10.0 200-PO-1 Operable Unit

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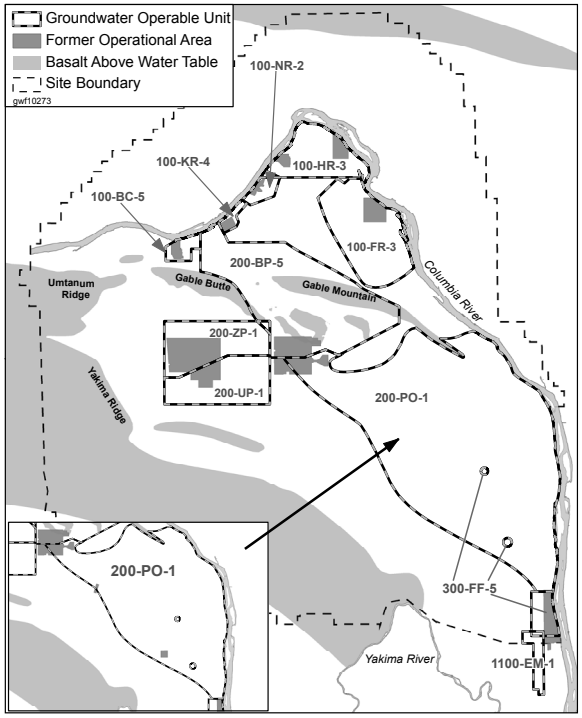
This chapter describes groundwater flow and chemistry for the 200-PO-1 groundwater interest area, which includes the 200-PO-1 Operable Unit (OU). This area encompasses the southern portion of the 200 East Area and a large, triangular-shaped portion of the Hanford Site that extends to the Hanford town site to the east and to the 300-FF-5 groundwater interest area to the southeast. Although the 216-B-3 Pond (B Pond) straddles the boundary of two interest areas, it is considered part of the 200-PO-1 groundwater interest area. The BC Cribs and Trenches are located completely outside of the 200-PO-1 OU but are within the 200-PO-1 groundwater interest area. Potential groundwater contamination in the area is discussed in this chapter to ensure that potential groundwater impact from these cribs and trenches is not overlooked. The 51 wells located in the 200 East Area (near the major sources for groundwater contamination) are considered to be in the 200-PO-1 OU near-field area, while the 80 wells located in the 600 Area to the east and southeast are considered to be in the far-field area. In addition, 34 of the 61 *Resource Conservation and Recovery Act of 1976* (RCRA) (and *Washington Administrative Code*-permitted) wells in the 200-PO-1 OU are cooperatively sampled with the 200-PO-1 OU. Figure 10-1 shows the location of local facilities and wells used in near-field monitoring of the southern 200 East Area. Figure 10-2 provides the locations of wells used in the remainder of the 200-PO-1 OU far-field area and shoreline monitoring sites within the 600 Area. Figure 10-3 provides a water table map of the 200-PO-1 OU.



Active groundwater remediation is currently not taking place in the 200-PO-1 OU. A ROD has not yet been prepared.

Groundwater monitoring in the 200-PO-1 groundwater interest area is designed to meet the requirements of the *Atomic Energy Act of 1954* (AEA); the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA); RCRA; and the *Washington Administrative Code*, as directed by U.S. Department of Energy (DOE) orders. Active groundwater remediation is currently not taking place in the 200-PO-1 OU. A Record of Decision (ROD) has not yet been prepared. The immediate goal for the 200-PO-1 OU is to monitor the contaminants of concern (COCs) and contaminants of potential concern (COPCs) under the CERCLA remedial investigation (RI)/feasibility study (FS) process until final cleanup decisions are made. A total of 131 wells are routinely monitored for AEA, CERCLA, and WAC requirements (51 near-field and 80 far-field wells). The OU has six RCRA units that are routinely monitored under separate groundwater monitoring plans. Some of the RCRA wells are sampled cooperatively with 200-PO-1 CERCLA sampling. The RCRA units and the number of monitoring wells include the following:

- Integrated Disposal Facility (IDF) (seven wells)
- RCRA Plutonium-Uranium Extraction (PUREX) Cribs (eleven wells)
- Waste Management Area (WMA) A-AX (single-shell tanks [SSTs]) (nine wells)
- 216-A-29 Ditch (nine wells)
- 216-B-3 Pond facility (four wells)
- Nonradioactive Dangerous Waste Landfill (NRDWL) (nine wells).

Facilities monitored under other WAC requirements include the Solid Waste Landfill (SWL) (nine wells) and the 200 Area Treated Effluent Disposal Facility (TEDF) (three wells). Water supply wells monitored under AEA include the three wells in the 400 Area and two new wells northwest of the 618-10 Burial Ground.

A detailed discussion of geology and hydrogeology within the 200-PO-1 OU is provided in the *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit* (DOE/RL-2009-85, Draft A), including geologic cross sections. The following four paragraphs summarize key characteristics of the aquifers and flow characteristics.

The suprabasalt aquifer system comprises the uppermost aquifer system in the 200-PO-1 OU. The aquifer system is primarily unconfined but due to its large extent and overall thickness (up to 215 meters), it includes localized semiconfined and confined intervals within the deeper portion of the suprabasalt sedimentary sequence. The suprabasalt aquifer system is primarily contained within the Ringold Formation, which is composed of silty, sandy gravel interspersed with thick, fine-grained (i.e., silty clayey) intervals such as the Ringold Formation lower mud unit. However, in some regions of the 200-PO-1 OU, the very uppermost portion of the unconfined aquifer is actually within the lower portion of the Hanford formation, which unconformably overlies the Ringold Formation. The younger, more permeable Hanford formation can create preferential groundwater flow (e.g., the southeast-trending paleo-channel cutting across the northern and eastern portions of the 200 East Area) because of the relatively higher hydraulic conductivity of the Hanford formation compared to the underlying Ringold Formation.

The Ringold Formation lower mud unit represents the base of the unconfined aquifer throughout the majority of the 200-PO-1 OU.

The Ringold lower mud unit represents the base of the unconfined suprabasalt aquifer throughout the majority of the 200-PO-1 OU, except where the Ringold lower mud unit is absent in the northern and central portions of the 200 East Area, where the uppermost basalt is the base of the aquifer.

The depth to the uppermost unconfined aquifer in the near-field area (area closest to the major waste sites in the 200-PO-1 OU in the southeastern portion of the 200 East Area) is more than 91 meters near the southern boundary of the 200 East Area, and it varies in depth to near zero meters below ground surface (bgs) at the Columbia River. Springs and seeps occur along the riverbanks where the aquifer flows in places laterally out of the ground directly into the river and/or down the sloping river shoreline into the Columbia River.

In the western portion of the 200-PO-1 OU (i.e. in the southern portion of the 200 East Area, where the main contaminant sources are located), the groundwater flow direction ranges from southeast to northeast in the unconfined aquifer before diverting primarily to the southeast upon exiting the 200 East Area (Figure 10-3) (see Chapter 3.0 for further discussion on the water table and groundwater flow). The southeasterly flow out of the 200 East Area is influenced by the higher groundwater elevations to the west, the large more permeable paleochannel (trending southeast) incised in the top of the underlying Ringold Formation, and the Ringold Formation lower mud unit situated above the water table in the vicinity of the 216-B-3 Pond. In the central to eastern portion of the OU, groundwater flow fans outward, flowing northeast, east, and southeast as it approaches the Columbia River. Based on the propagation of peak tritium concentrations from the southeast corner of the 200 East Area to the Columbia River, the apparent travel time for mobile contaminants is ~33 years (DOE/RL-2009-85, Draft A, Section 3.6.10). This

estimated travel time is based on historical water table conditions, and current travel times are expected to be slightly longer due to reduced hydraulic gradient.

Hydraulic head in the 200-PO-1 OU generally increases with depth, forming an upward gradient. In the 200 East Area, the hydraulic gradient between the aquifer below the Ringold lower mud unit and the overlying unconfined aquifer ranges from a few centimeters to ~1 meter, with the head decreasing upward. Along the Columbia River near well 699-20-E12, the vertical head difference is ~10 meters, with the 600 Area between the two areas having intermediate head differences. The exception to the general upward gradient is near B Pond where the heads decrease with depth, which is likely a condition remaining from the time period that the B Pond system was in operation. The *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington* (PNNL-12261) provides a detailed discussion of 200 East Area hydrogeology and groundwater flow characteristics.

Principal sources of groundwater contamination included cribs, ponds, pipelines, and potentially leaking SSTs.

Other important concepts associated with the 200-PO-1 OU include the following:

- Principal sources of groundwater contamination included cribs, ponds, pipelines, and SSTs that formerly leaked. These facilities are currently inactive, and pumpable liquids have been removed from the tanks; however, the waste sites have not yet been remediated and contamination remains in the vadose zone.
- Tritium, nitrate, and iodine-129 are the principal groundwater COCs because of their widespread plumes. The area of the iodine-129 plume above 1 pCi/L appears relatively stable, while the tritium and nitrate plumes are shrinking due to dispersion and (for tritium) also radioactive decay.
- Small plumes of strontium-90, technetium-99, and uranium in the 200 East Area exceed their respective drinking water standards (DWSs). Concentrations in the local plumes of strontium-90 and technetium-99 are stable to decreasing, but the small uranium plume may be increasing in size.
- The direction of groundwater flow in the 200 East Area is difficult to interpret because of the low hydraulic gradient. An effort to determine the hydraulic gradient near the PUREX Cribs and the IDF by improving the accuracy of the water-level measurements began during fiscal year (FY) 2008 and continued through 2010. This effort has yielded results that are in reasonable agreement with the interpreted movement of contaminant plumes.
- Most of the monitoring wells are screened at the top of the unconfined aquifer where the highest levels of groundwater contamination are detected. Twenty wells are screened (or have perforated casings) in deeper portions of the unconfined or confined aquifers. The deeper wells that were monitored during 2010 (or in 2009 for the basalt-confined aquifer wells) continued to show that groundwater contamination is either not detected at depth or that concentrations are much lower than near the water table (in the areas where the deeper wells are located).

10.1 Groundwater Contaminants

Major COCs in the 200-PO-1 OU include tritium, iodine-129, nitrate, strontium-90, technetium-99, and uranium.

This section describes the major COCs within the 200-PO-1 OU, which include tritium, iodine-129, nitrate, strontium-90, technetium-99, and uranium; other COPCs are also discussed. Most wells are screened (or casings perforated) in the upper portions of the unconfined aquifer at the water table. However, of the 124 wells that were scheduled for sampling during 2010, 16 wells are screened deeper in the unconfined aquifer (not at the water table), one well is screened below the Ringold

Plume areas (square kilometers) in the 200-PO-1 Operable Unit:

Iodine-129, 1 pCi/L — 54.74

Nitrate, 45 mg/L — 1.57

Strontium-90, 8 pCi/L — 0.013

Technetium-99, 900 pCi/L — 0.0035

Tritium, 20,000 pCi/L — 119.67

Tritium, 80,000 pCi/L — 1

Uranium, 30 µg/L — 0.09

lower mud unit, and 7 wells are screened in the basalt-confined aquifer below the Ringold Formation. When data from the deeper wells are discussed, the data will be identified or specifically mentioned as to their source from the deeper wells.

During 2010, many wells in the eastern portion of the 200-PO-1 OU were sampled for a relatively comprehensive list of analytes for the Decision Unit Risk Assessment Project. As a result, many of the wells in this area have additional results not normally scheduled for the 200-PO-1 OU. Some of the constituents were analyzed with lower than normal detection limits for wells in this area (e.g., tritium and technetium-99). The additional data provided more definition of the detectable boundaries in the distant areas of the 200 East Area plumes but did not affect concentrations or plume map contours near the DWSs.

The cribs, ponds, and ditches surrounding the PUREX Plant are responsible for most of the groundwater contamination in the 200-PO-1 OU. The PUREX Plant began operation in 1956, eventually replacing the Reduction-Oxidation (REDOX) Plant as the plutonium-separation facility. The first PUREX operational campaign was from 1956 to 1972. Following an 11-year shutdown, the PUREX Plant operation restarted in 1983, operating for 5 years until December 1988, when the mission for weapons production ended. Plant operation briefly restarted again in December 1989 to stabilize material in the system. The plumes that are present primarily contain those species associated with process condensates, including tritium, iodine-129, and nitrate. Some strontium-90 and technetium-99 are also associated with PUREX waste disposal, although technetium-99 is not found above the 900 pCi/L DWS in contaminant plumes from PUREX Cribs. Within the boundaries of the 200-PO-1 OU, technetium-99 exceeds the DWS only near WMA A-AX.

10.1.1 Tritium

The principal source for the large tritium plume is the PUREX Cribs.

The principal source for the large tritium plume extending from the southeastern portion of the 200 East Area to the Columbia River (Figures 10-4 and 10-5) is the PUREX Cribs. The highest concentrations of tritium in this plume remain near these cribs (Figure 10-5). The highest reported level of tritium during 2010 was 590,000 pCi/L for a sample collected April 2010 at well 299-E17-14 (near the 216-A-36B Crib).

Wells in the near-field area generally have higher tritium concentrations than wells in the far-field area because of their proximity to the tritium sources. However, like wells in the far-field areas, wells in the near-field area generally show decreasing to stable trends. Figure 10-6 shows tritium concentration trends in three wells at the PUREX Cribs (one well for each of the three PUREX Cribs). The wells shown had the highest tritium concentration for their respective cribs during 2010.

Concentrations of tritium generally continue to decline in the far-field area as the plume attenuates naturally due to radioactive decay, advection, and dispersion. The plume eventually discharges with normal groundwater flow to the river. Wells in the northeastern portion of the 200-PO-1 OU (699-35-9, 699-29-4, and 699-26-15A) previously had tritium concentrations greater than 80,000 pCi/L (Figure 5-4 in DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*). In 1997, the 80,000 pCi/L plume configuration was ~60 square kilometers in this area. In 2008, the 80,000 pCi/L plume configuration had decreased to ~18 square kilometers. Likewise, the tritium results for these wells has decreased from over 120,000 pCi/L in the mid-1990s to 69,000, 61,000,

and 58,000 pCi/L, respectively in 2010, eliminating concentrations greater than 80,000 pCi/L in this area (Figure 10-4).

The zone of lower tritium concentrations near the Energy Northwest complex (Figure 10-4) is likely an effect of a zone of lower hydraulic conductivity in the unconfined aquifer. In this area, the water table is within the upper portion of the Ringold Formation that may have a greater degree of local cementation. The small but concentrated tritium plume near the Energy Northwest complex is due to tritium from the 618-11 Burial Ground in the 300-FF-5 OU. Chapter 13.0 discusses tritium at the 618-11 Burial Ground, which is west of the Energy Northwest complex.

Wells screened (or casings perforated) in the middle or lower portions of the unconfined aquifer had tritium results ranging from nondetect to 62,000 pCi/L. The maximum concentration was at well 699-37-E4 (near the Columbia River, southeast of the Hanford town site). Other deep wells in the unconfined aquifer where tritium was above the 20,000 pCi/L DWS included well 699-31-11 (in the middle of the tritium plume) and wells 699-41-40 and 699-41-42 near B Pond. The tritium levels in those wells were 58,000, 36,000, and 22,000 pCi/L, respectively. In well 699-31-11, the well screen is 41 meters below the water table, but it was retrofitted from an older, carbon-steel well with potentially leaking seals or packers (well location in Figure 10-2). Wells 699-41-40 and 699-41-42 are in an area where the head decreases with depth, allowing downward flow.

Tritium was not detected in the three wells located near the TEDF, east of the 200 East Area. These wells are screened in the coarse basal Ringold unit 9 and below the Ringold lower mud unit, which locally confines the groundwater. Tritium was also not detected in four of the seven wells monitoring the basalt-confined aquifer. Three deep basalt-confined aquifer wells where tritium was detected were 699-42-40C, 699-S2-34B, and 699-S11-E12AP (Figure 10-2). The level was 3,500 pCi/L in well 699-42-40C near B Pond (where the head decreases with depth). At well 699-S2-34B near the Laser Interferometer Gravitational-Wave Observatory (LIGO) the concentration was 41.1 pCi/L. Well 699-S11-E12AP located near the Columbia River north of the 300 Area had a concentration of 33.8 pCi/L. Results from both the Ringold Formation and basalt-confined aquifers are discussed further in Chapter 15.0.

10.1.2 Iodine-129

The iodine-129 plume has changed very little over the past 15 years.

The iodine-129 plume (Figure 10-7) extends southeast into the 600 Area from the 200 East Area and appears to coincide with the northern portions of the tritium plume. The plume (above the 1 pCi/L isopleth line) has changed very little over the past 15 years, although the maximum concentrations have declined significantly (PNL-10698, *Hanford Site Ground-Water Monitoring for 1994*) and appear relatively stable.

The highest concentrations of iodine-129 in the 200-PO-1 OU are near the sources in the 200 East Area and B Pond area. The concentrations in this near-field area ranged from nondetect to 9.7 pCi/L at well 299-E17-19 (near the 216-A-10 Crib). The general trend was relatively stable for iodine-129 at this well (Figure 10-8), which is typical of the trend for iodine-129 at other wells near the PUREX Cribs.

It is likely that the sources of iodine-129 in the 200 East Area continue to contribute iodine-129 to the plume because of the persistence of the plume across the northern portions of the 200-PO-1 OU. With a low retardation factor, iodine-129 would be expected to disperse more quickly through natural processes if the plume were not continually replenished. Iodine-129 has a half-life of 15.7 million years and a low

distribution coefficient (ranging from 0 to 2 mL/g, depending on aquifer conditions, and averaging 0.2 mL/g) (PNNL-11800, *Composite Analysis of Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*; PNNL-14702, *Vadose Zone Hydrogeology Data Package for the 2004 Composite Analysis*).

Iodine-129 was detected in wells screened (or perforated) deeper in the unconfined aquifer, including wells near B Pond, the 216-A-37-1 Crib (299-E25-29Q), 216-A-29 Ditch (299-E25-28), near the Columbia River (699-37-E4), and in the central 600 Area in the possibly leaking well (699-31-11). The highest concentrations for the deeper unconfined aquifer wells were near B Pond where iodine-129 concentrations reached 3.4 pCi/L in well 699-41-42 (Figure 10-1). As noted for tritium, the hydraulic heads decrease downward in this area, allowing downward groundwater flow and downward movement of contaminants. The detection in well 699-37-E4 near the Columbia River was at a concentration of 0.168 pCi/L. Of the seven deep basalt-confined aquifer wells, iodine-129 was detected only in well 699-42-40C near the B Pond at 0.289 pCi/L.

The nitrate plume, with sources in the 200 East Area, appears to have dispersed over previous years, except near the PUREX Cribs.

10.1.3 Nitrate

The extent of the plume with nitrate concentrations elevated above background is similar to the tritium plume; however, the portion of this plume exceeding the 45 mg/L DWS is relatively small by comparison (Figure 10-9). During 2010, the highest nitrate concentration in the 200-PO-1 OU was at wells near the PUREX Cribs (Figure 10-10). Well 299-E17-19 (at the 216-A-10 Crib) had an average of 160 mg/L for samples collected during 2010. The average for well 299-E17-14 (216-A-36B Crib) was 110 mg/L. The nitrate plume, with sources in the 200 East Area, appears to be dispersing slightly over time when compared with previous years, except near the PUREX Cribs (PNNL-15670, *Hanford Site Groundwater Monitoring for Fiscal Year 2005*; DOE/RL-2008-01, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*) and WMA A-AX. Another nitrate plume with offsite sources exists near the 300 Area.

Many of the wells near the PUREX Cribs in the southeastern portion of the 200 East Area have increasing nitrate concentrations. The trend at well 299-E17-19 (near the 216-A-10 Crib) is typical of wells with increasing trends (Figure 10-11). Increasing nitrate concentrations were also observed at WMA A-AX (Section 10.3.3.2). The cause of the increase in nitrate concentrations at many of the wells in the southeastern portion of the 200 East Area is unknown but may be the result of shifting groundwater flow directions related to cessation of wastewater discharges at B Pond or the discharge of wastewater at the TEDF. These same discharges may have diluted the nitrate concentrations while B Pond was active. Increasing concentrations near the PUREX Cribs and WMA A-AX may also be due to continued seepage from the vadose zone.

For the wells screened (or casings perforated) in the middle to lower portions of the unconfined aquifer, nitrate did not exceed the 45 mg/L DWS. The highest nitrate concentration reported in the deeper wells was at well 699-2-7 near the 400 Area Process Ponds, which is a local source of nitrate; the nitrate concentration was 36.3 mg/L. In the main water supply well in the 400 Area (well 499-S1-8J), nitrate concentrations averaged 0.44 mg/L during 2010. In the Ringold Formation confined aquifer beneath the TEDF, nitrate concentrations averaged 6.64 mg/L at well 699-42-37, 0.79 mg/L at well 699-41-35, and 0.17 mg/L at well 699-40-36. Nitrate concentrations were very low in all of the basalt-confined aquifer wells, with the exception of 6.15 mg/L in well 699-42-40C near B Pond.

10.1.4 Strontium-90

Well 299-E17-14 (at the 216-A-36B Crib) was the only well with strontium-90 detected during 2010 in the 200-PO-1 OU. In previous years, several other wells near the PUREX Cribs had detections of strontium-90. At well 299-E17-14, the trend appeared to be decreasing in 2008 and 2009 when the levels dipped lower than the previously stable concentration of 18 to 20 pCi/L, with concentrations of 14 and 11 pCi/L, respectively (the DWS for strontium-90 is 8 pCi/L). The 2010 result was 16 pCi/L. Strontium-90 was not detected in any of the deeper unconfined aquifer wells or basalt-confined aquifer wells.

10.1.5 Technetium-99

Technetium-99 continues to be detected at WMA A-AX at levels above the 900 pCi/L DWS.

Technetium-99 (also a beta-emitter) continues to exceed the DWS (900 pCi/L) at only one location within the 200-PO-1 OU, WMA A-AX. Technetium-99 is most concentrated at well 299-E25-93, located along the southern boundary of WMA A-AX, with results for 2010 ranging from 3,400 to 5,300 pCi/L. Technetium-99 is also above the DWS in WMA A-AX upgradient well 299-E24-33, with results ranging from 1,200 to 1,300 pCi/L in 2010. The trend at both wells has been relatively level since 2009 (Figure 10-12) (technetium-99 at WMA A-AX is also discussed in Section 10.3.3). Technetium-99 was detected in wells at the PUREX Cribs up to a concentration of 140 pCi/L. The technetium-99 activity from these areas extends throughout the northern and central portions of the area occupied by the large tritium plume, with concentrations up to 120 pCi/L. The only deep well with technetium-99 detected was well 699-31-11 in the central 600 Area (Figure 10-2). As previously stated, this well may be leaking and in hydraulic communication with groundwater in the upper portions of the unconfined aquifer. Although, there is no direct evidence, the suggestion of leakage was deduced from sampling results of other contaminants in this well and other nearby deep and shallow wells. The monitoring results at well 699-31-11 are similar for tritium, iodine-129, nitrate, and technetium-99, as is also the case with shallow wells in the area. The nearby deep well 699-25-33A (at a similar horizon in the aquifer) has much lower values for these constituents. Well 699-31-11 is a noncompliant well (WAC 173-160) with a vulnerable neoprene packer at 49 meters. Based on the construction details and history of this older, noncompliant well, it is not unexpected that the well may be leaking. The range for technetium-99 in well 699-31-11 was 86 to 97 pCi/L.

10.1.6 Uranium

In recent years, uranium concentrations have been increasing in wells near the PUREX Cribs.

Elevated uranium concentrations were found at three locations within the 200-PO-1 OU, the PUREX Cribs, the 618-10 Burial Grounds, and the 618-11 Burial Grounds. In recent years, uranium concentrations have been increasing in wells near the PUREX Cribs (Figure 10-13). Uranium concentrations at well 299-E17-14 have been relatively stable since 2006, with concentrations near the 30 µg/L DWS (Figure 10-14). In two nearby wells, concentrations have been higher in recent years, with the highest concentration at well 299-E24-23 (106 µg/L in 2009) (Figure 10-14); however, well 299-E24-23 was not sampled during 2010, so it is not known if the upward trend continued. The other well with a higher uranium concentration was 299-E25-36, with a concentration of 75.4 µg/L in 2010.

At the 618-10 and 618-11 Burial Grounds (within small "islands" of 300-FF-5 OU, in the 200-PO-1 OU), uranium concentrations reached the 14.4 µg/L background concentration at the 95th percentile (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*), but these areas are sites of known uranium

contamination in the 300-FF-5 OU. Elsewhere, including the deeper wells, uranium concentrations are lower than the background range (at the 95th percentile).

