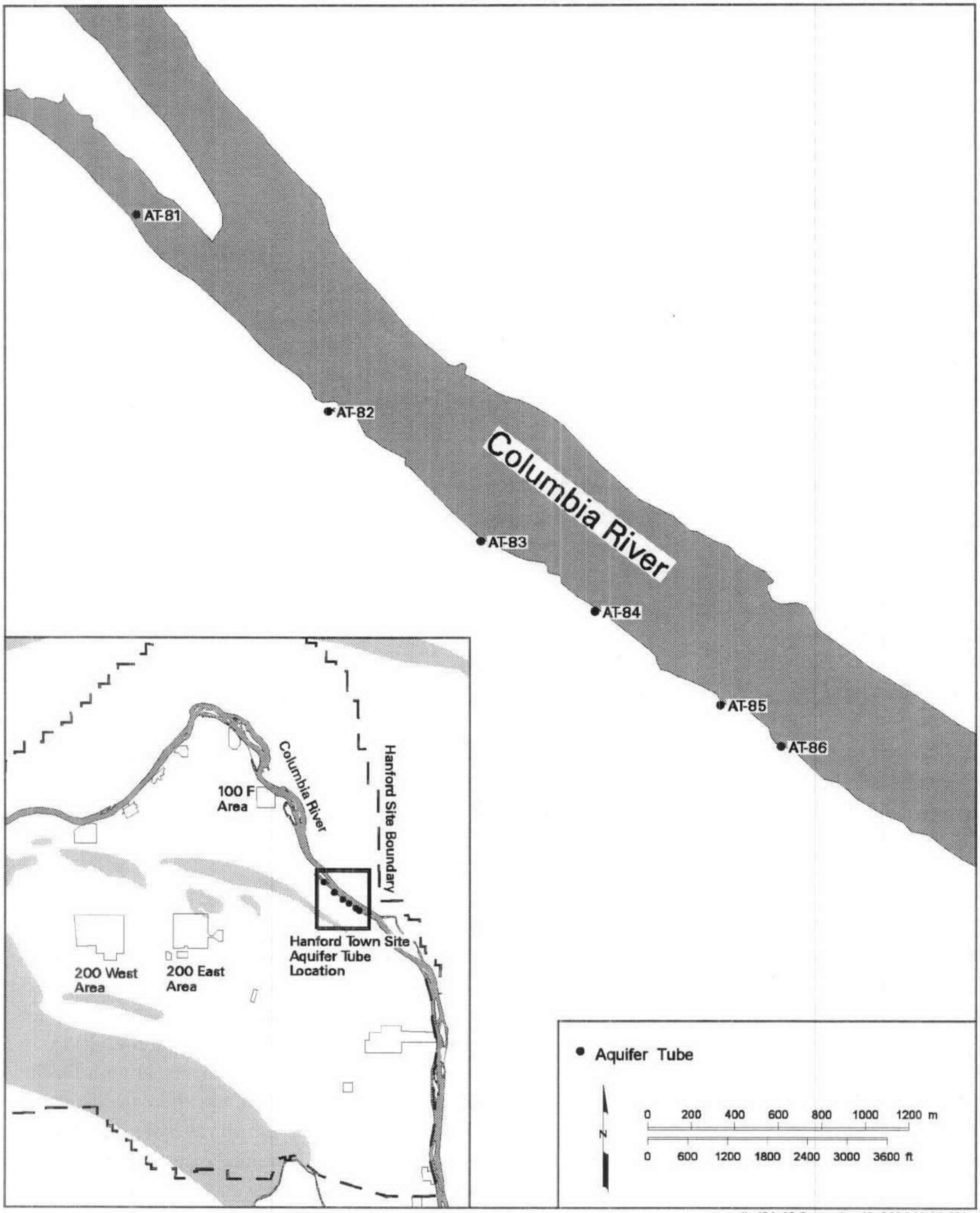

Figure 2.4. Location Map of Aquifer Sampling Tubes Near the Hanford Town Site

Wells co-sampled with 200-PO-1 Operable Unit wells and wells listed in Appendix A are sampled for the objectives of other monitoring programs [e.g., waste sites monitored under RCRA or WAC requirements]. Monitoring requirements for those wells are described in separate plans. They are listed in Appendix A of this document for information. Data from those wells are used to supplement data collected specifically for the 200-PO-1 Operable Unit.

2.3 Constituents to be Monitored

As stated in Section 1.2, near-field contaminants of concern are arsenic, chromium, iodine-129, manganese, nitrate, strontium-90, technetium-99, tritium, and vanadium. General far-field contaminants of concern are iodine-129, nitrate, and tritium. At the BC cribs, the contaminants of concern are chromium, cobalt-60, cyanide, nitrate, technetium-99, tritium, and uranium. For the transect wells, the groundwater samples are screened for anions; gross alpha, beta, and gamma; ICP metals; strontium-90; volatile organic compounds; as well as iodine-129, nitrate, and tritium. The sampling matrix for both near- and far-field wells is in Tables 2.1 and 2.2.

Appendix A (Supplementary Wells) lists the wells, constituents to be analyzed, and sampling frequency for wells sampled by other projects, such as RCRA units, within the boundaries of the 200-PO-1 Operable Unit. This sampling and analysis plan may not reflect recent changes to the RCRA (or other monitoring networks listed) monitoring schedules. Appendix B provides information about the screen intervals (such as elevation top and bottom, and screen length) for all wells listed in Tables 2.1 and 2.2 and Appendix A.

2.4 Water-Level Monitoring

Groundwater levels in 200-PO-1 Operable Unit wells, as well as elsewhere on the Hanford Site, are measured periodically to construct water-table maps. These maps, in turn, are used to help determine the direction and flow rate of groundwater in the uppermost aquifer (usually unconfined). Water levels are also measured in wells that are screened in confined, or partially confined, aquifers to help determine horizontal and vertical hydraulic gradients.

