2.11 200-PO-1 Operable Unit

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The scope of this section is the 200-PO-1 groundwater interest area, which includes the 200-PO-1 Operable Unit (see Figure 1.0-1 in Section 1.0). The "groundwater interest areas" are informal designations to facilitate scheduling, data review, and interpretation. This area encompasses the south portion of the 200 East Area and a large triangle-shaped portion of the Hanford Site extending to the Hanford town site to the east and to the 300-FF-5 groundwater interest area to the southeast. The 216-B-3 pond (B Pond) straddles two operable units but is considered part of the 200-PO-1 interest area. The BC cribs and trenches are completely outside of the 200-PO-1 Operable Unit, but potential groundwater contamination there is discussed in this section to ensure potential groundwater impact from these cribs and trenches is not overlooked. The location of local facilities and wells used in near-field monitoring of the southern 200 East Area are shown in Figure 2.11-1. The locations of wells used in the remainder of the 200-PO-1 Operable Unit far-field area and shoreline monitoring sites within the 600 Area are provided in Figures 2.1-1 and 2.11-2.

Tritium, nitrate, and iodine-129 are the contaminants of greatest significance in this operable unit.

Groundwater monitoring in the 200-PO-1 groundwater interest area includes the following monitoring activities:

CERCLA Monitoring (Appendix A)

- ***One-hundred twenty-two wells and six aquifer sampling tube sites (along the Columbia River) are sampled annually to triennially.***
- ***One new well was installed in FY 2007.***
- ***Two wells could not be sampled and three were delayed until October 2007; two aquifer tube sites could not be found.***

Facility Monitoring (Appendix B)

- ***Seven wells are sampled semiannually at the Integrated Disposal Facility.***
- ***Eleven near-field wells are sampled quarterly to semiannually at the RCRA PUREX cribs. Far-field wells are co-sampled with the 200-PO-1 Operable Unit. One well was delayed until October 2007.***
- ***Eight wells at the single-shell tank Waste Management Area A-AX are monitored quarterly.***
- ***Nine wells are sampled semiannually at the 216-A-29 ditch.***
- ***Four wells are sampled semiannually at the 216-B-3 pond (B Pond).***
- ***Three wells are sampled quarterly at the 200 Area Treated Effluent Disposal Facility under a Washington State waste discharge permit (WAC 173-216).***
- ***Nine wells are sampled semiannually at the Nonradioactive Dangerous Waste Landfill for RCRA monitoring.***
- ***Nine wells are sampled quarterly at the 600 Area Central Landfill under a Washington State permit (WAC 173-304).***
- ***Three water supply wells at the 400 Area are sampled quarterly to annually for AEA.***

Groundwater in the 200-PO-1 Operable Unit generally flows to the southeast and east.

Tritium, nitrate, and iodine-129 are the contaminants with the largest groundwater plumes. Other contaminants of concern in more localized areas include strontium-90 and technetium-99. Contaminants of potential concern include arsenic, chromium, manganese, vanadium, cobalt-60, cyanide, and uranium.

The primary monitoring objective is to meet the groundwater monitoring requirements for the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), *Resource Conservation and Recovery Act* (RCRA), Washington Administrative Code (WAC), and *Atomic Energy Act* (AEA) as directed in U.S. Department of Energy (DOE) Orders. The goal for the 200-PO-1 Operable Unit is to monitor the contaminants of concern (and potential concern) until final clean-up decisions are made. Included within the operable unit are six RCRA units including the Plutonium-Uranium Extraction (PUREX) cribs (called the RCRA PUREX cribs), Waste Management Area A-AX (single-shell tanks), 216-A-29 ditch, Integrated Disposal Facility, B Pond, and the Nonradioactive Dangerous Waste Landfill. Two other facilities that are not regulated under RCRA but are subject to WAC requirements are the 200 Area Treated Effluent Disposal Facility and the 600 Area Central Landfill (formerly called the 600 Area Central Landfill). Water supply wells in the 400 Area are monitored primarily for tritium under AEA.

Groundwater in the unconfined aquifer generally flows southeastward in the west portion of the operable unit and northeastward, eastward, and southeastward in the east portions of the operable unit as groundwater approaches the Columbia River (see Figure 2.1-2 in Section 2.1). A detailed discussion of 200 East Area hydrogeology can be found in PNNL-12261. Further discussion of more local groundwater flow characteristics are found in Section 2.11.3.

The remainder of this section describes contaminant plumes and concentration trends for the contaminants of concern under CERCLA, RCRA, AEA, and WAC monitoring.

2.11.1 Groundwater Contaminants

This section describes the major contaminants of concern within the 200-PO-1 Operable Unit including tritium, iodine-129, nitrate, strontium-90, technetium-99, and other contaminants of potential concern. Greater details at various RCRA or WAC facilities are discussed in Section 2.11.3.

Concentrations of tritium continue to decline in the far-field area as the plume is attenuating naturally.

2.11.1.1 Tritium

The principal source for the large tritium plume that extends from the southeast portion of the 200 East Area to the Columbia River (Figure 2.11-3 and Figure 1.0-2 in Section 1.0) is in the vicinity of the PUREX cribs.[a] The highest concentrations of tritium (drinking water standard 20,000 pCi/L) in this plume remain near these cribs (Figure 2.11-4). The highest reported level of tritium during fiscal year (FY) 2007 was 570,000 pCi/L for a sample collected April 2007 at well 299-E17-14 near the 216-A-36B crib.

Concentrations of tritium generally continue to decline in the far-field area as the plume attenuates naturally due to radioactive decay and dispersion combined with

(a) The term "PUREX cribs" refers to all the cribs in the southeast part of the 200 East Area and east of the 200 East Area where PUREX wastewater was discharged. Three of these cribs are monitored under RCRA and are termed RCRA PUREX cribs (see Section 2.11.3.2).

the generally decreasing source that resulted from the termination of PUREX Plant operations.[b] Wells in the east portion of the 200-PO-1 Operable Unit have tritium concentrations above 80,000 pCi/L (Figure 2.11-3) from an early period of discharge to the PUREX cribs (PNNL-11141). The area of the tritium plume with concentrations above 80,000 pCi/L in the eastern portion of the Hanford Site is ~18 square kilometers. Ten years ago this portion of the plume was over ~60 square kilometers. The wells within this portion of the plume are expected to continue to experience decreasing concentrations as portions of the plume with higher concentrations (representing the two periods of PUREX Plant operations) move beyond the wells into the river or decay and disperse. Modeling suggested that groundwater at this location will continue to be contaminated with tritium at levels greater than the drinking water standard for 40 to 50 years (PNNL-11801). These wells more distant from the source are sampled once every three years, and most were sampled during FY 2007. Wells in the south of the 200-PO-1 Operable Unit, immediately north of the 300 Area, also have decreasing tritium concentrations indicating that the southward migration of the plume has slowed or stopped because of the effects of dispersion and radioactive decay (see more about tritium near the 300 Area in Section 2.12.1.3).

Wells in the near-field area closer to the source of the tritium groundwater contamination have higher tritium concentrations than wells in the far-field area and show steady to rising trends (Figure 2.11-5). Well 299-E17-14 near the 216-A-36B crib had a decreasing trend until 2005 when it began to rise. Well 299-E24-16 near the 216-A-10 crib had a decreasing trend until 2002 when it began rising again. Tritium concentrations at well 299-E25-19 near the 216-A-37-1 crib have been relatively stable since approximately 1998. It is possible that the vadose zone near the 216-A-10 and 216-A-36B cribs is still contributing tritium to the unconfined aquifer. However, a more likely reason for the changing tritium concentrations in these near-field wells is changing groundwater flow directions after the cessation of waste water discharges at B Pond. Determining a precise groundwater flow direction in the vicinity of the PUREX cribs is not possible at this time due to the extremely flat water table there. Plans have been made to refine the regional water table map during FY 2008 in the southeast portion of the 200 East Area to more precisely map water table contours at a smaller contour interval, and in turn, provide a better indication of groundwater flow direction and flow rate (see Section 2.11.2 for more information on the plans to refine the water table map in the vicinity of the PUREX cribs).

Wells in the near-field area show steady to rising tritium trends.

The zone of lower tritium concentration near Energy Northwest (Figure 2.11-3) is suspected to be due to the effect of a zone of lower hydraulic conductivity in the unconfined aquifer where the water table is within the upper portion of the Ringold Formation that locally may have a greater degree of cementation. Tritium at the 618-11 burial grounds located just west of Energy Northwest is discussed in Section 2.12.1.3.

The 200-PO-1 Operable Unit wells screened below the upper parts of the unconfined aquifer (in the middle portions or lower portions of the unconfined aquifer) or deeper in confined aquifers generally show very little groundwater contamination with tritium. Tritium was not detected in wells at the 200 Area Treated Effluent Disposal Facility during FY 2007. The wells there are screened at the first occurrence

(b) There were two periods of PUREX Plant operation, i.e., 1956 to 1972 and 1983 to 1988.

of groundwater below the Ringold Formation lower mud unit where the aquifer is locally confined (i.e., potentiometric surface is within the lower mud unit). Well 499-S1-8J (a water-supply well in the 400 Area) is screened in the lower portion of the Ringold Formation (but not confined) and had tritium levels during FY 2007 that ranged from 2,100 to 2,510 pCi/L. The nearby well 499-S0-7, screened at the water table, had tritium values that ranged from 9,200 to 11,000 pCi/L during FY 2007. Tritium was not detected in the Laser Interferometer Gravitational Wave Observatory (LIGO) well (699-S2-34B), which is screened in a basalt-confined aquifer, in a sample taken during January 2007. Similarly, five other deep 200-PO-1 wells screened in basalt aquifers (and sampled triennially) showed no detectable tritium during FY 2006, the last time they were sampled.

The iodine-129 plume is dispersing, but at a very slow rate.

2.11.1.2 Iodine-129

The iodine-129 plume (Figures 1.0-4 in Section 1.0 and Figure 2.11-6) extends southeast into the 600 Area from the 200 East Area and appears to coincide with the tritium and nitrate plume (see Figures 1.0-2 and 1.0-3 in Section 1.0 and Figure 2.11-3). The iodine-129 plume is dispersing at a very slow rate. During FY 2007, the highest concentrations of the iodine-129 plume were near the sources of the plume, i.e., the PUREX cribs, where concentrations ranged from below the analysis method detection limit to 8.18 pCi/L in well 299-E17-14 (near the 216-A-36B crib) (Figure 2.11-6). The generally decreasing trend for iodine-129 at well 299-E17-14 (Figure 2.11-7) is typical of the gradually decreasing trend for iodine-129 in the vicinity of the PUREX cribs. Iodine-129 was not detected during FY 2007 in the few wells that sample deeper in the unconfined aquifer or during FY 2006 in wells screened in confined aquifers.

Historically, samples containing significant concentrations of technetium-99 required pretreatment to remove technetium-99 prior to iodine-129 analysis (see Section C.6.1 of PNNL-15070). Despite this practice, some nondetect values were greater than the drinking water standard (>1 pCi/L). During FY 2007, the analytical laboratory has changed their procedures to help alleviate this problem thereby generally reducing the minimum detectable activity to levels <1 pCi/L. This problem is discussed in greater detail in Section 1.8.

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

Iodine-129, 1 pCi/L — 53.8
Nitrate, 45 mg/L —0.66
Strontium-90, 8 pCi/L — 0.01
Technetium-99, 900 pCi/L — <0.01
Tritium, 20,000 pCi/L — 117.6
Tritium, 80,000 pCi/L — 17.8

2.11.1.3 Nitrate

The extent of the nitrate plume that originated in the 200 East Area (Figure 2.11-8 and Figure 1.0-3 in Section 1.0) is nearly identical to the tritium plume. However, the area with nitrate concentration above the drinking water standard (45 mg/L) is more restricted than the area with tritium above its drinking water standard (20,000 pCi/L). Nitrate at levels above the drinking water standard north of the 400 Area and at Energy Northwest, within the area impacted by the PUREX cribs, can be attributed to waste water disposal activities in those areas. The highest reported concentration of nitrate during FY 2007 within the 200-PO-1 interest area was at well 299-E17-14 (Figure 2.11-9) with a reported value of 154 mg/L in January 2007. The overall nitrate plume (Figure 2.11-8) appears to have receded slightly over previous years throughout most of its extent except for the southern-most portions of the plume near the 300 Area (see Figure 2.12-20 in Section 2.12) and in the immediate vicinity of the PUREX cribs (PNNL-16346; PNNL-15670) and Waste Management Area A-AX.

Wells near the PUREX cribs in the southeast portion of the 200 East Area continued to show stable or increasing nitrate trends during FY 2007. The trend at well 299-E24-16 near the 216-A-10 crib is typical of the increasing trend (Figure 2.11-10). The increase in nitrate concentration was also observed at a few wells near Waste Management Area A-AX (see Section 2.11.3.3). This increase in nitrate at some of the wells in the southeast portion of the 200 East Area most likely is due to changing groundwater flow conditions related to the cessation of wastewater discharges at B Pond. These increasing concentrations would be consistent with a reversal of nitrate-contaminated groundwater that moved northwestward in the PUREX cribs area during the active life of B Pond.

Nitrate was detected in wells that are deeper in the Ringold Formation unconfined aquifer or lower confined aquifer. However, none of the deeper wells had reported nitrate concentrations exceeding the drinking water standard (45 mg/L). At the Nonradioactive Dangerous Waste Landfill, nitrate concentrations were as high as 19.4 mg/L in well 699-26-35C, which is a well screened at the top of the low permeability unit (bottom of the unconfined aquifer there) in the Ringold Formation. Beneath the Ringold Formation lower mud unit at B Pond and the 200 Area Treated Effluent Disposal Facility (the uppermost aquifer there), nitrate concentrations continue to be lower (below 6.9 mg/L). In the lower portions of the unconfined aquifer beneath the 216-A-29 ditch (well 299-E25-28), the nitrate concentration was 1.7 mg/L. In the water supply well 499-S1-8J in the 400 Area, which is screened in the lower portion of the Ringold Formation, the nitrate level was 0.41 mg/L, which is near the method detection level. Nitrate remains undetected in the Laser Interferometer Gravitational Wave Observatory well (699-S2-34B) and in three other wells screened in the lower basalt aquifers beneath the 200-PO-1 interest area.

The strontium-90 plume near the 216-A-36 crib is very localized.

2.11.1.4 Strontium-90

A localized area of strontium-90 (a beta-emitter) contamination exists near the 216-A-36B crib (a PUREX crib). Well 299-E17-14 was the only well with strontium-90 concentrations above the 8-pCi/L drinking water standard during FY 2007, with a maximum of 19.2 pCi/L. The trend for strontium-90 in well 299-E17-14 shows an increasing trend from 1997 to 2001, and then a fluctuating trend that overall is neither increasing nor decreasing (Figure 2.11-11). The impact is localized because of the low mobility of strontium-90 compared to tritium, iodine-129, and nitrate.

2.11.1.5 Technetium-99

One well at Waste Management Area A-AX had technetium-99 levels ranging from 3,500 to 7,930 pCi/L during FY 2007, which is a decrease from FY 2006.

Technetium-99 (a beta-emitter) continues to be detected at Waste Management Area A-AX at levels far above the drinking water standard (900 pCi/L) and was detected indirectly (from gross beta measurements) at the PUREX cribs. Although most wells at Waste Management Area A-AX had technetium-99 levels below the drinking water standard, groundwater samples from well 299-E25-93 had technetium-99 concentrations ranging 3,500 to 7,930 pCi/L during FY 2007. The trend for technetium-99 in this well is decreasing (Figure 2.11-12). For more information about technetium-99 at Waste Management Area A-AX, refer to Section 2.11.3.3.

2.11.1.6 Other Constituents

Other constituents such as filtered arsenic, chromium, manganese, and vanadium are also contaminants of concern or potential concern at various facilities within the 200-PO-1 Operable Unit (DOE/RL-2003-04, Rev. 0). Chromium, cobalt-60, cyanide, and uranium are contaminants of potential concern at the BC cribs and trenches.

Filtered arsenic was detected at nearly every well analyzed, in concentrations ranging from 10.1 µg/L to the analysis detection level at 2 µg/L during FY 2007. However, these concentrations are not significantly different from Hanford groundwater background values (DOE/RL-96-61).

A plume of chromium entering the 200 East Area from the southwest may be causing increased dissolved chromium levels in the southwestern portion of the 200 East Area and BC cribs.

During FY 2007, the highest filtered chromium concentration in the 200-PO-1 Operable Unit was 42.1 µg/L at well 299-E25-37 near the 216-A-29 ditch, and nearly that elevated (41.6 µg/L) in well 299-E13-14 at the BC cribs. (The drinking water standard is 100 µg/L.) The result of 42.1 µg/L in well 299-E25-37 is higher than the historical trend for this well and is under further review. Chromium concentrations in wells at the BC cribs area and southwest 200 Area may be influenced by a plume of chromium entering the area from the west or southwest (see Section 2.9.1.7 and this report summary). The trend for filtered chromium at this well has been relatively stable since 2000.

Two wells in the 200-PO-1 Operable Unit had manganese concentrations that exceeded the 50-µg/L secondary drinking water standard during FY 2007. The highest concentration reported was from the Q-piezometer installed in well 299-E25-29 (that is screened in the lower portion of the unconfined aquifer near the 216-A-37-1 crib). The only result for a sample collected in that piezometer had a April 2007 result of 97 µg/L. Well 299-E25-20, which is also located near the 216-A-37-1 crib had an April 2007 result of 51.9 µg/L. The source of the manganese is unknown. It may be related to waste water discharges to the 216-A-37-1 crib or possibly to the deterioration of the well screen or casing. The trend for manganese in the nearby well 299-E25-19 shows elevated, but stable manganese levels since approximately 1998 (Figure 2.11-13).

Vanadium concentrations ranged in the 200-PO-1 Operable Unit from 8 µg/L at well 299-E18-1 (west of the Integrated Disposal Facility) to 47.2 µg/L at well 299-E25-22 near the Waste Management Area A A-AX and 45 µg/L at well 299-E25-41 near the 216-A-37-2 crib. In wells having enough values to establish trends, the trends appear to be stable to declining slightly. There is no drinking water standard for vanadium.

Contaminants of potential concern at the BC cribs and trenches were either not detected or were similar to background concentrations during FY 2007.

Groundwater monitoring results at the BC cribs and trenches for FY 2007 showed that the contaminants of potential concern (chromium, cobalt-60, cyanide, and uranium, as well as the other 200-PO-1 Operable Unit contaminants of concern) were either not detected or were similar to background concentrations. The only exception was chromium at well 299-E13-14 with results of 42 and 38 µg/L for samples collected in April 2007. Elevated chromium concentrations in the BC cribs area may be due to the chromium plume flowing into the area from the west or southwest (see previous chromium discussed in this section).

Although fluoride (4-mg/L drinking water standard) is not a contaminant of concern in the 200-PO-1 Operable Unit, it was reported at a concentration of 7.7 mg/L in well 699-S2-34B (the LIGO well – at the Laser Interferometer Gravitational-Wave Observatory, located in the south-central Hanford Site). This deep well is screened in a basalt-confined aquifer that is known to have elevated concentrations of fluoride. Since the well was first sampled in 2001, fluoride results ranged from 5.8 to 8.5 mg/L.

In recent years uranium has been increasing in concentration in the PUREX cribs area. The highest concentration during FY 2007 was reported in the new well (299-E24-23 installed at the 216-A-4 crib) with a result of 79.5 µg/L. The nearby well 299-E25-36 had a reported value of 75.3 μg/L for a sample collected April 2007. Although groundwater samples from these wells do not have enough historical results to establish a trend, the nearby well 299-E17-14 at the 216-A-36B crib, having uranium results since January 2005, shows a rising trend for uranium until 2006, and then stable since then (Figure 2.11-14).

In recent years uranium has been increasing in concentration in the PUREX cribs area.

2.11.2 Operable Unit Activities

The 200-PO-1 Operable Unit contains a large portion of the Hanford Site (Figure 1.0-1 in Section 1.0 and Figure 2.11-2). Its boundaries are generally defined by the largest contaminant plume of the operable unit – tritium. The north boundary is the line separating the 200-BP-5 Operable Unit with the 200-PO-1 Operable Unit in the 200 East Area and the 2,000-pCi/L tritium isopleth line that extends eastward to the Columbia River. The west or southwest boundary is the 2,000-pCi/L tritium isopleth line. The south boundary coincides with the north boundary of the 300-FF-5 Operable Unit, and east boundary is the Columbia River. The BC cribs and trenches, located south of the 200 East Area (Figures 2.11-1 and 2.11-2), are outside the 200-PO-1 Operable Unit boundary, but wells there are included in the 200-PO-1 Operable Unit monitoring network because it is the closest groundwater operable unit.

2.11.2.1 Status of CERCLA Five-Year Review Action Items

The second CERCLA five-year review was published in November 2006 (DOE/RL-2006-20). The review identified one issue and an associated action pertaining to the 200-PO-1 Operable Unit.

