

2.9 200-UP-1 Operable Unit

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The scope of this section is the 200-UP-1 groundwater interest area, which addresses groundwater contaminant plumes beneath the southern third of the 200 West Area and adjacent portions of the surrounding 600 Area (see Figure 1.0-1 in Section 1.0). This region includes the 200-UP-1 Operable Unit. The “groundwater interest areas” are informal designations to facilitate scheduling, data review, and interpretation. Figure 2.9-1 shows facilities and wells in the 200-UP-1 Area. Technetium-99, uranium, tritium, iodine-129, nitrate, and carbon tetrachloride are the contaminants of greatest significance in groundwater and form extensive plumes within the region. In addition to these constituents, high-priority contaminants of concern also include strontium-90, trichloroethene, chloroform, chromium, cadmium, and arsenic (DOE/RL 92-76). Groundwater is monitored to:

- Evaluate the extent and migration of existing contaminant plumes within the interest area.
- Assess the technetium-99 and uranium concentration response to activities at an interim action pump-and-treat remediation system.
- Assess the rate and extent of contaminant migration from Waste Management Areas U and S-SX, as well as the 216-U-12 crib, under the *Resource Conservation and Recovery Act* (RCRA).
- Detect impacts to groundwater quality from the 216-S-10 pond and ditch under RCRA.

Technetium-99, uranium, tritium, iodine-129, nitrate, and carbon tetrachloride are the contaminants of greatest significance in groundwater and form extensive plumes within the 200-UP-1 groundwater interest area.

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

CERCLA and AEA Monitoring

- ***Fifty-five wells are sampled quarterly to biennially. Three wells were not sampled as scheduled (Appendix A).***
- ***Four wells are sampled semiannually at the Environmental Restoration Disposal Facility.***

Facility Monitoring (Appendix B)

- ***Nine wells are sampled quarterly at Waste Management Area U for RCRA and AEA. One well went dry in FY 2007.***
- ***Nineteen wells are sampled quarterly at Waste Management Area S-SX for RCRA and AEA. One sample was delayed until October 2007.***
- ***Three wells are sampled semiannually under RCRA for the 216-S-10 pond and ditch.***
- ***Four wells were sampled quarterly for RCRA at the 216-U-12 crib. This site has been reclassified from a RCRA treatment, storage, or disposal unit to a RCRA past-practice unit. Therefore, RCRA groundwater monitoring will be discontinued for FY 2008.***

- Detect impacts to groundwater quality from operation of the Environmental Restoration Disposal Facility under a *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) record of decision (ROD 1995b).
- Identify emerging groundwater contamination issues within the interest area.

**Plume areas (square kilometers)
above the drinking water
standard at the 200-UP-1
Operable Unit:**

Chromium — 1.09

Iodine-129 — 4.55

Nitrate — 6.59

Technetium-99 — 0.30

Tritium — 6.97

Uranium — 0.42

***Carbon tetrachloride included
in Section 2.8.**

Groundwater flow in the uppermost unconfined aquifer is primarily to the east within the 200-UP-1 groundwater interest area (see Figure 2.8-2 in Section 2.8). Water levels have been falling in this area since the 1980s, and flow directions have generally changed from southeast to east during this time. When U Pond and the 216-U-14 ditch were active, a groundwater mound resulted in radial flow in the northwest portion of the interest area (e.g., see PNNL-16069). Discharges to ground ceased in the mid-1990s, and the groundwater flow resumed its pre-Hanford flow direction toward the east. Based on water-level measurements in April 2006 and March 2007, the water-table elevation fell by an average of 0.27 meter in the south 200 West Area over the 11-month period.

One new monitoring well, 299-W14-71, was installed within the interest area during fiscal year (FY) 2007. It is located north-northeast of U Plant and was drilled through the Ringold Formation lower mud unit and completed just above that unit. Sampling results for this well are included in the following sections, as appropriate.

The remainder of this section describes contaminant plumes and concentration trends for the contaminants of concern under CERCLA, RCRA, and *Atomic Energy Act* (AEA) monitoring.

2.9.1 Groundwater Contaminants

Large-scale waste disposal at the 200-UP-1 groundwater interest area began during the early 1950s when plutonium separation operations began at the Reduction-Oxidation (REDOX) Plant and uranium recovery operations began at U Plant. In general, the high-level radioactive waste was stored in underground storage tanks while other liquid waste streams were sent to ponds and cribs. Groundwater plumes of nitrate, tritium, and iodine-129 formed from the pond and crib waste. These plumes continued to grow in size while effluent disposal operations continued. Effluent disposal to the ponds and cribs ceased during the 1990s. At present, the groundwater plumes from these sources are dispersing naturally. However, constituents of lower mobility in the vadose zone beneath the ponds and cribs may potentially reach the water table in the future and affect groundwater quality.

Within the tank farms (Waste Management Areas U and S-SX), some of the underground storage tanks have leaked, resulting in contamination of the vadose zone beneath the tanks. Some of this contamination has migrated downward and reached the water table (e.g., PNNL-11810). Currently, plumes of nitrate, technetium-99, and chromium from the tank farms are found in groundwater and are generally growing in areal extent and exhibit increasing constituent concentrations. In addition, carbon tetrachloride is migrating into the 200-UP-1 groundwater interest area from the 200-ZP-1 interest area.