Field personnel measure depth to water in each well before sampling. The tapes used to make depth measurements are periodically calibrated. Field personnel obtain two consecutive measurements that agree within 6 millimeters (0.02 feet) and record them along with date, time, measuring tape number, and other pertinent information. In addition, the groundwater project measures water levels in many selected wells across the Hanford Site (including the 200-PO-1 Operable Unit) annually (usually in March) to construct a site-wide water-table map. A list of wells used for water-level measurements, criteria for their selection, hydrogeologic units monitored, and descriptions of the techniques used to collect the data are provided in *Water-Level Monitoring Plan for the Hanford Groundwater Monitoring Project* (McDonald et al. 1999). The wells identified in McDonald et al. (1999) will be used for annual measurements for the 200-PO-1 Operable Unit. Groundwater samplers measure depth to groundwater according to a subcontractor's procedure. The depth to groundwater is subtracted from the elevation of a reference point (usually top of casing) to obtain the water-level elevation. Tops of casing are known elevation reference points because they have been surveyed to local reference datum.

2.5 Sampling and Analysis Protocol

Groundwater monitoring for the 200-PO-1 Operable Unit is part of the Groundwater Performance Assessment Project and follows project quality assurance protocols. Groundwater monitoring will follow the requirements of the most recent revision of the project quality assurance protocols; this monitoring plan need not be revised to cite future revisions of those protocols.

Project staff schedule sampling and initiate paperwork, and oversee sample collection, shipping, and analysis. Quality requirements for any work are specified in statements of work or contracts.

The statement of work for sampling activities specifies that 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.

Groundwater project staff conduct laboratory audits and field surveillances to assess the quality of subcontracted work and initiate corrective action if needed.

The current controlling document for the aquifer tube task is the *Sampling and Analysis Plan for Aquifer Sampling Tubes* (DOE 2000). In order to foster consistency in aquifer tube sampling, procedures, and methods, a single sampling and analysis plan will be maintained.

2.5.1 Scheduling Groundwater Sampling

The groundwater project schedules well sampling. Many Hanford Site wells are sampled for multiple objectives and requirements (e.g., 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 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 sampling 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 Washington State Department of Ecology (Ecology) if sampling is delayed past the end of the scheduled quarter or if a well cannot be sampled. Should repairs require an extended effort (more than 60 days), Ecology will be consulted and a repair schedule approved.

2.5.2 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 and managed by the sample collector. Samplers enter required information on the forms, including the following:

- Sampler's name
- 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.

2.5.3 Sample Collection

Most of the wells in the 200-PO-1 Operable Unit network are equipped with dedicated sampling pumps. When temporary pumps are installed, they will be properly decontaminated prior to installation. Groundwater samples are generally collected after three casing volumes of water have been purged from the well or after field 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 metal analyses are filtered in the field with 0.45 micrometer, inline, 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 2.5.2.

2.5.4 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 is calibrated and controlled.

Laboratory analytical methods are specified in contracts with the laboratories, and are standard methods from *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA SW-846, 1986 as revised) or *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020, 1979 as revised).

3.0 Quality Assurance

The Groundwater Performance Assessment Project's quality assurance project plans meet *EPA Requirements for Quality Assurance Project Plans* (EPA/240/B-01/003, EPA QA/R-5, March 2001 as revised). Quality control project plans are included in the groundwater project quality documentation, and quality control sampling requirements for subcontracted work are discussed in a 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 200-PO-1 Operable Unit. The quality control practices of the groundwater project are based on EPA guidance cited in the *Tri-Party Agreement Action Plan*, Section 7.8 (Ecology et al. 1989). Accuracy, precision, and detection are the primary parameters used to assess data. 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 3.1 summarizes the types of samples in each category and the sample frequencies and characteristics evaluated.

3.1 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 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 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 Waste: Physical/Chemical Methods* (EPA SW-846, 1986 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 3.1. 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]

(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.
(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.
(c) Double blind standards containing known concentrations of selected analytes are typically submitted in triplicate or quadruplicate on a quarterly, semiannual, or annual basis.

Table 3.2 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 Waste: Physical/Chemical Methods* (EPA SW-846, 1986, as revised) or *Methods for Chemical Analysis of Water and Wastes* (EPA-600/4-79-020, 1979 as revised). These holding times are specified in laboratory contracts. Data associated with exceeded holding times are flagged with an "H" in the Hanford Environmental Information System (HEIS) database.

Table 3.2. Recovery Limits for Double Blind Standards

Constituent	Frequency	Recovery Limits	Precision Limits (RSD)
Specific conductance	Quarterly	75%–125%	25%
Fluoride	Quarterly	75%–125%	25%
Nitrate	Quarterly	75%–125%	25%
Chromium	Annually	80%–120%	20%
Carbon tetrachloride	Quarterly	75%–125%	25%
Chloroform	Quarterly	75%–125%	25%
Trichloroethene	Quarterly	75%–125%	25%
Gross alpha[(a)]	Quarterly	70%–130%	20%
Gross beta[(b)]	Quarterly	70%–130%	20%
Tritium	Annually	70%–130%	20%
Strontium-90	Semiannually	70%–130%	20%

(a) Gross alpha standards will be spiked with plutonium-239.
(b) Gross beta standards will be spiked with strontium-90.
RSD = Relative standard deviation.

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.

3.2 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 4.1) and loaded into the HEIS database. The outcome of the activities described below is an electronic data set with suspect or erroneous data corrected or flagged. Groundwater project staff document the validation process quarterly, and documentation is stored in the project file.

Responsibilities for data validation are divided among project staff. Each RCRA unit, operable unit, or geographic region is assigned to a project scientist, who is familiar with the hydrogeologic conditions of that area. 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 4.2). If necessary, the laboratory 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.