- **Issue 15**. Soil resistivity measurements have detected large regions of anomalously high soil conductivity in the area south of PUREX around the 216-A-4 crib and near the BC cribs and trenches.
  - **Action 15-1**. Complete data quality objective process and sampling plan to further characterize the high soil conductivity measurements detected at the BC cribs and trenches. The action due date is December 2007.

In FY 2007, the data quality objective process was completed and the report was released (SGW-34011) (see Section 2.11.2.2). A draft work plan is in the review process and is expected to be released in early FY 2008. The characterization sampling and analysis plan (containing the plans to further characterize the high soil conductivity measurements detected near the BC cribs and trenches) is included in the work plan as an appendix.

2.11.2.2 Remedial Investigation/Feasibility Study

Groundwater monitoring at the 200-PO-1 Operable Unit supports the remedial investigation/feasibility study process for the 200-PO-1 Groundwater Operable Unit. The goal is to monitor the groundwater contaminants of concern (and potential concern) under the guidance of the operable unit groundwater sampling and analysis plan (DOE/RL-2003-04, Rev. 1 or Rev. 2 when released) and any other sampling analysis plans generated by the remedial investigation/feasibility study process that require groundwater monitoring. During FY 2007, the only active sampling and analysis plan was DOE/RL-2003-04, Rev. 1, and the results of monitoring to that plan for FY 2007 are included in this report.

During FY 2006, work began on a data quality objectives report for groundwater remediation in the 200-PO-1 Operable Unit. That data quality objectives report

A data quality objectives report for groundwater remediation in the 200-PO-1 Operable Unit was completed in FY 2007.

(SGW-34011, Rev. 0) was completed during FY 2007, and work started on a work plan for a 2-year groundwater characterization study. Concurrently, a characterization sampling and analysis plan is being prepared to implement the requirements of the work plan. Groundwater monitoring in the characterization plan supplements (and does not overlap) groundwater monitoring activities already planned in the existing groundwater sampling and analysis plan (DOE/RL-2003-04). The work plan and companion characterization sampling and analysis plan are expected to be completed in FY 2008. Upon completion, groundwater monitoring for the remedial investigation/feasibility study for the 200-PO-1 Operable Unit will be conducted under the guidance of two sampling and analysis plans, (1) the existing groundwater sampling and analysis plan (DOE/RL-2003-04, Rev. 1) and (2) the characterization sampling and analysis plan.

Included in the characterization sampling and analysis plan is an effort to refine the water table map in the southeastern 200 East Area during FY 2008. Refinement of the water-table map for this area would be helpful to determine groundwater flow directions and flow rate because the water table there has an extremely low gradient. The gradient is so low that errors in measuring the depth to water are as large as, or larger than, the differences in water-table elevations between wells. Refining the water-table map for the southeastern portion of the 200 East Area will also assist in determining groundwater flow directions at RCRA sites at the Integrated Disposal Facility (Section 2.11.3.1) and PUREX cribs (Section 2.11.3.2). The solution is to decrease the amount of measurement error in determining water-table elevations at wells. Other than measurement variation caused by barometric effects, the two potential sources of significant error are (1) the surveys that provided well locations and elevations and (2) the deviation of the wells from vertical. (Note: For an error of 0.1 meter, a 100-meter well needs to be deviated only ~2.6 degrees from vertical.) Producing a corrected water-table map of the southeastern portion of the 200 East Area and interpreting groundwater flow directions will be attempted using the following three steps:

Efforts are underway to refine the water-table map for the southeastern 200 East Area.

- Resurvey well locations using state of the art methods to reduce vertical error to no more than 2 to 3 millimeters in a 100-meter well.
- Correct the depth-to-water measurements by checking the verticality of the wells using a down-hole gyroscope with an error of less than one degree.
- Conduct a trend surface analysis of the resulting water-table map to separate local from regional variability and determine any region trends on the water table surface (Davis 2002, p. 397-414).

2.11.2.3 Results of Operable Unit Monitoring for FY 2007

Groundwater monitoring results for the 200-PO-1 Operable Unit major contaminants of concern are discussed individually in Section 2.11.1. Results for the Southeast Transect, River Transect, and river aquifer tubes are discussed in the remainder of this section.

The 200-PO-1 Operable Unit sampling and analysis plan (DOE/RL-2003-04) specifies sampling of two lines of "guard wells" annually to screen for a comprehensive list of analytes. One of these lines of guard wells (the Southeast Transect) is located southeast of the 200 East Area (Figure 2.11-2) and ensures that unexpected contaminants do not migrate out of the 200 East Area undetected. The other line (the River Transect) is located along the Columbia River (Figure 2.11-2).

Its purpose is to assess the concentration of any groundwater contamination that may reach the river. The comprehensive list of analytes for both transects includes iodine-129, tritium, anions (including nitrate), gross alpha and beta, gamma scan, metals strontium-90, and volatile organic compounds.

The only constituents exceeding drinking water standards at the southeast transect during FY 2007 were iodine-129, pH, and tritium.

At the southeast transect, barium, calcium, chloride, chromium, fluoride, gross alpha and beta, iodine-129, iron, magnesium, manganese, nitrate, potassium, sodium, strontium, sulfate, and tritium were detected in groundwater samples during FY 2007. Many of these groundwater constituents occur naturally. A few volatile organic compounds were possibly detected at well 699-26-33 located near the Nonradioactive Dangerous Waste Landfill, but these were estimated values because they were at levels very close to the analysis method detection limit (see Section 2.11.3.7 for more information about volatile organic compounds at the Nonradioactive Dangerous Waste Landfill). The only constituents exceeding drinking water standards were iodine-129 in two wells, pH in one well, and tritium in four wells. The iodine-129 and tritium exceedances were consistent with their locations within the major iodine-129 and tritium plumes coming from the 200 East Area (see Sections 2.11.1.1 and 2.11.1.2). The elevated pH was in well 699-31-31 where the pH level has been gradually rising since 1990. Although well was reconditioned to collect groundwater samples near the water table (it formerly had two piezometers), the groundwater chemistry of samples collected from this well (including the elevated pH values) appear to be typical of groundwater deeper in the aquifer.

At the River Transect, seventeen groundwater constituents were detected, most of which are typical of background values. The detected constituents include barium, calcium, chloride, chloroform, fluoride, gross alpha and beta, iron, magnesium, manganese, nitrate, pH, potassium, sodium, strontium, sulfate, and tritium. Only pH (in one well) and tritium (in two wells) exceeded drinking water standards. The two wells where tritium exceeded the 20,000 pCi/L drinking water standard (699-41-1A and 699-46-4) are located near the Hanford town site. These results are consistent with known concentrations of the site-wide tritium plume at this location (see Section 2.11.1.1). The elevated pH (9.3) at well 699-20-E12O is similar to nature of the occurrence at well 699-31-31 in the Southeast Transect. In both cases the elevated pH is associated with wells that are older, complex wells with multiple piezometers, but the origin of the elevated pH is unknown.

Tritium and pH exceeded drinking water standards at the River Transect during FY 2007.

Three of the original six aquifer tube locations (84, 85, and 86) near the Hanford town site (see Figure 2.11-2 for location of the aquifer tubes) were sampled as scheduled during FY 2007. Aquifer tubes at the other three locations were either lost or destroyed since prior sampling in FY 1997. The specific tubes sampled at the three sites were 84-D, 85-M and 86-M.[c] Detected groundwater constituents included chloride, fluoride, gross alpha and beta, nitrate, sulfate, technetium-99, and tritium. None of these detected constituents had concentrations exceeding drinking water standards. The highest tritium and nitrate concentrations were 11,000 pCi/L and 9.4 mg/L (respectively) at aquifer tube 86-M. The highest technetium-99 level was 7.1 pCi/L, in a sample collected also from aquifer tube 86-M.

Three additional wells were sampled in the 200-PO-1 Operable Unit during FY 2007 in order to take advantage of two boreholes drilled to characterize the vadose

(c) Typical sampling practice for aquifer tubes is to collect water samples at a given aquifer tube location from the tube with the highest specific conductance (which, in turn, would provide samples with the highest groundwater to river water ratio).

A vadose zone exploratory borehole at the 216-A-4 crib was completed as a groundwater monitoring well.

zone near the 216-A-2 and 216-A-4 cribs (for locations see Figure 2.11-1) within the 200-MW-1 surface operable unit and another well scheduled for decommissioning. The vadose zone exploratory borehole at the 216-A-4 crib was completed as a groundwater monitoring well (compliant with WAC 173-160) that was screened at the water table. When completed, the new well was developed and sampled. The vadose zone exploratory borehole at the 216-A-2 crib was drilled to the water table but was not completed as a well. However, a grab sample of groundwater was collected prior to backfilling the borehole. Well 299-E23-2 located in the western portion of the 200-PO-1 Operable Unit, which had not been sampled since 1987 and was scheduled for decommissioning, was sampled one last time.

The new well at the 216-A-4 crib had elevated iodine-129, nitrate, tritium, and uranium.

Groundwater samples from all three of the additional wells sampled were analyzed for a comprehensive list of potential groundwater contaminants (44) in order to be consistent with future site characterization planned in the work plan and characterization sampling and analysis plan discussed in Section 2.11.2.1 above. Analysis results were mostly typical of what would be expected for their locations. In well 299-E23-2, the only groundwater constituent above its drinking water standard was manganese (50 µg/L maximum contaminant level) with a reported value of 90 µg/L. Elevated levels of manganese are common in older, Hanford Site wells that were constructed of carbon steel casing and do not meet WAC 173-160 construction standards. The grab sample from the borehole drilled at the 216-A-2 crib had elevated iodine-129 (6.2 pCi/L), manganese (119 µg/L), nitrate (69.5 mg/L) and tritium (601,000 pCi/L). All four constituents exceed their respective drinking water standards. Except for manganese the results are typical of other wells in the vicinity. Manganese is often elevated in boreholes or wells sampled soon after drilling. The new well at the 216-A-4 crib (299-E24-23) had elevated iodine-129 (5.2 pCi/L), nitrate (64 mg/L), tritium (420,000 pCi/L), and uranium (80 µg/L). The uranium concentration is higher than surrounding wells, but uranium has been increasing in nearby wells in recent years. A sample collected from the nearby well 299-E25-36 in April 2007 had a reported uranium concentration of 75 µg/L. Another nearby well (299-E17-14 located near the 216-A-36B crib) has a potentially rising uranium trend (Figure 2.11-14) with FY 2007 results of 25 and 27 µg/L (for more information about uranium, see Section 2.11.1.6).

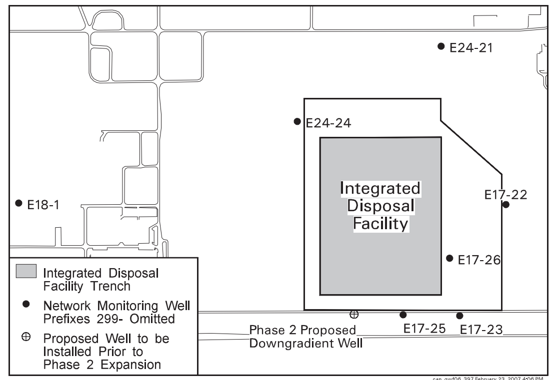
2.11.3 Facility Monitoring

This section describes results of monitoring individual facilities such as treatment, storage, or disposal units. Groundwater at some of these facilities is monitored under the requirements of RCRA for hazardous waste constituents and AEA for radionuclides including source, special nuclear, and by-product materials. Data for facility-specific monitoring are also integrated into the CERCLA groundwater investigations. Groundwater data for these facilities are available in the Hanford Environmental Information System (HEIS 1994) and on the data files accompanying this report. Additional information including well and constituent lists, maps, flow rates, and statistical tables are included in Appendix B.

The 200-PO-1 Operable Unit contains six RCRA sites, two sites regulated by the WAC, and one site regulated exclusively under AEA groundwater requirements. This section summarizes results of statistical comparisons, assessment studies, and other developments for FY 2007.

2.11.3.1 Integrated Disposal Facility

Construction of the Integrated Disposal Facility began in September 2004 and was completed in April 2006. DOE submitted a Part B RCRA permit application to the Washington State Department of Ecology (Ecology), and it was incorporated into the Hanford Facility RCRA Permit on April 9, 2006. The Integrated Disposal Facility operation is scheduled to begin in 2010.



The objective of RCRA and operational monitoring at the Integrated Disposal Facility is to determine whether the facility has impacted groundwater quality. The facility is not yet operational, and the current monitoring is directed at obtaining background values for monitored constituents. The current groundwater monitoring network consists of seven wells (Appendix B). Another well remains to be installed at a future date when required by facility expansion.

The Integrated Disposal Facility consists of an expandable, double-lined landfill with ~7 hectares of liner. The facility is located in the south-central part of 200 East Area (see Figure 2.11-1 for location of the site and Appendix B for a list of network wells, their locations, and groundwater constituents monitored). The landfill is divided lengthwise (north/south) into two distinct cells, one for the disposal of low-level radioactive waste (east cell) and the other for the disposal of mixed waste (west cell). 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 by 160 meters in length and up to 15 meters deep. The landfill will contain four layers of waste containers separated vertically by 0.9 meter of soil. The current waste disposal capacity is ~163,000 cubic meters. The waste will be segregated into a RCRA-permitted side and a non-RCRA-permitted side.

Current monitoring at the Integrated Disposal Facility is directed at obtaining background values for monitoring constituents.

The delineation of groundwater flow directions and water-table gradients are difficult to estimate for the 200 East Area from water-level data due to a flat water table. 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 to 0.0075 meter/day (see Appendix B).

Work planned for FY 2008 is designed to better understand the groundwater flow direction beneath the Integrated Disposal Facility. Gyroscope surveys will be completed on five of the monitoring wells (well 299-E17-26 and 299-E24-24 had gyroscope surveys completed in 2005). Also, new vertical elevation surveys will be done on all seven wells in the network. Finally, the Integrated Disposal Facility monitoring wells will be fitted with pressure transducers (to determine water level) for about one month to determine the response of each well to changes in barometric pressure. Afterward, the monitoring network will be scheduled for quarterly water level measurements. This detailed work will allow better definition of the water table in the area. (See Section 2.11.2.2 for more information on refining the regional water-table map in the southeastern portion of the 200 East Area.)

The Integrated Disposal Facility operational monitoring plan was published in 2005 (RPP-PLAN-26534). That plan called for analyses of gross alpha, gross beta, technetium-99, and iodine-129 in groundwater. Therefore, these constituents were

Groundwater monitoring at the Integrated Disposal Facility during FY 2007 included semiannual sampling (four independent sampling events each 6-month period).

added to the list of RCRA indicator parameters and supplemental groundwater quality parameters (alkalinity, anions, metals, temperature, and turbidity) for analysis. The complete sampling schedule including all constituents and sampling frequency is in Appendix B.

All groundwater monitoring wells in the Integrated Disposal Facility monitoring network initially were sampled twice quarterly for one year (June 2005 through May 2006) to determine baseline conditions. This was followed by collection of semi-annual samples (four independent sampling events each 6-month period) and semi-annual sampling continued throughout FY 2007. A RCRA permit modification is being finalized to reduce the number of independent samples from 8 per year to two per year during the pre-active life of the facility. Once the facility becomes active, groundwater monitoring will revert to the four samples per each 6-month period schedule.

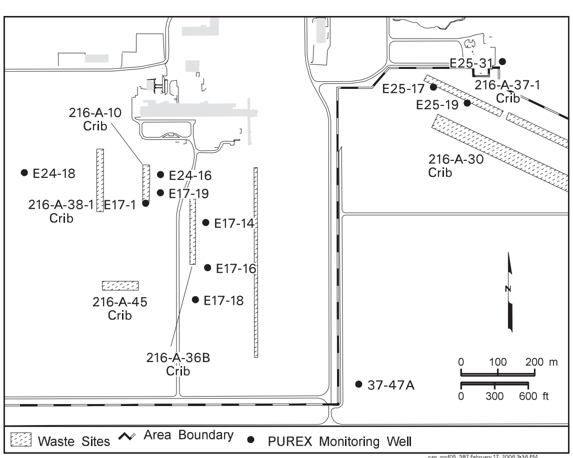
The Integrated Disposal Facility monitoring wells were sampled as scheduled in FY 2007 with the exception of most samples for AEA radionuclide analyses because of an administrative error. The laboratory has been asked to use groundwater left from other analytes to run the radionuclide analyses where possible, but results were not available at the writing of this report.

Permit condition III.11.E.1.a. requires "For the first sampling event (and only the first), samples for each well will include all constituents in 40 CFR 264 Appendix IX." The complete Appendix IX list was not obtained in July 2005 (the first year) but was analyzed in January 2007 instead. All data were received back from the laboratory by April 2007. No Appendix IX constituent had a concentration above the drinking water standard and only 79 of the 2,148 results were detectable (most of which had one or more data qualifiers).

Only iodine-129 and nitrate exceeded drinking water standards at the Integrated Disposal Facility during FY 2007.

Iodine-129 exceeded the drinking water standard (1 pCi/L) in one sample from well 299-E17-22 during FY 2007. The concentration was 1.08 pCi/L. This well is very near the edge of the regional 200 East Area iodine-129 plume, and the iodine-129 in the well most likely came from the nearby PUREX cribs.

Nitrate concentrations were routinely near or above the drinking water standard (45 mg/L) in samples from wells 299-E24-21, 299-E24-24, and 299-E17-22 during FY 2007. The highest nitrate concentration was 69.5 mg/L in well 299-E24-24. These wells are in the regional 200 East nitrate plume that is presumed to originate from the PUREX cribs east of the Integrated Disposal Facility (see Section 2.11.3.2).



2.11.3.2 RCRA PUREX Cribs

The RCRA PUREX cribs are located in the southeast part of the 200 East Area and include three cribs (216-A-10, 216-A-36B, and 216-A-37-1; Figure 2.11-1) monitored under RCRA interim status to assess groundwater quality. Other nearby cribs also received PUREX waste (e.g., 216-A-45 crib) but are not regulated as RCRA treatment, storage, or disposal units. They are monitored collectively under the 200-PO-1 Operable Unit.

The objective of RCRA monitoring at these cribs is to assess the nature and extent of groundwater contamination with hazardous constituents and determine their rate of movement in the aquifer per (40 CFR 265-93(d) as referenced by WAC 173-303-400). Groundwater monitoring under AEA tracks radionuclides at the cribs and surrounding vicinity, and is reported under the 200-PO-1 Operable Unit (see Section 2.11.1). Appendix B includes a well location map and list of wells and constituents monitored for the RCRA PUREX cribs. The RCRA PUREX cribs groundwater monitoring plan is PNNL-11523.

The objective of RCRA monitoring at the PUREX cribs is to assess the nature and extent of groundwater contamination with hazardous constituents and determine their rate of movement in the aquifer.

Groundwater flow direction in the vicinity of the two west cribs (216-A-10 and 216-A-36B) is most likely toward the southeast; in the vicinity of the 216-A-37-1 crib, it is estimated to be to the south or southwest. These flow directions are supported mainly by the distribution of the tritium, nitrate, and iodine-129 plumes emanating from the vicinity of these cribs. (See Appendix B for more information on flow direction and rate and Section 2.11.2.2 for information on plans for refining the water-table map in the southeastern portion of the 200 East Area.) The RCRA PUREX cribs are located in a region where several groundwater contamination plumes contain constituents that exceed drinking water standards. The similarities in effluent constituents disposed to these cribs, as well as to the 216-A-45 crib, make determining the contribution of the RCRA PUREX cribs difficult.

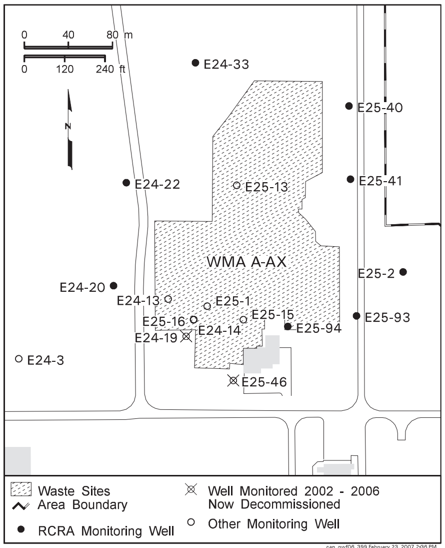
During FY 2007, all groundwater samples were collected as scheduled. Nitrate and iron were the only hazardous waste constituents exceeding drinking water standards. The nitrate drinking water standard (45 mg/L) was exceeded at seven of the 11 near-field monitoring wells during FY 2007, including the background well 299-E24-18 to the west. The highest concentration of nitrate in the RCRA PUREX cribs near-field monitoring network was 154 mg/L at well 299-E17-14 located near the 216-A-36B crib. The trend for nitrate in this well is stable to slightly increasing in concentration (Figure 2.11-10). Nitrate in downgradient wells is generally higher in concentration than in upgradient wells, which provides further evidence that the PUREX cribs are most likely the source for the large nitrate plume extending east and southeast to the Columbia River (see Section 2.11.1.3 for more information about nitrate in the 200-PO-1 Operable Unit).