The following sections provide an overview of the contaminant plumes and contaminants of concern for the 200-UP-1 groundwater interest area. These sections

are a summary of the combined results of CERCLA, RCRA, and AEA monitoring performed in this area with the focus being the upper part of the unconfined aquifer. Information on the vertical distribution of contaminants in the aquifer is given where available.

2.9.1.1 Technetium-99

Technetium-99 concentrations occur above the drinking water standard (900 pCi/L) in three regions of the 200-UP-1 groundwater interest area: downgradient from the 216-U-1,2 cribs near U Plant, at Waste Management Area S-SX, and at Waste Management Area U (Figure 2.9-2). A technetium-99 plume originates from the 216-U-1,2 cribs, which were active in the 1950s and 1960s. The plume extends ~1.5 to 2 kilometers east into the 600 Area, but mostly at levels below the drinking water standard. When effluent was disposed at the nearby 216-U-16 crib in the mid-1980s, it migrated north along a caliche layer and mobilized the technetium-99 and uranium in the soil column beneath the 216-U-1,2 cribs, adding contaminant to the groundwater plume (DOE/RL-92-76). Historically, the highest measured technetium-99 concentration in the 216-U-1,2 cribs plume was 41,000 pCi/L in well 299-W19-24 (west of the 216-U-17 crib) during October 1989.

An interim remedial action pump-and-treat system operated in the central part of the 216-U-1,2 cribs plume from 1994 until early 2005. This system was successful in containing and recovering the high concentration portion of the plume; the lower concentration portion outside the capture zone has continued to migrate east into the 600 Area. The remediation effort was successful in reducing concentrations below the remedial action goal of 9,000 pCi/L. During January 2005, groundwater extraction was terminated and a rebound study was initiated. Monthly sampling was performed to assess plume response to the termination of pumping. The rebound study concluded in January 2006, and technetium-99 concentrations at all monitoring wells were below the remedial action goal throughout FY 2006. Groundwater extraction resumed at wells 299-W19-36 and 299-W19-43 on April 19, 2007, with the goal of reducing uranium concentrations. Shortly thereafter, the technetium-99 concentration in 299-W19-36 increased to 13,000 pCi/L during July 2007, presumably in response to the resumption of groundwater extraction. Sampling of this well in September 2007 yielded a technetium-99 result of 9,700 pCi/L. Section 2.9.2 gives a more thorough discussion of the pump-and-treat activities.

At Waste Management Area S-SX, a technetium-99 plume originates from the southwest corner of the waste management area and another plume originates from the north part. The technetium-99 concentration in well 299-W23-19 (located inside the SX Tank Farm) peaked at 137,000 pCi/L during September 2005 (Figure 2.9-3), then decreased during FY 2006. During FY 2007, concentrations remained relatively stable in this well, fluctuating between 35,100 and 46,300 pCi/L. The overall trend at this well indicates that technetium-99 is entering the aquifer in an episodic manner. The south plume from Waste Management Area S-SX represents a growing contamination issue because the plume is increasing in areal extent and concentrations are increasing.

The north plume at Waste Management Area S-SX originates from the S Tank Farm, and concentrations increased in this plume during the fiscal year. In well 299-W22-44, the technetium-99 concentration increased from 1,230 pCi/L during June 2006 to 10,000 pCi/L during September 2007, the highest concentration ever

Concentrations of technetium-99 in well 299-W23-19, at Waste Management Area S-SX, were stable during the fiscal year at an average value of 41,000 pCi/L.

***U Tank Farm
is a source of
technetium-99
contamination.***

measured in this plume. The other mobile tank waste constituents (chromium and nitrate) are also increasing, while concentrations of all three of these constituents remain low in the upgradient well 299-W23-20. The technetium-99 concentration is still relatively low compared to the south plume, but the increase during the fiscal year indicates that this plume is now a growing contamination issue. Section 2.9.3.2 has more information about technetium-99 at this waste management area.

Technetium-99 concentrations in the downgradient wells at Waste Management Area U are elevated compared to concentrations in the upgradient wells. Thus, the U Tank Farm is a source of technetium-99 contamination (PNNL-13282). However, concentrations are very low compared to Waste Management Area S-SX. The drinking water standard (900 pCi/L) was exceeded in four wells during FY 2007: 299-W18-30 at ~930 pCi/L, 299-W19-42 at ~1,300 pCi/L, 299-W19-45 at ~1,000 pCi/L, and 299-W19-47 at ~1,500 pCi/L. Concentrations are increasing in six wells, declining in two wells, and stable in one well. Refer to Section 2.9.3.1 for more information about technetium-99 at this waste management area.

In the previous annual report (PNNL-16346), maps showing the depth distribution of technetium-99 (and uranium) in groundwater within the 200-UP-1 interest area were presented. Information for these maps came from depth-discrete groundwater sampling during well installation between FY 2003 and FY 2006. The data indicated three locations within the interest area where technetium-99 occurred above the drinking water standard relatively deep below the water table: well 299-W19-46 southeast of U Plant (1,360 pCi/L at 19 meters below the water table with concentrations less than 300 pCi/L above this depth), well 299-W19-49 south of U Plant (1,320 pCi/L at 28 meters below the water table), and well 699-38-70C east of U Plant in the 600 Area (1,200 pCi/L down to the lower mud unit at 33 meters below the water table). At all other locations, technetium-99 concentrations above the drinking water standard were limited to the upper ~20 meters of the aquifer or less. Depth discrete sampling during installation of 299-W14-71 during FY 2007 indicated that no significant technetium-99 was found in the aquifer (all detections were less than 100 pCi/L).