4.0 Data Management, Evaluation, and Reporting

This section describes how groundwater data are stored, retrieved, and interpreted.

4.1 Loading and Verifying Data

The contract laboratories report analytical results 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 Tri-Party Agreement administrative record. 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 work with the laboratory to get the problems corrected. Notes on condition of samples or problems during analysis may be used to support data reviews (see Section 4.2).

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.

4.2 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 form, e.g., project scientists, data management staff, and quality control staff. A project scientist assigned to examine review forms determines and records the appropriate response and action on the review 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 staff updates the temporary "F" flag to the final flag in HEIS.

4.3 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 chemical or radiological constituents 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.

4.4 Reporting

Chemistry and water-level data are reviewed after each sampling event and are available in HEIS.

Any unusual results for the 200-PO-1 Operable Unit will be summarized in letter reports or informal reports to EPA (e.g., reports via e-mail or presented at unit manager's meetings). Formal, interpretive groundwater reports for the entire Hanford Site are issued annually in March (e.g., Hartman et al. 2004).

4.5 Change Control

The approach to making changes in 200-PO-1 Operable Unit monitoring activities, associated documents, and approval requirements are listed in Table 4.1.

Table 4.1. Change Control for Groundwater Monitoring in the 200-PO-1 Operable Unit

Type of Change	Action	Documentation
Temporarily (≤1 year) adding constituents, wells, or increasing sampling frequency.	Project management approval; notify regulator if appropriate.	Project's schedule tracking system.
Permanently (>1 year) adding constituents, wells, or increasing sampling frequency.	Revise sampling and analysis plan.	Revised plan.
Deleting constituents or wells; decreasing frequency.	Obtain regulator approval prior to change.	Initial approval may be verbal or e-mail. Formal approval via letter or signed meeting minutes.
Unavoidable changes (e.g., dry wells; delayed samples, one-time missed samples due to broken pump, lost bottle, etc.).	Notify regulator.	Project's schedule tracking system; notification via letter, report, e-mail, or meeting minutes.
Revision to sampling and analysis plan.	Revise plan; obtain regulator approval; distribute plan.	Revised plan.

5.0 Health and Safety

All field operations will be performed consistent with PNNL health and safety requirements as described in PNNL's online Systems Based Management System. For work performed by other contractors, these standards are implemented via subcontracts and work orders.

Where necessary, work planning packages will include, as appropriate, a job hazard analysis, and/or a site-specific health and safety plan, and applicable radiological permits.

The sampling procedures and associated activities will implement as low as reasonably achievable practices to minimize the radiation exposure to the sampling team, consistent with the requirements outlined in accepted PNNL procedures.

6.0 References

40 CFR 265. "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 300, Subpart E. "State Involvement in Hazardous Substance Response." *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, D.C.

Atomic Energy Act of 1954. 1954. Public Law 83-703, as amended, 68 Stat. 919, 42 USC 2011 et seq.

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Appendix A

Sampling and Analysis Schedule for Supplementary Wells

Appendix A

Sampling and Analysis Schedule for Supplementary Wells

The following is a brief summary of the well networks within the 200-PO-1 Operable Unit area that are not part of the 200-PO-1 Operable Unit network. These wells are monitored under other groundwater monitoring plans. Some of these wells are co-sampled with 200-PO-1 Operable Unit wells. The table that follows is a sampling matrix that lists the constituents analyzed for groundwater samples from these wells and the sampling frequencies.

PUREX Cribs – The PUREX cribs are three *Resource Conservation and Recovery Act* (RCRA) regulated cribs (Interim Status, Groundwater Quality Assessment Project) located south and east of the PUREX Plant (see Figure 1.1). The well network includes 11 near-field wells and far-field wells (Lindberg 1997). Groundwater samples are analyzed for alkalinity, ammonium ion, anions, arsenic, inductively coupled plasma (ICP) metals, and phenols. Gross alpha, gross beta, iodine-129, strontium-90, and tritium are monitored to support the *Atomic Energy Act of 1954* and its implementing DOE Orders.

Waste Management Area A-AX – This RCRA unit includes single-shell tanks, and groundwater monitoring is under interim status, indicator-evaluation requirements (Narbutovskih 2001). The well network includes five wells. Groundwater samples are analyzed for alkalinity, anions, ICP metals, and phenols, as well as the four RCRA indicator parameters (pH, specific conductance, total organic carbon, and total organic halides). Technetium-99, tritium, and uranium are monitored to support the *Atomic Energy Act of 1954* and its implementing DOE Orders.

216-A-29 Ditch – The 216-A-29 ditch is a RCRA-regulated unit located to the east of the 200 East Area. Groundwater monitoring is under an interim status detection program. The well network includes 10 wells (Sweeney 1999). Groundwater samples are analyzed for alkalinity, anions, ICP metals, phenols, as well as the four RCRA indicator parameters.

B Pond – B-Pond (216-B-3 Pond) is a RCRA-regulated facility located east of the 200 East Area. Groundwater monitoring is under interim status detection program using alternative statistical methods (Barnett 2002). The well network includes five wells, one of which is north of B Pond and is in the 200-BP-5 Operable Unit. Groundwater samples are analyzed for anions, ICP metals, mercury, lead, trace metals, and specific conductance. Iodine-129, gross alpha and beta, and tritium are monitored to support the *Atomic Energy Act of 1954* and its implementing DOE Orders.

Integrated Disposal Facility – The Integrated Disposal Facility (IDF) is a RCRA-compliant landfill (with a double-lined trench with leachate collection system) located in the south-central portion of the 200 East Area. The waste disposed there will be segregated into a RCRA-permitted side and a non-RCRA-permitted side. Construction of the facility started in 2004. Sampling at the IDF well network will begin in 2005. The well network will consist of two upgradient wells and six downgradient wells. Two of the wells have not been drilled yet, but are planned for early FY 2005. Groundwater samples will be analyzed for RCRA indicator parameters including pH, specific conductance, total organic carbon, and total organic halides, and supplemental groundwater constituents including alkalinity, anions, and ICP metals (specifically filtered chromium).