10.1.7 Other Constituents

Other constituents (i.e., arsenic, chromium, manganese, and vanadium) are COPCs at various source sites within the 200-PO-1 OU (DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*). Chromium, cobalt-60, cyanide, and uranium are COPCs at the BC Cribs and Trenches. Arsenic was detected in nearly every well sampled in the 200-PO-1 OU, but mostly at concentrations below the background concentration at the 95th percentile of 11.8 µg/L. Results exceeded background at five wells in the Energy Northwest area, with the highest concentrations in well 699-13-1A (13.8 to 14.9 µg/L). The volatile organic compounds (VOCs) were constituents of concern at the NRDWL and SWL in the central 600 Area.

Manganese exceeded the 50 µg/L secondary DWS in the 200-PO-1 OU during 2010 in only one well (699-32-22B).

In 2010, manganese exceeded the 50 µg/L secondary DWS in the 200-PO-1 OU in only one well (699-32-22B), with 71 µg/L for an unfiltered sample and 8 µg/L for a filtered sample collected at the same time. Well 699-32-22B is a deep basalt-confined aquifer well that is screened across a basalt interbed at a depth of 236 to 255 meters bgs. It is located along the southeast transect (see Section 10.2.2) (Figure 10-2). The result for the unfiltered sample is anomalous for this well and is an isolated occurrence; it is likely that this result is a sampling or laboratory error or may be due to deterioration of the well screen or casing.

Vanadium concentrations ranged from the method detection limit of 12 to 42.6 µg/L in well 299-E25-22, located near the 216-A-37-2 Crib. This result is typical for well 299-E25-22, and vanadium was detected in many wells throughout the 200-PO-1 OU. The 95th percentile background level for vanadium is 19 µg/L. A DWS has not been established for vanadium.

Groundwater monitoring is routinely conducted at three wells at the BC Cribs and Trenches (299-E13-5, 299-E13-11, and 299-E13-19). Well 299-E13-11 was not sampled as scheduled during 2010 because of difficulties in accessing the well. The recent results from the other two wells show that COPCs (i.e., chromium, cobalt-60, cyanide, and uranium), as well as the 200-PO-1 OU major COCs, were either not detected or were similar to background (upgradient) concentrations in the BC Cribs and Trenches.

Although not a COC in the 200-PO-1 OU, a fluoride concentration of 9.2 mg/L observed in well 699-S2-34B (the well at the LIGO) during 2010 was above the 4 mg/L primary DWS. This well is used for water supply. The results are typical of the historical trend for this well. The well is screened in the Frenchman Springs Member of the Wanapum Basalts, and this member generally has relatively low levels of fluoride. At the LIGO site, the Wanapum Basalts may have upwelling groundwater from the underlying Grande Ronde Basalt, which is known to have fluoride concentrations in the range of 8 to 10 mg/L (PNNL-13962, *Natural Gas Storage in Basalt Aquifers of the Columbia Basin, Pacific Northwest USA: A Guide to Site Characterization*).

The VOCs were constituents of concern at the NRDWL and SWL in the central 600 Area; however, the VOCs were not detected there in 2010 and were occasionally detected in PUREX Cribs wells. During 2010, the only detection of a VOC was tetrachloroethene in well 299-E24-16 at 2.8 µg/L; however, the result was flagged by the analytical laboratory as estimated only.

10.2 CERCLA Groundwater Activities

Groundwater monitoring at the 200-PO-1 OU supports the RI/FS process under the direction of a work plan and two sampling and analysis plans.

The 200-PO-1 OU makes up a large portion of the Hanford Site (Figure 10-2). The OU boundaries are generally defined by the 2,000 pCi/L tritium (200 East Area origin) plume contour, which is the largest contaminant plume in the OU. Wells at the BC Cribs and Trenches are also within the 200-PO-1 groundwater interest area, even though they are located outside the OU boundaries.

Groundwater monitoring at the 200-PO-1 OU supports the RI/FS process under the direction of a work plan and two sampling and analysis plans (one for routine groundwater sampling, and a second for short-term characterization to supplement routine groundwater monitoring). Work began on a draft RI report in 2009 following completion of RI activities. Draft A of the report was submitted for regulatory review in May 2010. The work plan, sampling and analysis plans, and RI report documents are briefly described below.

Under the direction of the "routine" sampling and analysis plan, 124 wells were scheduled to be sampled in 2010, and 116 of those wells were successfully sampled.

DOE/RL-2003-04, Rev. 1, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.* This sampling and analysis plan (referred to as the "routine" sampling and analysis plan) provides the basis for routine sampling and analysis of 200-PO-1 COCs for CERCLA and AEA. Revision 1 of the routine sampling and analysis plan was approved in 2005 to provide groundwater data necessary to track the extent and concentration of known contaminant plumes. In 2008, the monitoring well list and groundwater analyte list were updated with additional wells and analytes. The monitoring well locations associated with the routine sampling and analysis plan are shown in Figure 10-1 (near-field wells) and Figure 10-2 (far-field wells). Appendix A, Tables A-14 and A-15 provide the well list and analyte list for the 200-PO-1 OU, respectively. The routine sampling results for 2010 are discussed in Sections 10.1 and 10.2.2. Of the 124 wells scheduled for sampling in the OU during 2010, 116 were successfully sampled. Eight well trips were unsuccessful due to a variety of reasons, including maintenance issues, wellhead damage, access problems, or insufficient water. Two wells were scheduled during the work stoppage in October 2010 and were not sampled prior to February 2011.

Work was completed for the "characterization" sampling and analysis plan in 2009, and the results were reported in the RI report in 2010.

DOE/RL-2007-31, Rev. 0, *Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit.* This work plan was issued in 2008 to further define the conditions within the 200-PO-1 OU. Data acquisition was designed to complement the routine sampling and analysis plan and to provide additional information regarding groundwater flow direction and rate, preferential pathways for contaminant migration, and contaminant mass transport. Appendix A of the work plan includes a RI sampling and analysis plan (referred to as the "characterization" sampling and analysis plan) that directed (1) sampling of additional wells to supplement the routine sampling and analysis plan, (2) opportunistic sampling of vadose zone boreholes when they reached groundwater, (3) sampling wells planned for decommissioning, and (4) sampling of eleven aquifer tubes. Work was completed for the characterization sampling and analysis plan in 2009, and the results were reported in the RI report (see below) and in the 2009 Hanford Site groundwater annual report (DOE/RL-2010-11).

DOE/RL-2009-85, Draft A, *200-PO-1 Operable Unit Remedial Investigation Report.* In 2009, work began on the RI report to document the completion of the RI studies in accordance with the work plan (DOE/RL-2007-31) for the 200-PO-1 OU, including the results of the two sampling and analysis plans (routine and characterization sampling). The report was completed in 2010 and was submitted

for review by the regulatory agencies prior to issuance. Results of the draft RI report are summarized in the following section.

10.2.1 Remedial Investigation Report

The purpose for conducting the RI was to collect additional data to refine the nature and extent, to assess fate and transport, and to evaluate potential risks to human health and the environment from 200-PO-1 Groundwater OU contaminants.

The RI was conducted in late 2008 and early 2009 and reported in DOE/RL-2008-85, Draft A, which was released for regulatory review in May 2010. Data that missed the deadline for inclusion in Draft A of DOE/RL-2008-85 were discussed in the 2009 annual Hanford Site groundwater report (DOE/RL-2011-11). The following is a summary of the results taken largely from the executive summary of DOE/RL-2008-85.

The purpose for conducting the RI was to collect additional data to refine the nature and extent, to assess fate and transport, and to evaluate potential risks to human health and the environment from 200-PO-1 OU contaminants. The information collected during the RI will also support development of the FS for the 200-PO-1 OU. The results and conclusions of the RI were largely based on data collected over a 5-year period, from 2004 through 2009.

Concentrations of tritium and iodine-129 within the primary plume have declined in the far-field area. These declining concentrations are due to natural attenuation as a result of radioactive decay and dispersion, cessation of liquid disposal operations, and a decreasing source of contaminants that resulted from the termination of PUREX Plant and B Plant operations.

In the near-field area (the 200 East Area), the extent of the strontium-90 and uranium plumes was found to be very small as a result of relatively low to moderate mobility of the contaminants in the aquifer. Prior to 2003, groundwater sampling in the area of the PUREX Cribs and WMA A-AX returned technetium-99 results up to a maximum concentration of 600 pCi/L. Since 2004, increasing technetium-99 concentrations have been detected, with concentration in one well (well 299-E25-93, installed in 2003) exceeding the 900 pCi/L DWS since the well was installed. In this area, a local source of technetium-99 and an upgradient source for technetium-99 are entering WMA A-AX from the northwest.

Computer simulation of the fate and transport of groundwater contamination was used to estimate future impact of current groundwater contamination in both the near-field and far-field regions.

In the far-field area (outside the 200 East Area), tetrachloroethene, trichloroethene, and carbon tetrachloride have been detected near the SWL and NRDWL in previous years and are being addressed through RCRA corrective action and final closure. Groundwater monitoring in the SWL and NRDWL wells since the early 1990s had shown decreasing trends in tetrachloroethene and trichloroethene concentrations.

Computer simulation of the fate and transport of 200-PO-1 groundwater contamination was used to estimate future impact of current groundwater contamination in both the near-field and far-field regions (ECF-200PO1-09-2007, *200-PO-1 Operable Unit Remedial Investigation Report – Far Field Contaminant Fate and Transport*; ECF-200PO1-10-0259, *Central Plateau MODFLOW Model Development*; ECF-200PO1-09-2352, *200-PO-1 OU Remedial Investigation Report – Near Field Groundwater Contaminant Fate and Transport Modeling)*. The simulation did not consider the effects of continuing vadose zone contribution to be addressed by overlying source OUs. The fate and transport simulation for the near-field (200 East Area) contaminants included the following results:

- The iodine-129 plume, beginning with an initial maximum concentration of less than 10 pCi/L, persists over the simulated timeframe (i.e., 1,000 years) due to moderate retardation and a long half-life. At the end of the simulation, the

maximum calculated iodine-129 concentration from all locations is less than 0.3 pCi/L.

- The technetium-99 plume increases initially, from ~53 pCi/L at 5 years to ~218 pCi/L at 10 years, and then gradually decreases to ~15 pCi/L at the end of the simulation.
- The tritium plume decreases from a maximum concentration of ~513,000 pCi/L to ~5,700 pCi/L after 50 years.
- The nitrate plume concentration declines gradually from a maximum of ~100 mg/L to ~3.5 mg/L within 300 years.
- The trichloroethene plume concentration declines from a maximum of ~0.5 µg/L to less than 0.04 µg/L within 100 years.
- The strontium-90 plume concentration declines from a maximum of 80 pCi/L to less than 0.02 pCi/L within 100 years.
- The uranium plume concentration declines from a maximum of 34 µg/L to less than 3 µg/L within 500 years.

The results of the transport model demonstrated that peak concentrations of contaminants that currently exist in the far-field region (e.g., tritium, iodine-129, and nitrate) generally decline over time and distance. Peak concentrations for COPCs that have not arrived in the far-field region (e.g., uranium, technetium-99, strontium-90, tetrachloroethene, trichloroethene, and carbon tetrachloride) are predicted to remain lower than those at the upstream boundary, suggesting decreasing risk.

The conceptual exposure model identified potentially complete human and ecological exposure pathways in the near-field, far-field, and river exposure areas.

A conceptual exposure model was also developed for the 200-PO-1 OU. This model identifies potentially complete human and ecological exposure pathways in the near-field, far-field, and river exposure areas. Potential human receptors, including Native American subsistence users, are assumed to be hypothetical future domestic groundwater users. Ecological receptors are limited to aquatic organisms in the Columbia River that may be exposed to contaminants in groundwater that discharges into the river. The following potential exposure routes were identified:

- Ingestion of contaminated water by drinking or from food preparation
- Inhalation of contaminant vapors during showering or other household activities
- Dermal contact exposure to contaminants in groundwater
- External radiation exposure from radioactive contaminants in groundwater
- Potential exposure for the near-field and river exposure areas (consumption of fish from the affected portion of the Columbia River).

Based on results of the modeling and baseline risk assessment, it was concluded that it is appropriate to proceed with the FS.

The draft RI report (DOE/RL-2008-85) described the baseline risk assessment that was conducted to evaluate current and potential future risks to hypothetical human and ecological receptors. Table 10-1 provides the results of the baseline risk assessments for each of the near-field, far-field, and river exposure areas. The table also identifies the standards that are exceeded under current and estimated future groundwater conditions, as well as provides a summary of the quantified risk results that would be encountered if remedial action were not taken. Based on the information provided in the modeling and the results of the baseline risk assessment, it was concluded that it is appropriate to proceed with the FS for the 200-PO-1 Groundwater OU.

10.2.2 CERCLA Groundwater Monitoring

This section discusses the groundwater monitoring results for 2010 for the "routine" sampling and analysis plan (DOE/RL-2003-04) that were not previously

discussed in Section 10.1. Characterization activities for the "characterization" sampling and analysis plan were completed prior to 2010, and the results were reported in earlier documents. Most of the results for the primary groundwater plumes and COCs for the 200-PO-1 OU are discussed in Section 10.1, but specific details of the guard wells are discussed here (guard wells discussed in the following paragraph). Lists of wells and groundwater constituents analyzed for 200-PO-1 OU wells are provided in Appendix A, Tables A-14 and A-15.

Wells along the southeast transect are screened for a comprehensive list of analytes.

The 200-PO-1 OU routine sampling and analysis plan (DOE/RL-2003-04) specifies annual sampling of two lines of guard wells to screen for a comprehensive list of analytes (i.e., additional groundwater constituents than usually analyzed on samples collected from far-field wells). One of the lines of guard wells (the southeast transect) is located southeast of the 200 East Area (Figure 10-2) and ensures that unexpected contaminants do not migrate undetected from the 200 East Area. The other line (the river transect) is a line of wells located along the Columbia River to assess the concentration of any groundwater contaminants that may reach the river. The comprehensive list of analytes for samples collected from wells of both transects includes tritium, iodine-129, anions (including nitrate), gross alpha and beta, gamma scan, metals, strontium-90, and VOCs.

The only constituents exceeding DWSs in southeast transect wells were tritium and iodine-129.

Most of the anions and metals (e.g., fluoride and arsenic) detected in southeast transect wells during 2010 are naturally occurring or are typical of Hanford Site background values at the 95th percentile (DOE/RL-96-61). The only constituents exceeding their DWS were tritium and iodine-129, but their concentrations were consistent with their respective plumes. Technetium-99 was detected at levels above Hanford Site background at the 95th percentile (0.99 pCi/L) but was similar to other wells in the area. The highest result for technetium-99 during 2010 for southeast transect wells was 43 pCi/L at well 699-32-22A. Gross alpha and gross beta were as high as 5.3 and 48 pCi/L, respectively, in southeast transect wells, and both are typical for wells in this area. Chromium, cobalt, copper, nickel, and vanadium were all detected at levels above Hanford Site background levels, but their results were low enough to be flagged by the analytical laboratory as "estimated" only. Nitrate and sulfate exceeded Hanford Site background and are elevated due to 200 East Area liquid waste discharges. The highest reported levels were 41.7 and 58.5 mg/L, respectively. The VOCs bromomethane, chloromethane, and trichloroethene were detected at very low levels in well 699-46-21B, but like the metals, these results were flagged by the analytical laboratory as "estimated" only.

The only groundwater contaminant exceeding its DWS in the river transect wells was tritium.

Groundwater monitoring results for 2010 at the river transect were similar to those for the southeast transect although generally lower in concentrations due to greater distance from contamination sources. Most of the anions and metals (e.g., fluoride and arsenic) detected in river transect wells during 2010 are naturally occurring or are typical of Hanford Site background values (DOE/RL-96-61). The only constituent exceeding DWS was tritium (DWS of 20,000 pCi/L) with a high of 52,000 pCi/L at well 699-41-1A. This tritium result is typical for this area of the large tritium plume emanating from the 200 East Area, and the trend for this well is decreasing. Aluminum, bismuth, molybdenum, and sodium were detected at levels above Hanford Site background concentrations, but all sodium results were flagged as estimated by the analytical laboratory. Sodium was above Hanford Site background values and had a high of 42 mg/L in well 699-S3-E12. The trend in this well is slightly increasing to stable, and the reason for the elevated levels at this location is unknown. Other wells in the area have sodium concentrations ranging from 15 to 30 mg/L.

10.2.3 Geophysical Investigations

Geophysical investigations conducted during FY 2010 to support groundwater investigations consisted of ground-truthing previously collected airborne electromagnetic (AEM) surveys (SGW-47996, *Testing Ground Based Geophysical Techniques to Refine Electromagnetic Surveys North of the 300 Area, Hanford, Washington*) in the 200-PO-1 Groundwater OU and collecting seismic check shot information (SGW-47535, *Measurement of Compressional-Wave Seismic Velocities in 29 Wells at the Hanford Site*) to help refine interpretations of previously collected seismic reflection data in both the 200-BP-5 and 200-PO-1 OUs.

The airborne electromagnetic data were collected as part of the 200-PO-1 RI and were initially interpreted to define potential groundwater migration routes based on a presumed electrical-resistivity/sediment grain-size relationship where more electrically resistive zones correlate with coarser grained and more hydraulically conductive intervals. The FY 2010 surface-based geophysical investigations used electrical-resistivity and electromagnetic techniques to determine subsurface electrical properties along a ~5-kilometer-long profile north of the 300 Area where the airborne electromagnetic data showed potential groundwater migration pathways (Figure 10-15). Results from the ground-based geophysical surveys indicated that the airborne electromagnetic methods are capable of imaging clay and mud units within the Ringold Formation to at least 50 meters bgs, with consistent subsurface spatial distributions developed from both the airborne electromagnetic and ground-based data. The airborne electromagnetic methods, however, proved insensitive to more electrically resistive zones at the Hanford Site and their use restricted to delineating clay/mud-dominated intervals.

Seismic check shot surveys (SGW-47535) were collected in seventeen wells during FY 2010 to refine the interpretations of existing seismic reflection profiles, with specific emphasis on recent seismic profile data collected in the Gable Gap region (SGW-43746, *Landstreamer/Gimbaled Geophone Acquisition of High Resolution Seismic Reflection Data North of the 200 Areas – Hanford Site*). Check shot information provided a direct link between lithology and reflector character and also allowed for interpreting the top of basalt throughout the Gable Gap region. The definition of the top of basalt allowed for improved mapping of likely saturated regions above the basalt surface.

10.3 RCRA Groundwater Monitoring

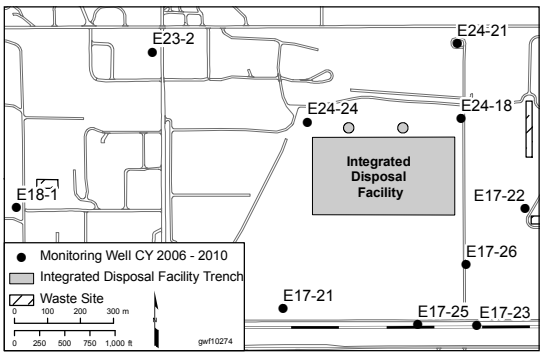
The 200-PO-1 OU contains six RCRA sites with groundwater monitoring requirements: IDF, PUREX Cribs, WMA A-AX, 216-A-29 Ditch, 216-B-3 Pond (B Pond), and NRDWL.

This section describes the results of monitoring at individual regulated units (i.e., treatment, storage, and disposal [TSD] units or tank farms [WMAs]). These facilities are monitored under RCRA requirements for dangerous waste constituents and under the AEA for source, special nuclear, and byproduct materials. Data from facility-specific monitoring are also integrated into the CERCLA groundwater investigations. Dangerous waste constituents and radionuclides are discussed jointly in this section to provide a comprehensive overview of groundwater contamination for each facility. Pursuant to RCRA, the source, special nuclear, and byproduct material components of radioactive mixed waste are not regulated under RCRA and are regulated by DOE, acting pursuant to its AEA authority. Therefore, while this report may satisfy RCRA reporting requirements, the inclusion of information on radionuclides in such a context is for information only and may not be used to create conditions or other restrictions set forth in any RCRA Permit.

The 200-PO-1 OU contains six RCRA sites with groundwater monitoring requirements: IDF, PUREX Cribs, WMA A-AX, 216-A-29 Ditch, 216-B-3 Pond (B Pond), and NRDWL. The 200-PO-1 OU also includes the SWL (regulated by the Washington State Department of Ecology [Ecology] under WAC 173-350, "Solid Waste Handling Standards"), the TEDF (monitored under WAC 173-216, "State Waste Discharge Permit Program"), and three 400 Area water supply wells (monitored under the AEA). The monitoring results for these three sites are discussed in Section 10.4. This section summarizes the results of statistical comparisons, assessment studies, and other developments for 2010. Groundwater data are available in the Hanford Environmental Information System (HEIS) database. Appendix B provides additional information, including well location and constituent lists, maps, groundwater flow rates, and statistical tables.

10.3.1 Integrated Disposal Facility (Immobilized Low-Activity Waste)

D.C. Weekes



Current groundwater monitoring at the IDF is directed at obtaining background values for monitored constituents.

Construction of the IDF began in September 2004 and was completed in April 2006. The DOE submitted a Part B RCRA Permit application to Ecology, which was incorporated into the Hanford Facility RCRA Permit (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste*) on April 9, 2006. The start date for IDF operations is estimated to be December 2016.

The objective of RCRA and operational monitoring at the IDF will be to determine whether the facility has impacted groundwater quality. The facility is not yet operational, and current monitoring is directed at obtaining baseline values for monitored constituents.

The IDF consists of an expandable, double-lined landfill with ~7 hectares of liner. The facility is located in the south-central portion of the 200 East Area (Figure 10-1). The landfill is divided lengthwise (north-south) into two distinct cells: (1) the east cell for the disposal of low-level radioactive waste, and (2) the west cell for the disposal of mixed waste. The facility is a RCRA-compliant landfill (i.e., a double, high-density, polyethylene-lined trench with leachate collection and leak detection system). The constructed liner is ~442 meters wide, 160 meters long, and up to 15 meters deep. The landfill will have four layers of waste containers, separated vertically by 0.9 meters of soil. The current waste disposal capacity is ~163,000 cubic meters.

The stratigraphy beneath the IDF consists of basalt bedrock overlain by the Ringold Formation, the Hanford formation, and Holocene deposits. The Elephant Mountain Member of the Columbia River Basalt Group forms the base of the suprabasalt aquifer and has no known or suspected erosional windows in the area of the facility. The Ringold Formation is 95 meters thick on the west side of the site and thins eastward. A northwest-southeast trending erosional channel or trough is scoured into the Ringold Formation in the northeast portion of the site. The Hanford formation is up to 116 meters thick beneath the site. Holocene eolian sand deposits cover the southern portion of the site.

The delineations of groundwater flow directions and water table gradients are difficult to calculate for the 200 East Area from water-level data because of a flat

water table. Work began in FY 2008 to better understand the groundwater flow direction beneath the IDF. Gyroscope surveys were completed on four of the monitoring wells and at well 299-E17-21 (wells 299-E17-26 and 299-E24-24 had gyroscope surveys completed in FY 2005). Vertical elevation surveys were performed in 2008 on all seven wells in the IDF water-level network, as well as some of the PUREX Cribs wells. Several sets of water-level measurements were made, and trend-surface analyses were applied to the measurements. The average groundwater flow direction was determined to be east at 80 (±17) degrees, with an average gradient of 2.0 x 10^{-5} m/m (±0.2 x 10^{-5} m/m) (see discussion in Chapter 3.0, Section 3.2.2).

Based on the geometry of existing contaminant plumes and on regional water-level measurements, the groundwater flow direction is estimated to be toward the east to southeast at rates between 0.002 and 0.0075 meters per day (see Appendix B, Table B-1). The unconfined aquifer occurs in the fluvial gravels of the Ringold Formation and flood deposits of the Hanford formation.

All seven wells of the IDF well network were sampled as scheduled in 2010.

All wells in the IDF groundwater monitoring network were initially sampled twice per quarter for one year (June 2005 through May 2006) to determine the baseline conditions. This was followed by semiannual sampling events in the remainder of 2006 and 2007 through 2010. Each semiannual sampling event included the collection of four time-independent samples from each well. All seven network wells were sampled as scheduled during 2010. Starting in 2011, sampling will be reduced to annually for each well in the network to maintain the baseline prior to operational status. This change was approved by a Permit modification.