2.9.1.2 Uranium

Within the 200-UP-1 groundwater interest area, uranium primarily occurs in an extensive plume downgradient from the 216-U-1,2 cribs (Figure 2.9-4) and is associated with the technetium-99 plume there. The plume extends a total of ~1.5 kilometers to the east at levels above the 30- μ g/L drinking water standard. Uranium adsorbs to soil particles and is not as mobile in the aquifer as technetium-99. The uranium originated from the 216-U-1,2 cribs that were active in the 1950s and 1960s. As with technetium-99, additional mass was added to the plume when effluent disposed at the nearby 216-U-16 crib in the mid-1980s migrated north along a caliche layer in the vadose zone and mobilized the technetium-99 and uranium in the soil column beneath the 216-U-1,2 cribs (DOE/RL-92-76).

An interim remedial action pump-and-treat system operated on a high concentration part of this plume from 1994 until early 2005 (i.e., the same system used for the technetium-99 plume). The remediation effort was successful in reducing uranium concentrations below the remedial action goal of 480 μ g/L, but concentrations at most wells continued to exceed the drinking water standard of 30 μ g/L. During January 2005, groundwater extraction was terminated and a rebound study was initiated. Monthly sampling was performed to assess plume response to the termination of

pumping. The rebound study concluded in January 2006, and uranium concentrations at all monitoring wells were below the remedial action goal throughout FY 2006. However, during FY 2007, the uranium concentration in 299-W19-36 increased to 613 $\mu\text{g/L}$, above the remedial action goal.

The remedial action goal was ten times the *Model Toxics Control Act* standard at the time the interim record of decision was issued (ROD 1997), which was 48 $\mu\text{g/L}$. This standard has since been revised to 30 $\mu\text{g/L}$. In expectation that the remedial action goal will be revised to 300 $\mu\text{g/L}$ (ten times the current standard), groundwater extraction was resumed in wells 299-W19-36 and 299-W19-43 on April 19, 2007. In response, the uranium concentration at 299-W19-36 declined to 343 $\mu\text{g/L}$ by September. Section 2.9.2 gives a more thorough discussion of the pump-and-treat activities.

Near the source of the 216-U-1,2 cribs plume, uranium continues to be elevated in well 299-W19-18, although the concentration has decreased since 2004 (Figure 2.9-5). During FY 2007, uranium was measured twice at just over 400 $\mu\text{g/L}$, down from 600 $\mu\text{g/L}$ in May 2004. The small change in uranium concentration in this well over the past 10 years may be due to an ongoing source of uranium to the aquifer water, such as continued leaching from the vadose zone beneath the 216-U-1,2 cribs or desorption of uranium from the aquifer sediment, or it may be due to the slow migration of uranium compared to technetium-99.

Maps of depth-discrete sampling results for uranium during well installation between FY 2003 and FY 2006 were presented in the previous annual report (PNNL-16346). Uranium was found above the drinking water standard only in the 216-U-1,2 cribs plume, and the data indicated that the plume is limited to the upper ~20 meters of the aquifer. There were no exceedances of the drinking water standard below 20 meters depth. Even in those wells (299-W19-46, 299-W19-49, and 699-38-70B) in which technetium-99 was found above the drinking water standard relatively deep in the aquifer, uranium was not elevated at the same depths. Uranium was not detected above the drinking water standard in the south part of the 200 West Area; all measured uranium concentrations were <5 $\mu\text{g/L}$.

2.9.1.3 Tritium

Disposal facilities associated with REDOX Plant are the primary sources of tritium in the 200-UP-1 groundwater interest area. The REDOX Plant operated from 1952 until 1967, although effluent releases continued to occur after that time. A large tritium plume from the REDOX Plant cribs originates from the south part of the 200 West Area and extends ~5 kilometers toward the east and northeast at levels above the 20,000-pCi/L drinking water standard. Two high concentration areas occur within this plume – a large one extending to the east and northeast from the 200 West Area and a smaller one extending ~550 meters to the east-southeast from the vicinity of the 216-S-25 crib (Figure 2.9-6).

Measured concentrations in the eastern high concentration area range from ~160,000 to 1 million pCi/L. Concentrations are generally declining at six wells and increasing at three, suggesting that the plume has localized areas of high concentrations. When these areas migrate past wells, increasing concentrations can occur. However, the plume overall exhibits declining concentrations and the areal extent as defined by the 2,000-pCi/L contour has changed little, indicating natural attenuation by dispersion and radiological decay.

Uranium responded more slowly than technetium-99 to the pump-and-treat system. All uranium concentrations were below the remedial action goal (480 $\mu\text{g/L}$) but above the drinking water standard (30 $\mu\text{g/L}$) within the pump-and-treat area.

The tritium plume originating from the south part of the 200 West Area is attenuating through dispersion and radiological decay.