The secondary drinking water standard for iron (300 µg/L) was exceeded at two wells located near the 216-A-37-1 crib during FY 2007. The highest concentration was 366 µg/L for a filtered sample collected from well 299-E25-19. This result is not consistent with historical trends at this well and is undergoing further review. The nearby well 299-E25-17 had the second to highest iron concentration with a reported value of 346 µg/L, but it was for an unfiltered sample. Elevated iron is relatively common in unfiltered groundwater samples from older Hanford Site wells (i.e., having carbon steel casings and not compliant with WAC 173-160).

None of the required groundwater quality constituents required by WAC 173-303-400 (chloride, iron, manganese, phenols, sodium, and sulfate) exceeded their respective drinking water standards during FY 2007, other than the anomalously elevated iron values in wells 299-E25-17 and 299-E25-17 (mentioned above). None of the phenols analyzed were detected. Both chloride and manganese are generally higher in concentration in downgradient wells than in upgradient wells possibly indicating a local source.

2.11.3.3 Single-Shell Tank Waste Management Area A-AX

Waste Management Area A-AX is located on the east-central border of the 200 East Area (see Figure 2.11-1) and consists of the A and AX Tank Farms, the 244-AR Vault and ancillary equipment (seven diversion boxes and waste transfer lines). The



farms contain ten 3.79-million-liter tanks constructed in 1954 and 1955. Five of the tanks in the waste management area are known or suspected to have leaked in the past. A well location map and a table of wells and analytes for this waste management area are shown in Appendix B.

Waste Management Area A-AX was placed in RCRA assessment monitoring (40 CFR 265.93(d) as referenced by WAC 173-303-400) because of elevated specific conductance in downgradient well 299-E25-93 in June 2005. The current groundwater assessment plan is PNNL-15315. The objective of RCRA groundwater monitoring at Waste Management Area A-AX is to assess if dangerous waste or dangerous waste constituents from the A and/or AX Tank Farms have compromised groundwater quality. Results from the Tank Farm Vadose Zone Project field characterization work inside the waste management area with further characterization conducted for the 200-PO-1 Operable Unit remedial investigation/feasibility study will assist in source determination of groundwater degradation at this site.

The objective of RCRA groundwater monitoring at Waste Management Area A-AX is to assess if dangerous waste or dangerous waste constituents from the A and/or AX Tank Farms have compromised groundwater quality.

The groundwater monitoring network for Waste Management Area A-AX consists of seven wells that are compliant with WAC 173-160 (RCRA-compliant) and one that is not compliant. The aquifer thickness is ~27 meters, while the saturated screened intervals range from 10.4 to 1.5 meters in RCRA-compliant wells. Based on five network wells, the average water table decline during FY 2007 was 5 centimeters, the same as FY 2006. Based on regression fits to water elevation data from 1991 to the present, replacement of older RCRA-compliant wells will not be required for over 15 years. This time estimate is valid only if the current rate of decline continues. During FY 2007, there were no changes in flow direction and only a slight increase in the estimated flow rate (see Appendix B, Table B.2). The flow direction, determined from local water levels, in situ flow measurements, and plume tracking ranges from east southeast to southeast (PNNL-14187). Independent results on flow direction reported in RPP-23740 confirm a southeast flow direction.

Potential dangerous waste constituents found beneath Waste Management Area A-AX in FY 2007 are nitrate and sulfate. Concentrations for both anions are below the drinking water standard (45 mg/L and 250 mg/L, respectively) except in one location, downgradient well 299-E25-93, where the June 2007 nitrate value was 48.7 mg/L. Technetium-99 concentrations in June 2007 were above the drinking water standard (900 pCi/L) in two wells, the upgradient well 299-E24-33 (994 pCi/L) and downgradient well 299-E25-93 (6,550 pCi/L).

Potential dangerous waste constituents found beneath Waste Management Area A-AX in FY 2007 are nitrate and sulfate.

In general, there were no significant changes in nitrate or technetium-99 during FY 2007 at Waste Management Area A-AX. Based on a time series of contaminant distributions, nitrate and technetium-99 values appear to separate into two separate plumes, one under the A Tank Farm in the south and one at the AX Tank Farm in the north (Figures 2.11-15 and 2.11-16) . For example, in Figure 2.11-15, the highest nitrate concentrations at the site were found in the south at both upgradient and downgradient wells, monitoring the A Farm. Note the migration of the nitrate high seen in upgradient well 299-E24-20 at 51 mg/L in June 2005 to the southeast at downgradient well 299-E25-93 in June 2006 where it remains through FY2007. The nitrate trends, shown in Figure 2.11-17, also illustrate the distinctively higher nitrate values around this tank farm (see trends in wells 299-E24-20, 299-E25-93 and 299-E25-94). Because the nitrate is also elevated upgradient of the site, it is likely some portion of the nitrate in the downgradient wells is from an upgradient source. In the north, the nitrate trends are relatively flat with the exception of well 299-E25-2, which increased slightly from 13.7 to 17.4 mg/L in FY 2007. This well is downgradient from well 299-E25-41, which has higher nitrate values. Well 299-E25-2 and upgradient well 299-E24-22 are distinctly lower than wells to the north or south causing the nitrate to appear as two different distributions.

When contaminant trends of technetium-99 are considered, the bifurcation into two distinct plumes is further delineated (Figure 2.11-16). In general, technetium-99 concentrations decreased for the plume around the AX Tank Farm as seen by the decreased area of the 400 pCi/L contour. In the south, technetium-99 concentrations increased only marginally in upgradient well 299-E24-20 from 57 to 77.5 pCi/L and in downgradient well 299-E25-94 from 488 to 574 pCi/L. Presently, technetium-99 is decreasing in this well from a maximum value of 642 pCi/L, reported in March 2007. The trend plots in Figure 2.11-18 illustrate the distinctly high technetium-99 concentration found in well 299-E25-93, downgradient from the A Tank Farm. Concentrations decreased from 7,740 pCi/L to 6,555 pCi/L during FY 2007. A comparison of the nitrate to technetium-99 ratio provide further evidence of two contaminant plumes with a value of 22 µg/pCi for upgradient of the AX Tank Farm (well 299-E24-33) and 7.4 µg/pCi downgradient of the A Tank Farm (well 299-E25-93).

While the high technetium-99 concentration and low nitrate to technetium-99 ratio may suggest a local source for the contamination observed at well 299-E25-93, upgradient of the AX Tank Farm, well 299-E24-33 has unique subsurface conditions. The presence of a perched water zone during drilling at 78 meters below the surface, shows that liquids migrated from the surface to depth. Also in the recent past, the sporadic data reporting coliform bacteria in the groundwater may provide further evidence that liquids have migrated from the surface to the vicinity of this well. Thus the increasing contaminant levels observed under the AX Tank Farm may have an upgradient source.

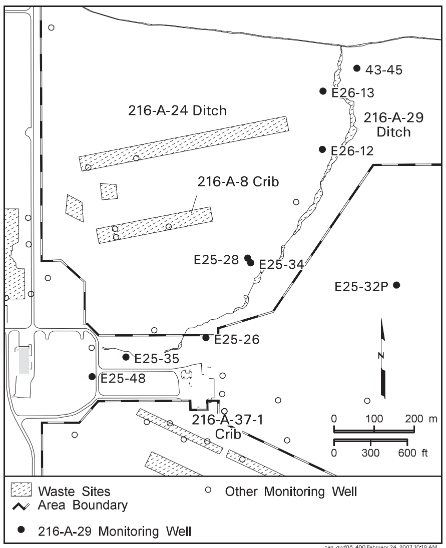
The high technetium-99 concentration and low nitrate to technetium-99 ratio may suggest a local source for the contamination observed at well 299-E25-93.

Five of the eight monitoring wells increased slightly in sulfate over the last year changing the contours shown on the time series maps from 2005 to 2007 (Figure 2.11-19). The sulfate plume appears to be broadening in the east-west direction with the 80 mg/L contour expanding to include well 299-E25-2 and the 100-mg/L contour expanding to include well 299-E25-94. Thus sulfate does not appear to have the distant two-plume pattern seen in the nitrate and technetium-99 data. This lack of upgradient/downgradient distinction may be results of regional influences on the local sulfate distribution. Alternatively, the high levels of sulfate observed in the groundwater on the southeast side of Waste Management Area C may be influencing sulfate at his site. Regardless as seen on the trends plots in Figure 2.11-20 sulfate is generally increasing albeit slowly. With regional trends displaying increasing sulfate and calcium across the northern part of the 200 East Area, separating local effects from these upgradient influences is difficult.

Over the last year, contaminant trends at Waste Management Area A-AX continue to display two distinct plumes for nitrate and technetium-99. In general, values have not changed significantly except for technetium-99 in downgradient well 299-E25-93, which decreased. The nitrate plume at the A Tank Farm, with the only occurrences above the drinking water standard (45 mg/L), appears to have an upgradient source.

Furthermore, a regional sulfate source may also be the main cause of increasing sulfate at the site. However, the locally high technetium-99 concentrations observed in the groundwater at downgradient well 299-E25-93 cannot be explained with upgradient contamination. Consequently, the locations of contaminated soils that may be the source of this groundwater contamination appear to be local. Recent field characterization work performed by the Tank Farm Vadose Zone Project along with further characterization efforts in support of the 200-PO-1 Operable Unit remediation investigation may provide results to assist in source determination for the elevated contamination at this site.

2.11.3.4 216-A-29 Ditch



The groundwater beneath the 216-A-29 ditch is monitored for evidence (detection) of hazardous waste migration as required by interim status RCRA regulations (40 CFR 265.93(b) as referenced by WAC 173-303-400). The nine wells of the groundwater monitoring network are sampled semiannually for contamination indicator parameters and annually for groundwater quality parameters and site-specific constituents (PNNL-13047; see Appendix B for list of wells, their locations, and groundwater constituents monitored). The well network is adequate for the current groundwater flow directions. Groundwater samples were collected and analyzed as scheduled at all nine wells monitoring the 216-A-29 ditch in FY 2007.

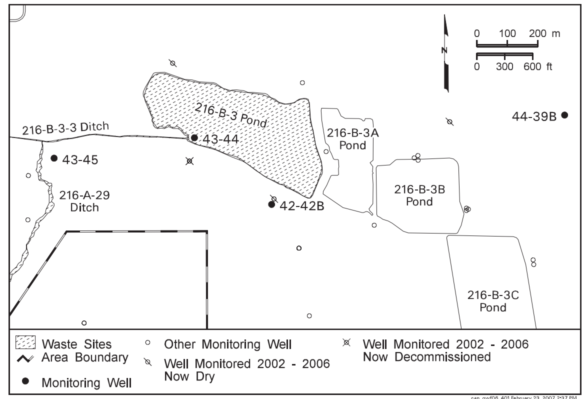
Specific conductance continues to remain above the critical mean in downgradient wells 299-E25-35, 299-E25-48, and 299-E26-13 during both semiannual sampling events (Figure 2.11-21) (see Appendix B). Sulfate, nitrate, chloride, and the major cations are also rising in these wells. Wells 299-E25-28 (deep completion) and 299-E25-34 appear to be least affected by these trends. The cause of this rise is unknown, but appears to coincide with a general, multi-year increase in ionic strength throughout much of the 200 East Area and adjacent areas (see sections on Liquid Effluent Retention Facility, 216-B-63, B Pond, Low-Level Waste Management Areas 1 and 2), and as such cannot be uniquely attributed to the 216-A-29 ditch. None of these constituents exceed drinking water standards. The remaining three contamination-indicator parameters (pH, total organic carbon, and total organic halides) were below critical means for all wells in the 216-A-29 network during FY 2007.

Specific conductance continued to remain above the critical mean in downgradient wells at the 216-A-29 ditch during FY 2007.

Based on general interpretations of the water table map in the 200 East Area (Section 2.1) the direction of groundwater flow near the 216-A-29 ditch is generally to the south or southwest. The water-table gradient in the immediate vicinity of the 216-A-29 ditch is too low to provide confidence in estimates of flow direction or rate.

2.11.3.5 216-B-3 Pond Facility (B Pond)

The original B Pond system included the main pond and three expansion ponds (Figure 2.11-1). The main pond and an adjacent portion of 216-B-3-3 ditch are regulated now under RCRA and require groundwater monitoring under 40 CFR 265.93(b) as referenced by WAC 173-303-400. These features are the regulated remnants of a more expansive system of ponds and ditches, most of which have been clean closed. The B Pond system continued in an interim status, indicator parameter evaluation program during FY 2007. The monitoring plan, including the well network, constituents of concern, sampling and analysis procedure, and a conceptual model is described by PNNL-15479.



The current network wells and hydraulic gradient configuration allows upgradient/downgradient comparisons as prescribed by RCRA and WAC procedures for interim status facilities. The groundwater monitoring well network for the B Pond system consists of a total of four wells (see Appendix B). Well 699-44-39B is located in an area currently upgradient of the B Pond with three wells (699-42-42B, 699-43-44, and 699-43-45) located at the downgradient edges of the main pond and 216-B-3-3 ditch (Figure 2.11-1). The wells are sampled semiannually for B Pond. In FY 2006, the second semiannual sampling event scheduled for July was postponed at B Pond due to extreme wildfire danger on the Hanford Site, which prevented access to off-road wells. These wells were rescheduled and sampled in November 2006, but no analytical results for that period were available in time for the FY 2006 report. Hence, in addition to the FY 2007 analytical results, the results discussed below include the November 2006 sampling event that was initially scheduled for July 2006.

During the entire period of November, 2006 through September 2007, no averaged replicate results exceeded the limits of quantitation for indicator parameters total organic halides and total organic carbon. Both pH and specific conductance were both within critical range/mean for all downgradient wells. Specific conductance remains below site-wide background (DOE/RL-96-61) in all B Pond network wells.

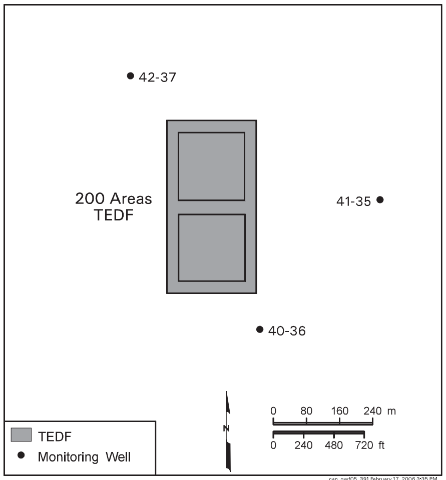
Nitrate, which had been rising in well 699-42-42B since 1998, continued to rise until July 2007, thereafter retreating from the historical high of 8.4 to 7 mg/L. Well 699-43-44 continued a rising trend in nitrate to a maximum of 3.8 mg/L in July 2007. Sulfate reached historic maxima in all three downgradient wells at B Pond during FY 2007, with the highest concentration of 24.8 mg/L in well 699-42-42B. Levels of both nitrate and sulfate remain below estimates of site-wide groundwater background concentrations. The cause of the low-levels for nitrate and sulfate may be the large volume of waste water discharged to B Pond, which may have caused dilution of these constituents.

During FY 2007, none of the indicator parameters exceeded their critical means at the 216-B-3 Pond Facility.

Gross beta in well 699-43-45 increased abruptly from 6.06 pCi/L in November 2006 to 15.1 pCi/L in April 2007 before retreating slightly to 11.0 pCi/L in July 2007. Upgradient well 699-44-39B is also displaying an upward trend in low levels of gross beta that began in early 2005. The maximum for this well was 10.0 pCi/L in July 2007 (Figure 2.11-22) . The reason for these small departures from historical trends is not known. However, other wells in the B Pond network, which have since gone dry or were part of the closed expansion ponds network, have also displayed brief, intermittent gross beta excursions of the same magnitude or higher. Well 699-42-40A, upgradient of B Pond, and screened just above basalt, also produced a result of 15 pCi/L in July of 2007 when it was sampled for the 200-PO-1 Operable Unit.

Based on a September 2007 gradient of 0.0016 calculated between wells 699-44-39B (upgradient well) 699-43-44, and 699-42-42B, an average hydraulic conductivity of 1.0 meter/day, and an estimated effective porosity of 0.25, the average linear flow velocity of groundwater is estimated at 0.01 meter/day (Appendix B) in a west-southwest direction.

Head measurements in vertically separated wells 699-43-41E (shallow) and 699-43-41G (deep) indicated that a downward flow potential still exists near the main pond. The head difference between these two wells, as determined by September 8, 2007 water-level measurements, was ~0.49 meter. This translates to a downward head gradient of 0.03.



2.11.3.6 200 Area Treated Effluent Disposal Facility

The 200 Area Treated Effluent Disposal Facility is located southeast of the B Pond RCRA facility and has received effluent since June 1995. Groundwater beneath the facility is monitored under a Washington State waste discharge permit (WAC 173-216, PNNL-13032). Three wells, 699-40-36, 699-41-35 and 699-42-37, monitor groundwater beneath the facility.

Because no unconfined aquifer exists beneath the 200 Areas Treated Effluent Disposal Facility, the groundwater monitoring wells used are installed in the locally confined aquifer below the Ringold Formation lower mud unit (see also Section 2.14). Thus, these three wells are isolated from the effects of the effluent from the disposal facility by the relatively impermeable silts and clays of the Ringold Formation lower mud unit (PNNL-14098). The quarterly analytical results from these wells are used to demonstrate continuation of the isolation.

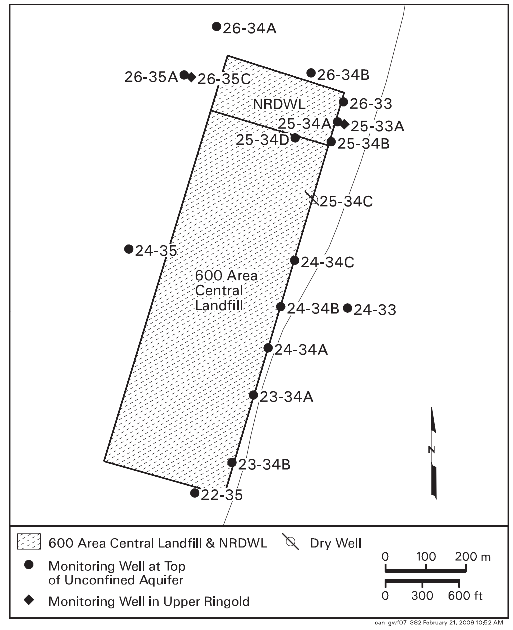
Based on hydraulic head measurements in FY 2007, and estimates of effective porosity and hydraulic conductivity, groundwater flow potential in the confined aquifer beneath the 200 Area Treated Effluent Disposal Facility is directed southwest at 0.0004 meter/day. Historically, major ionic composition and extremely low tritium concentration have suggested that groundwater in the Ringold Formation confined aquifer beneath this facility is isolated from groundwater in the adjacent unconfined aquifer, and its water quality is largely unaffected by Hanford Site operations. Results of annual low-level tritium analyses confirm this interpretation. Hydraulic head continues to decline in all three wells at the 200 Area Treated Effluent Disposal Facility as a result of the dissipating pressure effect of historical discharges at the nearby B Pond facility.

The three monitoring wells at the 200 Area Treated Effluent Disposal Facility are isolated from the effects of the effluent from the disposal facility by the relatively impermeable silts and clays of the Ringold Formation lower mud unit.

Groundwater samples are collected quarterly from wells for a list of constituents required by the state waste-discharge permit ST-4502 (Ecology 2000). Three of the constituents (cadmium, lead and pH) are compared with specific enforcement limits set by the permit (see Appendix B). All scheduled samples were collected during FY 2007, and no enforcement limits were exceeded. Most results for anions, metals and radionuclide indicators have been below Hanford Site groundwater background levels (e.g., WHC-EP-0595 and DOE/RL-96-61) since monitoring began at the site.

2.11.3.7 Nonradioactive Dangerous Waste Landfill

The Nonradioactive Dangerous Waste Landfill is located southeast of the 200 East Area (Figure 2.11-2) next to the 600 Area Central Landfill (formerly the Solid Waste Landfill). The objective of RCRA monitoring at the Nonradioactive Dangerous Waste Landfill is to determine if hazardous waste constituents from the landfill have contaminated groundwater (40 CFR 265.93(b) as referenced by WAC 173-303-400). Appendix B includes a well location map and lists of wells and constituents monitored for the landfill. Groundwater flow direction is southeast as determined from the general direction of movement of major 200 East Area plumes (see beginning of Section 2.11).



Monitoring of the Nonradioactive Dangerous Waste Landfill focuses on the RCRA interim status indicator parameters: pH, specific conductance, total organic carbon, and total organic halides (PNNL-12227; Appendix B). Volatile organic compounds are monitored because they may represent groundwater contamination originating from this landfill. Nitrate is present in groundwater and has a source in the 200 East Area (see Section 2.11.1.3). The groundwater quality parameters (chloride, iron, manganese, phenols, sodium, and sulfate) are required analytes, but during FY 2007 were either not detected (i.e., phenols) or were reported in concentrations below their respective drinking water standards.