400 Area Water Supply – Three wells at the 400 Area monitor groundwater for water supply purposes and are included as part of the 200-PO-1 Operable Unit well network. These wells are completed in the unconfined aquifer system. Monitoring also is conducted to provide information needed to describe the nature and extent of site-wide contamination. Groundwater samples are analyzed for alkalinity, ammonium ion, anions, gross alpha and beta, ICP metals, iodine-129, and tritium.

300-FF-5 Operable Unit (618-10 burial ground, 618-11 burial ground, and 316-4 crib) – These wells are isolated from the 300 Area, yet are sampled in response to the sampling and analysis plan for the 300-FF-5 Operable Unit (DOE 2002). Four wells are located near the 618-10 burial ground and 316-4 crib, and are designed to monitor for potential releases from those facilities as well as the site-wide nitrate and tritium plumes. Sampling frequency is semiannual, though the screening analyses for radioactive constituents in three of the wells are reduced to annual. Constituents analyzed include: alkalinity, anions, gross alpha and gross beta, gamma scan, ICP metals, iodine-129, pH, strontium-90, tritium, uranium, semivolatile compounds, and volatile organic compounds. Five wells are located near the 618-11 burial ground to monitor the small but high-concentration tritium plume. The wells are sampled quarterly, but quarterly analyses include only gross alpha, beta, and gamma; tritium; and uranium. Alkalinity, anions, iodine-129, and pH, are analyzed semiannually. ICP metals and volatile organic compounds are analyzed annually.

Nonradioactive Dangerous Waste Landfill – This landfill is a RCRA-regulated unit located south and east of the 200 East Area and, with the Solid Waste Landfill, and is part of the Central Landfill. Groundwater monitoring is under an interim status detection program. The well network includes nine wells (Lindberg and Hartman 1999). Groundwater samples are analyzed for anions, ICP metals, phenols, volatile organic compounds, as well as the four RCRA indicator parameters.

Solid Waste Landfill – The Solid Waste Landfill is regulated by the Washington State Department of Ecology. The well network consists of nine wells sampled quarterly for constituents specified in WAC 173-304-490(2)(d) including anions, coliform bacteria, chemical oxygen demand, filtered ICP metals, pH, specific conductance, temperature, and total organic carbon. Also, the wells are sampled for site-specific constituents including volatile organic compounds and filtered arsenic (Lindberg and Chou 2000).

200 Area Treated Effluent Disposal Facility – This facility is regulated by WAC 173-216 under a state waste discharge permit (ST-4502). The network consists of three wells sampled quarterly for cadmium, lead, and pH, and annually for ICP metals, anions, trace metals, alkalinity, specific conductance, total dissolved solids, turbidity, gross alpha, gross beta, and low-level tritium (Barnett 2000).

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Table A.1. Sampling and Analysis Schedule for Supplementary Wells

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and Pb	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	VOA	Other Constituents	Water Level[d]
RCRA Treatment, Storage, and Disposal Units																									
PUREX Cribs																									
A4728	299-E17-1			S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4732	299-E17-14	200-PO-1		Q	Q	Q	Q	Q					Q	Q	Q	Q					Q			Q:Amm	Q
A4734	299-E17-16	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4736	299-E17-18	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4737	299-E17-19	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4751	299-E24-16			Q	Q	Q	Q	Q					Q	Q	Q	Q					Q			Q:Amm	Q
A4753	299-E24-18	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A6031	299-E25-17	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4765	299-E25-19	200-PO-1		Q	Q	Q	Q	Q					Q	Q	Q	Q					Q			Q:Amm	Q
A4778	299-E25-31			S	S	S	S	S					S	S	S	S					S			S:Amm	S
B2822	699-37-47A	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
Waste Management Area A-AX																									
A4756	299-E24-20	200-PO-1		S		S		S			A		A	S	A	A	S		S	S	A	A			S
C4123	299-E24-22		Top of confined	S		S		S			A		A	S	A	A	S		S	S	A	A			S
	299-E24-33			S		S		S			A		A	S	A	A	S		S	S	A	A			S
	299-E24-94			S		S		S			A		A	S	A	A	S		S	S	A	A			S
A4766	299-E25-2			S		S		S			A		A	S	A	A	S		S	S	A	A			S
A4789	299-E25-40			S		S		S			A		A	S	A	A	S		S	S	A	A			S
A4790	299-E25-41	200-PO-1		S		S		S			A		A	S	A	A	S		S	S	A	A			S
A4791	299-E25-42	200-PO-1		S		S		S			A		A	S	A	A	S		S	S	A	A			S
C4122	299-E25-93		Top of confined	S		S		S			A		A	S	A	A	S		S	S	A	A			S
C4665	299-E25-94			S		S		S			A		A	S	A	A	S		S	S	A	A			S