10.3.1.1 Network Evaluation and Compliance Status

The current groundwater monitoring network consists of three upgradient wells (299-E18-1, 299-E24-21, and 299-E24-24) and four downgradient wells (299-E17-22, 299-E17-23, 299-E17-25, and 299-E17-26). Appendix B, Table B-17 lists the network wells, their locations, and the groundwater constituents monitored. Groundwater flow direction has been changing since the network was initially planned and the current network is no longer considered adequate. A revised monitoring network has been provided in a plan that is undergoing Ecology review. All monitoring wells are in compliance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

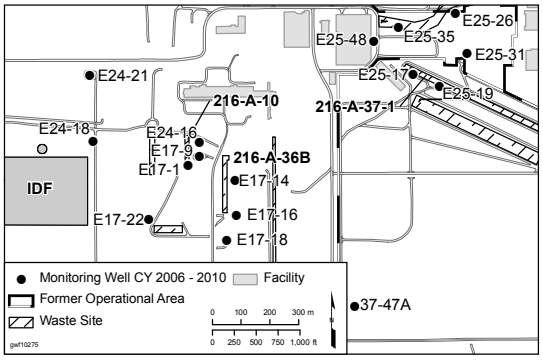
10.3.1.2 Groundwater Contaminants

Nitrate exceeded its DWS in IDF wells during 2010.

Nitrate exceeded the DWSs (45 mg/L) during 2010 in wells at the IDF, and the results are comparable to previous years. The maximum nitrate concentration was 68.6 mg/L in well 299-E24-24. This well is in the regional 200 East Area nitrate plume that is presumed to originate from the PUREX Cribs east of the IDF (Section 10.3.2), contamination occurred possibly during an earlier time when groundwater flow direction was flowing radially outward from B Pond.

10.3.2 216-A-10, 216-A-36B, and 216-A-37-1 (RCRA PUREX) Cribs

The RCRA PUREX Cribs are located in the southeastern portion of the 200 East Area and include the 216-A-10, 216-A-36B, and 216-A-37-1 Cribs (Figure 10-1), which are monitored under RCRA interim status to assess groundwater quality. Other nearby cribs also received PUREX waste (e.g., 216-A-45 Crib); however, these other cribs are not regulated as RCRA TSD units, but are instead monitored under CERCLA through the 200-PO-1 OU.



The objective of RCRA monitoring at the PUREX Cribs is to assess groundwater contaminated with dangerous waste constituents. Appendix B, Table B-28 lists the wells, their locations, and groundwater constituents monitored for the PUREX Cribs. Groundwater monitoring at the PUREX Cribs is conducted as described in the *Interim-Status RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 Cribs* (PNNL-11523). The eleven RCRA wells near the PUREX Cribs (see Appendix B, Figure B-4) monitor contaminant plumes in the near-field area, close to the cribs. More distant portions, or far-field area, of the contaminant plumes are monitored by the 200-PO-1 OU (see Appendix A). Section 10.1 discusses the concentration of major plumes in both the near-field and far-field areas.

The cribs, ponds, and ditches surrounding the PUREX Plant are responsible for most of the groundwater contamination in the 200-PO-1 OU.

The cribs, ponds, and ditches surrounding the PUREX Plant (including the RCRA PUREX Cribs) are responsible for most of the groundwater contamination in the 200-PO-1 OU. The groundwater contamination plumes from the PUREX Plant cribs primarily contain those species associated with PUREX process condensates, including tritium, iodine-129, and nitrate. Some strontium-90 and technetium-99 are also associated with PUREX waste disposal, although technetium-99 is not found above the 900 pCi/L DWS in contaminant plumes from the PUREX Cribs.

Groundwater flow direction near the 216-A-10 and 216-A-36B Cribs (the two cribs to the west) is likely toward the east (see Chapter 3.0, Section 3.2.2). After migrating beneath the two cribs, the flow veers toward the southeast as it leaves the 200 East Area. The gradient is 2.0×10^{-5} based on detailed analysis of the water table surface (Section 3.2.2). The groundwater flow rate is calculated to range between 0.001 and 0.6 meters per day. Near the 216-A-37-1 Crib, groundwater flow is estimated to be toward the southeast. Flow directions are influenced by (1) the northwest-southeast-trending paleo-channel with high permeability Hanford formation sediments cutting across the 200 East Area, (2) the Ringold lower mud unit at the water table east of the 200 East Area, and (3) the higher water table elevations to the west and north. These flow directions are supported mainly by the distribution of the tritium, nitrate, and iodine-129 plumes emanating from near these cribs and recent efforts to refine the water table map in the southeastern portion of the 200 East Area (Section 3.2.2). Appendix B, Table B-1, provides additional information on the flow direction and rate. The RCRA PUREX Cribs are located in a region where several groundwater contaminant plumes contain constituents exceeding DWSs. The similarities in effluent constituents disposed to these cribs, and other PUREX cribs such as the 216-A-45 Crib, make it difficult to determine the contribution of the individual cribs to these plumes.

The primary constituent of interest at the RCRA PUREX Cribs is nitrate.

The primary constituent of interest at the PUREX Cribs is nitrate because it is a breakdown product of nitric acid, which was disposed to the 216-A-10 Crib. Additional groundwater quality constituents required by WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards" (and by reference, 40 CFR 265.93[d][3] and [d][4]) include chloride, iron, manganese, phenols, sodium, and sulfate.

Sampling is required quarterly for RCRA sites in an interim status groundwater quality assessment program. Therefore, one well at each of the three PUREX Cribs is sampled on a quarterly schedule and the other wells are sampled semiannually (Appendix B provides details on well scheduling and specific analytes for PUREX Cribs groundwater samples). All scheduled groundwater samples were collected from wells at the PUREX Cribs during 2010.

10.3.2.1 Network Evaluation and Compliance Status

The PUREX Cribs well network is capable of meeting the groundwater monitoring objectives to assess the rate and extent of migration of groundwater contamination with dangerous waste constituents and determine their levels in the aquifer. The upgradient and downgradient wells of the near-field network are aligned appropriately, based on the recent determination of groundwater flow direction.

The PUREX Cribs remained in a RCRA interim status groundwater quality assessment program during 2010. However, the 216-A-10 Crib was officially closed March 30, 2010, and was removed from Part A of the Hanford Facility Dangerous Waste Permit. Two cribs, 216-A-36B and 216-A-37-1, will remain in RCRA interim status. Due to the relatively large distance between these two remaining cribs, different monitoring well networks were considered appropriate for these cribs, and two separate groundwater monitoring plans were written. The revised groundwater monitoring plans (DOE/RL-2010-92, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*; DOE/RL-2010-93, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*) are designed to bring the groundwater monitoring plans up to date with current protocols and incorporate the data quality objective process. An important update for the two remaining cribs (and the two new groundwater monitoring plans) includes returning the cribs to an indicator parameter evaluation program. The cribs were returned to indicator evaluation programs because groundwater constituents detected were not dangerous wastes or dangerous waste constituents. Groundwater monitoring under the two new plans began January 1, 2011.

The 216-A-10 Crib was officially closed March 30, 2010, and removed from Part A of the Hanford Facility Dangerous Waste Permit.

10.3.2.2 Groundwater Contaminants

The large nitrate plume emanating from the PUREX Cribs extends east and southeast to the Columbia River. Although concentrations remain elevated near the PUREX Cribs, the overall concentrations are decreasing because the plume is dissipating. The movement of nitrate in groundwater is nearly the same as the groundwater itself due to the very low distribution coefficient for nitrate (nearly 0 mL/g) (PNNL-11800; PNNL-14702). In the near-field, the nitrate DWS (45 mg/L) was exceeded at seven monitoring wells during 2010, including upgradient well 299-E24-18 (west of the 216-A-10 Crib). The highest concentrations were 172 and 138 mg/L in well 299-E17-19 (near the 216-A-10 Crib) and 125 and 124 mg/L in well 299-E17-14 (near the 216-A-36B Crib). Section 10.1.3 discusses the nitrate plume in the far-field area of the 200-PO-1 OU.

Nitrate concentrations are decreasing throughout most of the plume but remain elevated near the PUREX Cribs.

Nitrate trends vary depending on location. Near the 216-A-36B Crib (Figure 10-16), the nitrate concentration appears to be stable. At the 216-A-10 Crib, nitrate trends have been generally increasing (Figure 10-17). At the 216-A-37-1 Crib, nitrate has an increasing trend in most wells (Figure 10-18). Figure 10-10 shows the nitrate plume in the southeastern portion of the 200 East Area. Figure 10-9 shows the nitrate concentrations for the entire 200-PO-1 OU.

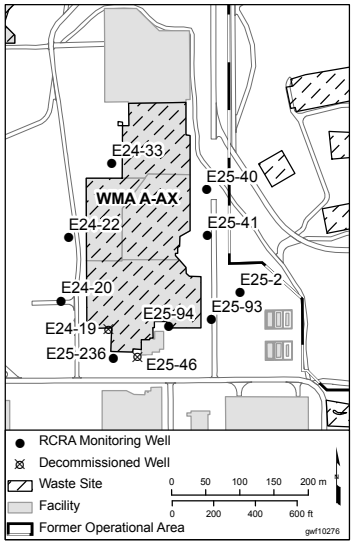
Groundwater quality constituents required by WAC 173-303-400 (i.e., chloride, iron, manganese, phenols, sodium, and sulfate) continue to be lower than their respective DWSs during 2010, except for the anomalously elevated iron and manganese values in wells with carbon-steel casings.

Groundwater quality constituents required by WAC 173-303-400 continue to be lower than their respective DWSs during 2010, except for iron and manganese anomalies in wells with carbon-steel casings.

10.3.3 Waste Management Area A-AX

The WMA A-AX is located on the east-central border of the 200 East Area (Figure 10-1) and consists of the A and AX Tank Farms, the 244-AR vault, and

Since 2006, WMA A-AX has been monitored under a RCRA interim status groundwater quality assessment program.



ancillary equipment (seven diversion boxes and waste transfer lines). The tank farms contain ten 3.79-million-liter tanks constructed from 1954 to 1964, and some of the tanks are suspected to have leaked. Since 2006, WMA A-AX has been monitored under a RCRA interim status groundwater quality assessment program (first determination). Appendix B, Figure B-4 provides a well location map and Table B-29 lists wells and monitored analytes for the WMA.

The WMA A-AX lies within the large northwest-southeast-trending paleochannel incised in the Ringold Formation by cataclysmic Pleistocene flooding and filled with ~11 meters of highly permeable Hanford formation sands and gravels between the remnant Ringold Formation gravel and the water table. Groundwater flow direction in the unconfined aquifer is most likely southeast, based on slightly higher heads to the northeast, the orientation of the paleochannel, and the configuration of the major contaminant plumes. Although the water table gradient is very low (2×10^{-5}) (see Chapter 3.0, Section 3.2.2), the hydraulic conductivity of the Hanford sediments is relatively high, allowing average flow velocities ranging from 0.1 to 0.4 meters per day (see Appendix B, Table B-1).

The current groundwater monitoring plan for WMA A-AX (PNNL-15315, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area A-AX at the Hanford Site*) requires the analysis of nitrate, sodium, sulfate, total organic carbon, filtered chromium, and filtered lead in groundwater samples. Technetium-99 is analyzed under that monitoring plan only to help evaluate groundwater contamination sources within WMA A-AX. Appendix B, Table B-19 contains supporting information, including a list of the wells, constituents, and sampling frequencies for this site. In 2010, two of the wells were not sampled as scheduled in December 2010.

10.3.3.1 Network Evaluation and Compliance Status

With the installation of well 299-E25-236 in 2008, the groundwater monitoring well network was considered complete (PNNL-15315). The network currently has three upgradient wells and six downgradient wells and is considered capable of determining whether the facility has contributed dangerous wastes or dangerous waste constituents to groundwater. The locations of the current wells are appropriately oriented with a southeast groundwater flow direction.

An assessment report concluded that WMA A-AX had impacted groundwater quality with dangerous waste or dangerous waste constituents.

The WMA A-AX was placed in assessment monitoring in 2005 due to elevated specific conductance, and a "first determination" groundwater quality assessment plan (40 CFR 265.93[d][5]) was implemented in 2006 (PNNL-15315). The first determination plan continued to be implemented until replacement well 299-E25-236 was installed in 2008, and an additional year of monitoring data were collected and assessed from the completed well network. An assessment report of the findings was issued in August 2010 (SGW-47538, *Groundwater Quality Assessment Report for Waste Management Area A-AX: First Determination*), and it was concluded that the tank farm had impacted groundwater quality with dangerous waste or dangerous waste constituents (nickel). A new plan was written as required by 40 CFR 265.93(d)(7) that will continue the path forward in an interim status groundwater quality assessment program. The new plan, *Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX* (DOE/RL-2009-70), is under review by Ecology. Until the new plan is approved, groundwater monitoring at WMA A-AX will continue under the current groundwater monitoring plan (PNNL-15315).

Chemical analysis of split-spoon samples from the replacement well demonstrated that vadose sediments there could also corrode stainless-steel casings.

In 2008, when replacement well 299-E25-236 was installed, four split-spoon core samples were collected between the depths of 82 and 85.5 meters and chemically

analyzed (PNNL-SA-18197, *Analytical Data Report for Sediment Samples Collected from Well 299-E25-236 in the 200-PO-1 Operable Unit*). The results indicated that sediments were capable of generating porewater with sufficient chloride concentrations to cause corrosion of the stainless-steel well casing. The equivalent porewater concentrations of chloride ranged from 220 to 233 mg/L, which is higher than the 100 mg/L commonly considered concentrated enough to corrode stainless steel. Because bentonite was not present when well 299-E25-236 was drilled, chemical analysis of the split-spoon samples demonstrated that the vadose zone chemistry of the zone at 82 to 85.5 meters was affected by a Hanford Site waste stream (possibly from WMA A-AX). The stainless-steel casing in well 299-E25-236 is not expected to experience any significant corrosion because the 82- to 85.5-meter zone was sealed with Portland cement rather than bentonite.

10.3.3.2 Groundwater Contaminants

Only nitrate and technetium-99 exceeded their DWSs in WMA A-AX wells during 2010.

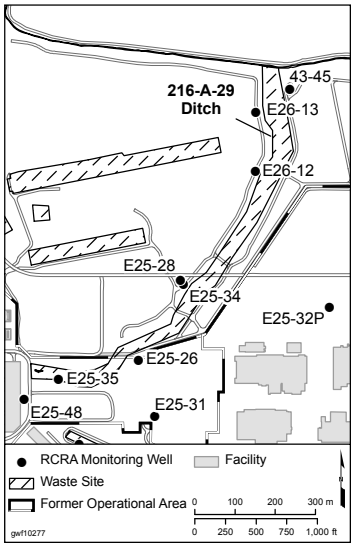
Only nitrate and technetium-99 exceeded DWSs (45 mg/L and 900 pCi/L, respectively) in WMA A-AX wells during 2010. Chromium and lead were detected, but chromium was detected only at very low levels (less than 18 µg/L) in two wells (one upgradient). The detections for lead (in the two wells) were below Hanford Site background levels at the 95th percentile (1.3 µg/L) (DOE/RL-96-61). Sodium and sulfate were detected in all of the WMA A-AX samples and are naturally occurring constituents in Hanford Site groundwater. Detected sodium was at or below background levels. Sulfate concentrations were well above Hanford Site background levels, but upgradient wells had concentrations similar to downgradient wells. Total organic carbon was detected in many of the network wells as isolated spikes. The highest of these spikes was 1,890 µg/L at well 299-E25-94. The cause of these spurious detections is unknown; however, total organic carbon concentrations at well 299-E25-236 increased continually throughout 2010, starting at 578 µg/L in January and ending the year at 2,520 µg/L in December (Figure 10-19). Like the isolated spikes in the other wells, the cause for the rising total organic carbon concentrations in well 299-E25-94 is unknown. Efforts to determine the source of the elevated total organic carbon will continue in 2011.

Most likely there is a nitrate source within WMA A-AX.

Figure 10-10 shows the nitrate concentrations near the WMA A-AX and southeastern 200 East Area. Two wells had nitrate concentrations exceeding the 45 mg/L DWS (Figure 10-20). The average nitrate concentration for well 299-E25-93 for 2010 was 58 mg/L, and the trend is rising. At well 299-E24-20, the average concentration for 2010 was 37 mg/L, although the last result (December 2010) was 45.2 mg/L. Upgradient well 299-E24-20 had a significantly lower average concentration, indicating a nitrate source within WMA A-AX. The trends for upgradient wells 299-E24-20, 299-E24-22, and 299-E24-33 have been relatively stable since 2007, but a slight increase has occurred in all three wells in the previous 2 years.

A technetium-99 source is likely located within WMA A-AX.

As with nitrate, technetium-99 is more concentrated at well 299-E25-93 than any other well in WMA A-AX, suggesting a local source (Figure 10-21). During the reporting period, the technetium-99 DWS (900 pCi/L) was exceeded in two wells (upgradient well 299-E24-33 and downgradient well 299-E25-93). Downgradient well 299-E25-93 had the highest concentrations, ranging from 3,400 to 5,300 pCi/L, with a stable to decreasing trend since 2006 (Figure 10-12). During 2010, upgradient well 299-E24-33 had a concentration range from 1,200 to 1,300 pCi/L. As with nitrate, a likely technetium-99 source is located near well 299-E25-93, but there is also an upgradient source (possibly WMA C).



The 216-A-29 Ditch is monitored as required by WAC 173-303-400 and 40 CFR 265.93(b) for detection of dangerous waste constituents impacting groundwater.

10.3.4 216-A-29 Ditch

C.J. Martin

The 216-A-29 Ditch is located just east of the 200 East Area fence line (Figure 10-1) and is planned for closure. The 216-A-29 Ditch is a regulated unit because it received nonradioactive dangerous waste regulated by 40 CFR 261, "Identification and Listing of Hazardous Waste," after November 19, 1980. The 216-A-29 Ditch is regulated as a surface impoundment, as defined in WAC 173-303-400.

The groundwater beneath the 216-A-29 Ditch is monitored as required by WAC 173-303-400 and 40 CFR 265.93(b) for detection of dangerous waste/dangerous waste constituents impacting groundwater. A revised and updated groundwater monitoring plan for this unit was issued in March 2010 (DOE/RL-2008-58, *Interim Status Groundwater Monitoring Plan for the 216-A-29 Ditch*). The revised plan removed one older well and replaced it with a different well. The nine wells of the groundwater monitoring network are sampled semiannually for contamination indicator parameters and annually for groundwater quality parameters (i.e., alkalinity, metals, phenols, and anions) and site-specific constituents (DOE/RL-2008-58). Appendix B, Table B-8 lists the network wells, their locations, and the groundwater constituents monitored.

The 216-A-29 Ditch was excavated to convey liquid effluent from the PUREX chemical sewer (low-level contaminants) to the B Pond and was placed in service in November 1955. Flow from the chemical sewer (low-level contaminants) was continuous, with an average flow of ~3,671 liters per minute. The 216-A-29 Ditch received continuous discharge of corrosive waste and potentially hazardous spilled chemical materials from the PUREX Plant. The most significant chemical discharges included acidic and caustic effluents associated with backwashing for the regeneration of demineralizer columns. The ditch also received spills from the PUREX Plant chemical sewer (low-level contamination). A complete, estimated inventory of materials discharged to the 216-A-29 Ditch is provided in the *Groundwater Monitoring Plan for the 216-A-29 Ditch* (WHC-SD-EN-AP-045).

The 216-A-29 Ditch is currently backfilled with material from the ditch sides and spoils piles in the bottom. The portion of the 216-A-29 Ditch inside the 200 East Area security fence was brought to grade with clean material. The portion of the ditch outside of the 200 East Area security fence was topped with clean material in a series of eleven terraces progressing down the length of the ditch. Both areas have been revegetated and appropriately signed (the 216-A-29 Ditch is an underground radioactive material area).

The stratigraphy beneath the 216-A-29 Ditch is similar to that found at the nearby B Pond. However, in the area of the 216-A-29 Ditch, the contact between the Hanford/Cold Creek/Ringold Formation is difficult to identify. For this reason, many descriptions simply call out the lowest sediments as "undifferentiated Hanford/Ringold Formation."

The uppermost aquifer beneath the 216-A-29 Ditch is unconfined and occurs within undifferentiated Hanford/Ringold Formation. The water table elevation near and beneath the 216-A-29 Ditch is ~122 meters above mean sea level.

Groundwater at 216-A-29 Ditch monitoring wells is sampled and analyzed for the parameters listed in Appendix B, Table B-8. In compliance with WAC 173-303-400(3) (and 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and

Analysis," as incorporated by reference), the 216-A-29 Ditch network groundwater wells are monitored semiannually for total organic carbon, total organic halides, pH, and specific conductance. Wells are monitored annually for metals (including cadmium), and phenols. Alkalinity, anions, and water levels are also analyzed semiannually. Alkalinity (and metals and anions) is used to calculate a groundwater charge balance, while anions are included to detect potential nitrate contamination and to provide input for charge-balance calculations. During calendar year (CY) 2010, all but three groundwater samples were collected as scheduled. Well 299-E25-26 was not sampled during the year due to a lack of water in the well. Well 299-E25-28 was not sampled in April as scheduled due to pump problems. These issues were resolved during the second half of the calendar year. The April sampling event at well 699-43-45 was missed due to restrictions on access (impassable off-road conditions followed by wildfire/off-road travel closure). As with well 299-E25-28, the access restrictions did not clear until the second half of the year. Also, due to a site-wide sampling work stoppage, the second round of sampling originally scheduled for October did not occur until November and December. With the exception of the wells noted above, all wells were sampled twice during the calendar year as required.

10.3.4.1 Network Evaluation and Compliance Status

Historically, well 699-43-45 has served as an upgradient well for the 216-A-29 Ditch. With the apparent shift in groundwater flow direction from the southwest to the southeast continuing, this well is no longer upgradient of the unit. Wells 299-E26-12 and 299-E26-13, which have always been included in the network, will be the new upgradient wells starting in CY 2011.

Wells 299-E25-26, 299-E25-35, and 299-E25-48 are located south of the 216-A-29 Ditch and are downgradient of the inlet end of the ditch. Well 699-43-45 now monitors the distal end of the ditch, while well 299-E25-32P monitors downgradient of the middle of the ditch.

Well 299-E25-34 was removed from the network because it is now upgradient of the central portion of the ditch and is no longer needed.

The present network is capable of the detection of potential releases from the 216-A-29 Ditch throughout CY 2011.

The nine groundwater monitoring wells that currently comprise the 216-A-29 Ditch monitoring network are shown in Appendix B, Figure B-4. All but two of the groundwater monitoring wells (299-E25-26 and 299-E25-28) were constructed to meet the resource protection well standards of WAC 173-160.

The water table gradient at the 216-A-29 Ditch is estimated to be similar to that at the PUREX Cribs and IDF at 2 x 10^{-5} (see Chapter 3.0, Section 3.2.2) with a southeastern flow direction interpreted from plume maps. Based on the interpretation of a southeasterly flow direction, the current network was capable of the detection of potential releases from the 216-A-29 Ditch throughout CY 2010 and will continue to meet the needs of monitoring this unit throughout CY 2011. In accordance with requirements, the network will be re-evaluated annually, although it is not believed that any significant changes will be needed in 2011.

No dangerous waste subject to WAC 173-303 has been found to date at the 216-A-29 Ditch. Therefore, the site will remain under detection monitoring for indicator parameters.

To date, no dangerous waste subject to WAC 173-303 from the 216-A-29 Ditch has contaminated groundwater. Therefore, the site remains in an interim status indicator evaluation program, as specified in 40 CFR 265.92(b).

10.3.4.2 Groundwater Contaminants

As required under WAC 173-303-400 and RCRA (40 CFR 295.93[b]) for interim status facility indicator parameter monitoring, the required indicator parameters (i.e., pH, specific conductance, total organic carbon, and total organic halides) are

statistically compared between upgradient and downgradient wells using the most recent data. Statistical evaluation of the first indicator evaluation monitoring results in January 1990 indicated that the specific conductivity (field) value in downgradient well 299-E25-35 was statistically greater than the background levels. Resampling later verified this measurement, and the required groundwater quality assessment plan was prepared and initiated for the 216-A-29 Ditch (WHC-SD-EN-AP-031, *Interim-Status Groundwater Quality Assessment Plan for the 216-A-29 Ditch*). The groundwater network was expanded to include new well installations and additional existing monitoring wells.

The results of the final groundwater assessment report (WHC-SD-EN-EV-032, *Results of Groundwater Quality Assessment Program at the 216-A-29 Ditch RCRA Facility*) issued in 1995 identified increased sulfate, sodium, and calcium as the cause of elevated specific conductivity in well 299-E25-35. Because these constituents are not regulated as dangerous wastes, it was concluded that groundwater had not been adversely impacted by discharges to the 216-A-29 Ditch. Subject to these findings, the 216-A-29 Ditch reverted to indicator parameter monitoring in 1994 under the *Groundwater Monitoring Plan for the 216-A-29 Ditch* (PNNL-13047).

Specific conductance continued to remain above the critical mean in downgradient wells at the 216-A-29 Ditch during CY 2010.