Wells at the Nonradioactive Dangerous Waste Landfill (Appendix B) are sampled semiannually, usually in February and August. During FY 2007, all Nonradioactive Dangerous Waste Landfill network wells were sampled as scheduled.

Three of the four indicator parameters (pH, total organic carbon, and total organic halides) did not exceed their critical means in downgradient network wells where valid upgradient/downgradient comparisons could be made. However, the critical mean for specific conductance (594 μS/cm) was exceeded at three downgradient wells during FY 2007 (699-25-34A, 699-25-34B, and 699-25-34D). Specific conductance at these three wells ranged from 594 to 624 μS/cm during FY 2007. The trend for specific conductance at these three wells increased from before 1990, but stabilized by about 2003 (Figure 2.11-23). The increase in specific conductance at the Nonradioactive Dangerous Waste Landfill is interpreted to be due to increases in the concentrations of non-hazardous constituents (e.g., calcium and magnesium) at the nearby 600 Area Central Landfill.

The critical mean for specific conductance (594 μS/cm) was exceeded at three downgradient wells during FY 2007.

When the specific conductance exceedance was first discovered in FY 2001, the DOE notified Ecology of the exceedance by letter on June 7, 2001.[(d)] An accompanying report served as both the assessment plan and assessment. The assessment plan proposed a continuing detection monitoring program at the site. Groundwater monitoring data collected at both the Non-radioactive Dangerous Waste Landfill, as well as the 600 Area Central Landfill, since 2001 (including FY 2007) continue to suggest that the increased levels of specific conductance are due to increases in non-hazardous waste constituents at the nearby 600 Area Central Landfill (see Appendix B for a reassessment of specific conductance exceedances at the Nonradioactive Dangerous Waste Landfill).

Drinking water standards of volatile organic compounds, as well as the groundwater quality parameters, were not exceeded at the Nonradioactive Dangerous Waste Landfill network wells during FY 2007.

2.11.3.8 600 Area Central Landfill

The 600 Area Central Landfill is located south of with the Nonradioactive Dangerous Waste Landfill (Figure 2.11-2). It is regulated by Ecology under WAC 173-304. WAC 173-304 constituents and site-specific constituents (including volatile organic compounds and filtered arsenic) are analyzed on groundwater samples

The 600 Area Central Landfill is regulated by Ecology under WAC 173-304 (Washington Solid Waste Regulations).

(d) Letter from JG Morse (U.S. Department of Energy, Richland, Washington) to J. Hedges (Washington State Department of Ecology), Results of Assessment at the Non-Radioactive Dangerous Waste Landfill, dated June 7 2001.

collected quarterly (PNNL-13014; Appendix B). Compliance is determined by comparing results from monitoring downgradient wells with statistically derived background threshold values from upgradient wells. Groundwater flow direction in this area is southeast as inferred from the general direction of movement of major 200 East Area plumes (see beginning of Section 2.11). The well network for the 600 Area Central Landfill includes two upgradient and seven downgradient wells and is shown in Appendix B. During FY 2007, all scheduled samples were collected at the 600 Area Central Landfill.

Disposed waste at the 600 Area Central Landfill has impacted groundwater with minor chlorinated hydrocarbon contamination.

A leachate collection system underlying one set of double trenches within the landfill has detected contamination from the landfill in past years. Arsenic and 1,4-dioxane were two constituents detected in the leachate that were not already being analyzed in groundwater samples. Therefore, they have already been added to the list of constituents analyzed in groundwater samples from the network wells. During FY 2007, ammonium ion, filtered iron, filtered manganese, filtered arsenic, filtered nickel, and 1,4-dichlorobenzene were detected in the leachate (FH-0702400). Of these detected constituents, ammonium, iron, manganese, and arsenic had concentrations that exceeded their respective groundwater quality criteria (WAC 173-200) or drinking water standards in the leachate. All of the constituents detected in the leachate collection system are analyzed in groundwater samples collected from 600 Area Central Landfill network wells. For more detail about vadose zone contamination and results of analyses in the 600 Area Central Landfill leachate collection system, see Section 3.2.

Disposed waste at the 600 Area Central Landfill has impacted groundwater with minor chlorinated hydrocarbon contamination (Table 2.11-1). The only chlorinated hydrocarbon exceeding its WAC 173-220-40 limit (0.8 µg/L) was tetrachloroethene. The highest reported tetrachloroethene result during FY 2007 was 1.5 µg/L at the downgradient well 699-24-33. In recent years, the trend for tetrachloroethene has been relatively stable to slightly decreasing in concentration at the 600 Area Central Landfill wells.

Some downgradient wells continue to show higher chemical oxygen demand, chloride, coliform bacteria, specific conductance, sulfate, and lower pH. The lower pH apparently is a result of high concentrations of carbon dioxide in the vadose zone resulting from the degradation of sewage material disposed to the 600 Area Central Landfill (see Section 5.3 of DOE/RL-93-88; PNL-7174; WHC-SD-EN-TI-199). The elevated chemical oxygen demand, coliform bacteria, and possibly the specific conductance, may also be related to the disposed sewage material.

WAC 173-304 Parameters. Each WAC 173-304 parameter is discussed separately in the following paragraphs. See Appendix B (Table B.42) for a complete list of all results for required constituents at the 600 Area Central Landfill during FY 2007 and background threshold values. Table 2.11-1 shows concentration ranges of the chlorinated hydrocarbons during the same period. The increased amounts 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-13014).

- *Ammonium* – Results for ammonium ion (background threshold value 90 µg/L) in 600 Area Central Landfill wells during FY 2007 ranged from less than the method detection limit (6.08 µg/L) to 34.3 µg/L at well 699-24-34B for a sample collected in December 2006. Ammonium ion was detected at the upgradient wells, as well as the downgradient wells. Detections of this groundwater constituent have been sporadic in previous years at the 600 Area Central Landfill, and the sporadic occurrence continued in FY 2007.

- *Chemical Oxygen Demand* – Chemical oxygen demand (background threshold value 10 mg/L) ranged from less than the method detection limit (<10 mg/L) at both up- and downgradient wells to 285 mg/L at well 699-22-35. However, the 285 mg/L result at well 699-22-35 was outside the historical trend for the well so it is under further investigation. The next highest result was 63 mg/L at the background well 699-26-35A. Historically, chemical oxygen demand values are generally sporadic at the 600 Area Central Landfill, but have been increasing in the rate of occurrence in recent years. Elevated values of this constituent could be an indication of groundwater contaminated by sewage, which was known to be discharged to 600 Area Central Landfill trenches.
- *Chloride* – Chloride ranged in concentration from 2.9 mg/L at well 699-24-34C to 9.6 mg/L at well 699-23-34A. The background threshold value (7.8 mg/L) was exceeded six times at six different wells during the December 2006 and February 2007 sampling events. Chloride concentrations have been increasing slightly in some 600 Area Central Landfill wells for the last five to seven years, including well 699-24-35 (one of the upgradient wells).
- *Coliform Bacteria* – The background threshold value (of 1 col/100 ml groundwater) was exceeded three time at three different wells throughout FY 2007. The highest result was 345 col/100 ml at well 699-23-24A. Like chemical oxygen demand, coliform bacteria have been detected sporadically at 600 Area Central Landfill wells in past years, and the occurrences have been increasing in more recent years. Elevated values of coliform bacteria are expected with the known disposal of sewage disposed at the 600 Area Central Landfill.
- *Filtered iron* – None of the filtered iron results for FY 2007 exceeded the 160 µg/L background threshold value. The reported values ranged from less than 25 µg/L to 126 µg/L. Elevated filtered iron data are reported occasionally at the 600 Area Central Landfill in recent years but are not typical of the overall historical results.
- *Filtered manganese* – None of the filtered manganese results for FY 2007 exceeded the 11 µg/L background threshold value. Most results were less than the method detection limit (2.5 µg/L). The highest result was 6.8 µg/L at well 699-24-34C for a sample collected in May 2007.
- *Nitrate* – Nitrate results at 600 Area Central Landfill wells during FY 2007 were all less than the 29 mg/L background threshold value. The values ranged from 11.6 to 18.1 mg/L. The 600 Area Central Landfill is located on the western edge of the major nitrate plume emanating from the 200 East Area (Figure 2.11-8), and the nitrate reported in 600 Area Central Landfill wells may be mostly from the 200 East Area sources.
- *Nitrite* – Nitrite is historically not detected in 600 Area Central Landfill wells. However, February 2007 results at all of the 600 Area Central Landfill wells were elevated. Results for this sampling event ranged from 526 µg/L (at the background well 699-24-35) to 1150 µg/L at well 699-23-34A. The background threshold value was 59 µg/L. These elevated results are most likely sampling or laboratory errors and are under further review.

Downgradient wells at the 600 Area Central Landfill show elevated concentrations of chemical oxygen demand, chloride, coliform bacteria, specific conductance, sulfate, and lower pH.

Specific conductance values at all seven downgradient 600 Area Central Landfill wells exceeded the 583 µS/cm background threshold value during FY 2007.

- *Field pH* – Field pH remained within the 6.68 to7.84 background threshold range for eight of the nine 600 Area Central Landfill wells during FY 2007. However, two results at well 699-23-34A were 6.63 and 6.49 for December 2006 and September 2007, respectively. Trends of pH are relatively steady at 600 Area Central Landfill wells.
- *Specific Conductance* - Specific conductance values at all seven downgradient 600 Area Central Landfill wells exceeded the 583 µS/cm background threshold value during FY 2007. At the two background wells the values were lower. At least one result from each of the seven downgradient wells also exceeded the 700 µS/cm WAC 246-290-310 limit. The highest reported value during FY 2007 was 829 µS/cm at well 699-22-35 for a sample collected in December 2006. Specific conductance values at the 600 Area Central Landfill wells have remained relatively stable since 2001. Elevated specific conductance may be due to increased concentrations of sulfate and other anions in groundwater at the 600 Area Central Landfill.
- *Sulfate* – Reported results in downgradient wells ranged from 39.6 to 51.9 mg/L. Two of the downgradient wells (699-23-34A and 699-24-34B) had one result each that exceeded the 47.2 mg/L background threshold value. The overall trend for sulfate at 600 Area Central Landfill wells is stable to slightly increasing.
- *Temperature* – The temperature of groundwater measured at 600 Area Central Landfill wells during FY 2007 was less than the 20.7^{o} C background threshold. The range was 17.4 to 19.9^{o} C, and there was no significant difference between up- and downgradient wells.
- *Total organic carbon* – Not only were all total organic carbon results from 600 Area Central Landfill wells during FY 2007 less than the 2,700 µg/L background threshold value, all were also non-detect (<760 µg/L). In previous years, spurious values for total organic carbon have been reported in 600 Area Central Landfill wells.
- *Zinc* – Reported values for filtered zinc during FY 2007 ranged from less than the analytical method detection (9.6 µg/L) to 18.3 µg/L. The background threshold value was 43.2 µg/L.

Eight chlorinated hydrocarbons were detected in 600 Area Central Landfill network wells, including the upgradient wells, during FY 2007.

Site-Specific Parameters. Site-specific parameters at the 600 Area Central Landfill include chlorinated hydrocarbons and three waste constituents detected in the leachate collection system but were not included in the WAC 173-304 parameters list. The three constituents detected in the leachate collection system were 1,4-dioxane, filtered arsenic, and filtered nickel (FH-0702400). The detected chlorinated hydrocarbons and the three other waste constituents are discussed in the following paragraphs.

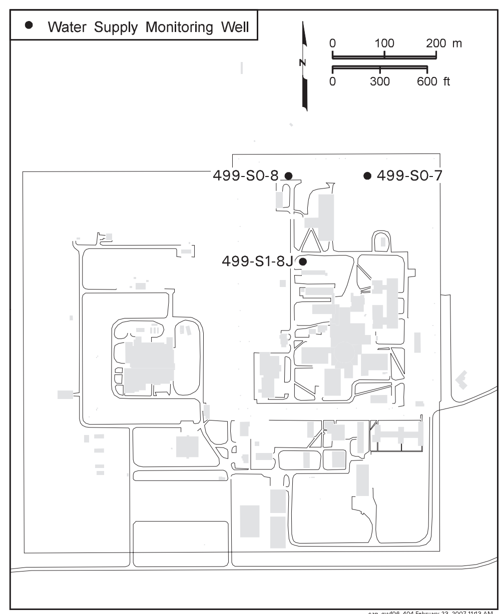
Eight chlorinated hydrocarbons were detected in 600 Area Central Landfill network wells, including the upgradient wells, during FY 2007. The concentration ranges of the detected chlorinated hydrocarbons are given in Table 2.11-1. The general trends for these detected chlorinated hydrocarbons in 600 Area Central Landfill wells are stable to decreasing. Of the chlorinated hydrocarbons detected, only tetrachloroethene exceeded its WAC 173-200 limit (0.8 µg/L). The 0.8-µg/L limit was exceeded in six wells, including the background well 699-24-35. The highest reported value was 1.5 µg/L in the downgradient well 699-24-33, where the trend for tetrachloroethene is decreasing slightly since 2001 (Figure 2.11-24). None of the chlorinated hydrocarbons exceeded federal drinking water standards in FY 2007. 1,4 Dioxane was not detected.

A potential cause of the widespread, low-level chlorinated hydrocarbon contamination at the 600 Area Central Landfill, including the upgradient wells and the adjacent Nonradioactive Dangerous Waste Landfill wells, is the dissolution of vadose zone vapors into groundwater. However, the source of the vapors is uncertain. One potential source is the chlorinated hydrocarbons dissolved in the liquid sewage of the catch tank liquid from the 1100 Area heavy equipment garage and bus shop that were disposed to the 600 Area Central Landfill (PNNL-13014).

Filtered arsenic and nickel were detected at only low concentrations during FY 2007 at the 600 Area Central Landfill. Most results for these two constituents were non-detect, and there were no differences between up- and downgradient wells. The highest concentration detected for filtered arsenic was 3.5 µg/L at well 699-24-34C. For arsenic, the federal drinking water standard is 10 µg/L, and the WAC 173-200 limit is 0.05 µg/L. The analytical method detection limit for arsenic was 2 µg/L. Filtered nickel was only detected at well 699-24-34A where the highest reported value during FY 2007 was 27.7 µg/L. The WAC 173-200 limit and federal drinking water standard for nickel are 100 µg/L, and the analytical method detection limit was 7.5 µg/L.

2.11.3.9 400 Area Water Supply Wells

Primary groundwater monitoring activities in the 400 Area involve monitoring of the 400 Area water supply wells. Monitoring is also conducted to provide information needed to describe the nature and extent of site-wide contamination (primarily tritium, nitrate, and iodine-129). This section discusses the monitoring of the 400 Area water supply wells, specifically tritium, and general aspects of groundwater chemistry in the 400 Area. The water supply wells were sampled quarterly as scheduled in FY 2007.



The Hanford Site water-table map (see Figure 2.1-2 in Section 2.1) 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 Pleistocene cataclysmic flood deposits (informally-the Hanford formation), which is approximately 49 meters below ground surface (WHC-EP-0587). Hanford formation sediment dominates groundwater flow in the 400 Area because of its relatively high permeability compared to that of the sediments in the Ringold Formation.

Elevated levels of tritium associated with the groundwater plume originating from the vicinity of PUREX cribs in the 200 Area were identified in the 400 Area wells as in previous years (Figure 2.11-3 and Figure 1.0-2 in Section 1.0). Groundwater tritium levels are relevant to the water supply wells, which provide drinking water and emergency supply water for the 400 Area. Well 499-S1-8J serves as the main water supply well, while wells 499-S0-7 and 499-S0-8 are backup supply wells. Well 499-S1-8J has lower tritium concentrations because it is screened as a greater depth than the other two water supply wells. The tritium concentrations in wells 499-S0-7, 499-S0-8, and 499-S1-8J are compared in Figure 2.11-25 to that of the 400 Area drinking water supply. Tritium was measured at levels below the drinking water standard (20,000 pCi/L) in all three of the water supply wells in FY 2007. Tritium levels in well 499-S1-8J (the main water supply well) during FY 2007 ranged from 2,100 to 2,510 pCi/L.

Tritium was measured at levels below the drinking water standard (20,000 pCi/L) in all three of the water supply wells in FY 2007.

Tritium remained below the drinking water standard (20,000 pCi/L) and the 4-millirem/year dose equivalent in the drinking water supply, sampled at a tap, for all sampling events in FY 2007 (Figure 2.11-25). Nitrate remained below the drinking water standard in FY 2007 for the water supply wells. Data from FY 2007 and earlier from these wells indicate no other constituents are present at levels above their drinking water standards.

Table 2.11-1. Ranges of Detected Chlorinated Hydrocarbon Concentrations in 600 Area Central Landfill Wells, FY 2007

Constituent	Limit (ug/L)	699-22-35	699-23-34A	699-23-34B	699-24-33	699-24-34A	699-24-34B	699-24-34C	699-24-35	699-26-35A
1,1,1-Trichloroethane	WAC 200	0.99-1.2	0.98-1.3	1.0-1.4	0.78-0.96	0.84-1.0	0.89-1.0	0.72-0.93	0.85-1.0	0.61-0.78
1,1-Dichloroethane	WAC 1.0	0.42-0.45	0.42-0.5	0.35-0.51	0.32-0.4	0.27-0.33	0.32-0.36	0.21-0.3	0.19-0.21	<0.046
1,1-Dichloroethene	MCL 7.0	<0.045-0.17	<0.21	<0.21	<0.045	<0.21	<0.21	<0.21	<0.045	<0.045
1,4-Dichlorobenzene	WAC 4.0	<0.2	0.047-0.12	<0.2	<0.047	<0.2	<0.2	<0.2	<0.2	<0.047
Carbon Tetrachloride	WAC 0.3	<0.039-0.27	<0.15	<0.039-0.22	<0.039	<0.039-0.2	<0.039-0.27	<0.15	<0.1	<0.039
Chloroform	WAC 7.0	0.31-0.39	<0.1-0.24	0.21-0.36	<0.048	<0.19	<0.19	<0.19	<0.1	0.13-0.15
Tetrachloroethene	WAC 0.8	0.17-0.68	0.43-**1.1**	<0.17-0.65	**1.2-1.5**	0.41-**1.0**	0.71-**1.3**	0.52-**1.4**	0.23-**0.94**	0.31-0.62
Trichloroethene	WAC 3.0	0.37-0.46	<0.1-0.51	0.31-0.41	0.64-0.79	0.46-0.57	0.56-0.69	0.57-0.71	0.35-0.42	0.36-0.4

Values in **BOLD** exceed limits of WAC 173-200-40.
MCL = Maximum contaminant level (federal drinking water standard).
WAC = Washington Administrative Code (WAC 173-200-40).