Table A.1. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and Pb	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	VOA	Other Constituents	Water Level[d]
A5898	299-E24-4[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A4749	299-E24-13[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A4750	299-E24-14[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A4759	299-E25-1[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A4788	299-E25-4[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A6025	299-E25-5[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A6026	299-E25-7[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A6027	299-E25-8[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A4797	299-E25-9[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A4762	299-E25-13[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
A6641	299-E26-5[e]			(e)		(e)		(e)			(e)		(e)	(e)	(e)	(e)	(e)				(e)	(e)			(e)
216-A-29 Ditch																									
A4770	299-E25-26			S		S								A	A				S	S					S
A4773	299-E25-28	200-PO-1	Deep unconfined	S		S								A	A				A	A					S
A4779	299-E25-32P	200-PO-1		S		S								A	A				S	S					S
A4782	299-E25-34	200-PO-1		S		S								A	A				S	S					S
A4783	299-E25-35	200-PO-1		S		S								A	A				S	S					S
A4795	299-E25-48			S		S								A	A				S	S					S
A4801	299-E26-12			S		S								A	A				S	S					S
A4802	299-E26-13			S		S								A	A				S	S					S
A5180	699-43-45	200-PO-1		S		S								A	A				S	S					S
216-B-3 Pond																									
A5171	699-42-42B	200-PO-1	Confined Ringold[f]	S	S	A		S				A		A	A				S	S	A			A:Cd	S
B8758	699-43-44			S	S	A		S				A		A	A				S	S	A			A:Cd	S

Table A.1. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and Pb	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	VOA	Other Constituents	Water Level[d]
A5180	699-43-45	200-PO-1		S	S	A		S				A		A	A				S	S	A			A:Cd	S
A5185	699-44-39B	200-PO-1		S	S	A		S				A		A	A				S	S	A			A:Cd	S
Non-Radioactive Dangerous Waste Landfill																									
A5094	699-25-33A		Bottom unconfined			S								A	A				S	S			S		S
A5095	699-25-34A					S								A	A				S	S			S		S
A5096	699-25-34B					S								A	A				S	S			S		S
A5419	699-25-34D					S								A	A				S	S			S		S
A5101	699-26-33	200-PO-1				S								A	A				S	S			S		S
A5102	699-26-34A					S								A	A				S	S			S		S
A5420	699-26-34B					S								A	A				S	S			S		S
A5103	699-26-35A	200-PO-1				Q	Q							Q	A				Q	S			Q	Q:Amm, COD, Col	Q
A5104	699-26-35C		Bottom unconfined			S								A	A				S	S			S		S
IDF																									
B8500	299-E17-21			A	A	A		A						A	A				S	S			A	A:Amm	S
C3826	299-E17-22			A	A	A		A						A	A				S	S			A	A:Amm	S
C3827	299-E17-23	200-PO-1		A	A	A		A						A	A				S	S			A	A:Amm	S
C3926	299-E17-25	200-PO-1		A	A	A		A						A	A				S	S			A	A:Amm	S
A4743	299-E18-1	200-PO-1		A	A	A		A						A	A				S	S			A	A:Amm	S
C3177	299-E24-21			A	A	A		A						A	A				S	S			A	A:Amm	S
	Proposed Well		TBD 12/04																						
	Proposed Well		TBD 12/04																						

Table A.1. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and Pb	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	VOA	Other Constituents	Water Level[d]
WAC Sites																									
Solid Waste Landfill																									
A8443	699-22-35	200-PO-1				Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5087	699-23-34A					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A8450	699-23-34B					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5089	699-24-33					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5090	699-24-34A					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5091	699-24-34B					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5092	699-24-34C	200-PO-1				Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5093	699-24-35					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5103	699-26-35A	200-PO-1				Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q

Table A.1. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and Pb	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	VOA	Other Constituents	Water Level[d]
200 Area Treated Effluent Disposal Facility (TEDF)																									
A5154	699-40-36			Q	Q	Q	Q	Q	Q			Q		Q				Q			A			Q: Cd	Q
A5160	699-41-35			Q	Q	Q	Q	Q	Q			Q		Q				Q			A			Q: Cd	Q
A5164	699-42-37			Q	Q	Q	Q	Q	Q			Q		Q				Q			A			Q: Cd	Q
CERCLA (300-FF-5)																									
618-10 Burial Grounds and 316-4 Crib																									
A9152	699-S6-E4A	200-PO-1		S	S	S		S			S			S							S	S	S	S:SVOA	S
A9153	699-S6-E4B	200-PO-1		S	A			A			A										S	A			S
A5406	699-S6-E4D			S	A			A			A										S	A			S
A9155	699-S6-E4E			A																					A
C4072	699-S6-E4K			S	S	S		S			S			S							S	S	S	S:SVOA, pH	S
C4073	699-S6-E4L			S	S	S		S			S			S							S	S	S	S:SVOA, pH	S
618-11 Burial Grounds																									
C3253	699-12-2C			S	Q	S		Q			Q		S	A							Q	Q	A		Q
C3256	699-13-0A			S	Q	S		Q			Q		S	A							Q	Q	A		Q
C3798	699-13-1E			S	Q	S		Q			Q		S	A							Q	Q	A		Q
C3254	699-13-2D			S	Q	S		Q			Q		S	A							Q	Q	A		Q
B2540	699-13-3A	200-PO-1		S	Q	S		Q			Q		S	A							Q	Q	A		Q

Table A.1. (contd)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and Pb	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	VOA	Other Constituents	Water Level[d]
Miscellaneous Units																									
400 Area Water Supply Wells																									
A8098	499-S0-7	200-PO-1			A	A		A					A	A							Q			A:Amm	Q
A8099	499-S0-8				A	A		A					A	A							Q				Q
A8114	499-S1-8J		Drinking water well; deeper aquifer (unit unknown)		A	A		A			A		A	A		A	A				Q	A	A	A:Amm, Uiso	Q

(a) Anions – Analytes include but not limited to nitrate.
(b) Metals – Analytes include but not limited to chromium, manganese, and vanadium.
(c) Optional constituent.
(d) Field measurement.
(e) Note: Waste Management Area A-AX wells will be sampled and evaluated for possible continued use to monitor cribs and to provide a monitoring location between Waste Management Area A-AX and Waste Management Area C.
(f) McDonald et al. (1999).
A = To be sampled annually.
S = To be sampled semiannually.
Q = To be sampled quarterly.