Tritium occurs above the drinking water standard in nine wells downgradient of the 216-S-25 crib. Concentrations fluctuate in a single well (299-W23-9) on the downgradient side of the crib. Farther downgradient, trends are stable in three wells, decreasing in four wells, and increasing in one well. Radioactive liquid effluent was disposed to this crib from 1973 through 1980, and in 1985, effluent from a pump-and-treat system at the 216-U-1,2 cribs was disposed to this crib. In the vadose zone beneath this crib, tritium in the residual soil moisture is likely to be slowly migrating to the water table, which would account for the fluctuating tritium concentration trend in well 299-W23-9. The plume has migrated under Waste Management Area S-SX, but the tank farms are not considered a direct source of tritium to the groundwater. Tritiated water in the tanks was removed by the 242-S evaporator and disposed of at the 216-S-25 crib. The areal extent of the plume is growing as evidenced by increasing trends in the far-field downgradient wells 299-W22-82 and 299-W22-83 for Waste Management Area S-SX. The maximum concentration measured in this plume during the fiscal year was 150,000 pCi/L in 299-W23-9, adjacent to the crib.

The tritium concentration in groundwater near the 216-S-21 crib (west of Waste Management Area S-SX) has increased to above the drinking water standard (20,000 pCi/L) for the first time since 1989 (Figure 2.9-7). The August 2007 sample result was 26,000 pCi/L. This crib has been a major source of tritium in the past; the peak tritium concentration in 299-W23-4 occurred in 1963 and 1964 at 110 million pCi/L.

Information on the vertical distribution of tritium in the aquifer is sparse. Three of the eight wells (299-W19-48, 699-30-66, and 699-36-70B) installed within the operable unit during calendar year 2004 were sampled for tritium at different depths during drilling. The results indicated that tritium mainly occurs in the upper part of the aquifer near the water table. However, none of these wells were located in a high concentration portion of the plume. No tritium was detected in depth-discrete samples collected during drilling of 299-W14-71.

2.9.1.4 Iodine-129

Iodine-129 plumes in the 200-UP-1 groundwater interest area originate from both U Plant and REDOX Plant disposal facilities (Figure 2.9-8). One plume originates from the vicinity of the 216-U-1,2 cribs, while another originates from the south part of the 200 West Area. At the current level of monitoring detail, these plumes merge downgradient and become indistinguishable. This combined plume (as defined by the 1-pCi/L contour level) extends to the east a total distance of ~3.5 kilometers. Measured concentrations near the REDOX Plant cribs are below the drinking water standard (1 pCi/L) except at the 216-S-9 crib.

Groundwater sampling results near the 216-U-1,2; 216-U-12; and 216-S-9 cribs are flagged as non-detectable (Figure 2.9-8) but are believed to represent valid approximations of the iodine-129 concentration in the aquifer. The analytical laboratory is conservative, by requiring confirmation through the presence of a secondary (less sensitive) energy peak, prior to considering the iodine-129 detected (see Section 1.8). In the late 1980s, shortly after the large uranium release to the aquifer beneath the 216-U-1,2 cribs, iodine-129 was detected at ~30 pCi/L. Iodine-129 was detected at ~9 pCi/L in 2000 in a single well just before it went dry (well 299-W19-3). Similarly at the 216-U-12 crib, iodine-129 was detected at ~12 pCi/L during the 1990s. Thus, these cribs were a source of iodine-129, and it is reasonable to conclude that the vadose zone beneath these cribs contains residual

A high concentration portion of the iodine-129 plume is migrating to the east out of the 200 West Area into the 600 Area.

iodine-129 that may be currently leaching into the aquifer. The same may be true for the 216-S-9 crib, although there are no historical sample results for iodine-129 in the vicinity of this crib.

A high concentration part of the iodine-129 plume has migrated to the east out of the 200 West Area into the surrounding 600 Area. Measured concentrations in the central part of this plume typically range up to ~30 pCi/L. Concentrations are generally declining or stable throughout the plume, and dispersion is slowly reducing the plume size (i.e., the region of the plume above the drinking water standard). Radiological decay is not a factor in the declining areal extent, because iodine-129 has a long half-life (15.7 million years).

2.9.1.5 Strontium-90

During FY 2007, 30 analyses for strontium-90 were performed on samples collected from 11 wells within the groundwater interest area. Strontium-90 was detected in one sample from 299-W19-48 at 0.45 pCi/L, but was not detected in two other samples collected from this well. There were no other strontium-90 detections during the fiscal year. In prior years, strontium-90 has been routinely detected in well 299-W22-10, located downgradient of the 216-S-1,2 cribs, but this well was not sampled during FY 2007. The FY 2006 sample result was 27 pCi/L during December 2005, which is above the drinking water standard (8 pCi/L). Concentrations have been declining in this well after increasing to 76 pCi/L in December 2001. The 216-S-1,2 cribs received highly acidic waste from the REDOX Plant between 1952 and 1956. In 1955, the waste is believed to have corroded the casing of a nearby well 299-W22-3 (not shown in Figure 2.9-1, but the well is located 20 meters east of well 299-W22-2 at the 216-S-1,2 cribs), which allowed the effluent to bypass the soil column and flow down the well directly into groundwater (Waste Information Data System [WIDS]). This is the postulated pathway by which strontium-90 may have reached groundwater at this location.