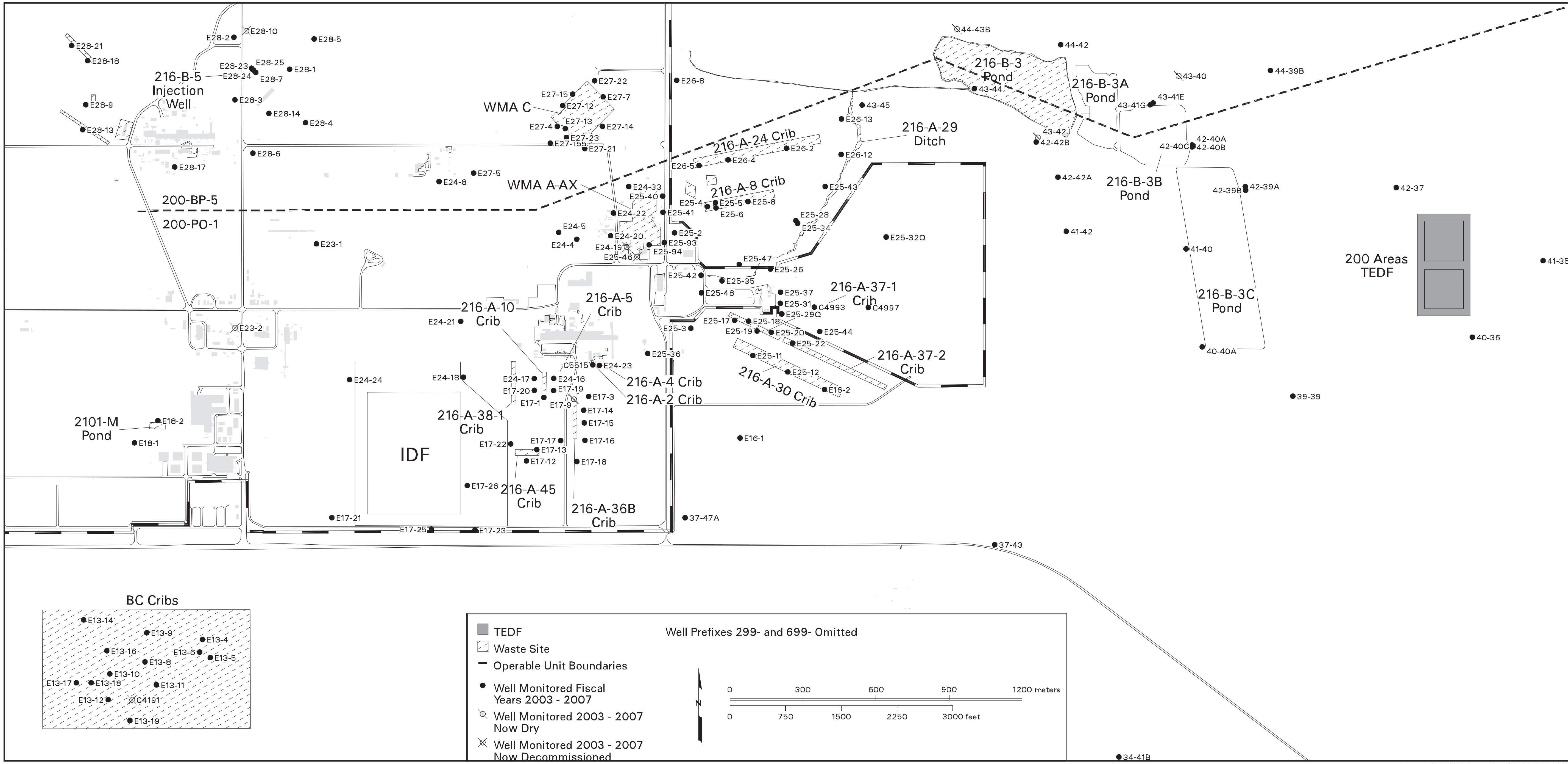


Figure 2.11-1. Facilities and Groundwater Monitoring Wells in North Portion of 200-PO-1 Operable Unit

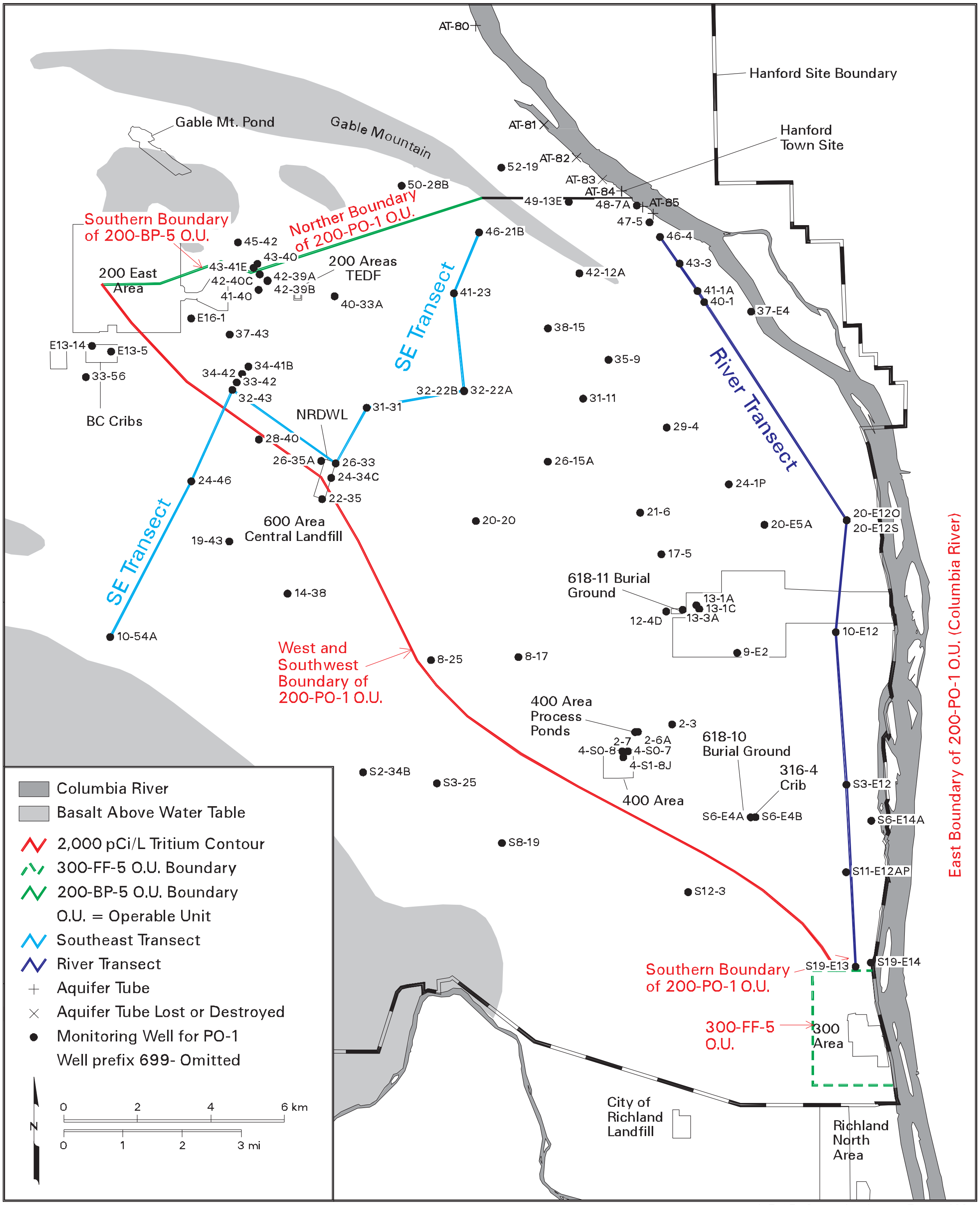


Figure 2.11-2. 200-PO-1 Operable Unit Boundaries, Far-Field Monitoring Wells, and Transects

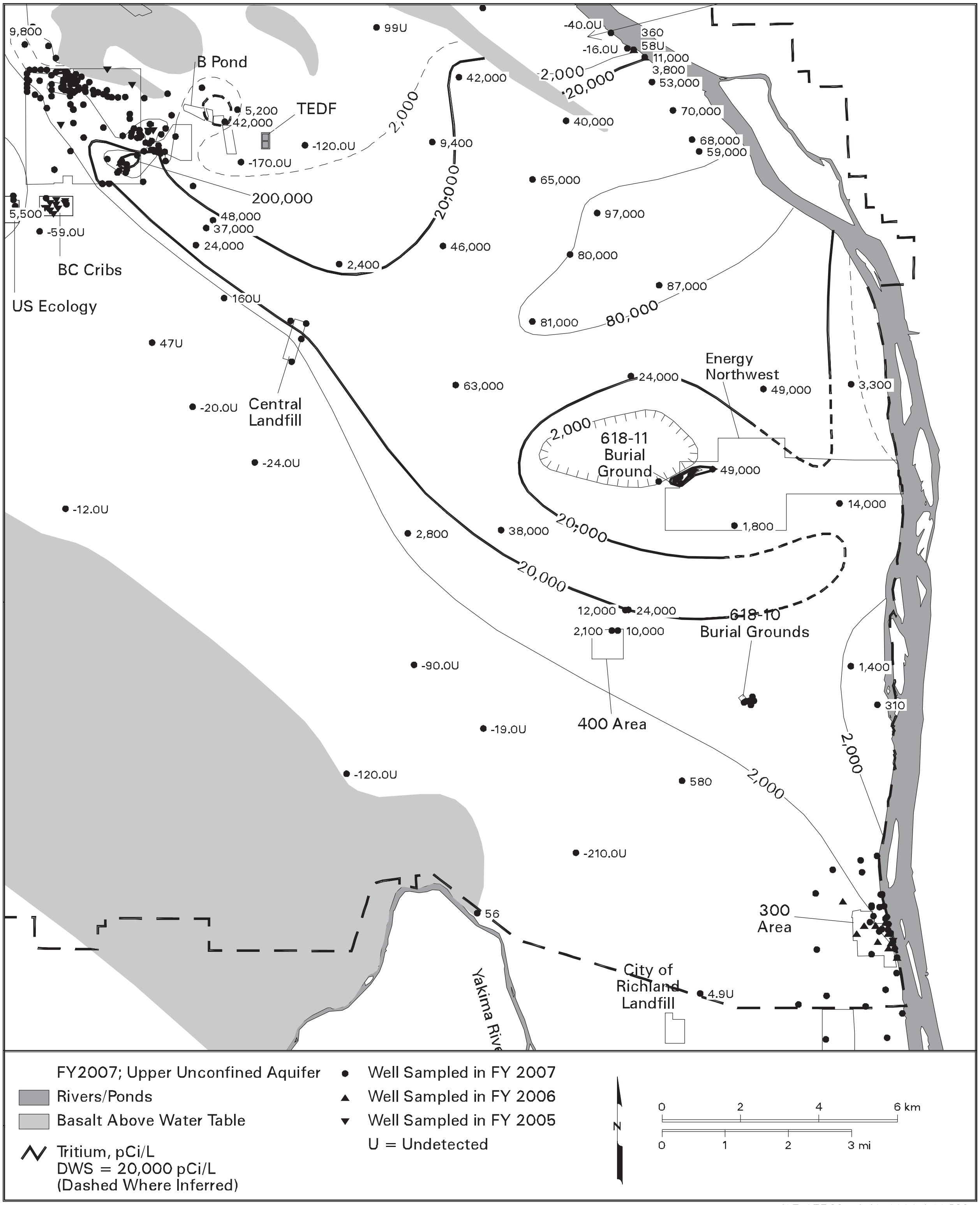


Figure 2.11-3. Tritium Concentrations in 200-PO-1 Operable Unit, Upper Part of Unconfined Aquifer

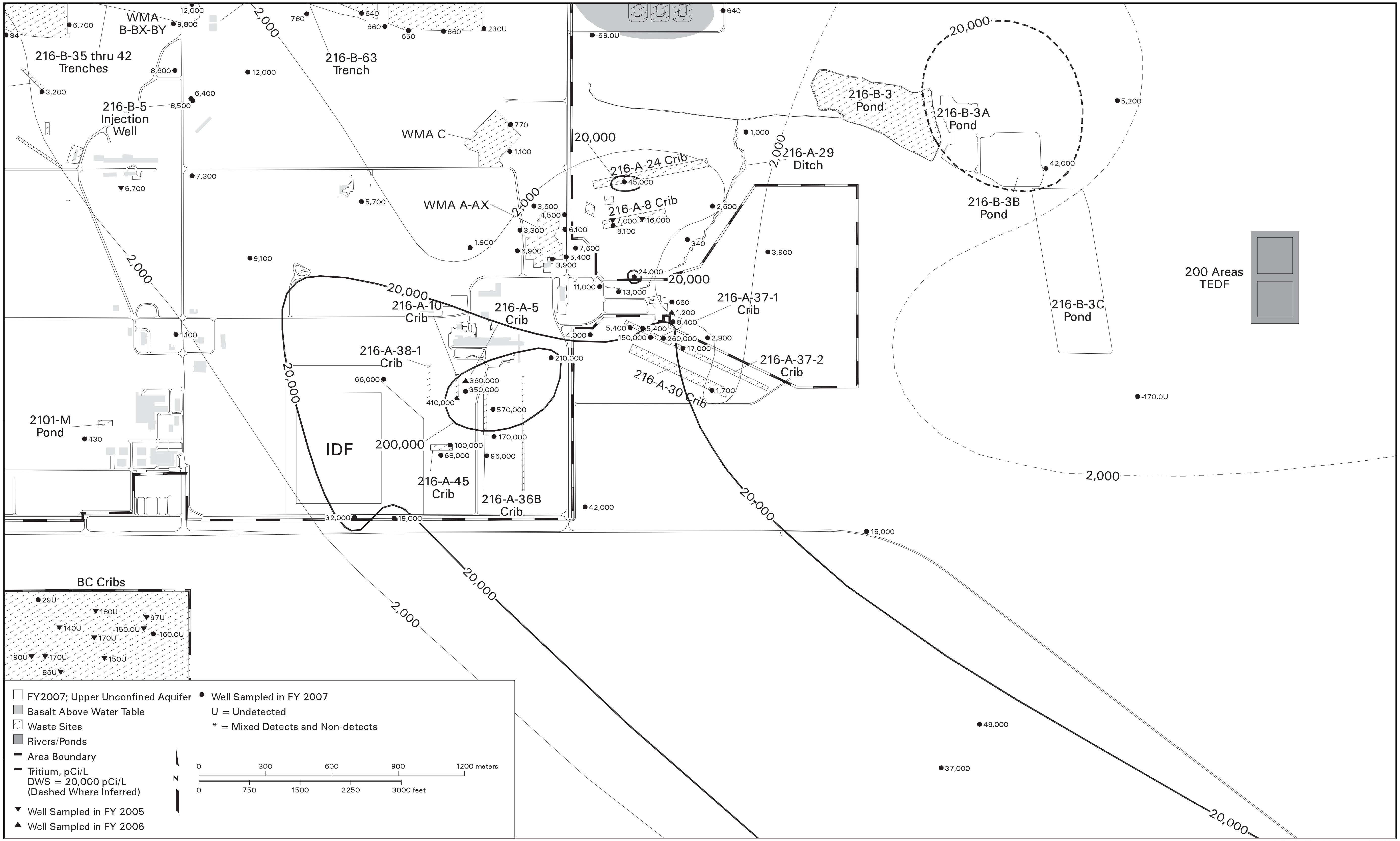


Figure 2.11-4. Average Tritium Concentration in Near-Field Area of 200-PO-1 Operable Unit, Upper Part of Unconfined Aquifer

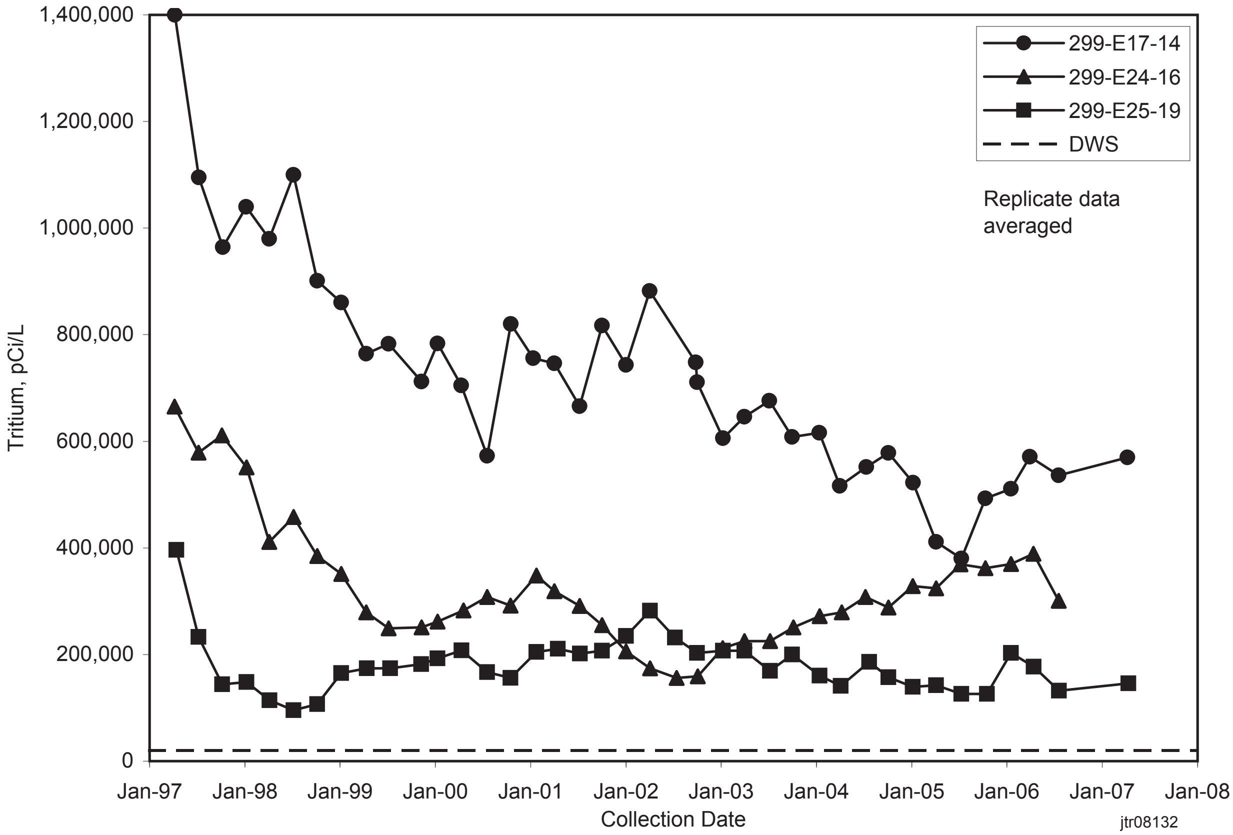


Figure 2.11-5. Tritium Concentrations in Wells Near Three PUREX Cribs

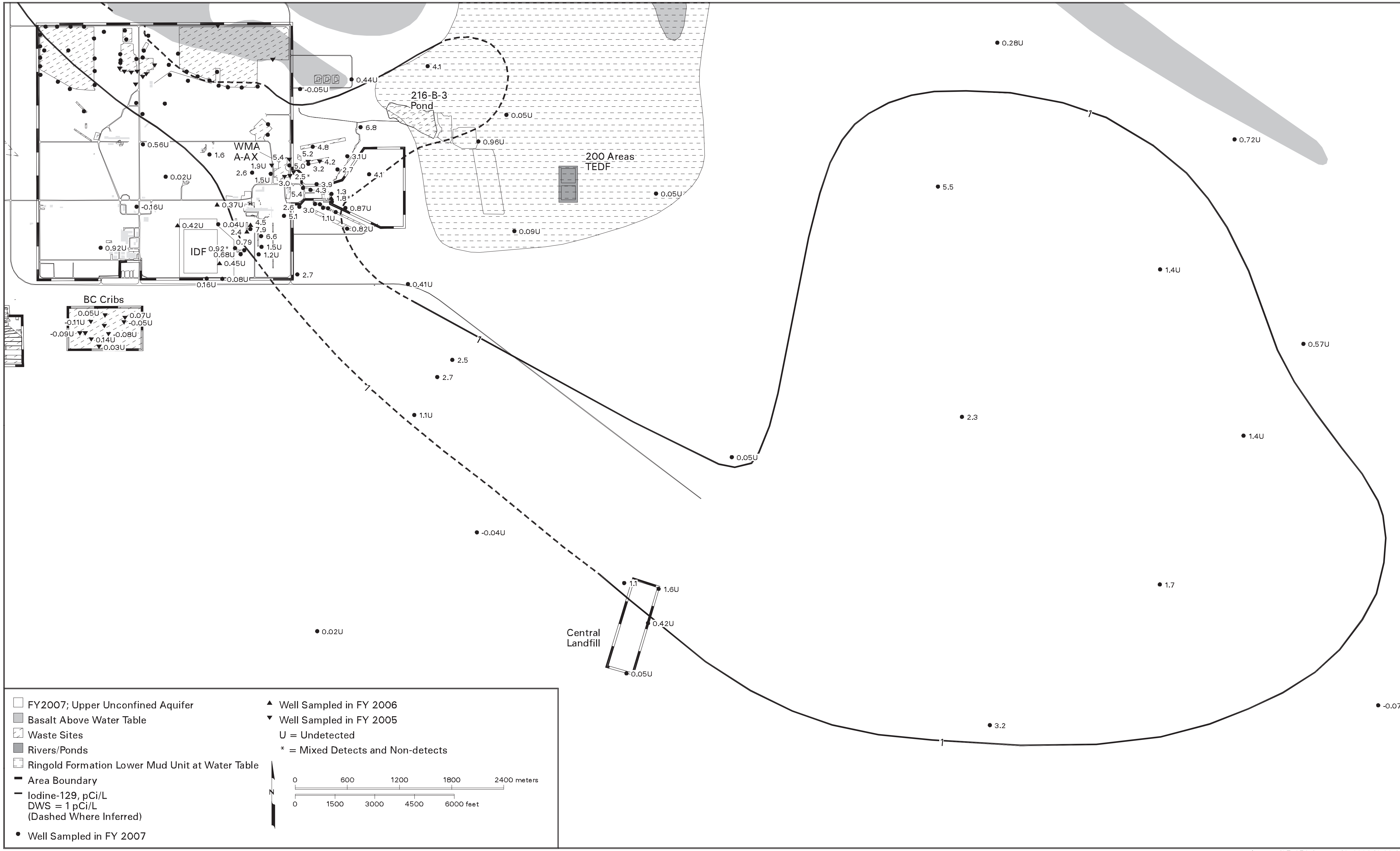


Figure 2.11-6. Iodine-129 Plume Map for 200-PO-1 Operable Unit, Upper Part of Unconfined Aquifer