Appendix B

Sampling Interval Information for 200-PO-1 Operable Unit Wells

Appendix B

Sampling Interval Information for 200-PO-1 Operable Unit Wells

This appendix provides the following information of 200-PO-1 Operable Unit wells and supplementary wells.

- Well name
- Zone – the aquifer or portion of the aquifer screened or open by perforated casing
  U = Unconfined aquifer
  TU = Top of the unconfined aquifer
  MU = Midlevel in the unconfined aquifer
  LU = Lower unconfined aquifer
  UU = Upper unconfined aquifer
  C = Confined aquifer
  CR = Locally confined Ringold Formation
  UC = Upper confined, but above the Pomona Member of the Saddle Mountains Basalt
- Elevation at top of the screen or perforated interval
- Elevation at the bottom of the screen or perforated interval
- Open interval = Length of the open interval, difference between elevations of top and bottom of the screen or perforated interval
- Water-Level Elevation = Most recent water level elevation in the well
- Water-Level Date = Date of most recent water level elevation measured in the well
- NA = Information not available

Table B.1. Sampling Interval Information for Wells within the 200-PO-1 Operable Unit Area

Well or Aquifer Tube Name	Zone	Elevation Top of Interval	Elevation Bottom of Interval	Open Interval	Water Level	Water Level Date
299-E13-1	U				123.72	12/08/1976
299-E13-11	U				122.425	12/30/1957
299-E13-12	TU	130.034032	114.184432	15.8496	123.621	06/10/1994
299-E13-14	TU	130.09	120.03	10.06	122.37	07/29/2004
299-E13-16	U				122.456	07/25/1957
299-E13-17	U				123.8	12/14/1961
299-E13-18	U				122.443	12/30/1957
299-E13-19	TU	128.555752	113.315752	15.24	124.538	04/27/1990
299-E13-3	UU				123.872	12/01/1980
299-E13-4	U				122.611	12/30/1957
299-E13-5	TU	126.900688	116.232688	10.668	122.301	04/06/2004
299-E13-6	U				122.675	12/30/1957
299-E13-7	U				122.94	12/30/1957
299-E13-8	TU	130.14376	116.42776	13.716	124.524	04/27/1990
299-E13-9	U				122.934	12/30/1957
299-E16-1	UC				123.1	07/29/2004
299-E16-2	TU	127.824232	106.183432	21.6408	122.115	04/01/2004
299-E17-1	TU	127.23	118.08	9.15	122.112	07/28/2004
299-E17-12	TU	123.64	117.24	6.4	122.224	07/28/2004
299-E17-13	TU	123.6058	117.5098	6.096	122.305	03/10/2003
299-E17-14	TU	125.8	119.7	6.1	122.215	07/29/2004
299-E17-16	TU	125.8558	119.455	6.4008	122.192	04/08/2004
299-E17-18	TU	124.75	118.35	6.4	122.191	07/29/2004
299-E17-19	TU	126.8	120.71	6.09	122.032	07/29/2004
299-E17-21		124.56464	115.472456	9.092184	122.16	07/29/2004
299-E17-22					122.221	07/28/2004
299-E17-23					122.224	07/29/2004
299-E17-25					121.901	07/29/2004
299-E18-1	TU	125.31	119.21	6.1	122.282	07/28/2004
299-E23-1	TU	122.8	112.8	10	122.243	07/29/2004
299-E24-13	UU	129.31608	108.58968	20.7264	123.616	07/20/1993
299-E24-14	UU				123.657	07/20/1993
299-E24-16	TU	125.55	119.45	6.1	122.233	07/28/2004
299-E24-18	TU	125.9	117.94	7.96	122.203	07/29/2004
299-E24-20	TU	125.07	118.67	6.4	122.271	08/09/2004
299-E24-21						
299-E24-22	UU				122.249	06/02/2004
299-E24-33						
299-E24-4	TU	129.98128	122.05648	7.9248	122.892	08/10/1998

Table B.1. (contd)

Well or Aquifer Tube Name	Zone	Elevation Top of Interval	Elevation Bottom of Interval	Open Interval	Water Level	Water Level Date
299-E24-5	TU	129.37816	113.22376	16.1544	122.253	03/01/2004
299-E24-94						
299-E25-1	TU				123.621	07/20/1993
299-E25-13	UU	130.95876	112.97556	17.9832	123.656	07/20/1993
299-E25-17	TU	123.44648	116.74088	6.7056	122.269	04/05/2004
299-E25-18	TU	125.3688	117.7488	7.62	122.971	03/08/2004
299-E25-19	TU	108.96	102.87	6.09	122.181	07/29/2004
299-E25-2	U	121.83	109.64	12.19	122.233	08/09/2004
299-E25-20	TU	124.5148	116.8948	7.62	122.194	04/02/2004
299-E25-22	TU	125.02148	115.87748	9.144	122.13	04/05/2004
299-E25-26	UU	122.53	116.43	6.1	122.205	07/27/2004
299-E25-28	LU	104.8	96.2	8.6	122.294	07/27/2004
299-E25-29P	TU	129.167704	115.451704	13.716	123.718	10/13/1993
299-E25-29Q	MU	108.069504	105.326304	2.7432	123.233	08/26/1997
299-E25-3	TU	127.2454	114.4438	12.8016	123.133	04/05/2004
299-E25-31	TU	126.34	120.24	6.1	122.225	07/29/2004
299-E25-32P	TU	127.5	115.71	11.79	122.03	07/27/2004
299-E25-32Q	LU	109.53556	101.15356	8.382	122.187	03/22/2004
299-E25-34	TU	125.63	118.2	7.43	122.175	07/27/2004
299-E25-35	TU	126.05	119.95	6.1	122.204	07/27/2004
299-E25-36	TU	125.29	118.89	6.4	122.217	07/29/2004
299-E25-37	TU	126.1826	119.87324	6.30936	122.2	04/07/2004
299-E25-4	UU	130.66728	116.34168	14.3256	123.852	06/10/1993
299-E25-40	TU	126.3	119.9	6.4	122.215	08/09/2004
299-E25-41	TU	127.01	120.6	6.41	122.233	08/09/2004
299-E25-42	TU	126.55	120.15	6.4	122.249	07/29/2004
299-E25-43	TU	125.457504	119.056704	6.4008	122.244	04/07/2004
299-E25-44	TU	125.04	118.94	6.1	122.209	08/03/2004
299-E25-47	TU	125.193472	119.036512	6.15696	122.276	04/07/2004
299-E25-48	TU	124.67	118.27	6.4	122.219	07/27/2004
299-E25-5	UU	129.142008	112.073208	17.0688		
299-E25-6	TU	130.73116	114.27196	16.4592	122.265	05/27/2004
299-E25-7	UU	128.90932	112.14532	16.764		
299-E25-8	UU				124.248	10/16/1973
299-E25-9	UU	129.1554	112.3914	16.764	123.498	06/27/1996
299-E25-93	UU				122.013	06/03/2004
299-E25-94						
299-E26-12	TU	125.81	119.41	6.4	122.246	07/27/2004
299-E26-13	TU	125.9	119.8	6.1	122.219	07/27/2004