2.9.1.6 Chlorinated Hydrocarbons

Carbon tetrachloride occurs above the drinking water standard (5 µg/L) in numerous wells within the 200-UP-1 groundwater interest area. At the water table, the plume is widespread in the south 200 West Area, and extends ~1 kilometer east into the 600 Area (Figure 2.8-3 in Section 2.8). The plume originated from waste disposal sites associated with the Plutonium Finishing Plant in the 200-ZP-1 groundwater interest area. Concentration trends are increasing in nine wells, decreasing in three wells, and fluctuating but generally stable in numerous wells. No clear spatial pattern is evident among wells having increasing or decreasing trends. Depth-discrete sampling in the eastern part of the plume shows that concentrations generally increase with depth to the Ringold Formation lower mud unit. This pattern was also observed at new well 299-W14-71 (Figure 2.9-9), located north of U Plant.

The highest carbon tetrachloride concentration measured during FY 2007 was 1,600 µg/L in new well 299-W14-71, which was screened from 40.9 to 45.4 meters below the water table just above the Ringold Formation lower mud unit. This concentration is higher than what was measured during drilling (Figure 2.9-9); the reason for this discrepancy is not known. In the west part of the plume concentrations tend to be higher near the water table. Depth-discrete sampling during installation of well 299-W22-47 at Waste Management Area S-SX showed that concentrations peaked (at 96 µg/L) 12 meters below the water table and then quickly declined to

Carbon tetrachloride is widespread in the 200-UP-1 groundwater interest area, but this plume originated from disposal facilities in the 200-ZP-1 groundwater interest area.

Depth-discrete sampling during well installation shows that carbon tetrachloride, chloroform, and trichloroethene concentrations generally increase with depth in the eastern part of the operable unit.

In well 299-W23-19 at Waste Management Area S-SX, chromium concentrations were stable during the fiscal year at an average value of 740 µg/L.

about the drinking water standard 37 meters below the water table. See Section 2.8 for more information regarding the vertical distribution of carbon tetrachloride in the aquifer.

Chloroform is a degradation product of carbon tetrachloride and tends to occur in the same wells with carbon tetrachloride. Thus, some degradation of carbon tetrachloride may be occurring, although chloroform could have been introduced to the aquifer from the 2607-Z tile field (see Section 2.8). A total of 135 chloroform analyses were performed on samples from 50 wells within the 200-UP-1 groundwater interest area, and no exceedances of the drinking water standard (80 µg/L) were observed in FY 2007. The maximum concentration measured during the fiscal year was 35 µg/L in new well 299-W14-71. Depth-discrete sampling during new well installation showed that concentrations tend to increase with depth, similar to carbon tetrachloride.

Trichloroethene is found within the 200-UP-1 groundwater interest area above the drinking water standard (5 µg/L) in the vicinity of the pump-and-treat system, as well as to the north at new well 299-W14-71. Depth-discrete sampling results show that concentrations tend to increase with depth. A total of 135 trichloroethene analyses were performed on samples from 50 wells within the interest area, and the drinking water standard was exceeded in four wells in FY 2007: 299-W14-71, 299-W19-34B, 699-38-70B, and 699-38-70C. All of these wells are screened deep within the unconfined aquifer just above the Ringold Formation lower mud unit. Concentrations are generally stable in wells 299-W19-34B, 699-38-70B, and 699-38-70C; more data are needed to establish a trend at well 299-W14-71. There were no exceedances of the drinking water standard in wells completed across the water table. The maximum concentration measured was 13 µg/L in new well 299-W14-71. The areal extent of trichloroethene does not coincide with the distribution of carbon tetrachloride suggesting a localized source in the U Plant area.

2.9.1.7 Chromium

Chromium is found in four regions of the 200-UP-1 groundwater interest area: at Waste Management Area S-SX, at the 216-S-10 pond and ditch, in the vicinity of the 216-S-20 crib, and in the 600 Area east and southeast of the 200 West Area. During FY 2007, samples from five wells exceeded the drinking water standard (100 µg/L) - four at Waste Management Area S-SX and one southeast of the 200 West Area. The highest concentrations occurred at well 299-W23-19, where the filtered total chromium trend was relatively stable during the fiscal year, averaging 740 µg/L (Figure 2.9-3). Filtered total chromium peaked in this well at 1,750 µg/L in December 2005. This well is near the source of a chromium, technetium-99, and nitrate plume originating from the SX Tank Farm. The chromium fluctuations in well 299-W23-19 are interpreted to indicate that the contaminant enters the aquifer from the vadose zone beneath the tank farm in an episodic manner.

A second plume occurs in the north part of Waste Management Area S-SX, downgradient from the S Tank Farm. At well 299-W22-44 in this plume, the filtered total chromium concentration increased from 74 µg/L during October 2006 to 345 µg/L during September 2007. The other mobile tank waste constituents, technetium-99 and nitrate, have also increased significantly during this time. In general, chromium concentrations are increasing at Waste Management Area S-SX and the areal extent of both plumes is growing. Chromium at Waste Management Area S-SX is further discussed in Section 2.9.3.2.

Filtered total chromium has been found above the drinking water standard in well 299-W26-7 at the 216-S-10 pond and ditch. The sample collected in June 2003 yielded a result of 209 µg/L. The well has since gone dry, so no further sampling is possible. The source for this contamination is unconfirmed, but it could be the 216-S-10 pond and ditch, even though well 299-W26-7 is an upgradient well. The areal extent of the plume appears to be small and stable, because chromium concentrations in downgradient and side-gradient wells are at minimal to non-detectable levels.