Specific conductance continued to remain above the critical mean in downgradient wells 299-E25-35 and 299-E25-48 and upgradient well 299-E26-13 during both semiannual sampling events. The continued trend of increasing specific conductance coincides with similar increases in sulfate, nitrate, and chloride in these wells. An example of the increases is provided for well 299-E25-32P in Figure 10-22. Wells 299-E25-28 (deep completion) and 299-E25-34 appear to be least affected by these trends. Well 299-E25-32P also exceeded the specific conductance critical mean for the first time (Figure 10-23). This was expected, as these constituents have been steadily increasing in this well.

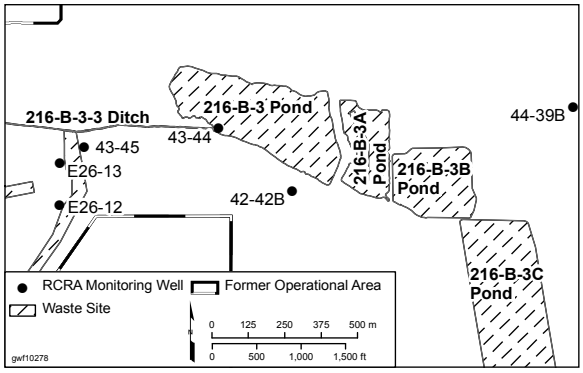
None of the increasing constituents exceed their respective DWSs. The remaining three contamination indicator parameters (i.e., pH, total organic carbon, and total organic halides) were below critical means for all wells in the 216-A-29 Ditch network during CY 2010. Appendix B, Table B-9 lists the critical mean values to be used for CY 2011 comparisons.

10.3.5 216-B-3 Pond

C.J. Martin

The B Pond is regulated as a surface impoundment, as defined in WAC 173-303-400.

The 216-B-3 Pond (B Pond) is an inactive, nonoperational TSD unit that will undergo closure. The B Pond is regulated as a surface impoundment, as defined in WAC 173-303-400. The original B Pond system included the main pond and three expansion ponds (Figure 10-1). The three expansion ponds have been subsequently clean closed, however, leaving the main pond and an adjacent portion of the 216-B-3-3 Ditch to be regulated under WAC 173-303-400.



The B Pond is located in a natural topographic depression that is diked on the eastern margin and covers ~14.2 hectares. The B Pond began receiving effluent in 1945 at the site of the main pond (initially referred to as the B-3 Pond). Discharges to B Pond were terminated in 1994.

The 216-B-3-1, 216-B-3-2, 216-B-3-3, and 216-A-29 Ditches were used to convey effluent from the production facilities in the 200 East Area to the main pond, where the water then evaporated

and infiltrated into the ground. These ditches were decommissioned and stabilized (backfilled) over the lifetime of the pond, mostly as a result of unplanned releases of dangerous waste (DOE/RL-89-28, *216-B-3 Expansion Ponds Closure Plan*). Details of the operation of these ponds and ditches are presented in the *B Plant Source Aggregate Area Management Study Report* (DOE/RL-92-05).

Discharge volumes to the B Pond averaged around 1.0×10^{10} liters per year, except for a short period in the mid-1980s. From 1986 to 1991, more than 6.4×10^{10} liters per year were discharge to the B-3 Pond, with a maximum discharge in 1988 of over 1.0×10^{11} liters. Total discharge to the facility since 1945 is estimated to have exceeded 1.0×10^{12} liters.

Beginning in April 1994, discharges to the main pond and 3A expansion pond ceased, and all effluents were re-routed to the 3C expansion pond via a pipeline. The main pond and 216-B-3-3 Ditch were then filled with clean soil as part of interim stabilization activities. Just before the effluent was diverted from the main pond, the 3A, 3B, and 3C expansion ponds were clean closed under RCRA. This determination indicates that no identifiable waste remains in the closed facilities; thus, only the main pond and an adjoining part of the 216-B-3-3 Ditch require groundwater monitoring under RCRA requirements.

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

As discussed in Chapter 2.0, the lowermost stratigraphic unit beneath the B Pond is the subdivided lower portion of the Ringold Formation. In the area of the B Pond, only units 8 and 9 (including the lower mud unit) are present. The Ringold lower mud unit (unit 8) is not present in the northwestern portion of the B Pond, but it is up to 24 meters thick near the southern extreme of the 3C expansion pond and is generally thicker south and southeast of the main pond. This unit is particularly important to effluent infiltration and groundwater flow patterns near B Pond (see Chapter 3.0).

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

Some B Pond effluent apparently entered unit 9 where the overlying Ringold lower mud unit has been removed by erosion. Groundwater sampling data indicate that the contamination associated with this effluent apparently did not migrate very far to the east and south, even though there was a hydraulic gradient in these directions due to groundwater mounding beneath the B Pond. Hydrostratigraphic research presented in PNNL-12261 indicates that a stratigraphic "trap" could exist near the south and

southeast extremities of the facility (e.g., south of the TEDF and 216-B-3C Pond) that may have prevented any appreciable groundwater movement in this direction. In addition, it is postulated that the north-south trending May Junction Fault (located to the east of the B Pond area, or the low-permeability Ringold Formation sediments just west of the fault, may represent a barrier to groundwater flow in unit 9, preventing any appreciable flow to the east. Within unit 9 in the area of B Pond, groundwater currently flows to the west-southwest and discharges to the unconfined aquifer along the erosional boundary of the confining units. Flow within unit 9 confined by the Ringold Formation lower mud unit is to the west with a gradient of 1.4×10^{-3}.

West of B Pond and within the unconfined aquifer, groundwater flow is to the southeast, with an estimated regional gradient of $\sim 2 \times 10^{-5}$ m/m (see Chapter 3.0, Section 3.2.2).

The groundwater in B Pond monitoring wells is sampled and analyzed for the parameters listed in Appendix B, Table B-10. In compliance with WAC 173-303-400(3) (and 40 CFR 265.92, as incorporated by reference), a revised and updated monitoring plan was issued in September 2010 (DOE/RL-2008-29). The B Pond network groundwater wells are monitored semiannually for interim status facility indicator parameters (i.e., pH, specific conductance, total organic carbon, and total organic halides). Wells are monitored annually for metals and phenols. Additional groundwater quality parameters (i.e., alkalinity, dissolved oxygen, temperature, and turbidity) are measured as indicators of sample quality and general aquifer/well environmental conditions. During CY 2010, all but one well had groundwater samples collected as scheduled. As noted above in the 216-A-29 Ditch discussion, the April sampling event at well 699-43-45 was missed due to restrictions on access (impassable off-road conditions followed by wildfire off-road travel closure). The access restrictions did not clear until the second half of the year. The site-wide sampling stop work delayed collection of the second semiannual sample at well 699-43-45 from November to December.

10.3.5.1 Network Evaluation and Compliance Status

Appendix B, Figure B-5 shows the locations of the four wells (699-44-39B, 699-42-42B, 699-43-44, and 699-43-45) in the groundwater monitoring well network for the B Pond system. The network consists of one upgradient well (699-44-39B) and three downgradient wells (699-43-45, 699-43-44, and 699-42-42B). None of these wells are anticipated to go dry within the foreseeable future.

The current network wells and hydraulic gradient configuration continue to allow for determination of groundwater flow directions and allow the specified upgradient/downgradient comparisons to be made.

No dangerous waste subject to WAC 173-303 has been found to date from the B Pond. Therefore, the site will remain under detection monitoring for indicator parameters.

Using the water table map for the 200 East Area and the measured head differences between network wells, the direction of groundwater flow in the confined aquifer at B Pond is estimated to be southwesterly. The water table gradient at B Pond is estimated at 1.21×10^{-3}. Applying an average hydraulic conductivity of 1.0 meter per day and an estimated effective porosity of 0.25 yields an estimated groundwater flow velocity of 0.0048 meter per day (see Appendix B, Table B-1).

As noted above during CY 2010, all but one of the groundwater samples were collected as scheduled. To date, no groundwater contamination or dangerous waste subject to the requirements of WAC 173-303 beneath the B Pond site can be conclusively linked to past practices at the site. Therefore, the site remains under indicator parameter evaluation monitoring as specified in 40 CFR 265.92(b).

A revised monitoring plan (DOE/RL-2008-59, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*) was completed and issued in September 2010.

10.3.5.2 Groundwater Contaminants

As required by RCRA regulations for interim status facility indicator parameter monitoring, the indicator parameters (i.e., pH, specific conductance, total organic carbon, and total organic halides) are statistically compared between upgradient and downgradient wells using the most recent data. All but one of the wells were sampled as required during the reporting period.

During 2010, none of the indicator parameters exceeded their critical means at the B Pond facility.

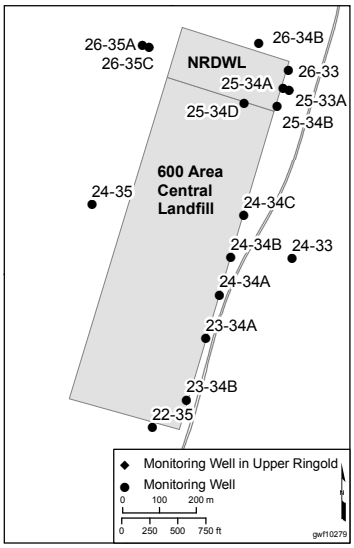
The B Pond has been monitored under interim status since 1988. Total organic carbon and total organic halides exceeded the critical means in two wells in 1990. Results of the groundwater quality assessment concluded that no dangerous constituents were present in the groundwater. The B Pond was returned to indicator evaluation monitoring in 1996 and continues in an indicator evaluation program.

Constituents continue to show stable trends. The major anions show a gradual increasing trend, but concentrations are an order of magnitude below DWSs.

During CY 2010, critical mean values for the indicator parameters were not exceeded in any of the downgradient wells. During the reporting period, no detected constituents were outside of historical ranges and were well below their respective DWSs.

10.3.6 Nonradioactive Dangerous Waste Landfill

The NRDWL is located southeast of the 200 East Area (Figure 10-2) next to the SWL. The objective of RCRA monitoring at the NRDWL is to determine if dangerous waste constituents from the landfill have contaminated groundwater (40 CFR 265.93[b], as referenced by WAC 173-303-400), through an interim status indicator evaluation monitoring program.



Groundwater at NRDWL is monitored under an interim status indicator evaluation monitoring program.

The NRDWL is underlain by ~40 meters of vadose zone composed mostly of sand, silty-sandy gravel, and gravel of the Hanford formation. The uppermost aquifer below the water table consists of ~9 meters of additional Hanford formation, 8 meters of the Cold Creek unit (a pre-Missoula gravel deposit), and 6 meters of undifferentiated Ringold Formation sandy gravel. Below the 6 meters of Ringold Formation sandy gravel is a low-permeability unit composed of silt and silty sand that forms the base of the unconfined aquifer locally. Two of the wells in the NRDWL network (one upgradient and the other downgradient) reach the top of this low permeability unit to sample groundwater from the lower portion of the local unconfined aquifer. Groundwater flow direction is southeast, as determined from the general direction of movement of major contaminant plumes originating in the 200 East Area.

The main groundwater constituents of interest at the NRDWL are the RCRA interim status indicator parameters (i.e., pH, specific conductance, total organic carbon, and total organic halides), and the groundwater quality parameters (i.e., chloride, iron, manganese, phenols, sodium, and sulfate) (see Appendix B, Table B-26 and PNNL-12227, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill*). The site-specific constituents nitrate and VOCs are also monitored. Groundwater quality parameters are monitored annually, and the indicator parameters and site-specific COCs are monitored semiannually. All wells were sampled as scheduled except for well 699-25-34A.

The main groundwater constituents of interest at the NRDWL are the RCRA interim status indicator parameters (i.e., pH, specific conductance, total organic carbon, and total organic halides).

10.3.6.1 Network Evaluation and Compliance Status

The NRDWL well monitoring network consists of nine wells (see Appendix B, Figure B-14), with two of the wells screened at the bottom of the unconfined aquifer, just above the low-permeability unit. The two deeper wells are monitored for information only and not used for upgradient/downgradient comparisons. Of the seven wells screened at the water table, two wells are upgradient (west and northwest) and five are downgradient (north, east, and south). The wells are located appropriately to accomplish the objectives of the interim status groundwater indicator parameter evaluation program.

Critical means for pH and specific conductance continued to be exceeded in NRDWL wells during 2010 but did not require verification sampling or regulator notification.

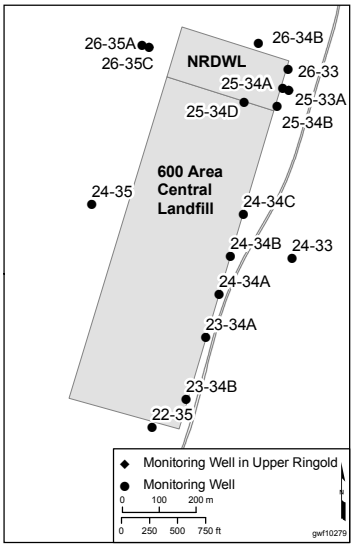
During 2010, a new combination RCRA groundwater monitoring plan was written for the NRDWL and the SWL (DOE/RL-2010-28, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill and Solid Waste Landfill*). Because the two landfills are adjacent to one another, combining the ultimate remedial action for the two landfills was considered a reasonable option to maximize available resources. In the new plan, NRDWL groundwater monitoring will move into RCRA final status under WAC 173-303-645, "Releases from Regulated Units." The plan is under review by Ecology. Until the plan is approved, NRDWL will continue to be monitored under the current groundwater monitoring plan (PNNL-12227).

10.3.6.2 Groundwater Contaminants

Critical means of two of the four indicator parameters (7.72 for pH and 593 µS/cm for specific conductance) were exceeded in NRDWL wells during 2010 but did not require verification sampling or regulator notification. The pH exceedances (7.85 to 7.91) were in the two deep wells screened at the base of the local unconfined aquifer, and these wells are not used for upgradient/downgradient comparisons. Specific conductance results that exceeded the 593 µS/cm critical mean were in wells 699-25-34A and 699-25-34B and ranged as high as 602 µS/cm in well 699-25-34A and 601 µS/cm in well 699-25-34B. Specific conductance exceedances occurred previously at NRDWL and were determined to be caused by nonhazardous groundwater constituents likely from the nearby SWL (DOE/RL-2008-01).

Compliance at the SWL is determined by comparing results from downgradient wells with statistically derived background threshold values from upgradient wells.

The VOCs, manganese, and phenols were not detected at NRDWL wells during 2010. Chloride, iron, sodium, and sulfate were detected at levels consistent with Hanford Site background values (i.e., less than the 95th percentile) (DOE/RL-96-61). The highest nitrate result was 21 mg/L, which is consistent with the large nitrate plume emanating from the 200 East Area (Figure 10-9).



10.4 Other Regulated Facilities

This section presents the results for non-RCRA facilities that require groundwater monitoring.

10.4.1 Solid Waste Landfill

The SWL is located south of the NRDWL (Figure 10-2). The landfill is regulated by Ecology in accordance with WAC 173-350. However, the groundwater monitoring plan (PNNL-13014, *Groundwater Monitoring Plan for the Solid Waste Landfill*) was written to accommodate the requirements WAC 173-304 ("Minimum Functional Standards for Solid Waste Handling"), which are similar to WAC 173-350 ("Solid Waste Handling Standards"). WAC 173-350 superseded WAC 173-304. WAC 173-304 constituents and site-specific constituents (including VOCs and filtered arsenic) are analyzed in groundwater samples collected quarterly. Compliance

is determined by comparing results from downgradient monitoring wells with statistically derived background threshold values from upgradient wells.

The groundwater flow direction is southeast, as inferred from the general direction of movement of major 200 East Area plumes. Hydrogeology is similar to that at the NRDWL (Section 10.3.6). The well network for the SWL includes two upgradient wells and seven downgradient wells. Appendix B, Table B-42 lists the network wells, their locations, and the groundwater constituents monitored. During 2010, the January, April, and July sampling events occurred as scheduled, but the October sampling event was delayed until December 2010 due to a work stoppage. In addition, three of the nine network wells (699-22-35, 699-24-34B, and 699-24-35) were not sampled in December 2010.

10.4.1.1 Leachate and Soil Vapor Monitoring

A leachate collection system (lysimeter) underlying one set of double trenches within the SWL is sampled quarterly and has detected contamination from the landfill in previous years. The leachate is analyzed for ammonia, metals, anions, total organic carbon, total organic halides, total dissolved solids, and VOCs. Most of the inorganic analytes were detected, but the VOCs were generally not detected. Most of the constituents detected in the leachate during 2010 were also analyzed in groundwater samples from the SWL well network. However, nine of these constituents were not analyzed in groundwater samples: boron, silicon, aluminum, lead, molybdenum, tin, uranium, thorium, and thallium.

The eighteen soil vapor monitoring stations at the SWL are monitored quarterly for methane, carbon dioxide, methylene chloride, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, carbon tetrachloride, trichloroethene, 1,1,2-trichloroethane, tetrachloroethene, and ammonia. During 2010, only methane, carbon dioxide, 1,1,2-trichloroethane, and ammonia were detected in soil vapor samples. The methane results ranged from zero to 38 parts per million (ppm). Carbon dioxide ranged from 714 to 10,400 ppm (the typical concentration in air ~387 ppm; concentrations above 1%, or 10,000 ppm, are lethal). Two stations had detections of 1,1,2-trichloroethane (SWL-4 and SWL-6) in the January 2010 sampling event, ranging from 1.58 to 2.57 ppm. Ammonia ranged from zero to 159 ppm and was detected only in the September 2010 sampling event. Concentrations of ammonia, methane, and carbon dioxide at levels greater than normally found in air have possibly resulted from degradation of sewage discharged at the SWL. One of the known VOCs disposed at the SWL is 1,1,2-trichloroethane, which came to the site as catch tank liquid from the 1100 Area heavy equipment garage and bus shop.

10.4.1.2 Groundwater Monitoring Results

Each WAC 173-304 parameter is discussed separately below. A complete list of the results for required constituents at the SWL during 2010 and the background threshold values for 2011 are provided in Appendix B, Table B-44. The increased amount of detail in the discussions of individual groundwater constituents (compared to other sections of this report) is provided to meet the annual reporting requirements of the groundwater monitoring plan (PNNL-13024). Only the filtered results for the metals are presented because WAC 173-304 specifies that the groundwater samples be analyzed for the dissolved metals.

Ammonium. Results for ammonium ion (background threshold value 90 µg/L) in SWL wells during the reporting period ranged from less than the method detection limit (3.09 µg/L) to 51.3 µg/L (July 2010) in well 699-24-33. Ammonium ion was detected in the upgradient and downgradient wells. Detections of this groundwater

constituent have been sporadic in previous years at the SWL and continued during the reporting period.

Chemical oxygen demand remained below the background threshold value of 10 mg/L at all SWL wells during 2010.

Chemical Oxygen Demand. Chemical oxygen demand remained below the background threshold value of 10 mg/L at all SWL wells during 2010. Historically, chemical oxygen demand values are sporadic at the SWL. Elevated values of this parameter could be an indication of groundwater contaminated by sewage, which is known to have been discharged to the SWL trenches.

Chloride. Chloride ranged from 5.9 mg/L at downgradient well 699-23-34B to 7.5 mg/L at upgradient well 699-26-35A. The background threshold value of 7.8 mg/L was not exceeded during 2010. Chloride slightly increased in concentration in most SWL wells until about 2005 and has stabilized thereafter.

Coliform Bacteria. The background threshold value (of one colony per 100 milliliters of groundwater) was exceeded at one SWL well (699-24-34A) during 2010 with a concentration of 3.1 colonies per 100 milliliters. As with chemical oxygen demand, elevated levels of coliform bacteria have been detected sporadically at the SWL in previous years. Elevated levels of this constituent are expected with the known disposal of sewage at the SWL.

Filtered Iron. None of the filtered iron results exceeded the 160 µg/L background threshold value during 2010. The reported values ranged from less than 18 to 149 µg/L. Elevated filtered iron results have been reported above the background threshold value occasionally at SWL wells in recent years but are not typical of overall historical trends.

Filtered Manganese. Filtered manganese was not detected above the method detection level of 4 µg/L in SWL wells during 2010. The background threshold value was 18 µg/L.

Nitrate. The SWL is located on the western edge of the major nitrate plume emanating from the 200 East Area (Figure 10-9). Downgradient wells have levels of nitrate similar to the upgradient wells. During 2010, the highest level of nitrate at the SWL was 20.1 mg/L at downgradient well 699-23-34A, which was significantly lower than the 29 mg/L background threshold value.

Nitrite. There were no detections of nitrite at SWL wells during 2010. The background threshold value was 266 µg/L, and the analytical laboratory's required detection limit was 118 µg/L.

pH. Two wells at the SWL during 2010 had pH levels lower than the background threshold range (6.68 to 7.84): wells 699-23-34A and 699-23-34B. The lowest pH value reported was 6.63 at well 699-23-34A. The pH trends are relatively steady at the SWL wells.

Specific conductance values at all seven downgradient wells exceeded the 583 µS/cm background threshold value during 2010.

Specific Conductance. Specific conductance values at all seven downgradient wells exceeded the 583 µS/cm background threshold value during 2010. Specific conductance values at the two upgradient wells did not exceed the background threshold value. Five of the seven downgradient wells also had specific conductance values greater than the 700 µS/cm limit of WAC 246-290-310, "Group A Public Water Supplies," "Maximum Contaminant Levels (MCLs) and Maximum Residual Disinfectant Levels (MRDLs)." The highest reported value during 2010 was 812 µS/cm at downgradient well 699-22-35. Specific conductance values at the SWL have remained relatively stable since 2001. Elevated specific conductance may be caused by increased concentrations of sulfate and other anions in groundwater at the SWL.

Sulfate. The results for sulfate reported ranged from 40.0 mg/L at upgradient well 699-26-35A to 49.2 mg/L at downgradient well 699-23-34A. Only well 699-23-34A had results exceeding the 47.2 mg/L background threshold value. The overall trend for sulfate concentrations at the SWL is stable to slightly increasing.

Temperature. Temperatures recorded at two of the downgradient wells exceeded the 20.7°C background threshold value during 2010. They were 22.6°C at well 699-24-34B and 20.8°C at well 699-24-34C. These were at two adjacent wells during July, and none of the other wells exceeded the limit. These exceedances appear to be anomalous and are not consistent with historical trends at these wells.

Total Organic Carbon. None of the SWL wells had total organic carbon results during 2010 that exceeded the 1,200 µg/L background threshold value. In previous years, elevated total organic carbon results have occurred occasionally. As with chemical oxygen demand and coliform bacteria, elevated total organic carbon could be due to the degradation of the sewage disposed at the site.

Filtered Zinc. During 2010, filtered zinc ranged from less than 4 µg/L (the analytical method detection limit) to a maximum of 9.2 µg/L at downgradient well 699-24-33. None of the SWL wells had filtered zinc values exceeding the 42.3 µg/L background threshold value.

Site-Specific Parameters. Disposed waste at the SWL has impacted groundwater with minor chlorinated hydrocarbon contamination. However, the concentrations of chlorinated hydrocarbons at the SWL have decreased over the years, and for the first time since groundwater monitoring began at the SWL, chlorinated hydrocarbons were not detected.

Most of the constituents detected in the leachate of the SWL lysimeter were also detected in groundwater but at levels lower than the regulatory limits.

Most of the constituents detected in the leachate were also detected in groundwater but had results lower than the primary DWSs (or secondary DWSs, if appropriate) or the limits specified in WAC 173-200-40 ("Water Quality Standards for Ground Waters of the State of Washington," "Criteria"), except for arsenic and iron. Cobalt, copper, and manganese were not detected. The DWS for arsenic is 10 µg/L, but the WAC 173-200-40 limit is 0.05 µg/L. The results for filtered and non-filtered arsenic ranged from 1.1 to 3.4 µg/L, all exceeding the WAC 173-200-40 limit. However, results from downgradient wells were not significantly different than the results from upgradient wells. Although none of the filtered iron results exceeded the 300 µg/L DWS, this limit was exceeded in unfiltered samples from downgradient wells (699-24-34B and 699-24-33). Well 699-24-34B had the highest result at 786 µg/L.

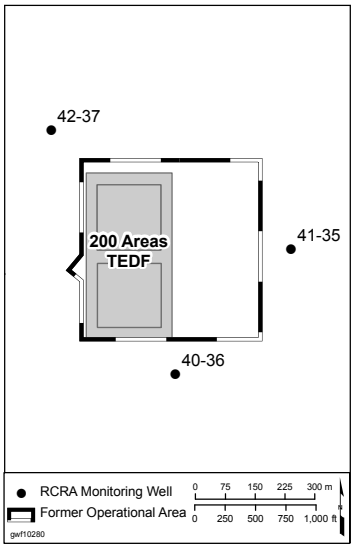
10.4.1.3 Compliance Status

During 2010, the SWL continued to be regulated by Ecology in accordance with WAC 173-304. Several background threshold values were exceeded, and their exceedances were reported.

A new groundwater monitoring plan was written in 2010, combining groundwater monitoring at the SWL with that of the NRDWL.