Table B.1. (contd)

Well or Aquifer Tube Name	Zone	Elevation Top of Interval	Elevation Bottom of Interval	Open Interval	Water Level	Water Level Date
299-E26-4	TU	129.38	112.31	17.07	122.248	07/29/2004
299-E26-5	U	126.6434	110.489	16.1544	125.362	06/21/1988
499-S0-7	U	100.849432	47.509432	53.34		
499-S0-8	U	110.39272	82.04632	28.3464		
499-S1-8J	LU					
699-10-54A	UU	126.01	119.92	6.09	126.956	03/26/2004
699-10-E12	TU	114.038128	28.694128	85.344	109.623	03/12/2004
699-12-2C	TU	117.00612	110.888784	6.117336	117.983	06/29/2004
699-12-4D	TU	116.62	92.23	24.39	118.566	07/20/2004
699-13-0A	TU	116.746288	110.635048	6.11124	118.502	06/25/2004
699-13-1A	U	111.5922	107.0202	4.572	117.73	05/14/2002
699-13-1C	UC				121.711	03/29/2004
699-13-1E	TU	117.920184	111.854664	6.06552	117.41	06/25/2004
699-13-2D	TU	118.343744	112.229456	6.114288	117.854	07/12/2004
699-13-3A	TU	119.369488	113.2552	6.114288	118.101	07/12/2004
699-14-38	UU	123.44	106.68	16.76	124.085	03/26/2004
699-17-5	TU	119.2	115.84	3.36	118.175	08/30/2004
699-19-43	UU	137.65	111.75	25.9	122.715	03/30/2004
699-20-20	TU	122.1	106.86	15.24	121.749	07/08/2004
699-20-E12O	TU	109.962952	103.866952	6.096	109.783	05/25/2004
699-20-E12S	MU	113.58	28.54	85.04	109.714	03/12/2004
699-20-E5A	TU	114.17	112.64	1.53	113.648	06/29/2004
699-21-6	TU	120.59	114.19	6.4	118.619	04/13/2004
699-22-35	TU	125.71	115.04	10.67	122.146	08/26/2004
699-2-3	TU	119.46	107.88	11.58	118.867	07/27/2004
699-23-34A	TU	125.82	121.25	4.57	122.089	08/26/2004
699-23-34B	TU	125.63	116.486	9.144	122.151	08/26/2004
699-24-1P	UC				120.805	06/30/2004
699-24-33	TU	125.422408	112.316008	13.1064	122.151	05/17/2004
699-24-34A	TU	125.696	121.124	4.572	122.158	05/17/2004
699-24-34B	TU	125.75	121.18	4.57	115.101	08/26/2004
699-24-34C	TU	125.7592	121.1872	4.572	122.098	08/26/2004
699-24-35	TU	125.52	120.95	4.57	122.093	08/26/2004
699-24-46	TU	125.34	-24.02	149.36	122.76	03/31/2004
699-25-33A	MU	103.3202	100.2722	3.048	122.083	08/31/2004
699-25-34A	TU	126.04	119.95	6.09	122.121	08/31/2004
699-25-34B	TU	125.64164	122.59364	3.048	122.127	08/31/2004
699-25-34D	TU	125.61436	115.09876	10.5156	122.154	02/24/2004
699-26-15A	TU	124.71	28.39	96.32	121.129	03/29/2004

Table B.1. (contd)