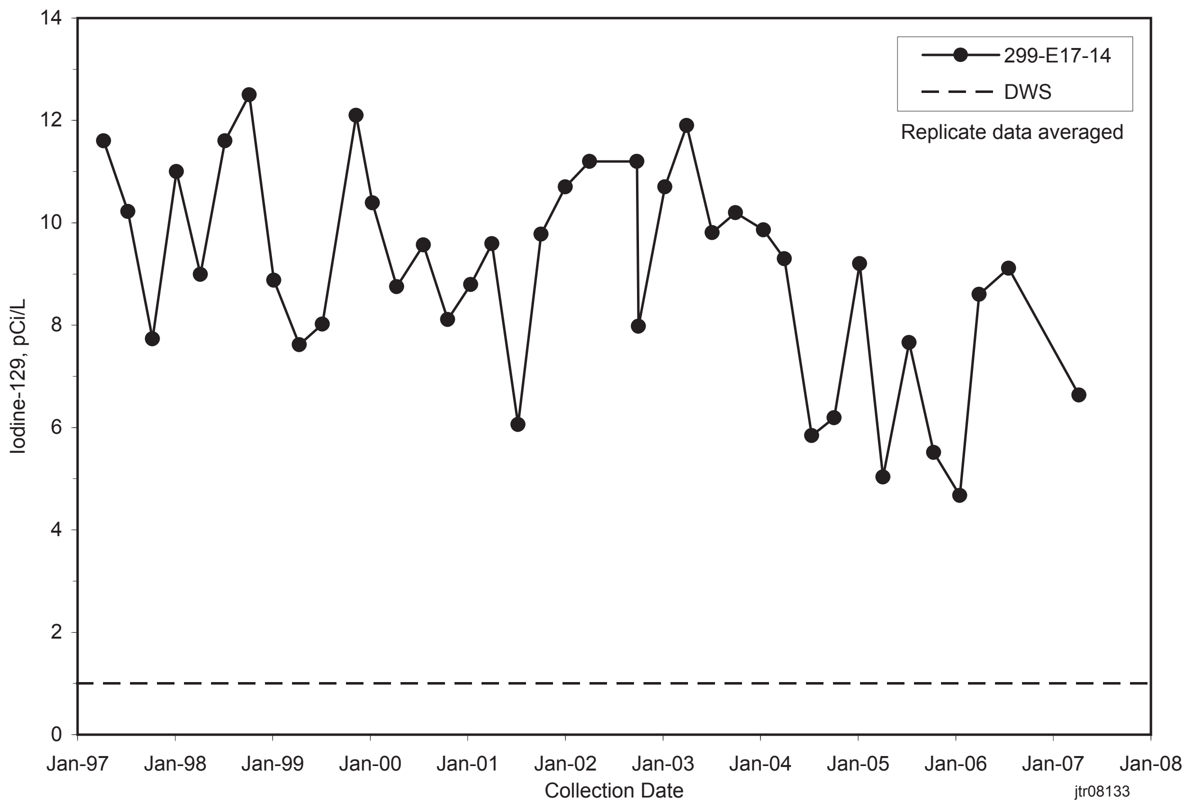


Figure 2.11-7. Iodine-129 Concentrations in Well 299-E17-14 at 216-A-36B Crib

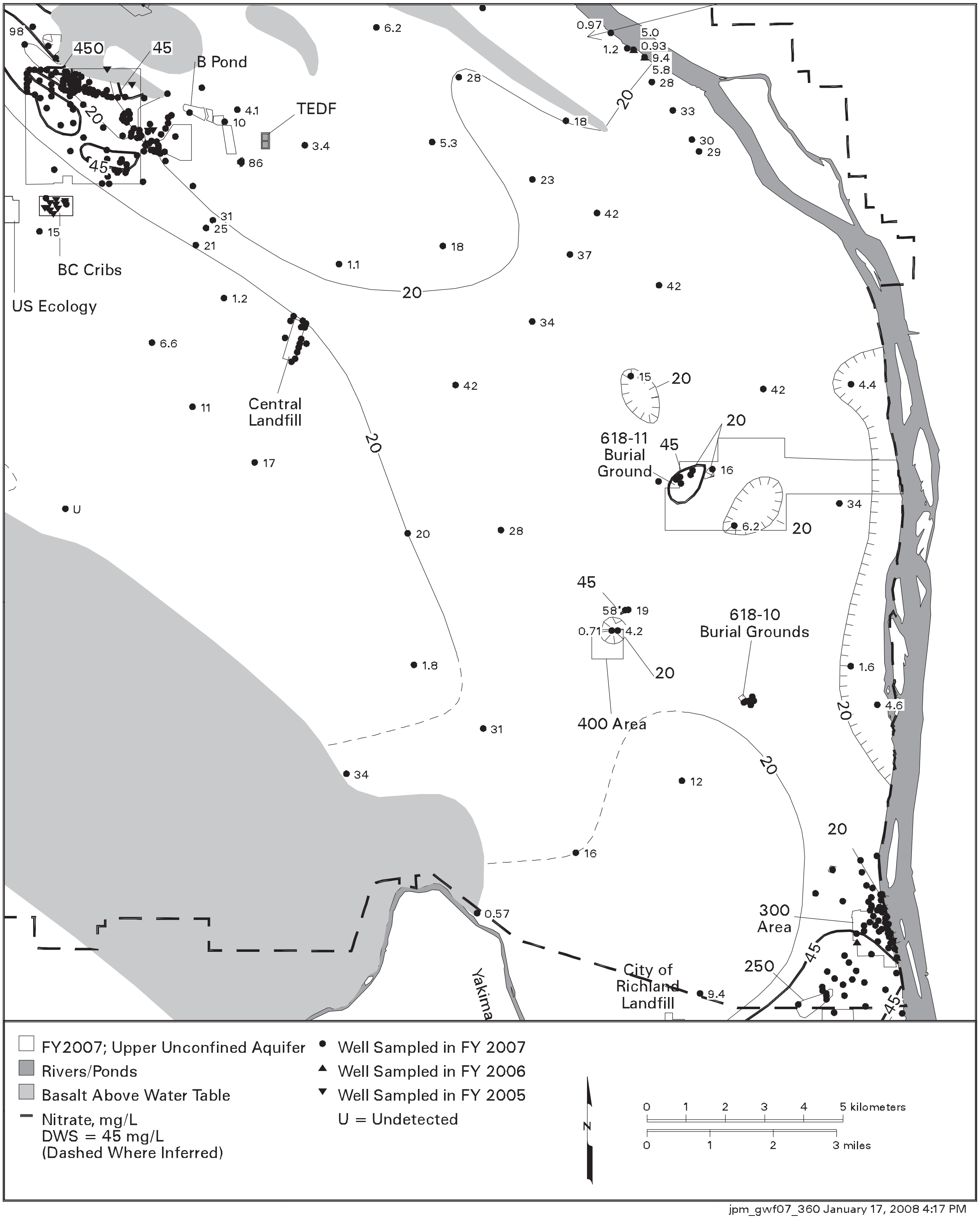


Figure 2.11-8. Nitrate Concentrations in 200-PO-1 Operable Unit, Upper Part of Unconfined Aquifer

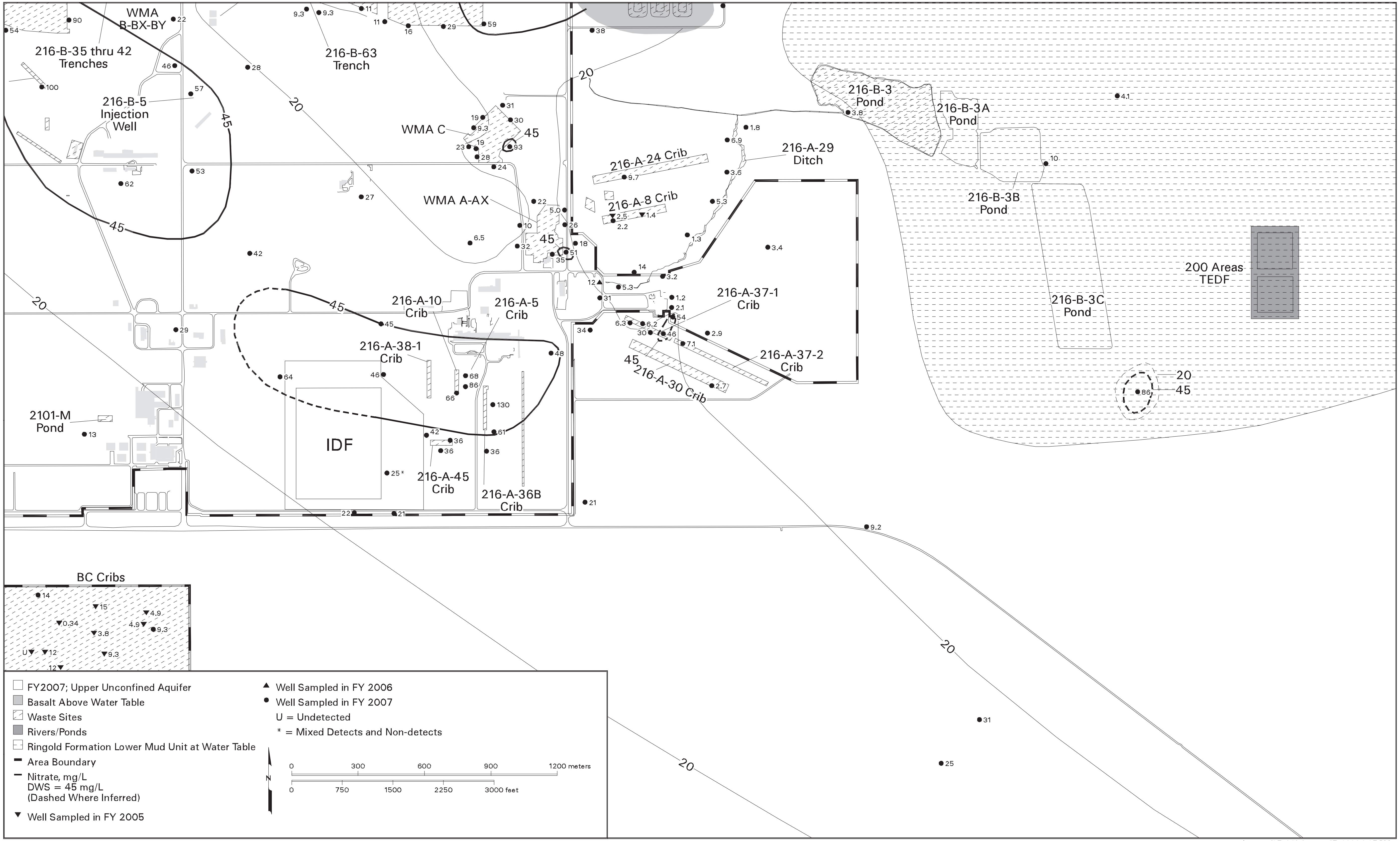


Figure 2.11-9. Nitrate Concentrations in 200-PO-1 Near-Field Area, Upper Part of Unconfined Aquifer

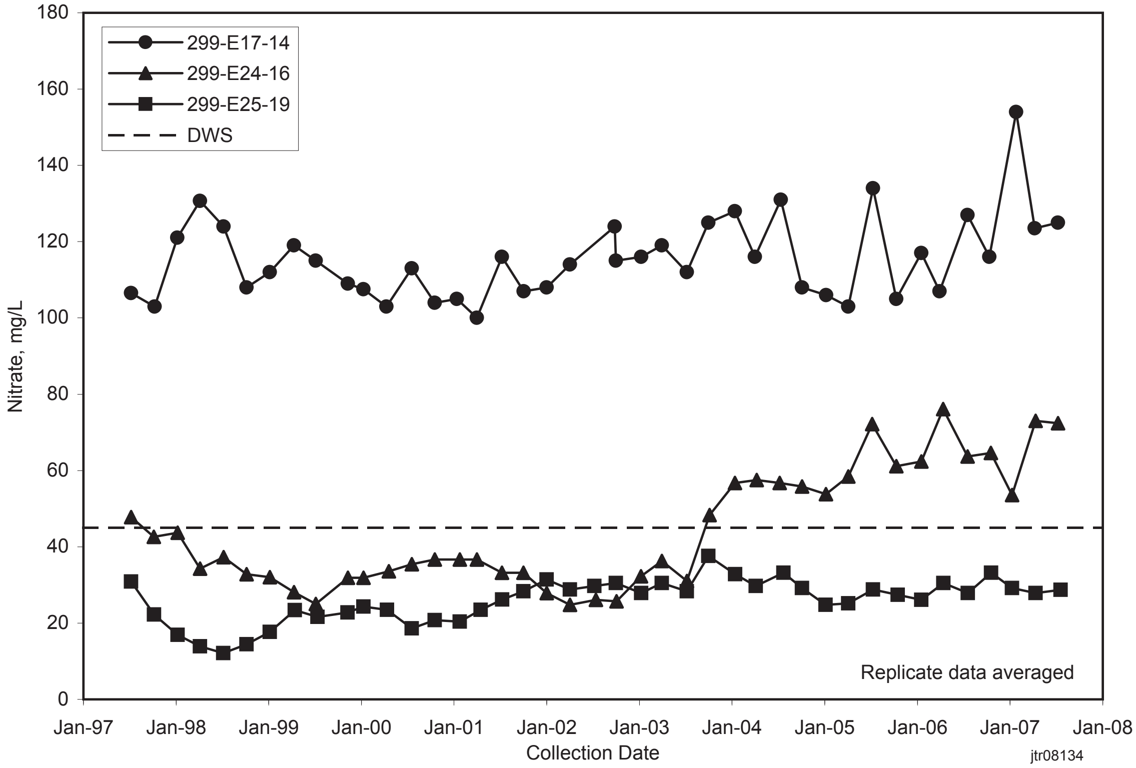


Figure 2.11-10. Nitrate Concentrations in Wells 299-E17-14 at 216-A-36B Crib, 299-E24-16 at 216-A-10 Crib, and 299-E25-19 at 216-A-37A Crib

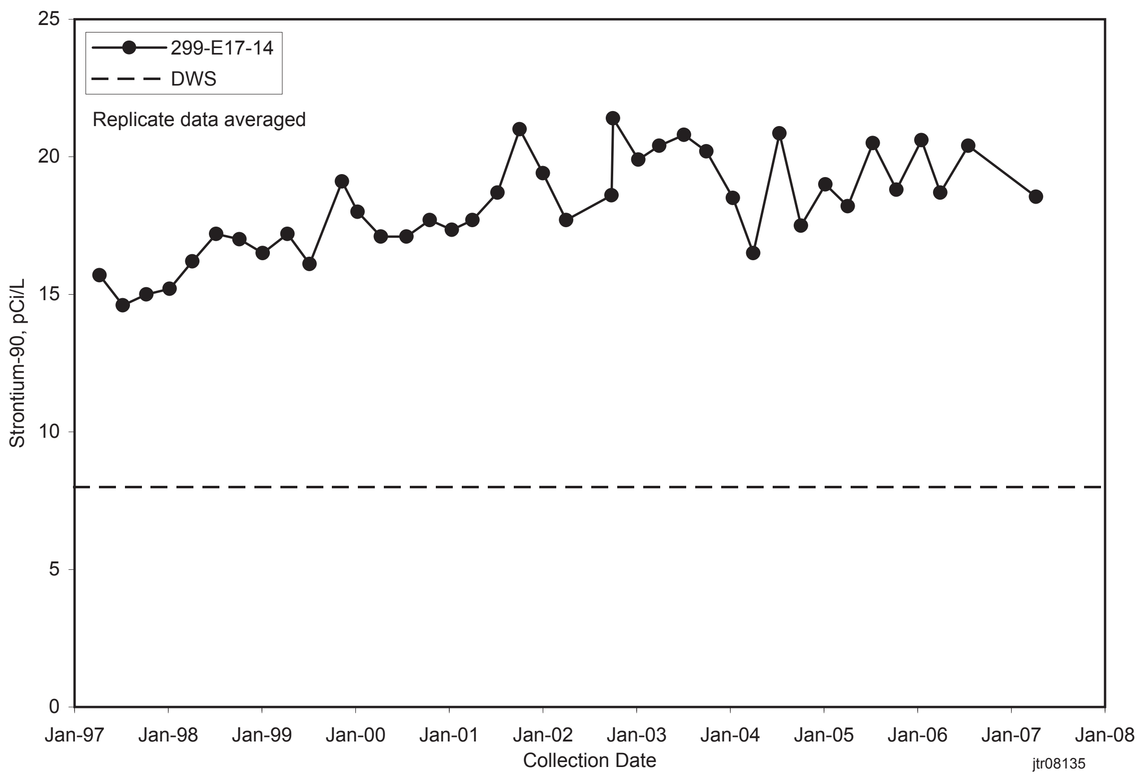


Figure 2.11-11. Strontium-90 Concentrations in Well 299-E17-14 at 216-A-36B Crib

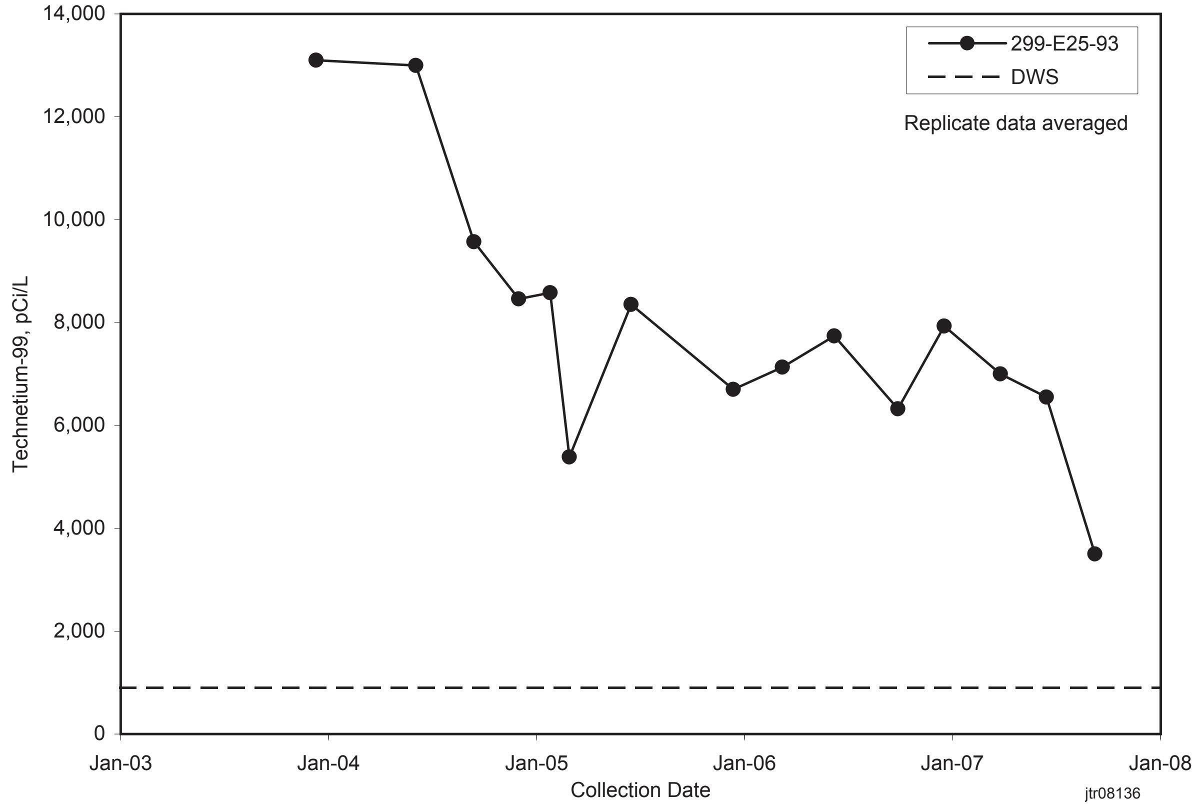


Figure 2.11-12. Technetium-99 Concentrations in Well 299-E25-93 at Waste Management Area A-AX