A new RCRA groundwater monitoring plan was written in 2010, combining groundwater monitoring with that of the NRDWL (DOE/RL-2010-28). Because the two landfills are adjacent to one another, combining the ultimate remedial action for the two landfills was considered a reasonable option to maximize available resources. At the SWL, closure and post-closure groundwater monitoring is subject to WAC 173-350-500 ("Ground Water Monitoring"); however, compliance with groundwater monitoring requirements for the SWL will be achieved through deferral under WAC 173-350-710(8) ("Permit Application and Issuance") to equal or greater requirements within WAC 173-303-645. Some downgradient wells at the SWL continue to show higher coliform bacteria, specific conductance, sulfate, and lower

pH. In previous years, some of the SWL wells also showed higher chemical oxygen demand. The lower pH is apparently a result of elevated levels of carbon dioxide in the vadose zone resulting from the degradation of sewage material disposed to the SWL (DOE/RL-93-88, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993,* Section 5.3; PNL-7147, *Final Report: Soil Gas Survey at the Solid Waste Landfill*; WHC-SD-EN-TI-199, *Nonradioactive Dangerous Waste Landfill Soil Gas Survey*: *Final Data Report*). The coliform bacteria and specific conductance also may be related to sewage disposed at the SWL. Soil vapor analysis shows elevated levels of carbon dioxide, methane, and ammonia.



Groundwater monitoring results are used to demonstrate continued isolation of TEDF discharges from the locally confined aquifer below the Ringold Formation lower mud unit.

10.4.2 200 Area Treated Effluent Disposal Facility

The 200 Area TEDF is monitored under a Washington State waste discharge permit (WAC 173-216; PNNL-13032, *Groundwater Monitoring Plan for the Hanford Site 200 Areas Treated Effluent Disposal Facility*). The facility is located southeast of the B Pond RCRA facility (Figure 10-1) and has received effluent since June 1995. Three wells monitor the site on the northwest, east, and southeast.

Prior to startup of the TEDF, there was no continuous unconfined aquifer above the Ringold lower mud unit (unit 8) at that location. Therefore, the three groundwater monitoring wells installed at the facility were installed in the locally confined aquifer below the Ringold lower mud unit and are isolated from the effects of the effluent from the disposal facility by the relatively impermeable silts and clays of the lower mud unit (PNNL-14098, *Results of Groundwater Monitoring at the Hanford Site 200 Area Treated Effluent Disposal Site – FY-1999 through FY-2002*; PNNL-15479, *Groundwater Monitoring for the Hanford Site 216-B-3 Pond RCRA Facility*). When the wells were installed, a minor amount of perched water was encountered above the Ringold lower mud unit, and recent discharges to the ground at the facility have likely increased the amount of perched water. The quarterly analytical results from the three wells are used to demonstrate continued isolation of the locally confined aquifer below the Ringold lower mud unit from TEDF discharges.

Based on hydraulic head measurements during 2010 (i.e., gradient 5.3×10^{-4}) and estimates of effective porosity (0.25) and hydraulic conductivity (1.1 meters per day [PNNL-13032]), the groundwater flow in the confined aquifer beneath the TEDF is directed southwest at 213 degrees azimuth, at 2.0×10^{-3} meters per day. Historically, major ionic composition and extremely low tritium concentrations have indicated that groundwater in the Ringold Formation confined aquifer beneath this facility is isolated from the perched groundwater above the lower mud unit. The water quality (determined from wells screened below the lower mud unit) is largely unaffected by discharges from the TEDF. Hydraulic head continues to decline in the TEDF wells as a result of the dissipating pressure effect of historical discharges at the nearby B Pond facility.

The three monitoring wells at the TEDF are monitored quarterly for three constituents with enforcement limits (i.e., pH, cadmium, and lead) that are required by *State Waste Discharge Permit ST 4502* (Ecology, 2000b), as well as the indicator parameters specific conductance, gross alpha and beta, anions, metals, total dissolved solids, trace metals, and tritium.

10.4.2.1 Network Evaluation

The three wells of the TEDF meet the requirements of the State Waste Discharge Permit (Ecology, 2000b) and WAC 173-160. The three wells (699-40-36, 699-41-35, and 699-42-37) were in existence when the current revision of the State Waste Discharge Permit (ST 4502) was issued and are specifically mentioned as the wells

to be monitored. Results from the three wells continue to demonstrate isolation of the wastewater discharges from the locally confined aquifer below the Ringold lower mud unit.

10.4.2.2 Groundwater Contaminants

The groundwater monitoring results for three constituents (cadmium, lead, and pH) from the two downgradient wells are compared with specific enforcement limits (5 µg/L for cadmium, 10 µg/L for lead, and pH ranging from 6.5 to 8.5) set by the State Waste Discharge Permit. During 2010, all groundwater samples were collected as scheduled, and none of the enforcement limits were exceeded. Most concentrations for anions, metals, and radionuclide indicators have been below Hanford Site groundwater background levels (e.g., WHC-EP-0595, *Westinghouse Hanford Company Operational Groundwater Status Report, 1990-1992*; DOE/RL-96-61) since monitoring began at the site.

During 2010, all groundwater samples were collected as scheduled at the TEDF, and none of the enforcement limits were exceeded.

10.4.2.3 Compliance Status

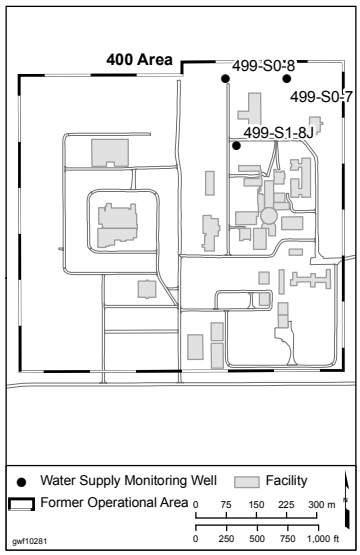
Groundwater monitoring results continue to demonstrate isolation of the wastewater discharges from the locally confined aquifer below the Ringold lower mud unit. Therefore, groundwater monitoring at the TEDF will continue under the State Waste Discharge Permit in accordance with WAC 173-216.

10.4.3 400 Area Water Supply Wells

Primary groundwater monitoring activities in the 400 Area involve monitoring of the area's three water supply wells in accordance with the AEA. Monitoring is conducted to provide information on the potential impact of site-wide contamination (primarily tritium, nitrate, and iodine-129) on the water supply wells, which provide drinking water and emergency supply water for the 400 Area (PNNL-19455, *Hanford Site Environmental Report for Calendar Year 2009*, Section 8.6). This section discusses monitoring of the 400 Area water supply wells (specifically tritium) and the general aspects of groundwater chemistry in the 400 Area.

Groundwater monitoring is conducted to determine if Hanford Site-wide groundwater contamination plumes are impacting groundwater pumped by the water supply wells.

Each of the three 400 Area water supply wells (499-S1-8J, 499-S0-7, and 499-S0-8) have a pumping capacity of 757 liters per minute. The wells provide water to a common header that supplies storage tanks. The 400 Area water usage ranges from 757 liters per minute in the summer months to 95 liters per minute in the winter months. Table 10-2 provides the characteristics of the well screens for the three water supply wells. Well 499-S1-8J is the main water supply well, but occasionally wells 499-S0-7 and 499-S0-8 are used for water supply. During the first 6 months of 2010, water supply came from well 499-S0-8 and during the remainder of the year came from well 499-S1-8J.



Since 2009, the water supply wells have been on an annual sampling schedule for the 200-PO-1 OU. They were sampled twice during 2010 for AEA (July and November 2010) as well as other times during the year for the Washington State Department of Health and Decision Unit Risk Assessment Program. The samples were analyzed for VOCs, ammonium ion, metals, anions, gamma scan, gross alpha and beta, iodine-129, strontium-90, technetium-99, tritium, and uranium.

The Hanford Site water table map (Figure 10-3) indicates that flow in the unconfined aquifer is generally to the east-southeast across the 400 Area. The water table is located near the contact of the Ringold Formation and overlying Hanford formation and is ~49 meters bgs (WHC-EP-0587, *Groundwater Impact Assessment Report for the 400 Area Ponds*). Hanford formation sediments dominate groundwater

flow in the 400 Area due to their relatively high permeability compared to the sediments in the underlying Ringold Formation.

Elevated levels of tritium associated with the groundwater plume originating in the 200 East Area (as compared with Hanford Site background value of 119 pCi/L at the 95th percentile) were identified in the 400 Area wells (Figure 10-4). Well 499-S1-8J has lower tritium levels because it is screened at a greater depth (top of screen 61 meters below the water table) than the other two water supply wells (19 and 9 meters, respectively). Figure 10-24 compares the tritium concentrations in the three wells to that of the 400 Area drinking water supply. Tritium was measured at levels below the DWS (20,000 pCi/L) in all three water supply wells during the reporting period. The maximum tritium concentration in well 499-S1-8J during 2010 was 1,900 pCi/L. Tritium remained below the DWS and the 4 mrem/year dose equivalent in the drinking water supply (sampled at a tap) for all of the sampling events during 2010 (Figure 10-24). The reason for the anomalous tritium results from tap water samples in late 2009 and 2010 is unknown, but it may be due to higher than expected levels of tritium in well 499-S0-8. A composite sample from well 499-S0-8 during 2010 (four separate dates) had a tritium concentration of 5,560 pCi/L (red "X" in Figure 10-24). Subsequently, tap water sampling results have returned to their historical trend below 2,000 pCi/L.

None of the groundwater constituents detected in the 400 Area water supply wells were above DWSs, except possibly for aluminum.

Although many groundwater constituents were detected in samples collected during 2010, none of the constituents were above DWSs, except for aluminum (and even aluminum results were detected at values less than the contract-required detection limit but greater than the method detection limit). The highest aluminum result was 88 µg/L in well 499-S0-7. Other constituents detected included bromodichloromethane, bromoform, bromomethane, carbon disulfide, chloroform, chloromethane, cobalt, copper, dibromochloromethane, diethylphthalate, gross alpha, gross beta, iodomethane, lead, molybdenum, thallium, and tritium. All of these constituents, except for gross beta and tritium, were found in very low concentrations; most were either outliers or detected in such low concentrations as to be lower than the laboratory's contract-required detection limit. The gross beta results ranged up to 9.7 pCi/L in well 499-S0-8, which is typical for these wells.

10.5 Conclusions and Recommendations

The conclusions and recommendations for the 200-PO-1 OU are presented below.

10.5.1 Conclusions

The focus of 200-PO-1 OU CERCLA groundwater monitoring during the reporting period was to complete the RI report (DOE/RL-2009-85, Draft A) and continue monitoring the wells in the routine groundwater monitoring plan (DOE/RL-2003-04).

A conclusion of the RI was that the nature and extent of groundwater contamination was similar to earlier monitoring results.

The RI report concluded that the nature and extent of contamination was similar to earlier monitoring results and of the current routine monitoring plan (discussed below). However, the VOCs formerly detected at the SWL and NRDWL were assumed to continue to be detected based on the last 5 years of monitoring data, but in 2010 the VOCs were no longer detected. Based on the information provided in the modeling and the results of the baseline risk assessment, the RI report concluded that it is appropriate to proceed with the FS for the 200-PO-1 Groundwater OU.

Groundwater monitoring results continue to show tritium, iodine-129, and nitrate as the major plumes extending from the 200 East Area into the remainder of the 200-PO-1 OU, and also that small, more isolated plumes (including strontium-90

and uranium) are located near the PUREX Cribs and technetium-99 at WMA A-AX. All of these groundwater contaminants continue to exceed their respective DWSs, but only tritium exceeded its DWS in wells near the Columbia River.

For the sites within the 200-PO-1 OU that are monitored under RCRA, the *Washington Administrative Code*, or Washington State waste discharge permits, some of the sites will continue their current monitoring efforts, but other sites will undergo changes. Because waste has not been disposed at the IDF, monitoring at the facility will continue focusing on establishing baseline water conditions for the monitored constituents.

Monitoring at two of the PUREX Cribs (216-A-36B and 216-A-37-1) reverted to an interim status indicator evaluation program, while the 216-A-10 Crib is no longer monitored under RCRA. A new groundwater monitoring plan was written for each of the two cribs where RCRA monitoring continues.

The WMA A-AX will continue under interim status groundwater assessment monitoring program. However, the groundwater monitoring plan was changed from "first determination" to a full groundwater quality assessment plan to reflect the conclusion that the WMA has contaminated groundwater with nickel (a dangerous waste constituent). The new plan for WMA A-AX (DOE/RL-2009-70) was issued in 2010 and is undergoing review by Ecology.

The 216-A-29 Ditch and 216-B-3 Pond (both RCRA TSD units) were monitored under interim status indicator parameter evaluation programs during the reporting period. Significant increases were not detected in indicator parameters at downgradient wells, so it is concluded that these units are not contributing to groundwater contamination.

The RCRA groundwater monitoring at the NRDWL continued in an indicator parameter evaluation program.

Groundwater monitoring efforts at the SWL and the TEDF did not detect any significant changes in monitoring results compared to previous years. Monitoring will continue under the current *Washington Administrative Code* regulations.

During 2010, a new RCRA groundwater monitoring plan was written for the combination of the NRDWL and the SWL (DOE/RL-2010-28). Because the two landfills are adjacent to one another, combining the ultimate remedial action for the two landfills was considered a reasonable option to maximize available resources. In the new plan, NRDWL groundwater monitoring will move into RCRA final status under WAC 173-303-645. At the SWL, closure and post-closure groundwater monitoring is subject to WAC 173-350-500; however, compliance with groundwater monitoring requirements for the SWL will be achieved through deferral under WAC 173-350-710(8) ("Permit Application and Issuance") to equal or greater requirements within WAC 173-303-645. The new combination plan was written to meet WAC 173-350-500 requirements for the SWL and WAC 173-303-645 requirements for NRDWL.

Groundwater monitoring at the three water supply wells in the 400 Area continues to show that tritium levels remain well below the 20,000 pCi/L DWSs; thus, the monitoring plan will not change.

10.5.2 Recommendations

Only one recommendation is made for the 200-PO-1 OU for this reporting period. Efforts should continue to refine the water table map in the eastern and southeastern portions of 200 East Area and at the NRDWL/SWL area by decreasing the amount

Efforts should continue to refine the water table map in the eastern and southeastern portions of the 200 East Area and at the NRDWL/SWL area.

of measurement error in determining water table elevations at the wells. The water table gradient in these areas is so low that errors in measuring the depth to water can be larger than the differences in water table elevations between wells.

During FY 2008 and the reporting period, wells at IDF and PUREX Cribs were resurveyed to a known datum and measured for deviation from vertical. Trend-surface analyses were conducted to separate local from regional variability and to determine any regional trends on the water table surface. Although the FY 2008 results were not definitive, continued work during 2009 and 2010 produced some significant results (see Chapter 3.0). It is recommended that this work, which was previously performed only at the IDF and PUREX Cribs, be extended to the north at WMA A-AX and the 216-A-29 Ditch and southeast toward the NRDWL and SWL facilities to more precisely define groundwater flow direction in these areas.

Table 10-1. Summary of Groundwater Conditions in 200-PO-1 Operable Unit Exceeding Standards and Basis for Feasibility Study

Exposure Area	Final COPC	Groundwater Standard[a]	Current Exceedance[b]	Year Maximum Projected Concentration Achieves Groundwater Standard
Near field	Iodine-129	1 pCi/L	Yes	2709
Near field	Technetium-99	900 pCi/L	Yes	2034
Near field	Strontium-90	8 pCi/L	No	2034
Near field	Tritium	20,000 pCi/L	Yes	2059
Near field	Trichloroethene	0.49 µg/L	Yes	2059
Near field	Nitrate	45,000 µg/L/ 25,600 µg/L	Yes	2309/ 2509
Near field	Uranium	30 µg/L	No	2209
Far field	Iodine-129	1 pCi/L	Yes	2709
Far field	Tritium	20,000 pCi/L	Yes	2084
Far field	Carbon tetrachloride	0.34 µg/L	Yes	2034
Far field	Tetrachloroethene	0.081 µg/L	Yes	2059[c]
Far field	Trichloroethene	0.49 µg/L	Yes	2059[d]
Far field	Nitrate	45,000 µg/L/ 25,600 µg/L	Yes	2309/ 2509
River	Tritium	20,000 pCi/L	Yes	2084
River	Nitrate	45,000 µg/L/ 25,600 µg/L	Yes	2309/ 2509

a. Standard exceeded; MCL established by the *Safe Drinking Water Act of 1974*. Groundwater cleanup standard in accordance with WAC 173-340-720.

b. Current exceedance:

Yes = Calculated groundwater exposure point concentration currently exceeds the applicable standard(s). The exposure point concentration is the 90th percentile value for each COPC calculated from the current groundwater data set.

No = Calculated groundwater exposure point concentration does not currently exceed the MCL; WAC 173-340-708 risk threshold of 1×10^{-5} for multiple hazardous substances or the upper National Contingency Plan threshold of 1×10^{-4}, or a noncancer hazard index of 1.

c. Represents the year that the 1×10^{-6} risk level is achieved.

d. Represents the year that the MCL of 5 µg/L is achieved.

Table 10-2. Well Screen Characteristics of the Three 400 Area Water Supply Wells

Well	Elevation Top of Screen (m)	Elevation Bottom of Screen (m)	Water Table to Screen Distance (m)
499-S1-8J	57	48	61
499-S0-7	100	46	19
499-S0-8	110	81	9

Notes: Depth to water in all three wells approximately 49 meters. Water table elevation approximately 118 meters.

Figure 10-1. Facilities and Wells in 200 East Area (Near-Field)

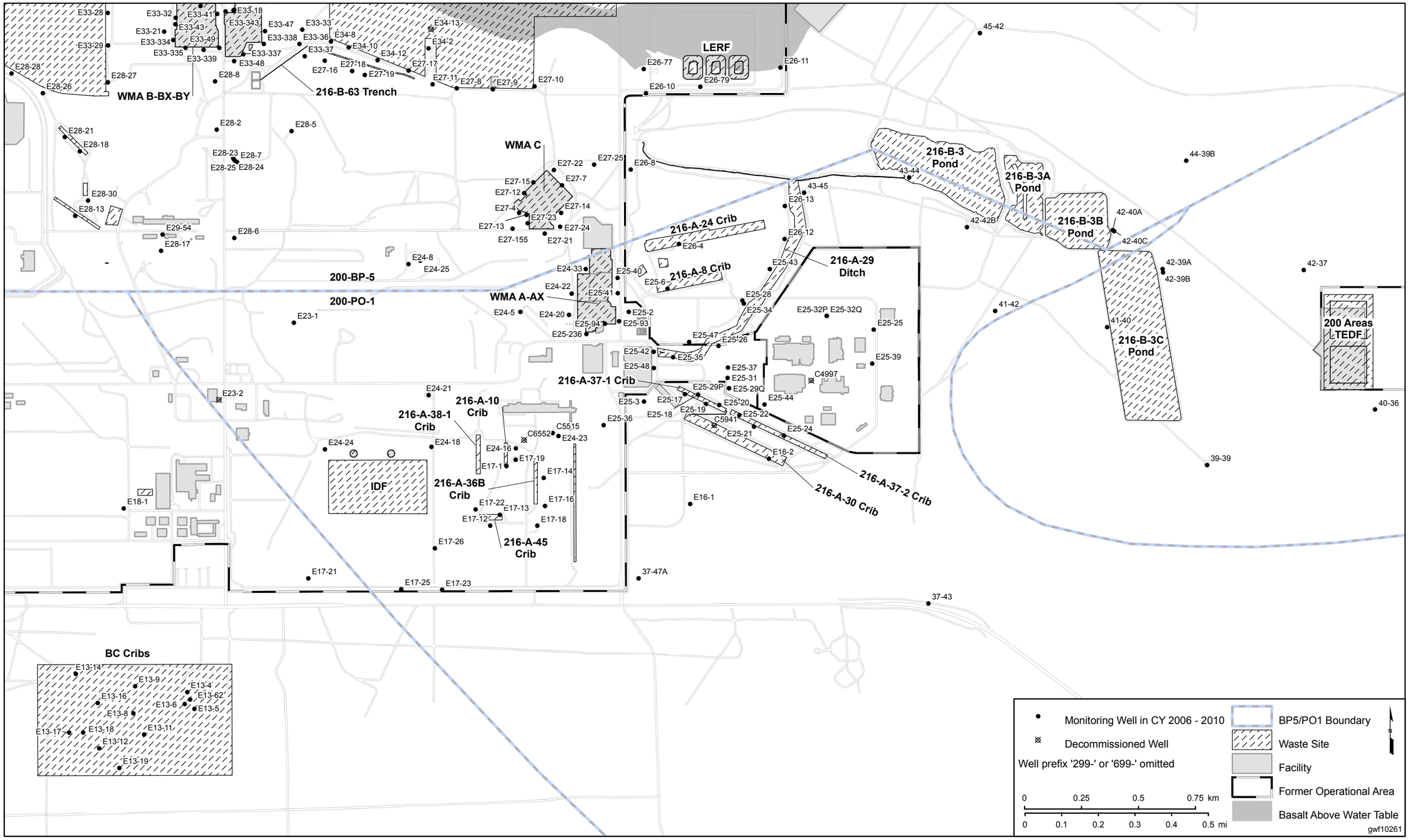


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Figure 10-2. Map of 200-PO-1 Operable Unit Boundaries, Far-Field Wells, Shoreline Monitoring Sites, and Transects