Filtered total chromium is frequently detected in wells east and southeast of the 200 West Area. An interpretation of the chromium extent in this area is shown on the map of major hazardous chemical plumes in the summary section of this report. The filtered total chromium concentration in well 699-32-62 was 152 µg/L in September 2007, little changed from the previous sampling two years earlier. Chromium concentrations have declined slowly since this constituent was first analyzed for at this well in 1992. Filtered total chromium is also above the drinking water standard at well 699-30-66 (102 µg/L in February 2006), which is completed deep in the aquifer just above the lower mud unit. This indicates that chromium may occur throughout the aquifer thickness in this region. The sources and extent of this contamination are uncertain. The location of this plume is consistent with disposal to the REDOX Plant ponds/ditches south and southwest of the 200 West Area. Chromium is detected in several other wells in this area, but its extent to the south is not well defined.

Filtered total chromium has also been found above the drinking water standard in well 299-W22-20, adjacent to the 216-S-20 crib. A concentration of 560 µg/L was measured in September 2004, and concentrations had been increasing since 2000. This well was not sampled for metals during FY 2007, but was sampled twice during FY 2006 with filtered total chromium results of 216 µg/L in December falling to 10 µg/L in August. This well has a perforated, carbon steel casing and is filling with fine sand. The sand is known to quickly destroy sample pump seals, so the well must be sampled with a bailer and cannot be purged. In addition, the well is going dry and manganese is elevated suggesting that reducing conditions are becoming prevalent. Another redox sensitive constituent, vanadium, has declined to nondetect levels, which is also consistent with reducing conditions. Thus, the FY 2006 sample results may not be representative of the aquifer.

2.9.1.8 Nitrate

Nitrate plumes in the 200-UP-1 groundwater interest area are thought to have originated from both the U Plant and REDOX Plant disposal facilities and are widespread throughout the area. Potential sources of nitrate from U Plant include the 216-U-1,2; 216-U-8; and 216-U-12 cribs. The nitrate plumes from these and other sources merge downgradient into a single large plume, which extends to the east and northeast a total distance of ~4 kilometers (Figure 2.9-10). Nitrate sources from REDOX Plant disposal facilities may also have contributed to this plume. With a few exceptions, concentrations throughout the large plume outside the 200 West Area are stable or declining. On the eastern margin of the plume, concentrations are stable in well 699-36-61A, increasing in well 699-40-62, and have started to decline in 699-44-64.

Within the pump-and-treat area, nitrate concentrations were generally stable in well 299-W19-43 during FY 2006 at ~1,600 mg/L. During FY 2007, the nitrate

Nitrate originates from multiple sources in the 200-UP-1 groundwater interest area and occurs in a large plume extending ~4 kilometers to the east-northeast.

The occurrence of nitrate above the drinking water standard deep in the unconfined aquifer does not appear to be widespread.

concentration in this well began to decline, presumably in response to the resumption of groundwater extraction. The September 2007 sample result was 930 mg/L. This decline doesn't necessarily mean that concentrations are being significantly reduced in the aquifer. As the capture zone grows in response to pumping, water having a lower nitrate concentration, quite possibly from beneath the plume, is drawn into the extraction well and dilutes the water of higher nitrate concentration. During FY 2006, nitrate concentrations had begun to increase in 299-W19-37, and that trend continued for the first part of FY 2007; the concentration increased from 536 mg/L in August 2006 to 633 mg/L in April 2007. In September 2007, the concentration had declined to 268 mg/L, presumably in response to the resumption of groundwater extraction. The maximum nitrate concentration values seen in these wells are higher than concentrations measured historically at the 216-U-1,2 cribs in the 1970s and 1980s, which were typically ~100 to ~300 mg/L. Thus, it appears that nitrate may have a local source in the vicinity of the pump-and-treat area. Section 2.9.2 also discusses nitrate at the pump-and-treat area.

The occurrence of nitrate above the drinking water standard deep in the unconfined aquifer does not appear to be widespread. The nitrate distribution depicted in Figure 2.9-10 represents nitrate concentrations in the upper portion of the unconfined aquifer, since most of the wells are screened across the water table. Of the wells actively sampled within the interest area, seven are screened deeper in the aquifer and five of these are within the mapped nitrate plume. In only one of these deeper wells, 699-38-70C, is nitrate found at levels above the 45-mg/L drinking water standard. The concentration trend in this well is stable at ~170 mg/L.

Waste Management Area U is a source of nitrate to groundwater (see Section 2.9.3.1). Nitrate concentrations in three of the downgradient wells were above the drinking water standard during FY 2007. The maximum measured nitrate concentration at the U Tank Farm during FY 2007 was 89 mg/L in well 299-W19-44.

Nitrate occurs in two small plumes associated with REDOX Plant disposal facilities: one near the 216-S-20 crib and another near the 216-S-25 crib. Well 299-W22-20 downgradient of the 216-S-20 crib had a nitrate concentration of 104 mg/L for September 2007. The concentration in this well has been declining since a maximum value occurred in December 2005 at 144 mg/L. From 1952 through 1972, this crib received waste from laboratory hoods and decontamination sinks in the 222-S Building, along with laboratory waste from the 300 Area. In well 299-W23-9, at the downgradient end of the 216-S-25 crib, concentrations have been elevated in recent years, suggesting that a pulse of nitrate has entered the aquifer from the soil column beneath the crib. A sample collected in August 2007 from this well showed a nitrate concentration of 216 mg/L, down from 317 mg/L in August 2006.