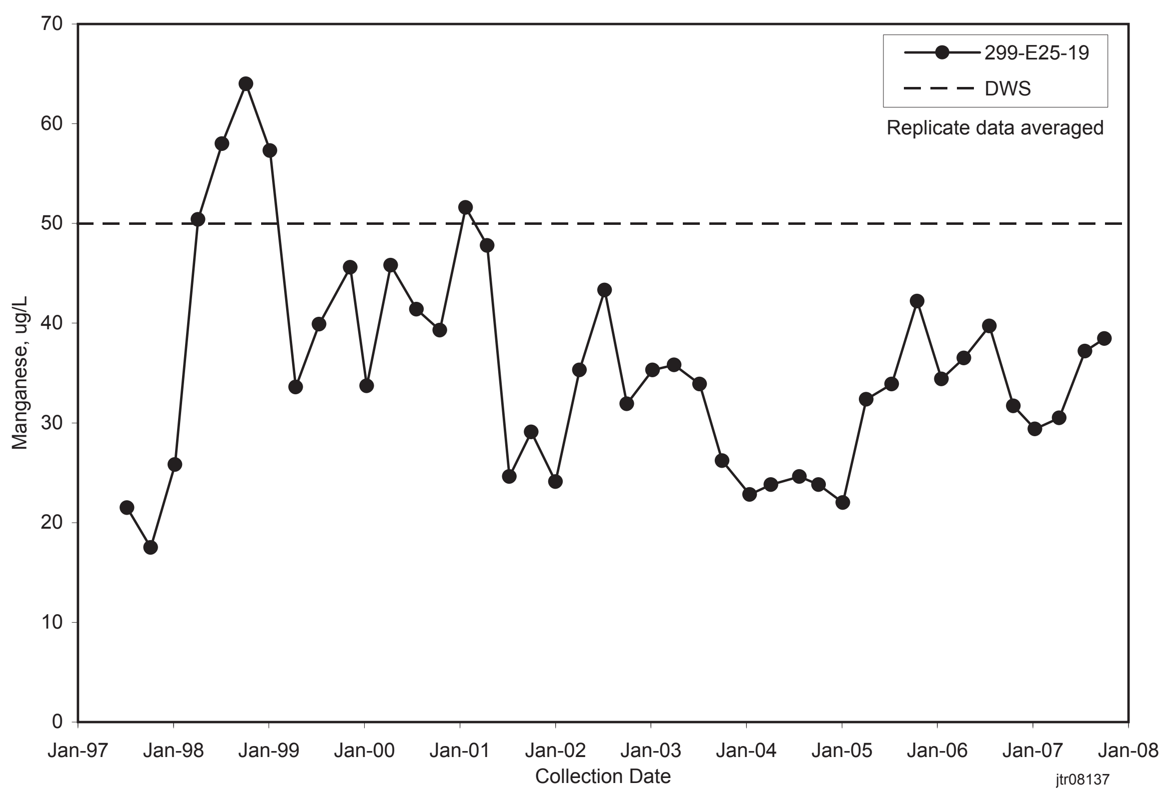


Figure 2.11-13. Manganese Concentrations in Well 299-E25-19 Near 216-A-37-1 Crib

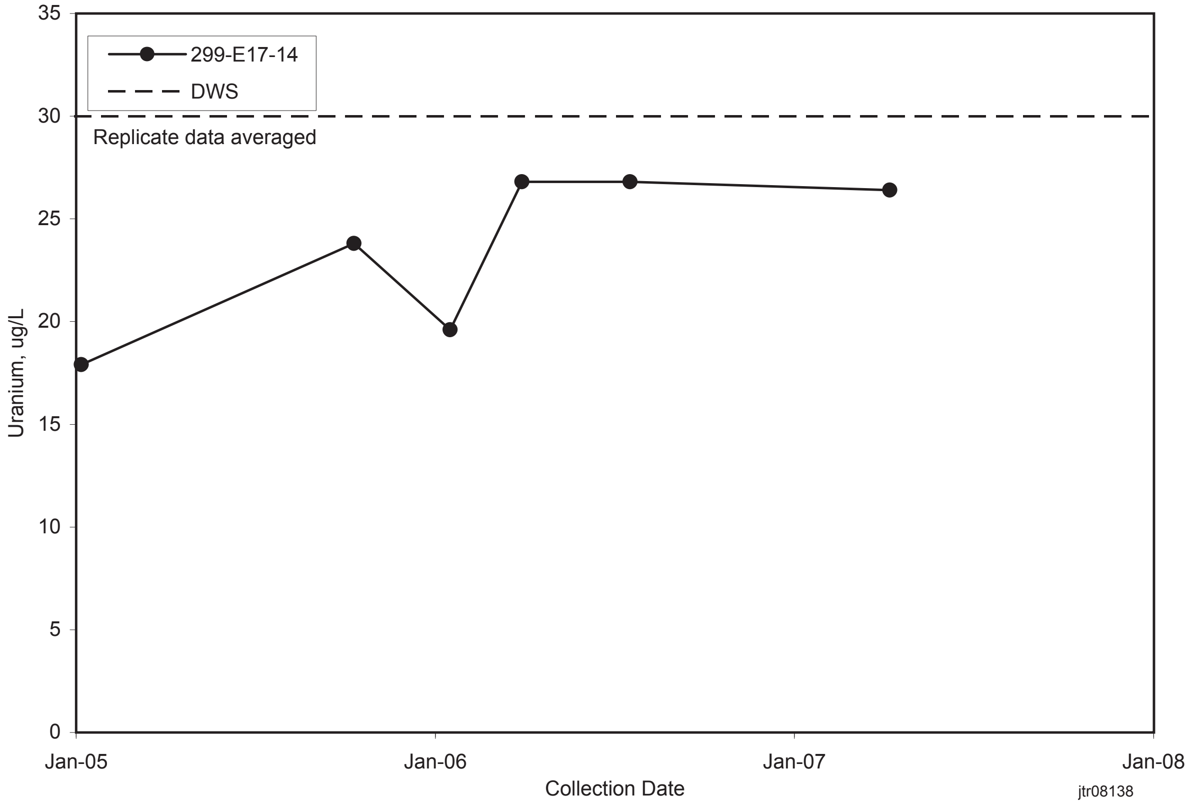


Figure 2.11-14. Uranium Concentrations in Well 299-E17-14 Near 216-A-36B Crib

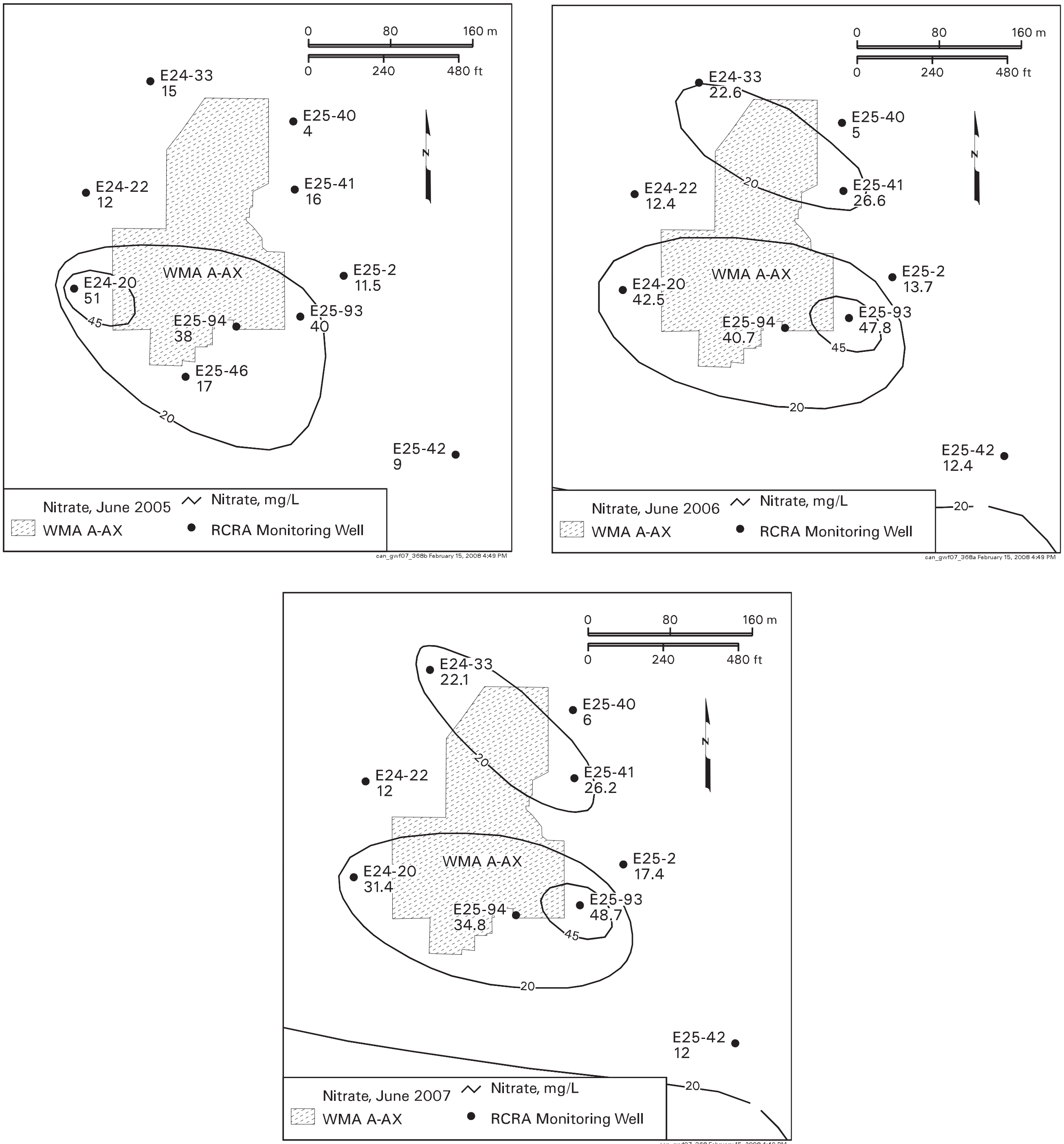


Figure 2.11-15. Nitrate Concentrations at Waste Management Area A-AX, June 2005 to June 2007

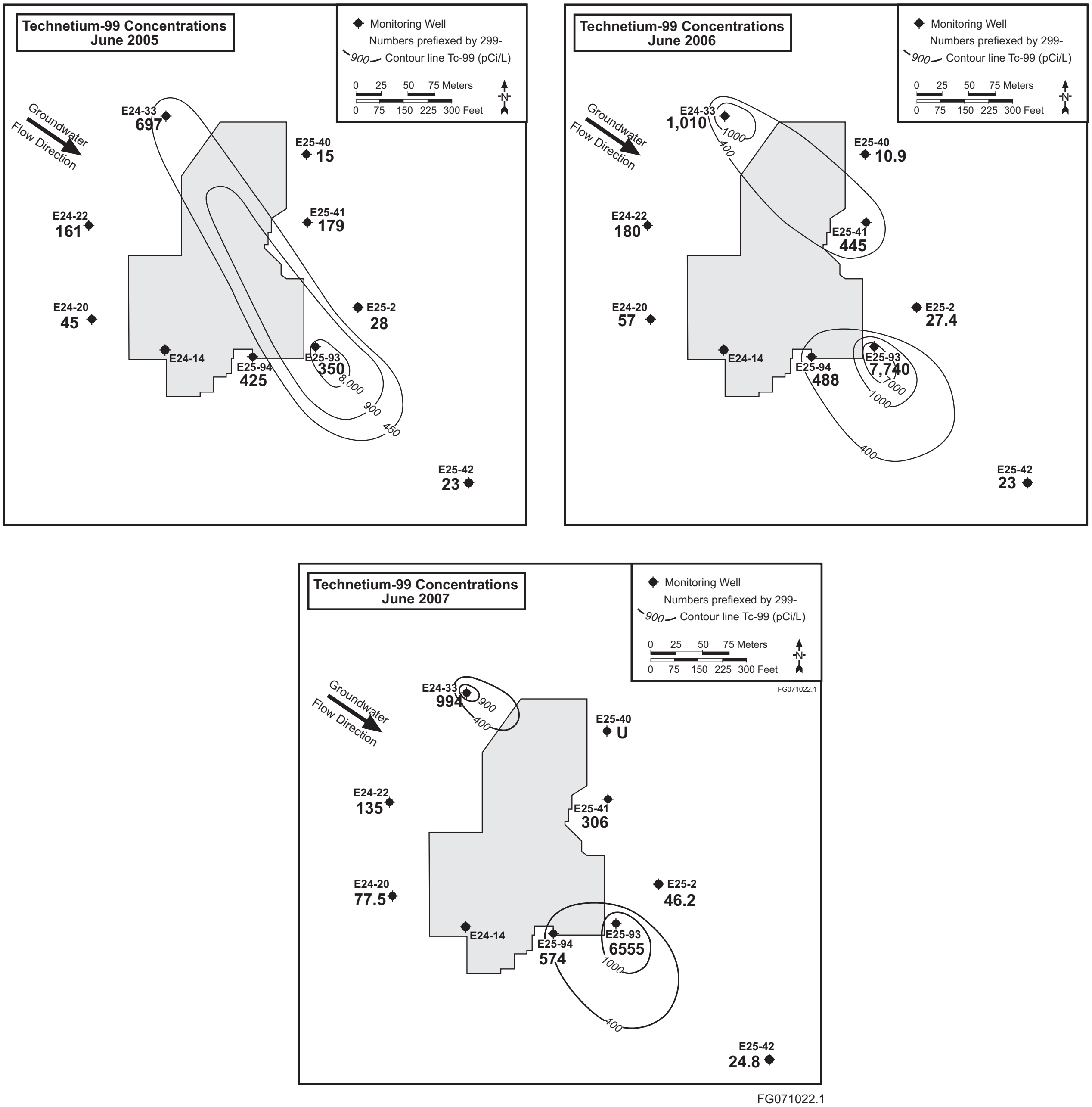


Figure 2.11-16. Technetium-99 Concentrations at Waste Managment Area A-AX, June 2005 to June 2007

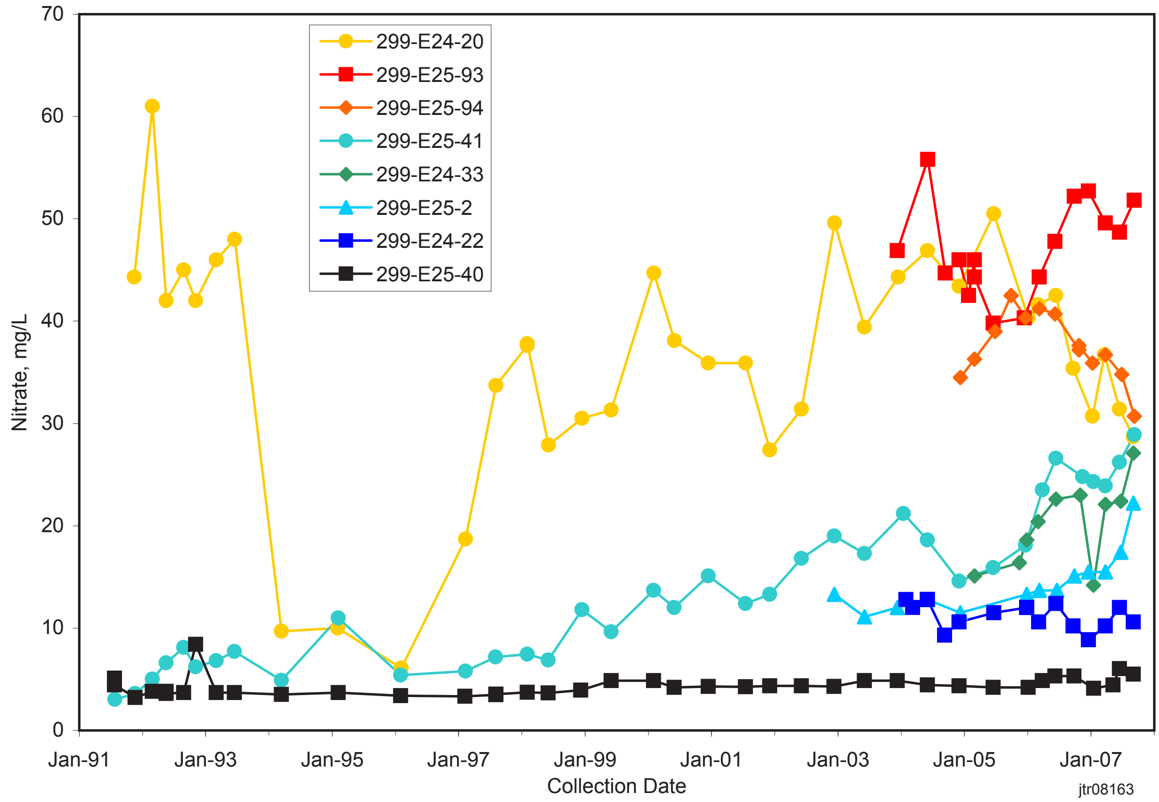


Figure 2.11-17. Nitrate Concentrations in Groundwater at Waste Management Area A-AX

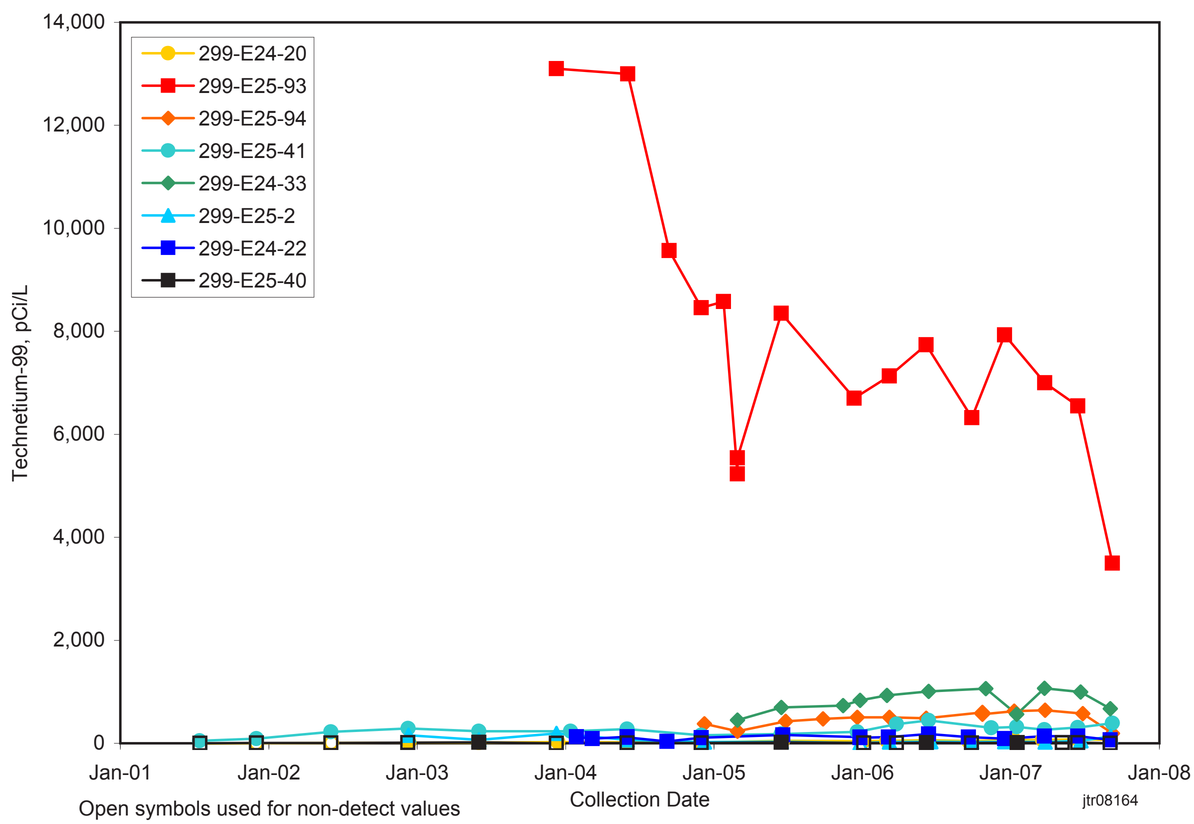


Figure 2.11-18. Technetium-99 Concentrations in Groundwater at Waste Management Area A-AX