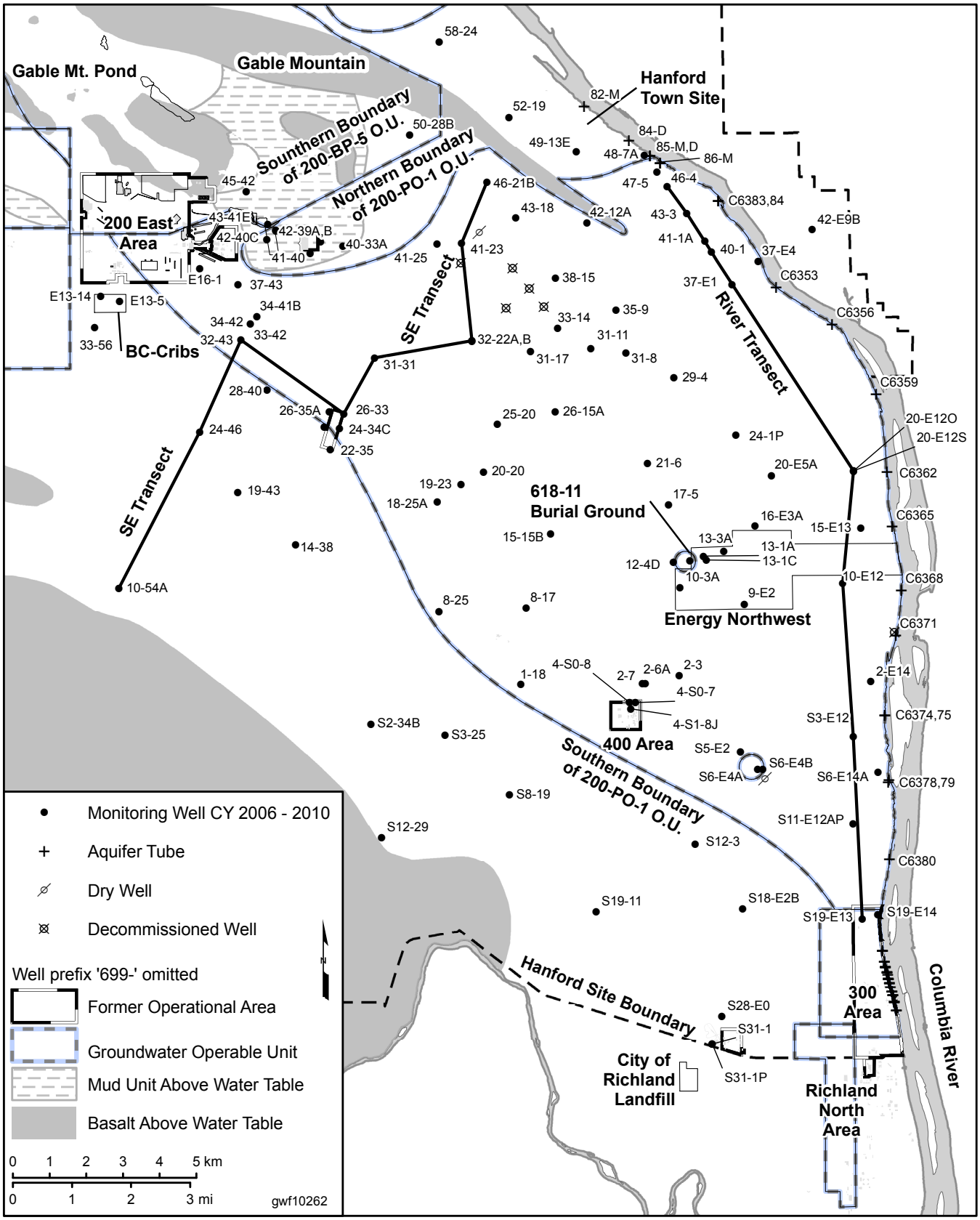

Figure 10-3. Water Table Map for the 200-PO-1 Operable Unit, March 2010

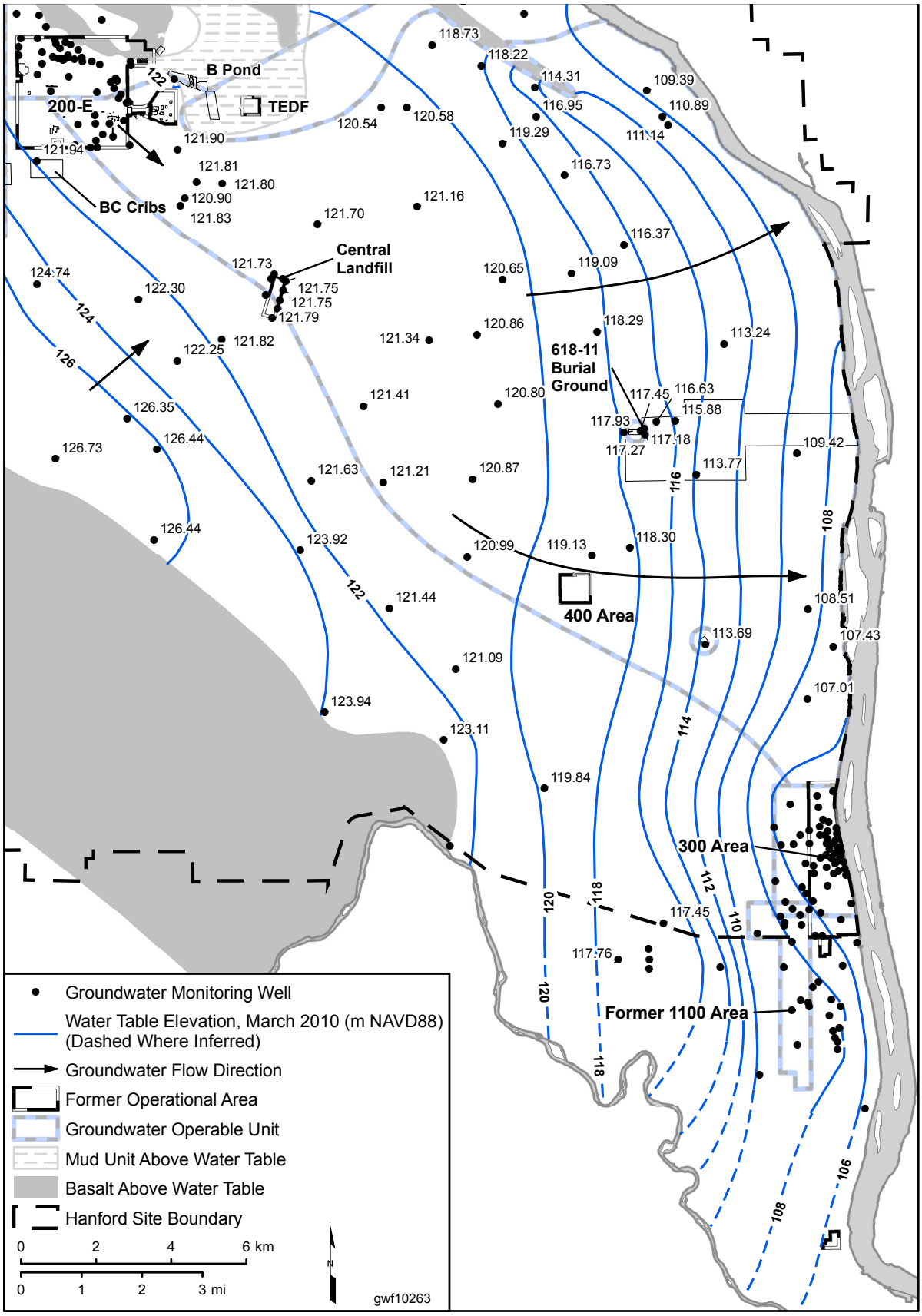

Figure 10-4. Tritium Plume Map for 200-PO-1 Operable Unit

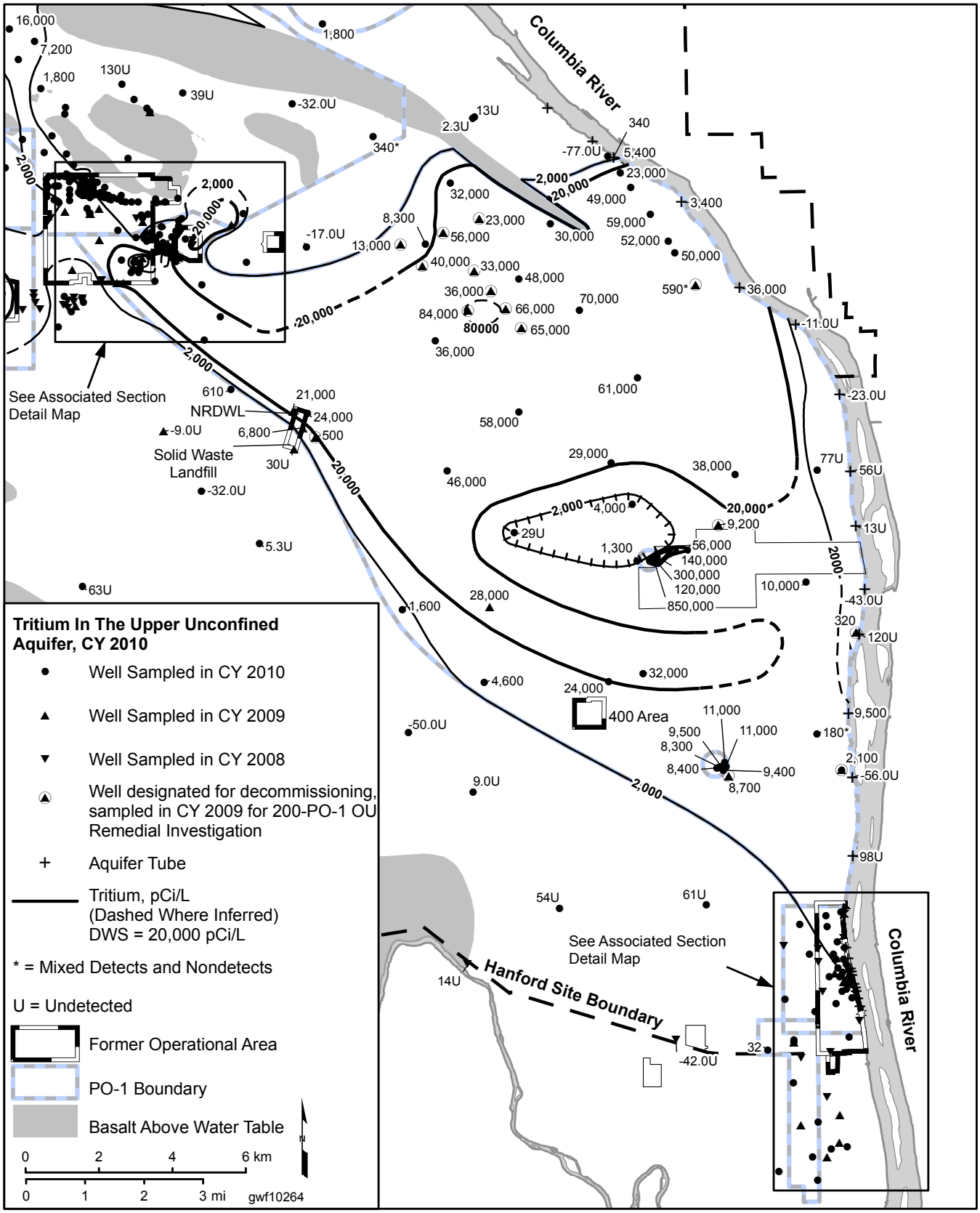

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Figure 10-5. Tritium Plume Map (Near-Field)

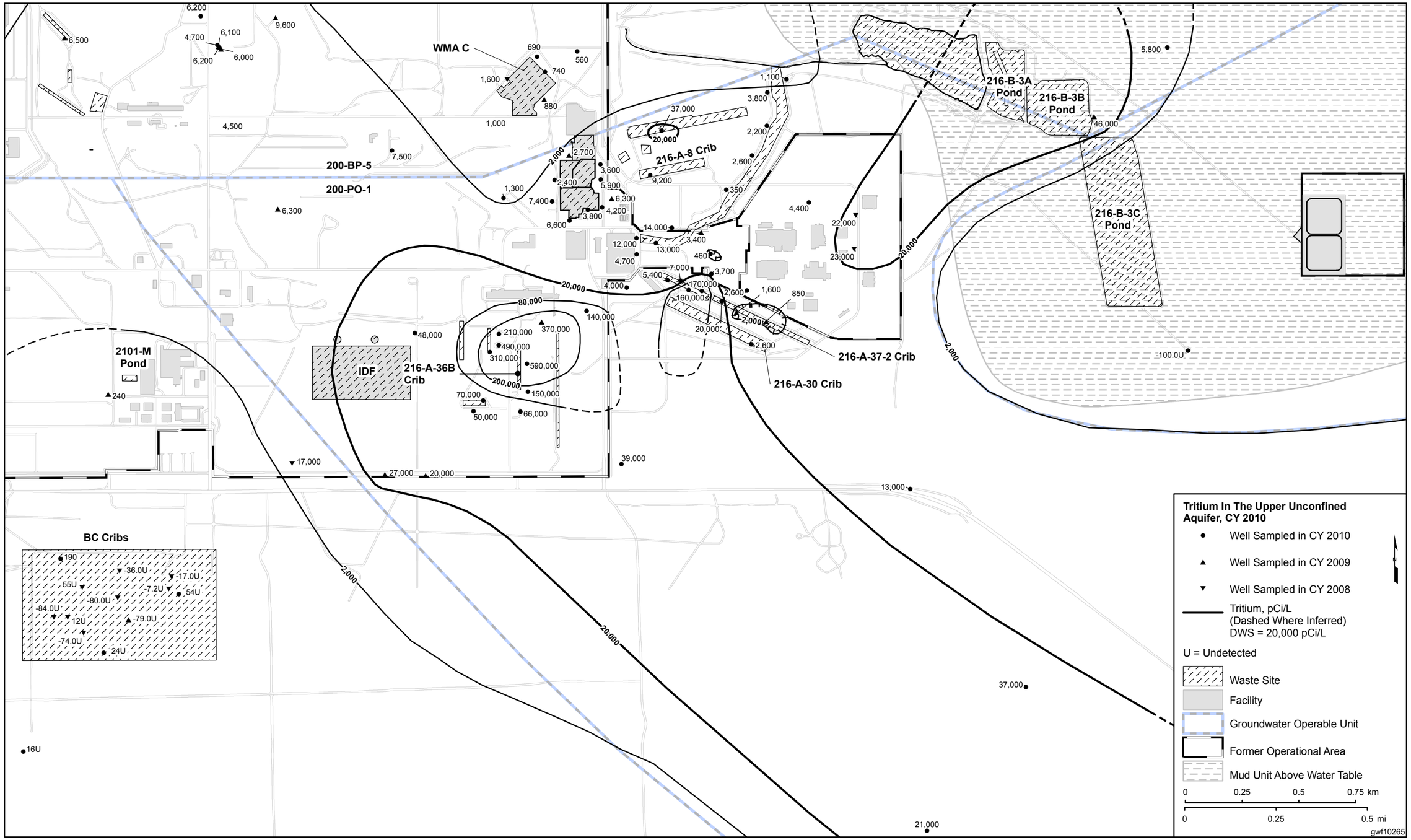

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Figure 10-6. Tritium Concentrations in PUREX Cribs

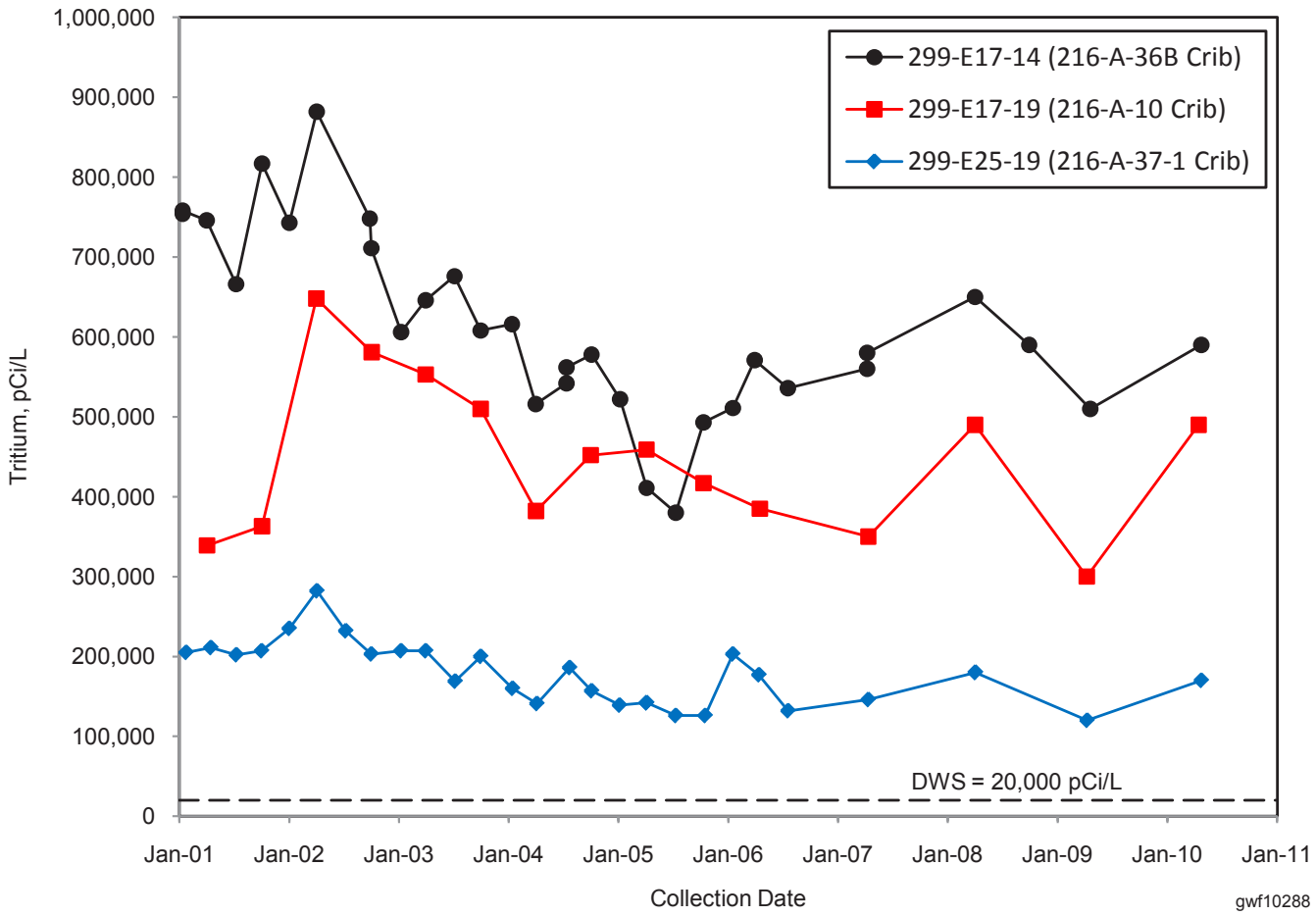

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Figure 10-7. Iodine-129 Plume Map for 200-PO-1 Operable Unit

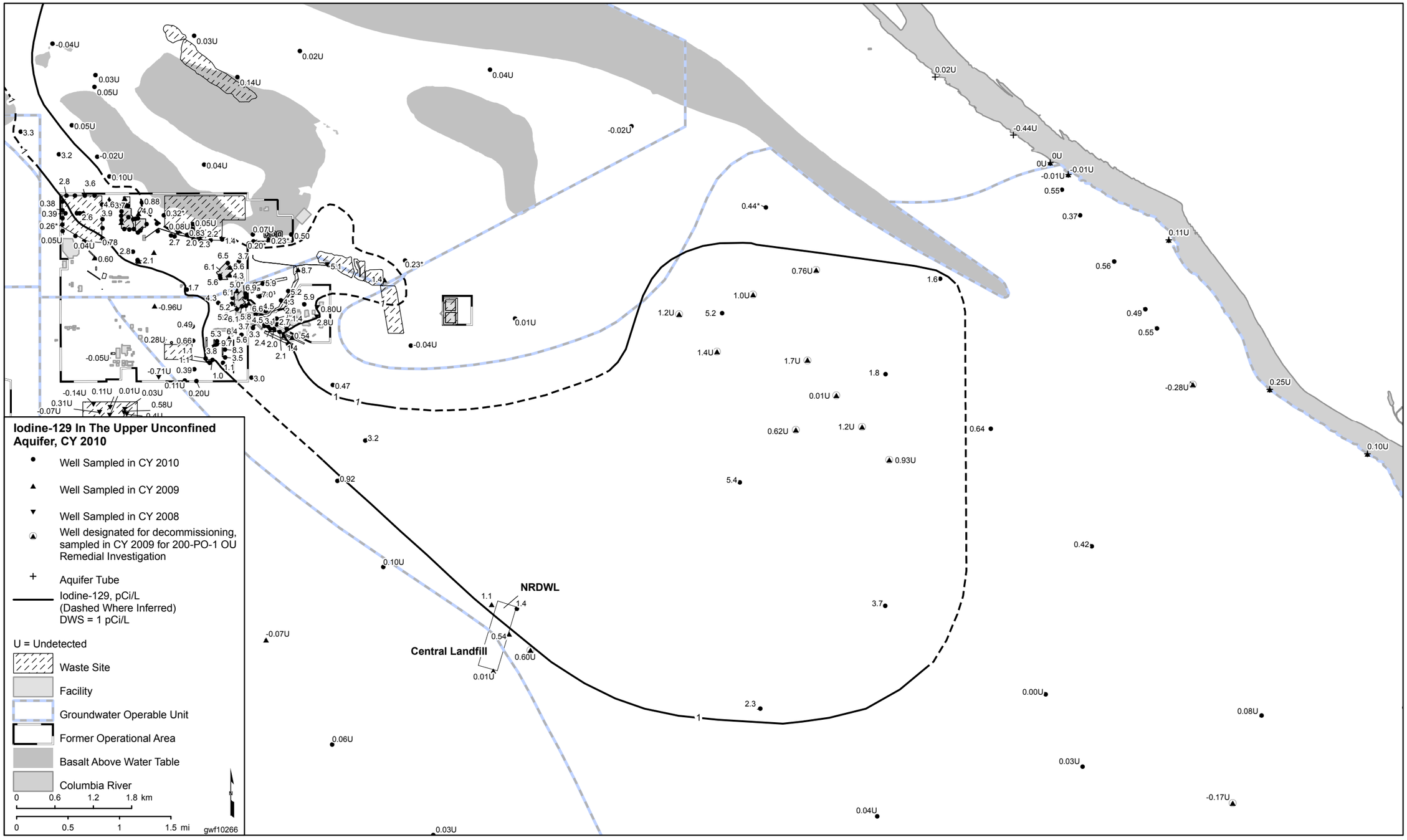

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Figure 10-8. Iodine-129 Concentration in Well 299-E17-19 at the 216-A-10 Crib

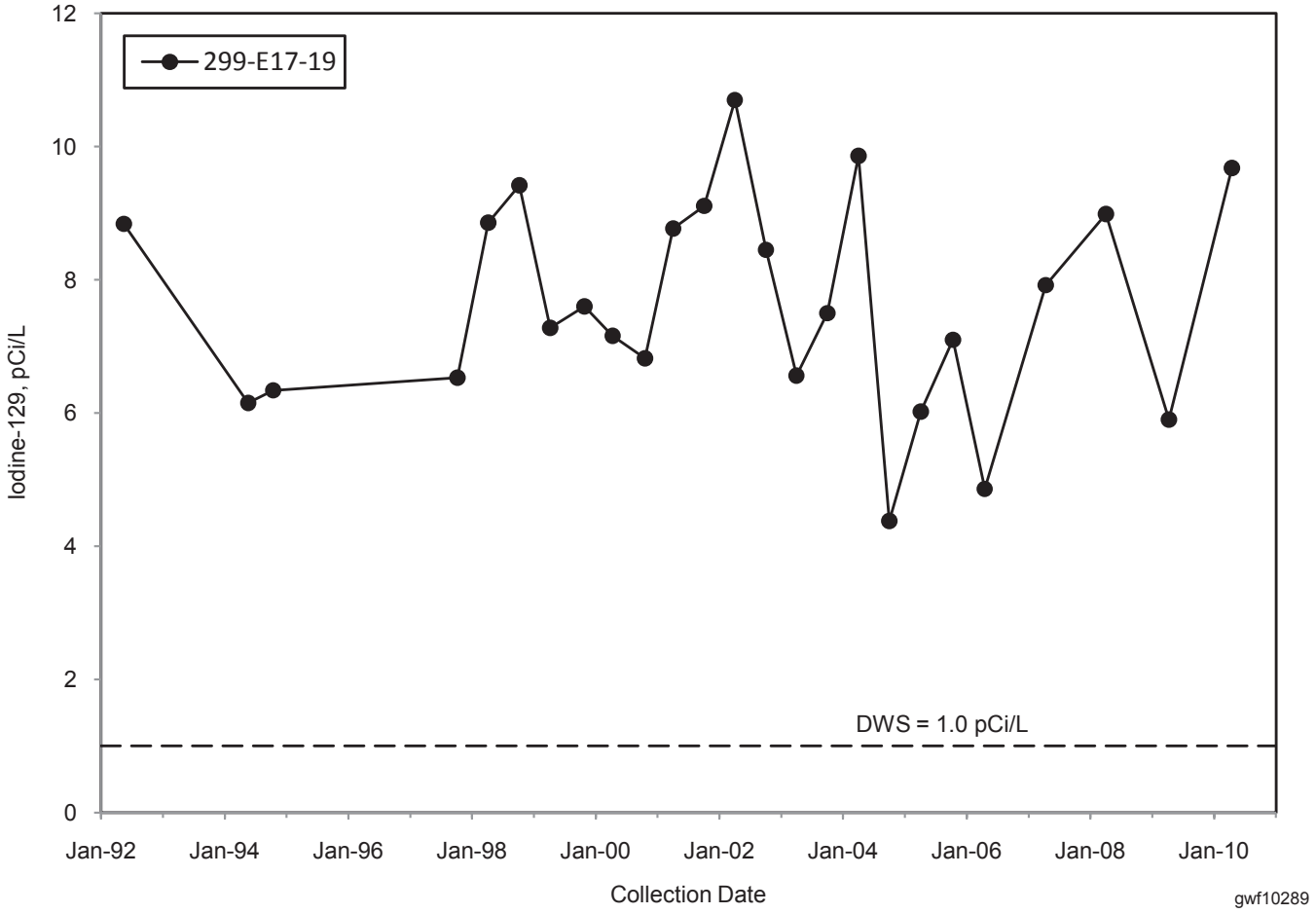


Figure 10-9. Nitrate Plume Map — 200-PO-1 Operable Unit (Far-Field)