Well or Aquifer Tube Name	Zone	Elevation Top of Interval	Elevation Bottom of Interval	Open Interval	Water Level	Water Level Date
699-26-33	TU	125.9	119.8	6.1	122.153	08/31/2004
699-26-34A	TU	125.79	119.69	6.1	121.895	08/26/2004
699-26-34B	TU	114.84	104.17	10.67	122.089	08/26/2004
699-26-35A	TU	128.22	119.99	8.23	122.121	08/26/2004
699-26-35C	MU	103.8416	100.7936	3.048	122.078	08/26/2004
699-2-6A	TU	120.760216	114.65812	6.102096	119.763	10/28/2003
699-2-7	U	111.92	105.83	6.09	119.713	05/04/2004
699-28-40	TU	124.83	73.01	51.82	122.223	03/30/2004
699-29-4	TU	119.68	114.8	4.88	116.93	03/12/2004
699-31-11	U	91.851736	76.581256	15.27048	119.027	02/05/2004
699-31-31	TU	120.22	76.02	44.2	122.142	03/31/2004
699-32-22A	TU	123.94	106.26	17.68	121.604	03/29/2004
699-32-22B	UC				123.162	03/29/2004
699-32-43	TU	123.98	120.93	3.05	122.224	03/30/2004
699-33-42	TU	124.08	121.04	3.04	122.273	04/14/2004
699-33-56	TU	122.56	93.9	28.66	122.587	03/30/2004
699-34-41B	TU	128.31	120.69	7.62	122.233	03/31/2004
699-34-42	TU	128.16256	121.45696	6.7056	122.238	02/03/2004
699-35-9	TU	118.84	111.22	7.62	117.191	03/12/2004
699-37-43	TU	126.54	59.48	67.06	122.002	05/25/2004
699-37-47A	TU	124.5616	115.4176	9.144	122.215	07/29/2004
699-37-E4	MU	92.9676	88.3956	4.572	109.549	03/01/2004
699-38-15	TU	120.36	114.27	6.09	119.835	03/29/2004
699-39-39	TU	131.04292	105.43972	25.6032	125.212	03/03/2004
699-40-1	TU	113.89	66.65	47.24	111.211	03/09/2004
699-40-33A	UU	126.1	101.54	24.56	124.784	03/29/2004
699-40-36	MU	97.59	94.23	3.36	124.589	07/07/2004
699-41-1A	TU	111.89924	105.28508	6.61416	110.579	01/26/2004
699-41-23	TU	122.89	118.32	4.57	121.011	07/27/2004
699-41-35	MU	100.83	97.78	3.05	124.903	07/07/2004
699-41-40	CR	116.5	113.45	3.05	123.829	05/14/2004
699-42-12A	TU	126	59.24	66.76	114.657	03/29/2004
699-42-37	MU	114.47	111.12	3.35	124.927	07/07/2004
699-42-39A	MU	118.81388	115.64396	3.16992	124.705	01/26/2004
699-42-39B	CR	108.27	104.92	3.35	124.597	03/16/2004
699-42-40C	UC				123.91	03/16/2004
699-42-41	TU	132.1	125.7	6.4		06/21/2000
699-42-42B	MU	121.94	115.54	6.4	123.005	07/15/2004
699-43-3	UU	109.094272	102.236272	6.858	109.819	05/25/2004

Table B.1. (contd)

Well or Aquifer Tube Name	Zone	Elevation Top of Interval	Elevation Bottom of Interval	Open Interval	Water Level	Water Level Date
699-43-40	TU	130.49	124.09	6.4		03/16/2004
699-43-41E	MU	126.83	123.48	3.35	124.551	05/14/2004
699-43-43	TU	129.799336	123.505216	6.29412	122.751	01/21/2002
699-43-44	TU	124.25	118.15	6.1	122.598	07/15/2004
699-43-45	TU	126.47	120.37	6.1	122.228	07/27/2004
699-44-39B	UU	126.18	120.09	6.09	124.814	07/15/2004
699-45-42	TU	127.9	121.19	6.71	124.175	07/28/2004
699-46-21B	TU	120.17	92.13	28.04	118.981	07/27/2004
699-46-4	TU	110.56036	103.54996	7.0104	109.125	01/26/2004
699-47-5	TU	111.109	104.0986	7.0104	109.919	05/14/2004
699-48-7A	TU	114.059184	107.963184	6.096	109.385	02/04/2004
699-49-13E	UU	109.07	102.97	6.1	110.869	07/01/2004
699-50-28B	UU	119.4	116.35	3.05	119.783	05/25/2004
699-52-19	TU	110.07	97.88	12.19	110.943	06/29/2004
699-8-17	TU	127.88	110.5	17.38	121.306	03/26/2004
699-8-25	TU	123.85	106.48	17.37	121.644	03/29/2004
699-9-E2	TU	123.62	50.47	73.15	114.195	03/26/2004
699-S11-E12AP	CR_UC	45.13504	26.2984	18.83664	118.205	03/17/2004
699-S12-3	TU	111.4	99.2	12.2	116.729	03/31/2004
699-S19-E13	TU	105.02	95.88	9.14	106.077	06/29/2004
699-S19-E14	TU	108.31	101.91	6.4	105.373	03/12/2004
699-S2-34B	C?					06/27/1997
699-S3-25	UU	124.86	107.19	17.67	121.802	03/30/2004
699-S3-E12	TU	110.63	60.34	50.29	108.777	03/12/2004
699-S6-E14A	TU	109.23	57.41	51.82	107.708	06/29/2004
699-S6-E4A	TU	114.8992	108.89464	6.00456	113.937	06/25/2004
699-S6-E4B	TU	114.800128	105.960928	8.8392	113.499	06/25/2004
699-S6-E4D	TU	113.919256	110.261656	3.6576	113.913	03/31/2004
699-S6-E4E	TU	113.078008	100.276408	12.8016	113.724	06/29/2004
699-S6-E4K					114.096	06/25/2004
699-S6-E4L					114.093	06/28/2004
699-S8-19	TU	121.92	113.39	8.53	121.476	06/29/2004
81-D	TU					
81-M	TU					
81-S	TU					
82-M	TU					
82-S	TU					
83-D	TU					
84-D	TU					

Table B.1. (contd)

Well or Aquifer Tube Name	Zone	Elevation Top of Interval	Elevation Bottom of Interval	Open Interval	Water Level	Water Level Date
84-M	TU					
84-S	TU					
85-D	TU					
85-M	TU					
85-S	TU					
86-D	TU					
86-M	TU					
86-S	TU					

C = Confined aquifer.
CR = Locally confined Ringold Formation.
LU = Lower unconfined aquifer.
MU = Midlevel in the unconfined aquifer.
TU = Top of the unconfined aquifer.
U = Unconfined aquifer.
UC = Upper confined, but above the Pomona Member of the Saddle Mountains Basalt.
UU = Upper unconfined aquifer.