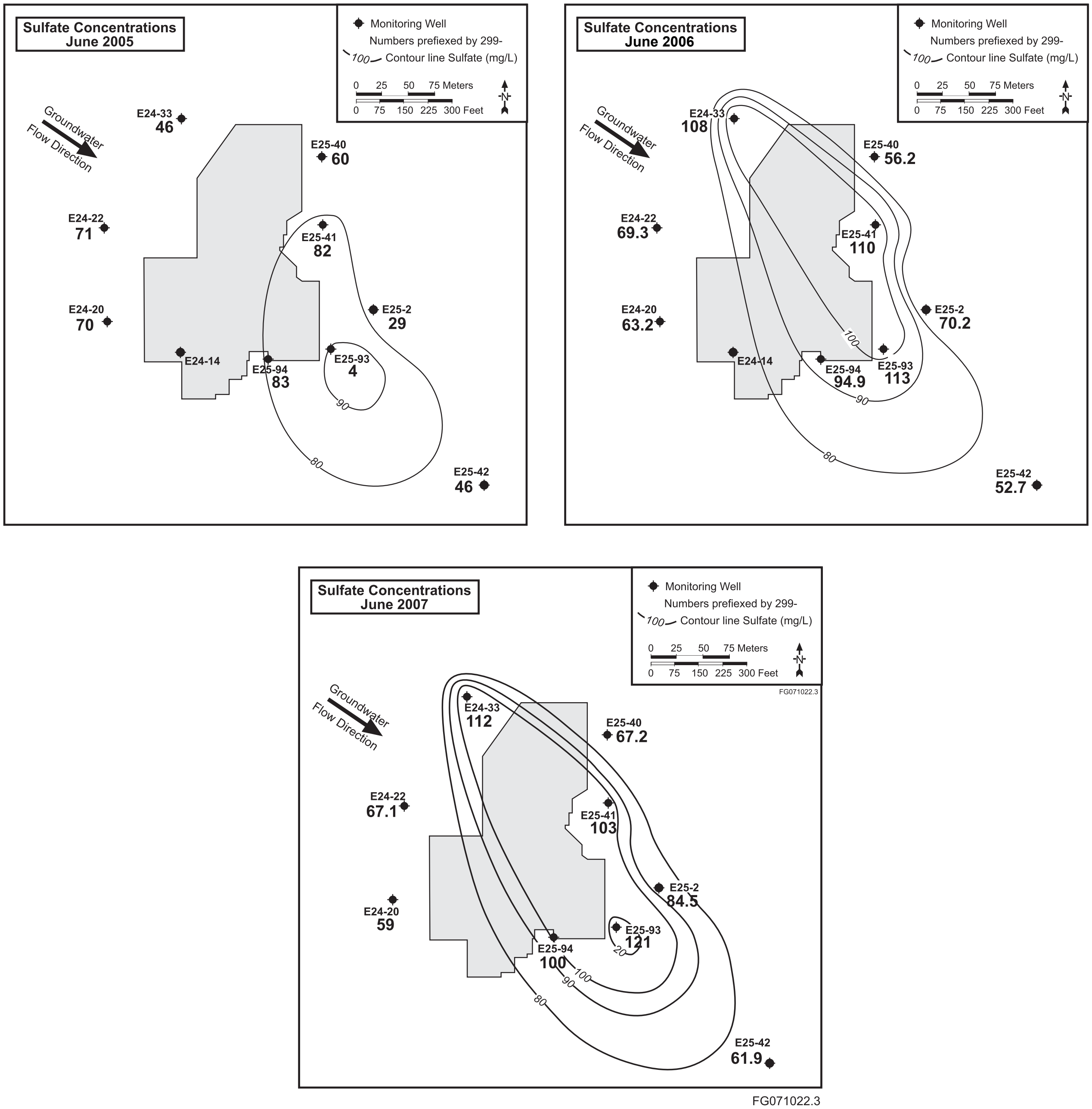


Figure 2.11-19. Sulfate Concentrations at Waste Management Area A-AX, June 2005 to June 2007

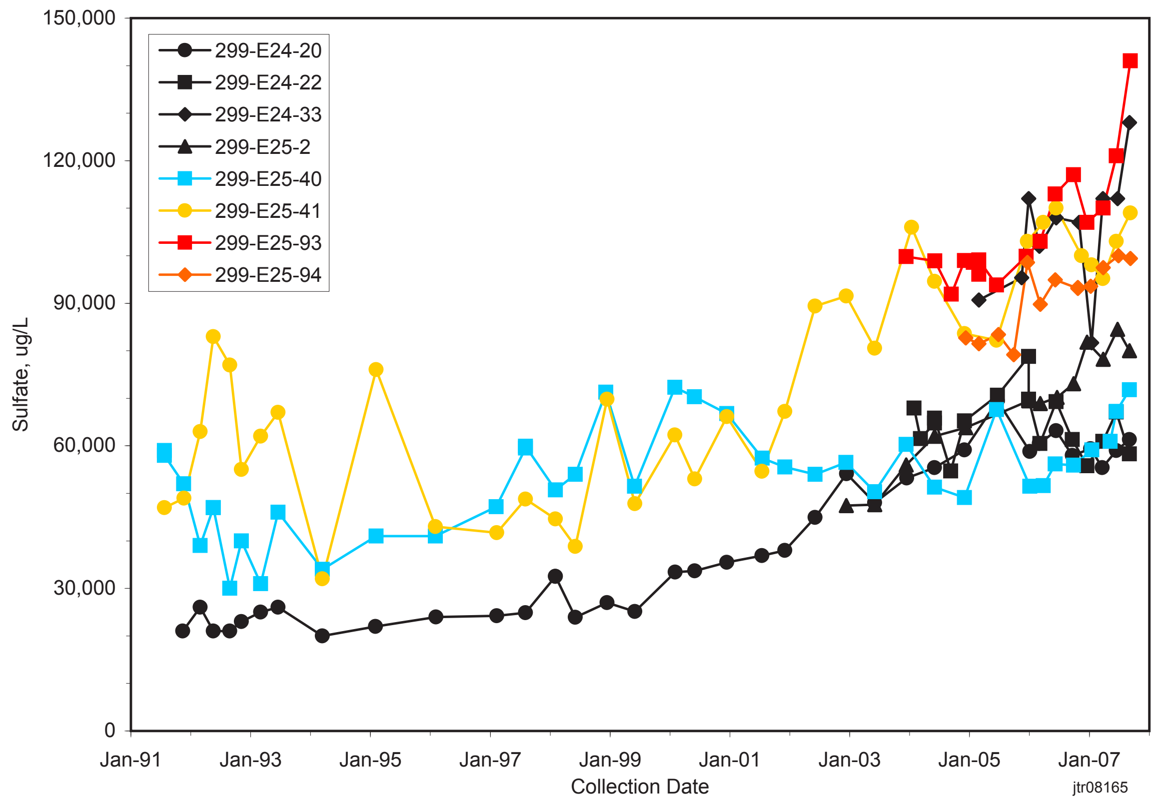


Figure 2.11-20. Sulfate Concentrations in Groundwater at Waste Management Area A-AX

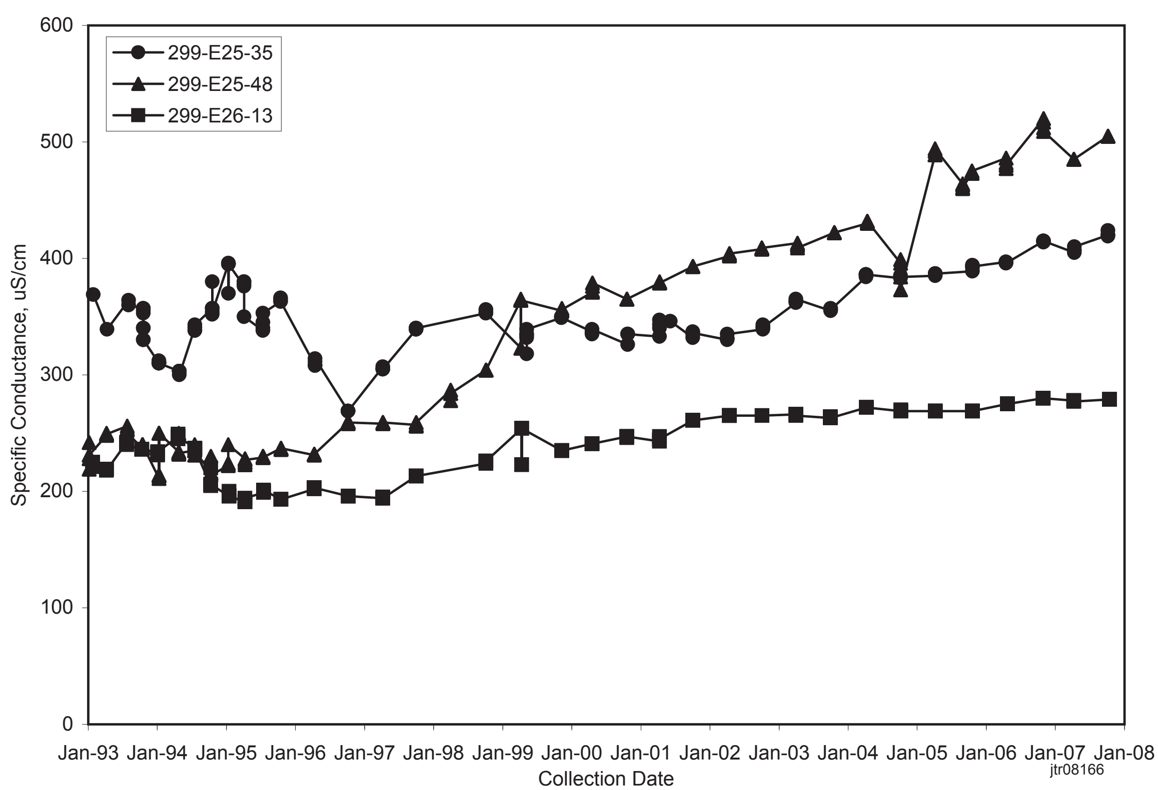


Figure 2.11-21. Specific Conductance in 216-A-29 Ditch Downgradient Wells 299-E25-35, 299-E25-48, and 299-E26-13

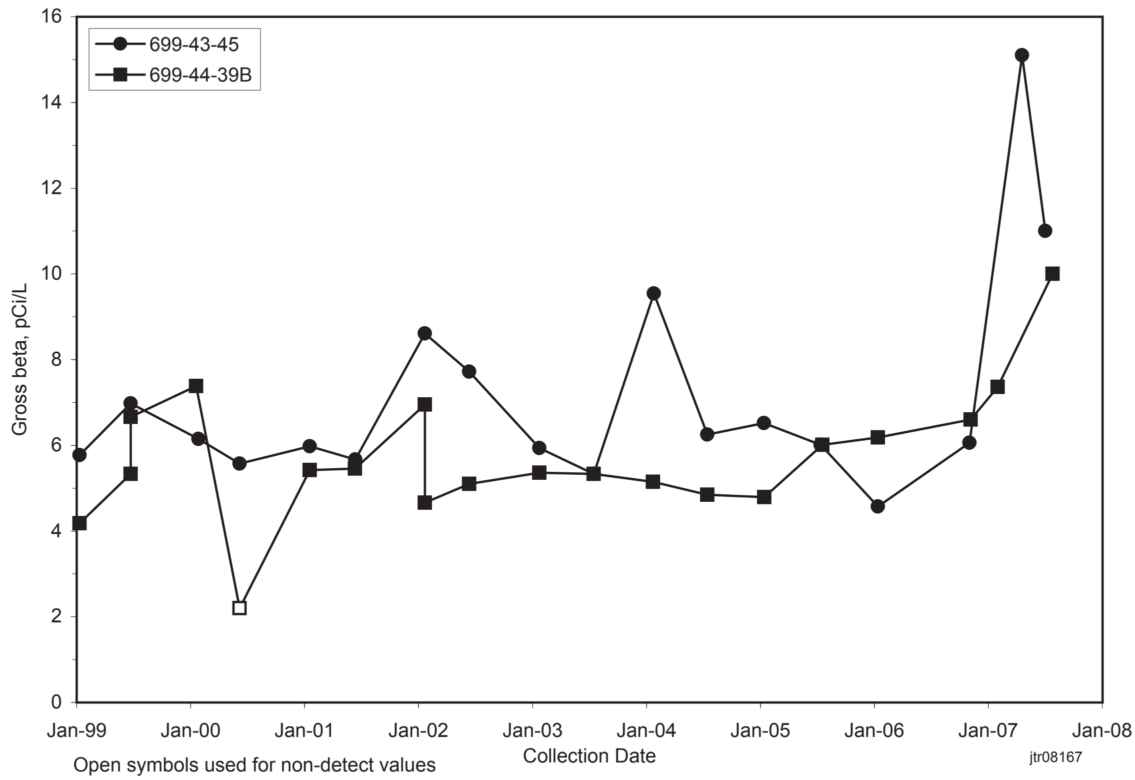


Figure 2.11-22. Gross Beta Concentrations Trends at Upgradient Well 699-44-39B and Downgradient Well 699-43-45, B Pond Facility

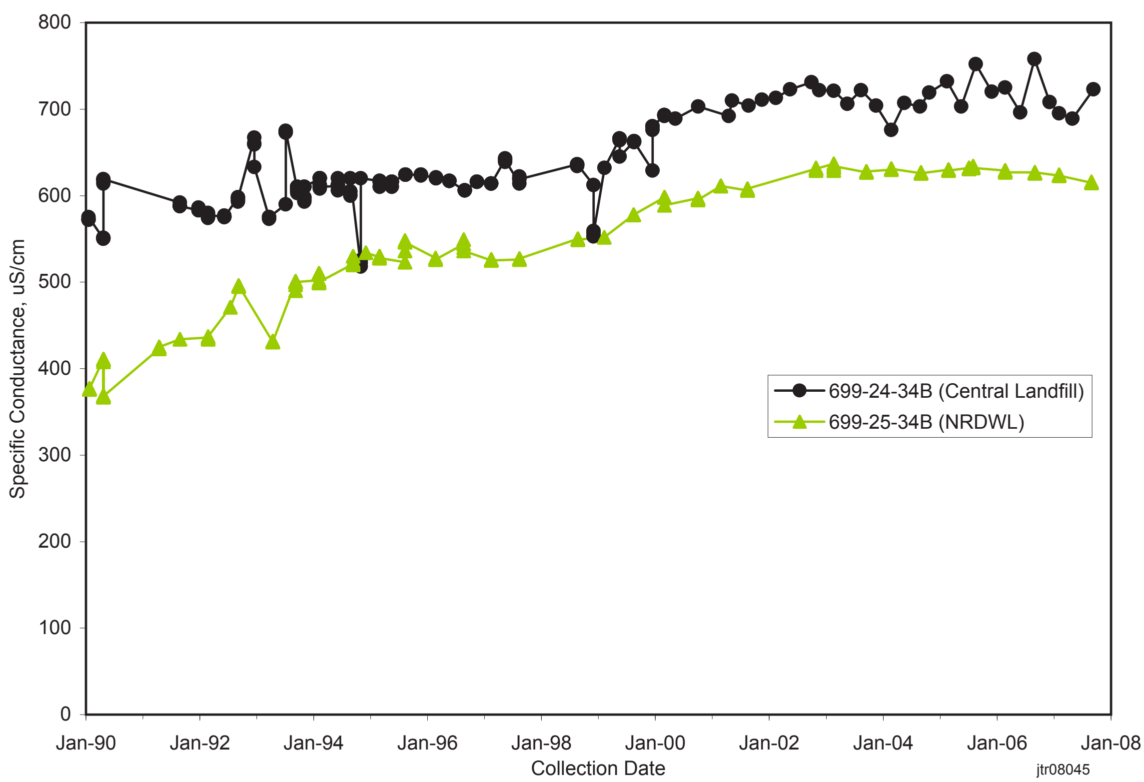


Figure 2.11-23. Specific Conductance at Nonradioactive Dangerous Waste Landfill Wells

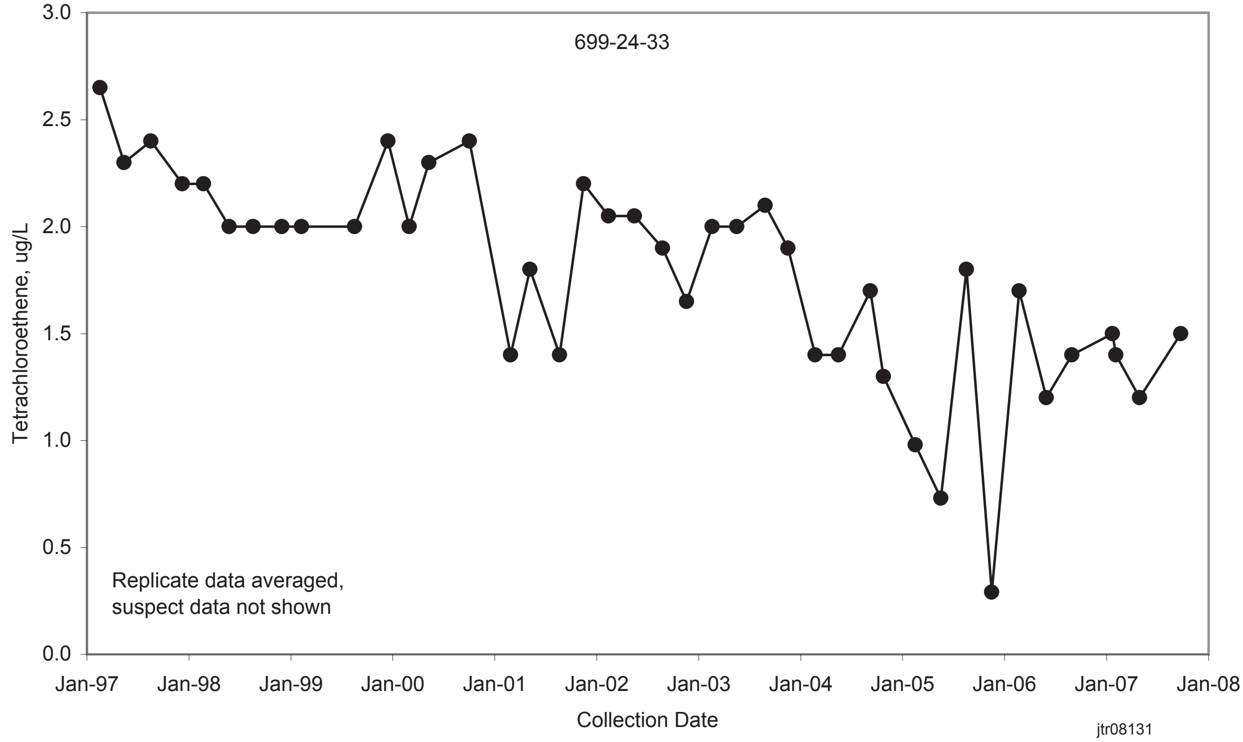


Figure 2.11-24. Tetrachloroethene Concentrations in Well 699-24-33 at the 600 Area Central Landfill

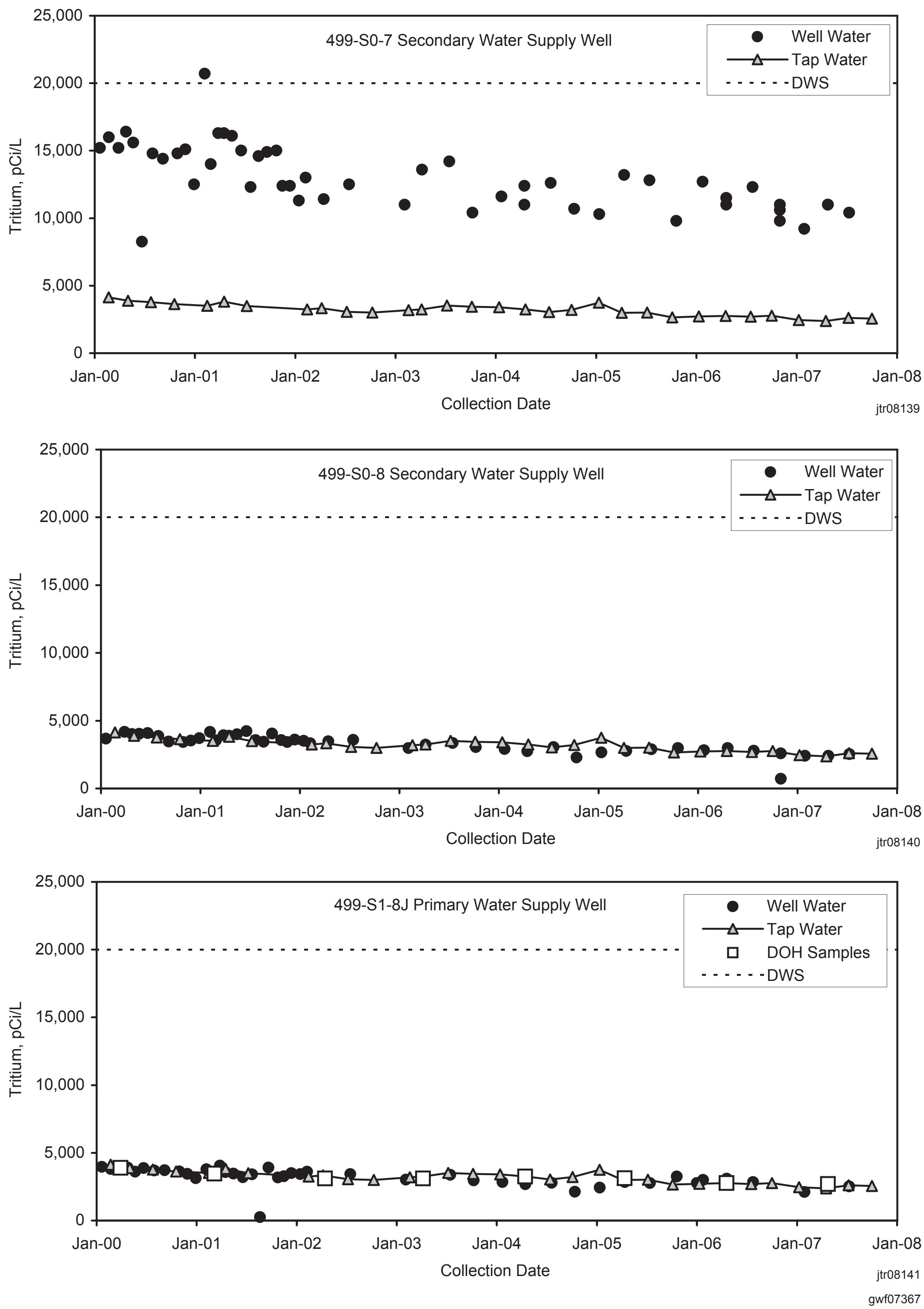


Figure 2.11-25. Tritium Concentrations in 400 Area Water Supply Wells