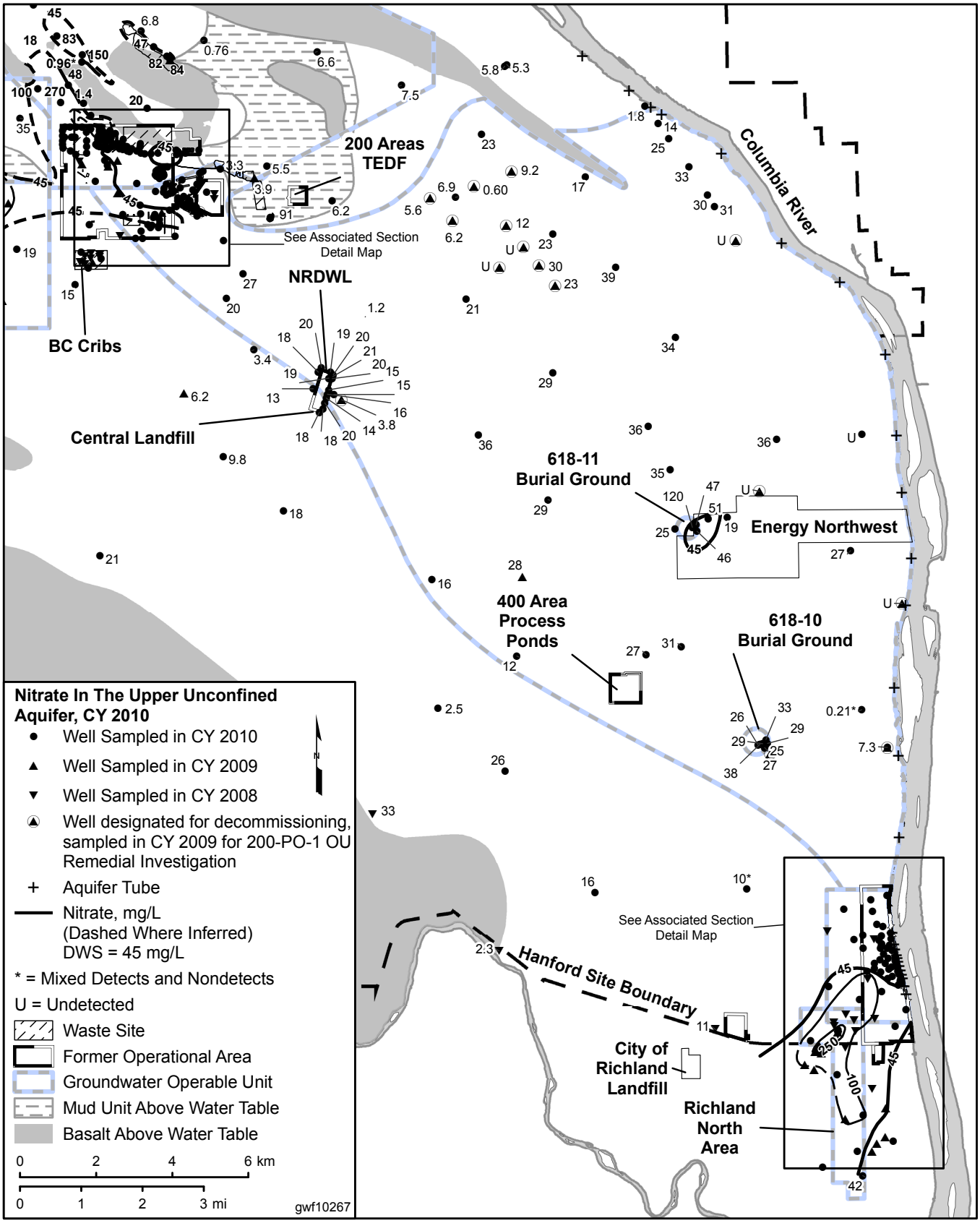


Figure 10-10. Nitrate Plume Map — 200 East Area (Near-Field)

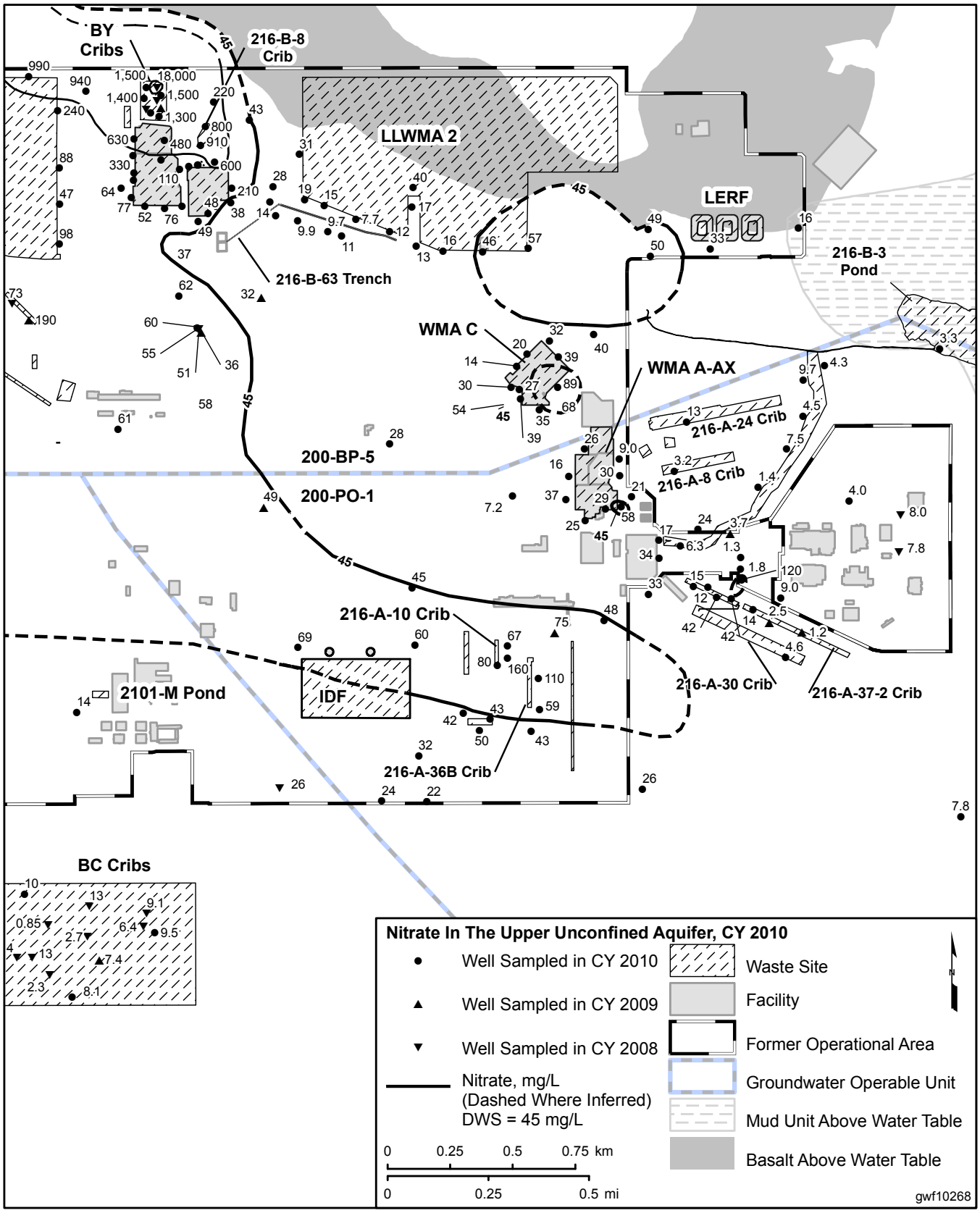


Figure 10-11. Nitrate Concentration in Well 299-E17-19 Near the 216-A-10 Crib

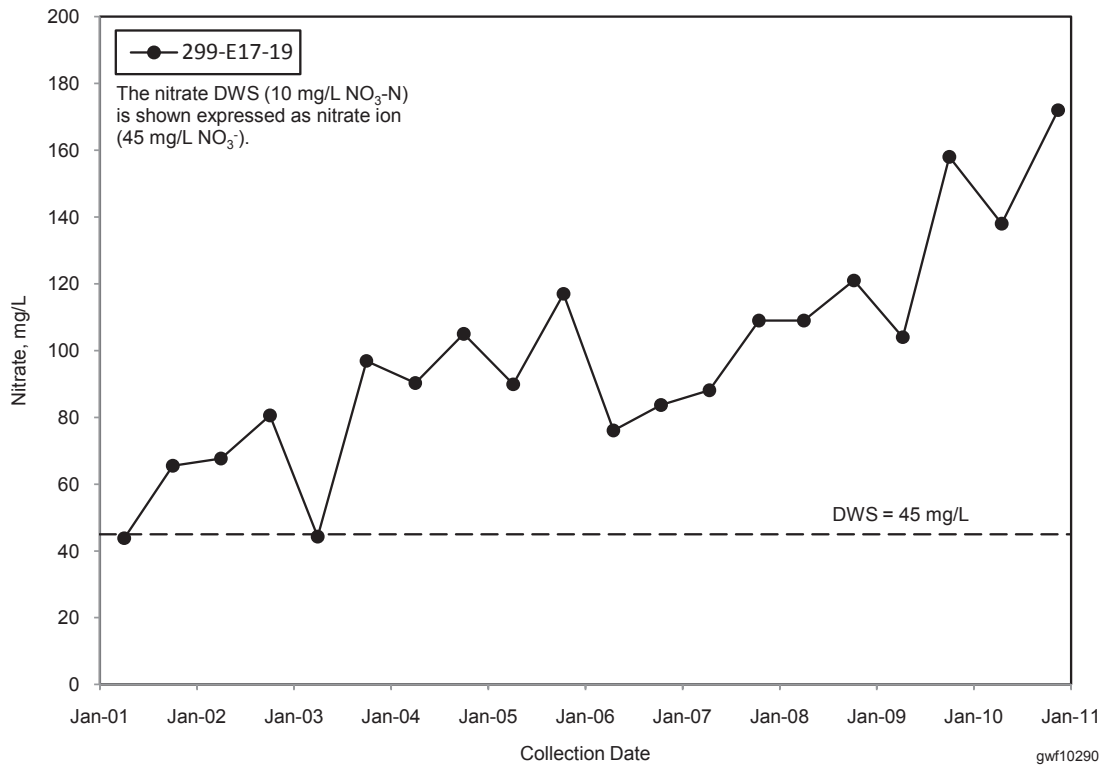


Figure 10-12. Technetium-99 Concentrations in Wells at Waste Management Area A-AX

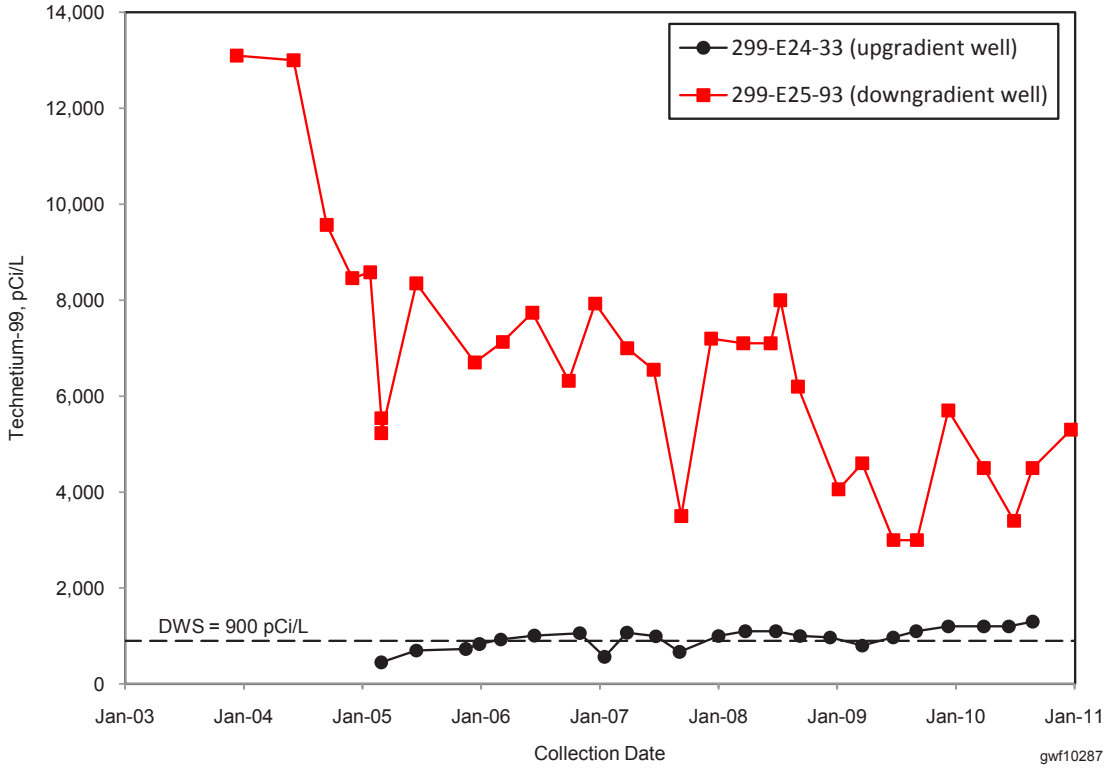


Figure 10-13. Local Plume Map for Uranium Near the PUREX Cribs

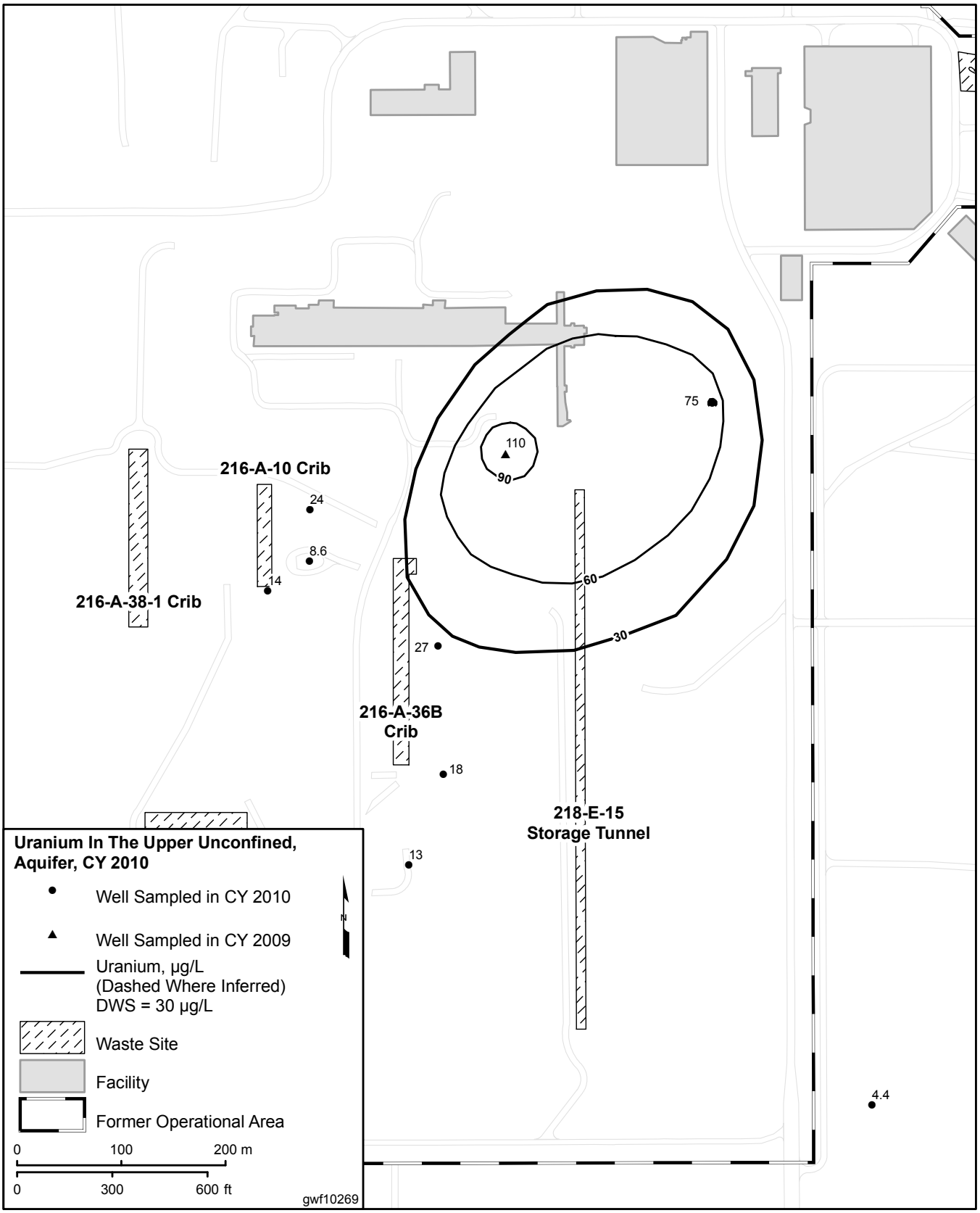


Figure 10-14. Uranium Concentration Near the PUREX Cribs

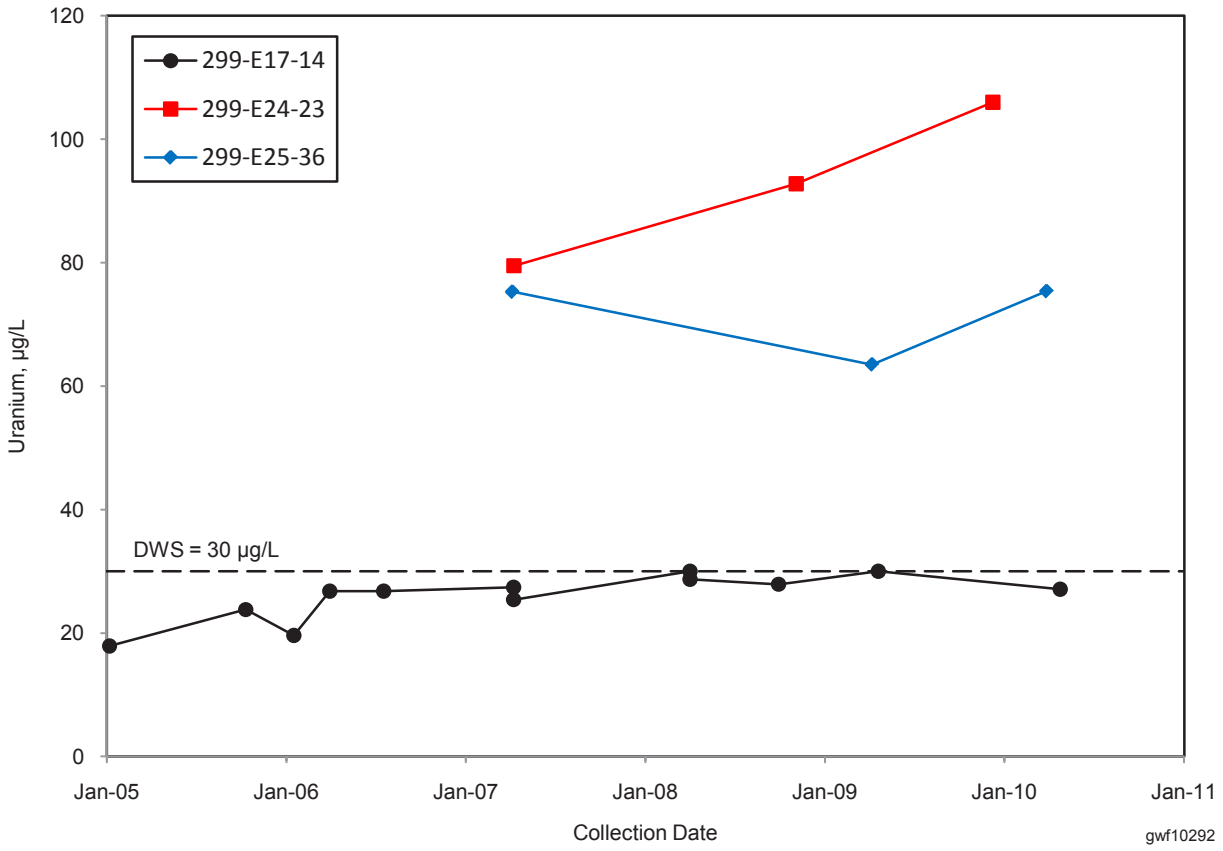


Figure 10-15. Cross Section of the Airborne Electromagnetic Geophysical Survey North of the 300 Area

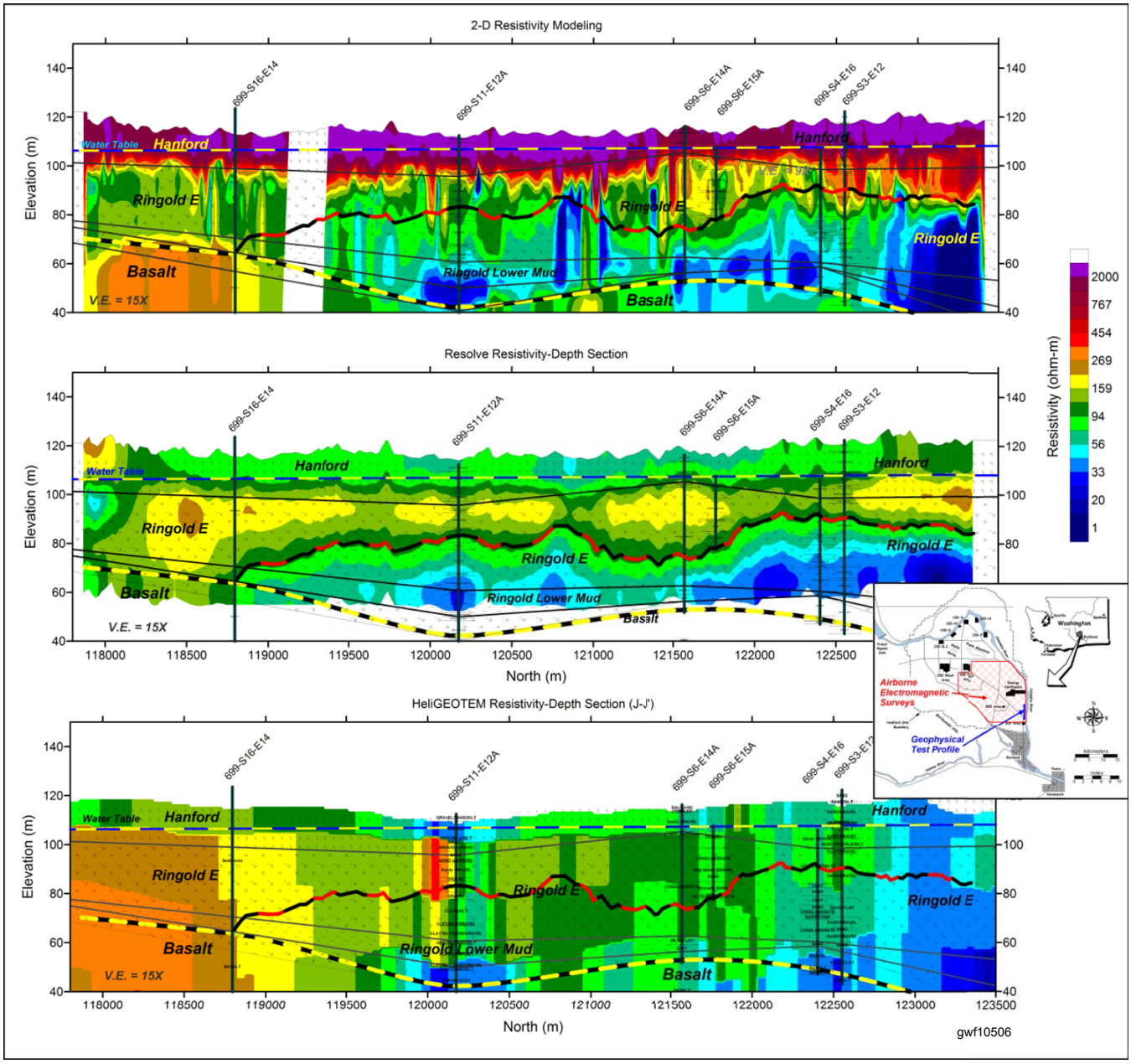


Figure 10-16. Nitrate Concentrations in Wells at 216-A-36B Crib

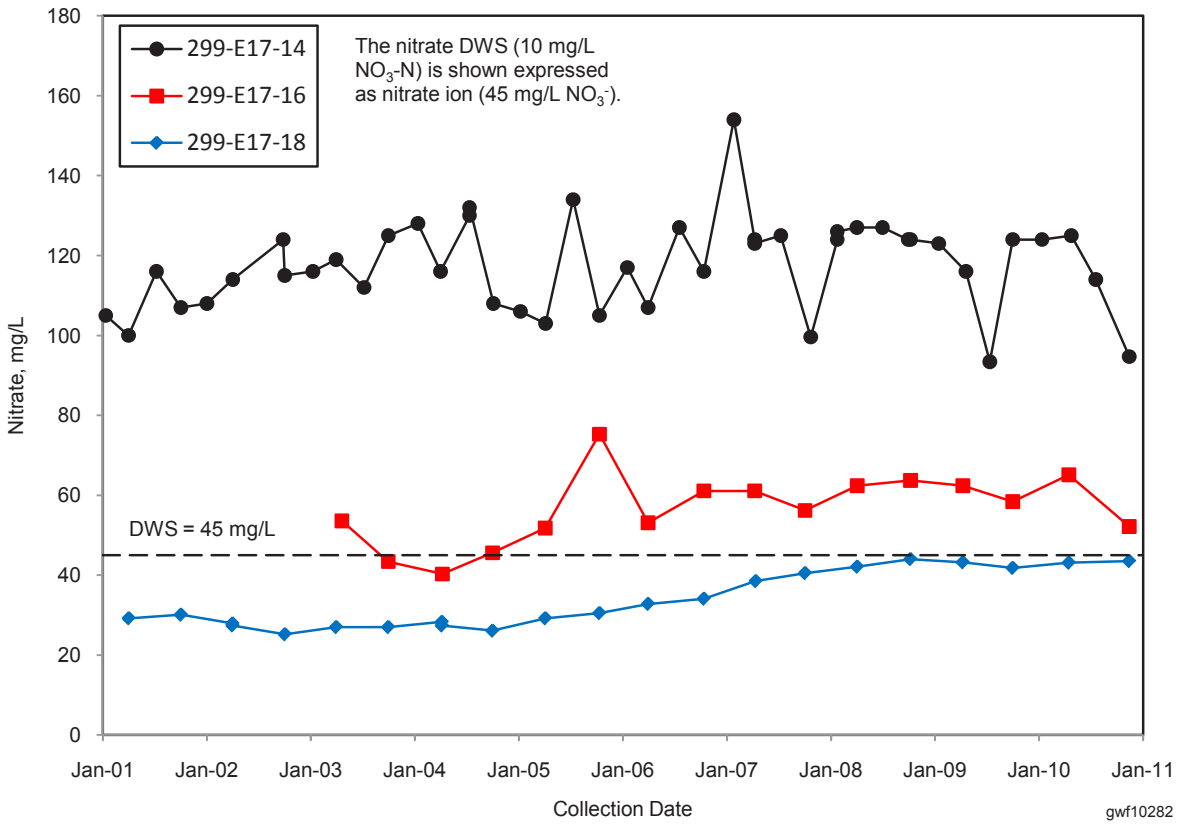


Figure 10-17. Nitrate Concentrations in Wells at 216-A-10 Crib

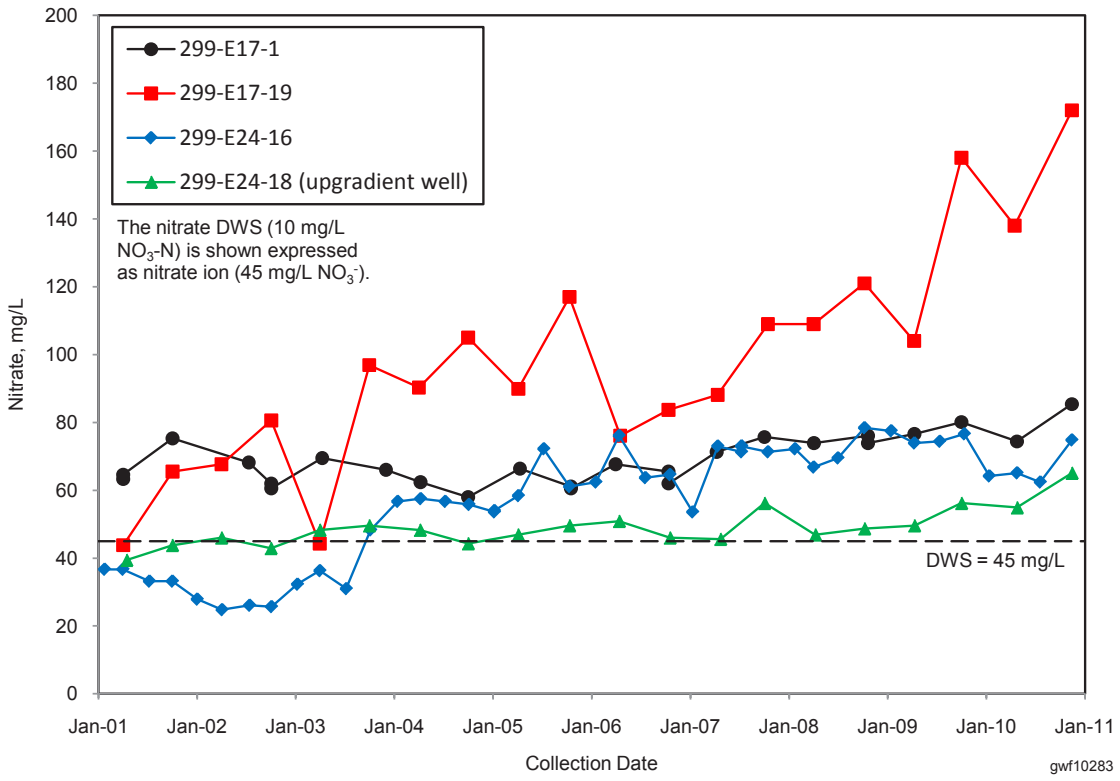


Figure 10-18. Nitrate Concentrations in Wells at 216-A-37-1 Crib

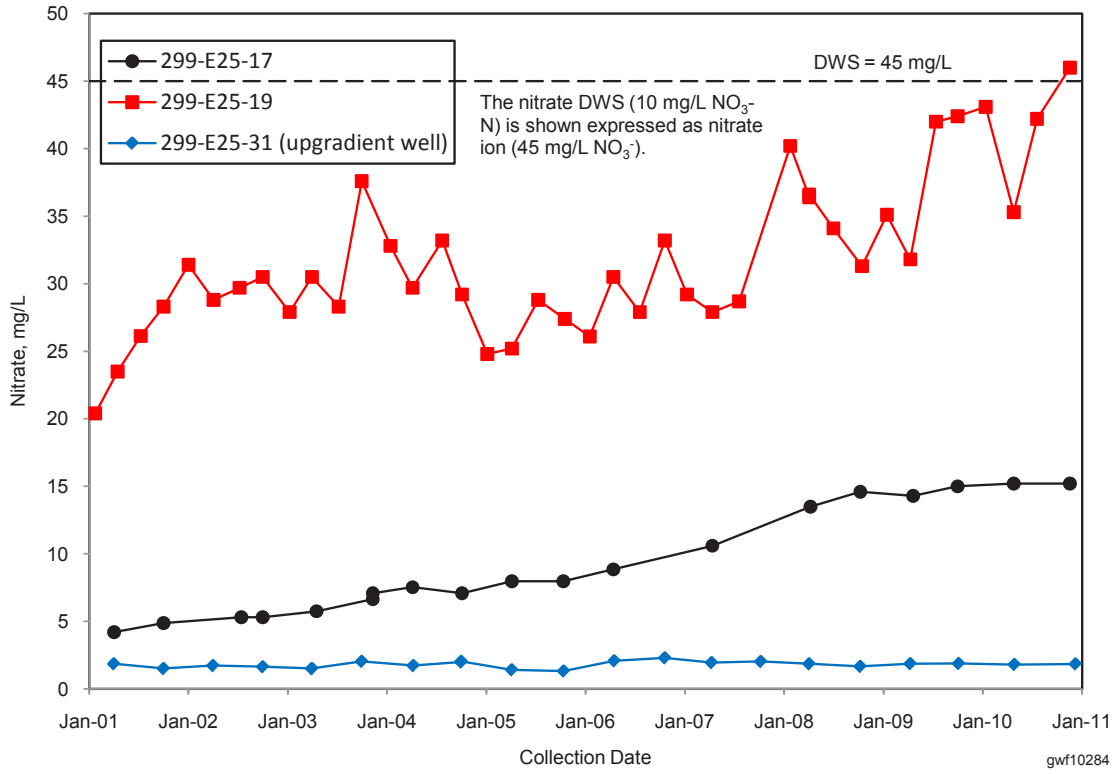


Figure 10-19. Total Organic Carbon Concentrations in Wells at Waste Management Area A-AX

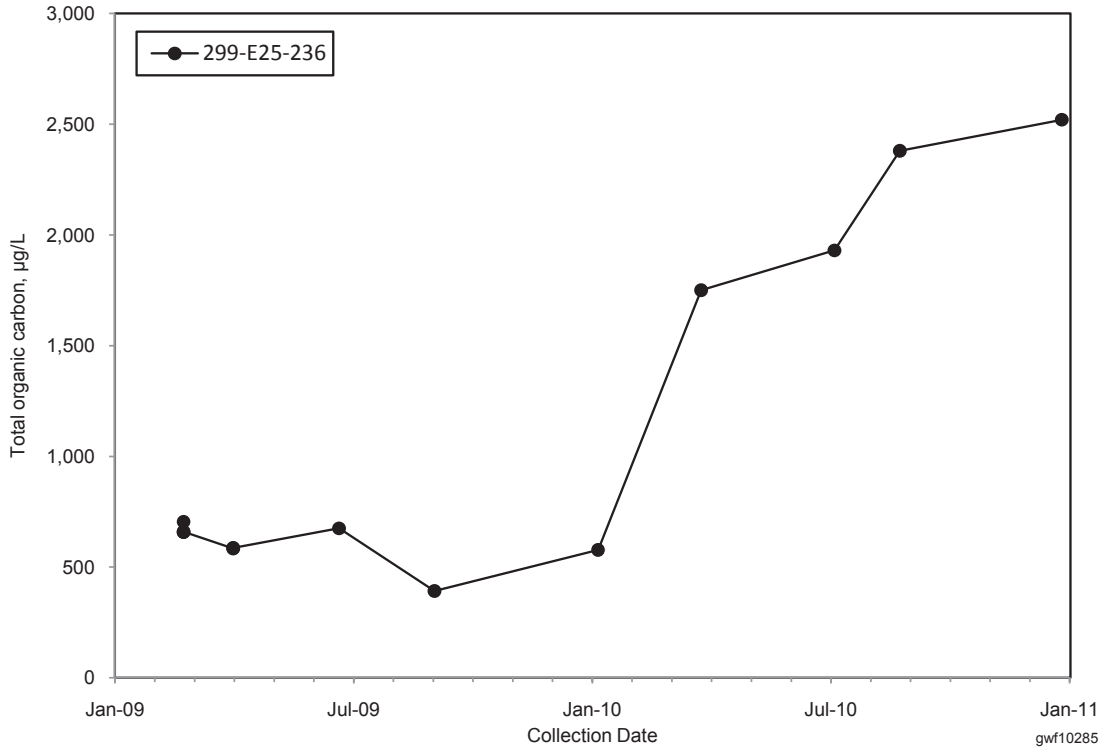


Figure 10-20. Nitrate Concentrations in Wells at Waste Management Area A-AX

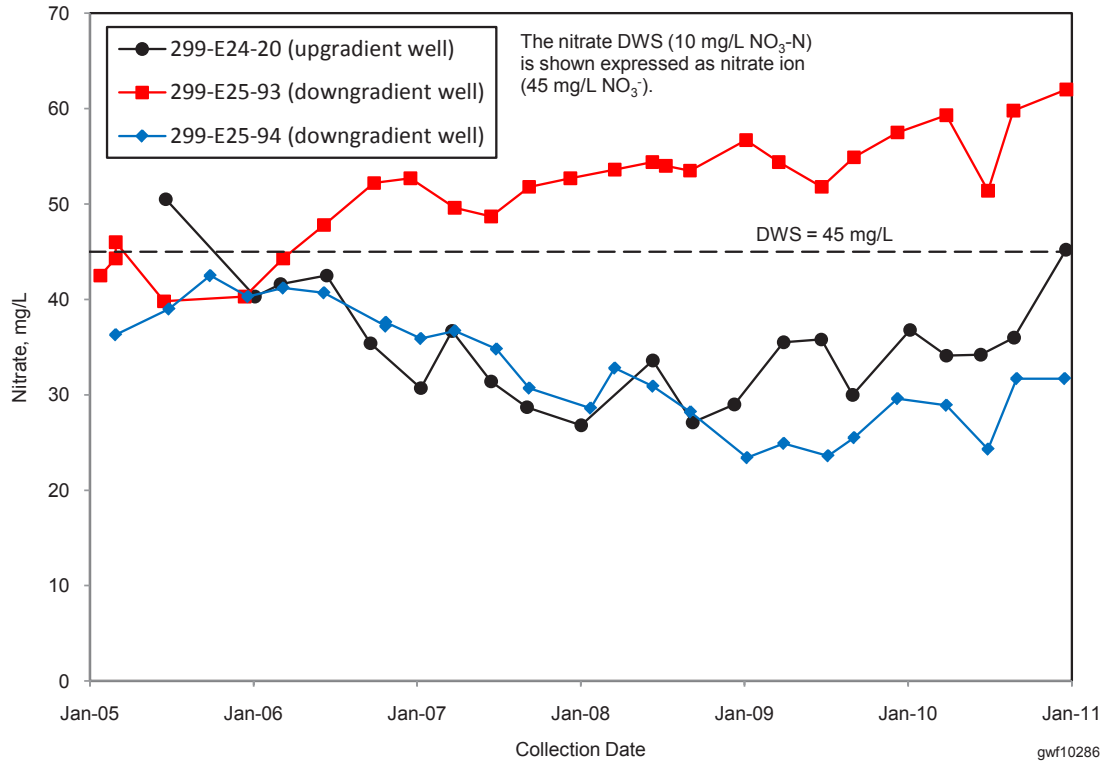


Figure 10-21. Technetium-99 Plume Map of Waste Management Area A-AX and Waste Management Area C

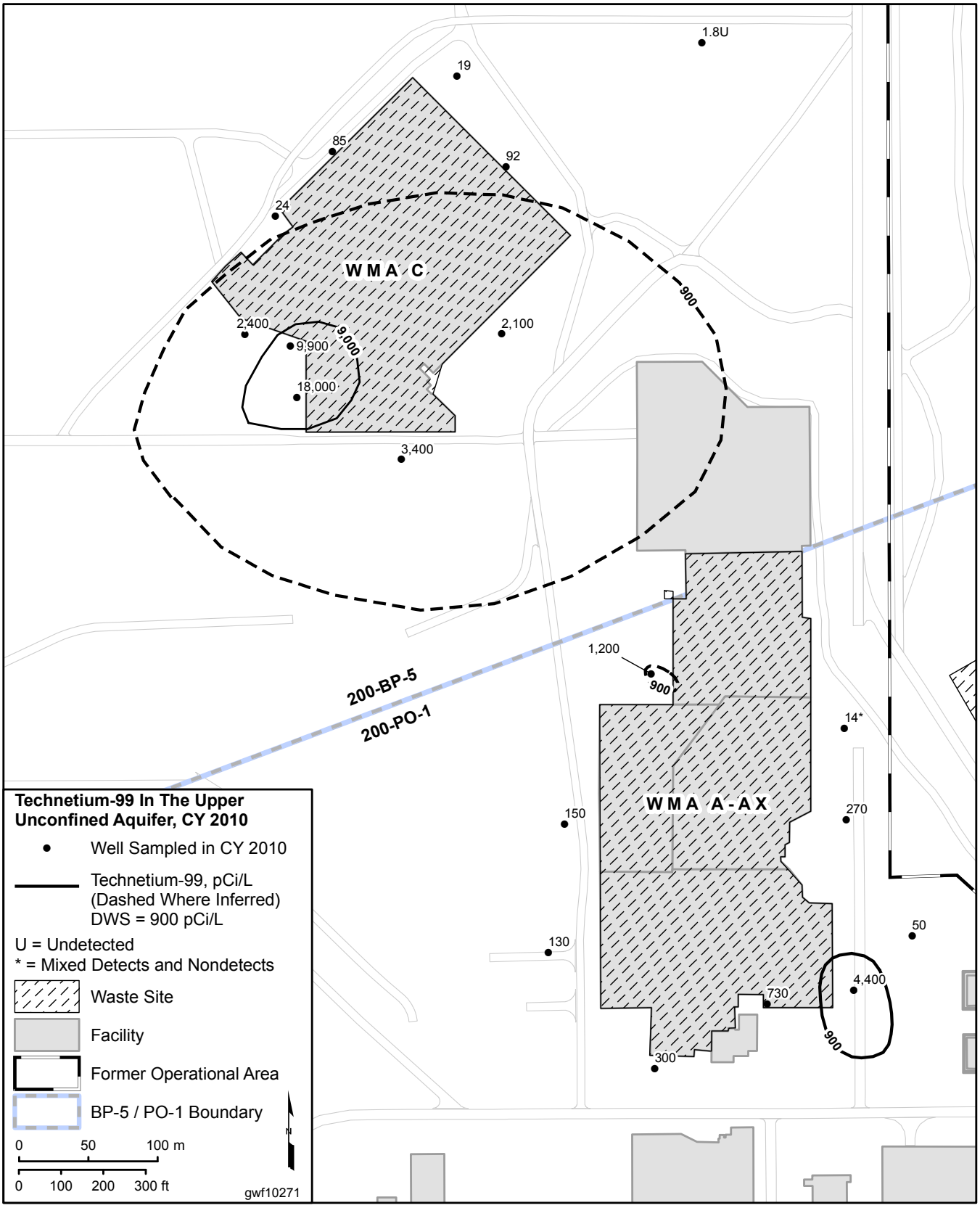


Figure 10-22. Major Anions and Specific Conductance in Well 299-E25-32P

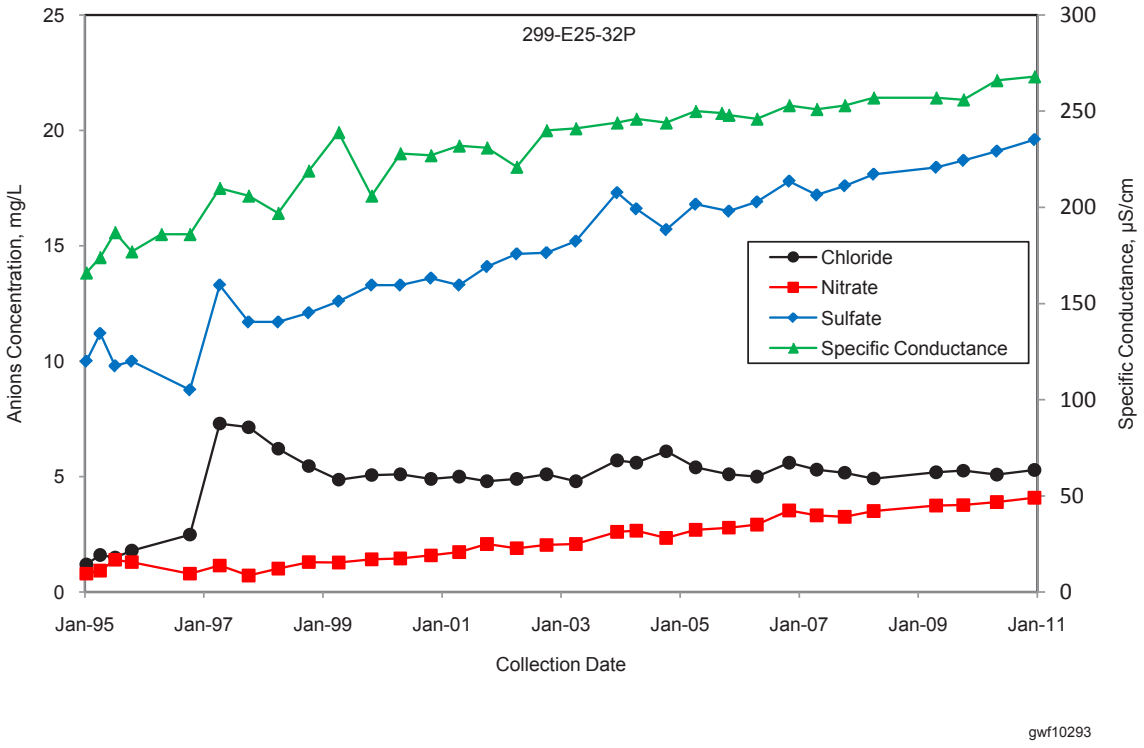


Figure 10-23. Specific Conductance in 216-A-29 Ditch Wells

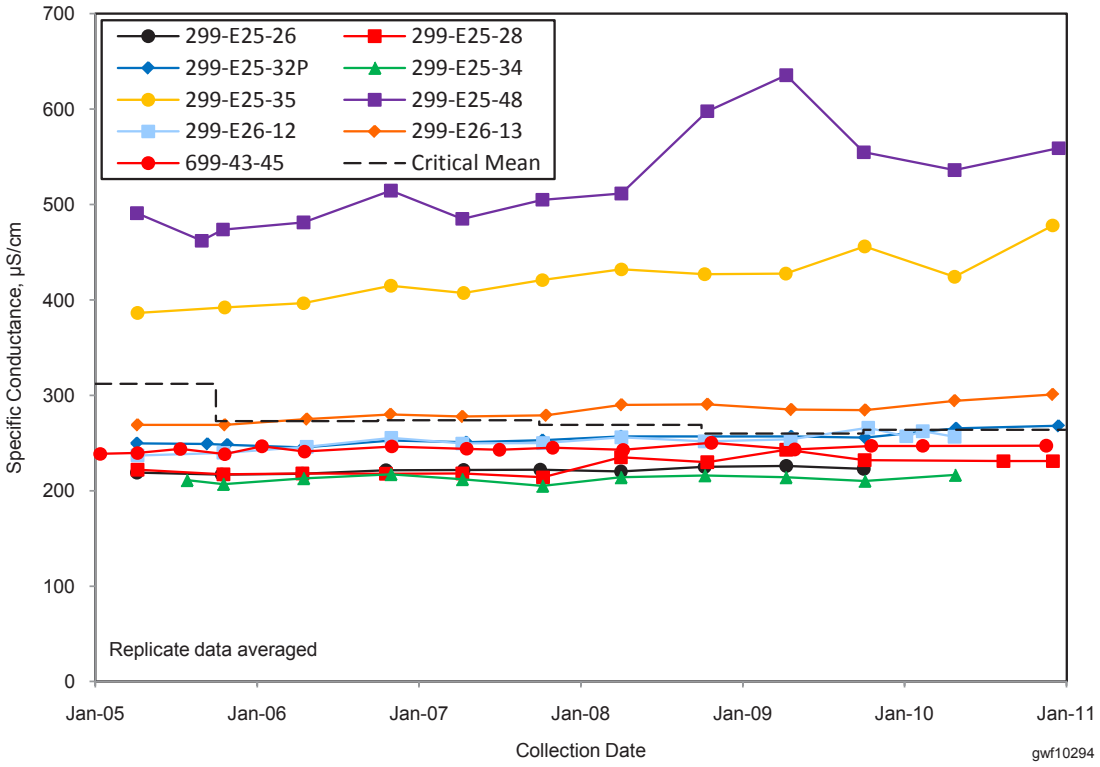
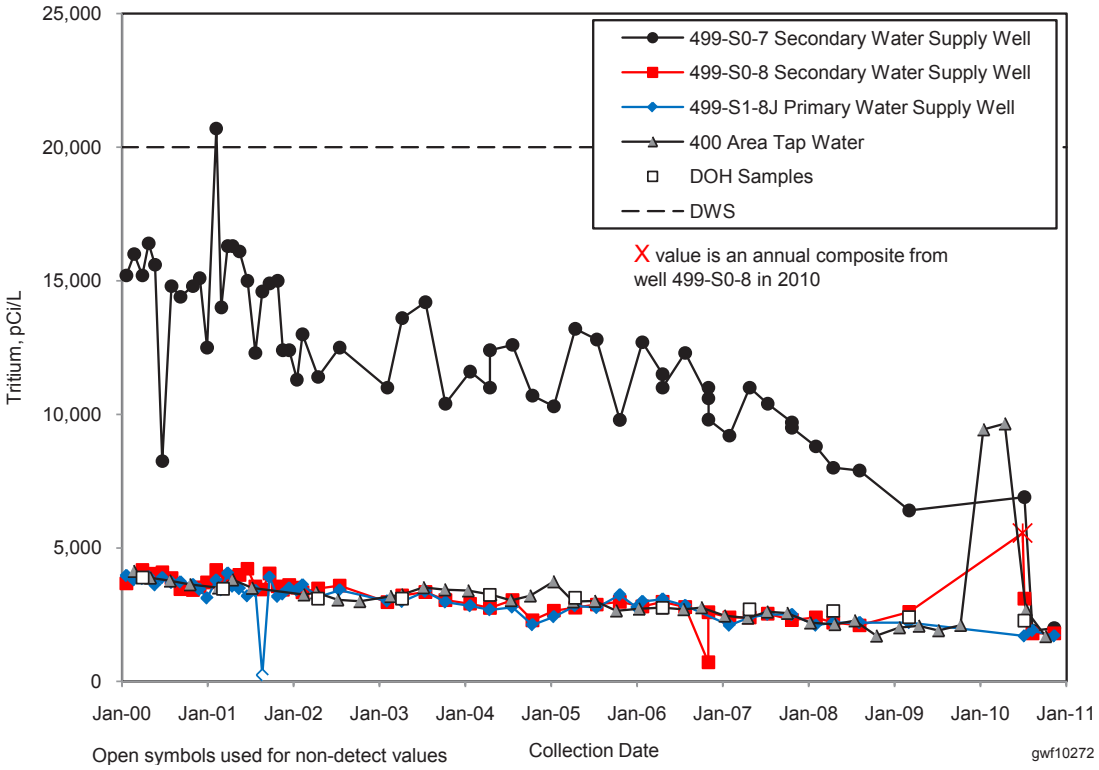


Figure 10-24. Tritium Concentrations in the Three 400 Area Water Supply Wells



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