The nitrate plume originating from the 216-S-25 crib merges with a nitrate plume from Waste Management Area S-SX (see Section 2.9.3.2). Nitrate concentrations from the tank farm correlate with technetium-99 concentrations. In well 299-W23-19 at the southwest corner of Waste Management Area S-SX, the nitrate concentration was generally stable during FY 2007 (coincident with the technetium-99 and chromium trend) at ~390 mg/L.

2.9.1.9 Other Constituents

Arsenic and cadmium are listed as contaminants of concern for the 200-UP-1 Operable Unit (DOE/RL-92-76). During FY 2007, 40 analyses were performed

for arsenic in 20 wells and 178 analyses were done for cadmium in 51 wells. No detections above a drinking water standard (10 µg/L for arsenic and 5 µg/L for cadmium) were observed.

The contaminants of concern for the 200-UP-1 Operable Unit have been classified into an initial list of high priority constituents (i.e., strontium-90, iodine-129, technetium-99, uranium, tritium, carbon tetrachloride, chloroform, trichloroethene, chromium, arsenic, cadmium, and nitrate) to support integrated CERCLA and AEA long-term monitoring, as well as additional contaminants of concern specifically identified to support the remedial investigation/feasibility study (DOE/RL-92-76). These additional contaminants of concern are documented in the remedial investigation/feasibility study work plan (DOE/RL-92-76) and include an extended list of volatile organic compounds, metals, anions, ammonium ion, ammonia, cyanide, sulfide, cresols, phenols, total petroleum hydrocarbons (kerosene range), beta emitters (carbon-14 and selenium-79), alpha emitters (neptunium-237 and protactinium-231), and gamma emitters (cesium-137 and cobalt-60).

Wells 299-W19-105, 299-W19-107, 299-W22-69, 299-W22-72, 299-W22-86, and 299-W22-87 were specifically sampled for the additional contaminants of concern during FY 2007. Other than those constituents that are naturally present in groundwater (i.e., magnesium, manganese, and vanadium), only three constituents were detected at least once without a laboratory qualifier: carbon-14, cyanide, and iron. Carbon-14 was detected in three of four samples collected from 299-W22-72, but at levels far below the drinking water standard. The maximum concentration was 12 pCi/L, and the drinking water standard is 2,000 pCi/L. Cyanide was detected at 6.5 µg/L in one sample from 299-W19-107, but not in a second sample. The cyanide drinking water standard is 200 µg/L. Iron was detected in two samples from 299-W22-69, but not in seven other samples from this well. Iron was also detected in one sample from 299-W22-72, but not in eight other samples.

There were several qualified detections of an additional contaminant of concern. The qualifiers indicated the results were estimated values below the quantitation limit of the analytical method, or below the contract required detection limit, or that the constituents were also detected in an associated quality control blank. The constituents with qualified detections were acetone, ammonia, ammonium ion, cobalt, iron, and tetrachloroethene, and these results are considered to be false positives.

In FY 2002 and FY 2003, 1,4-dioxane was detected in 299-W22-20 near the 216-S-20 crib at levels of 110 to 160 µg/L. This constituent was detected again at 120 µg/L in a sample collected during August, 2006. No 1,4-dioxane analyses were performed for this well during FY 2007. 1,4-Dioxane is typically used as a solvent stabilizer and tends to occur in association with chlorinated solvent plumes. A federal drinking water standard has not been established for this constituent.

2.9.2 Operable Unit Activities

This section describes activities related specifically to the 200-UP-1 Groundwater Operable Unit. These activities involve the pump-and-treat system operating near U Plant and responses to the second CERCLA five-year review. The sampling and analysis plan for FY 2007 sampling of the 200-UP-1 Operable Unit is incorporated into the Remedial Investigation/Feasibility Study Work Plan for the

200-UP-1 Groundwater Operable Unit (DOE/RL-92-76). This plan integrates CERCLA and AEA monitoring, and is a revision of the original integrated plan issued during June 2002 (DOE/RL-2002-10). Appendix A presents the monitoring well network for the 200-UP-1 Operable Unit, including a well list, sampling frequencies, and analyte lists.

One new well (299-W14-71) was drilled within the operable unit during FY 2007. Planning was initiated to drill an additional 6 wells within the operable unit, which are the second half of 12 wells requested by Ecology (DOE/RL-92-76, Rev. 1).

2.9.2.1 Status of Five-Year Review Action Items

The second CERCLA five-year review was published in November 2006 (DOE/RL-2006-20). One issue and associated action was identified for the 200-UP-1 Operable Unit:

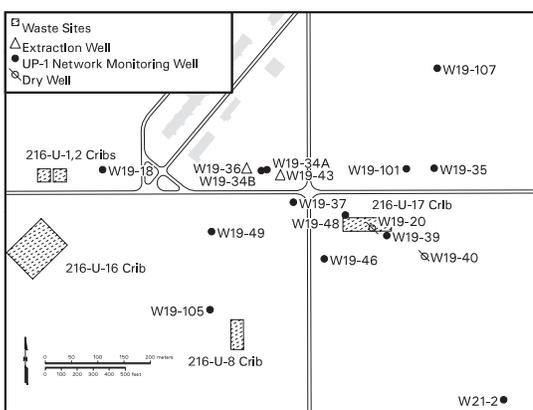
- **Issue 18.** The remedial action objective for uranium was based on the Washington State *Model Toxics Control Act* cleanup standard of 48 µg/L. Since this time, EPA has established a drinking water standard of 30 µg/L. There are also some other issues to be addressed within the record of decision, including the limited quarterly pumping requirement at well 299-W23-19, adjusting the pumping requirement for 200-UP-1 due to limited flow within the extraction well network, and technetium-99 groundwater contamination at other locations within the operable unit.
- **Action 18-1.** Prepare an explanation of significant difference for 200-UP-1 interim record of decision (due June 2008).
- **Response.** In anticipation of the release of the explanation of significant difference, the U.S. Department of Energy (DOE) directed on April 18, 2007, that the 200-UP-1 pump-and-treat system be restarted at wells 299-W19-36 and 299-W19-43 where uranium concentrations in groundwater exceeded 10 times the 30-µg/L drinking water standard.

2.9.2.2 Interim Groundwater Remediation for Technetium-99 and Uranium

Extraction wells 299-W19-36 and 299-W19-43 were restarted on April 19, 2007, following a 1-year rebound study and 15 months on hot standby during which the wells were maintained in a condition allowing for a quick restart. The system was active for the remainder of the fiscal year, and groundwater was pumped to the Liquid Effluent Retention Facility for eventual transfer to the Effluent Treatment Facility for removal of uranium along with technetium-99, carbon tetrachloride and nitrate. Restart was directed by DOE in anticipation of the Explanation of Significant Difference required by *The Second CERCLA Five-Year Review Report for the Hanford Site* (DOE/RL-2006-20). Restart was stipulated for wells where uranium concentrations exceeded 10 times the current 30-µg/L drinking water standard. During virtually all of the time the system was inactive, uranium concentrations at the 12 wells surrounding the original baseline uranium plume did not exceed the current 480 µg/L remedial action objective established by the interim record of decision (ROD 1997).

Progress During FY 2007. Restart of the extraction wells resulted in the discharge of 10 million liters of groundwater to Basin 43 at the Liquid Effluent Retention

*Following a
27-month interval
without pumping,
groundwater
extraction resumed at
the 200-UP-1 pump-
and-treat system
during April 2007.*



Facility. Groundwater was extracted at an average rate of 43 liters/minute in the 162 days of operation following the restart. Treatment at the Effluent Treatment Facility was started on September 28, 2007 and over 2 million liters were treated by the end of the fiscal year. An estimated 1.1 kilograms of uranium, 0.27 gram of technetium-99, 53 grams of carbon tetrachloride, and 356 kilograms of nitrate were removed (Table 2.9-1). Over 855 million liters have been treated since startup of remediation activities in FY 1994. A total of 212.9 kilograms of uranium, 119.1 grams of technetium-99, 34.6 kilograms of carbon tetrachloride, and 35,072 kilograms of nitrate have been removed from the aquifer.

Hydraulic head trends at several groundwater wells within the 200-UP-1 baseline plume area were used to determine the decline in groundwater elevations. The water table declined an average of 0.31 meter/year in FY 2007 within the baseline plume area. This rate is greater than the 0.23 meter/year in FY 2005 and 2006, but is still significantly lower than that observed in FY 2004 and FY 2003 when the water level decline was 0.37 meter/year.

Influence on Aquifer Conditions. Figures 2.9-11 and 2.9-12 show the technetium-99 and uranium plumes for the upper unconfined aquifer at the pump-and-treat area, based on average concentrations for the fiscal year. Maps depicting the baseline technetium-99 and uranium plumes in 1995 and the current plumes in FY 2007 are presented in the summary of this report.

Except for wells 299-W19-36 and 299-W19-37, uranium and technetium-99 concentrations at the wells monitored around the baseline plume for the rebound study were stable or declining for FY 2007. Uranium concentrations at well 299-W19-43 averaged 357 $\mu\text{g/L}$ for the fiscal year, consistent with the trend in FY 2006 (Figure 2.9-13). Concentrations at well 299-W19-37 increased to a peak value of 350 $\mu\text{g/L}$ in April 2007, and remained at that level (346 $\mu\text{g/L}$) in September. This well is expected to go dry in a few years; as of September, there was only 0.9 meter of water above the bottom of the screen. The concentration at well 299-W19-36 increased to 613 $\mu\text{g/L}$ in April 2007, just prior to the resumption of groundwater extraction. Sample results following restart showed that uranium concentrations declined to 445 and 343 $\mu\text{g/L}$ during July and September, respectively. Except for wells screened deeper in the aquifer or located farther away from the presumed source at 216-U-1,2 cribs, uranium concentrations were routinely above the 30 $\mu\text{g/L}$ drinking water standard currently in effect.

Technetium-99 concentrations were stable around the baseline plume except for well 299-W19-36. The technetium-99 trend in this well increased from 1,730 pCi/L in December 2006, to 3,700 pCi/L in April 2007, and then peaked at 13,000 pCi/L in July 2007 after the resumption of groundwater extraction (Figure 2.9-14). The September 2007, result declined to 9,700 pCi/L. This is a typical pattern for this well when pumping is resumed after a period of inactivity. The contaminant trend increases rapidly to a level above the remedial action objective and then rapidly declines once stable pumping conditions are achieved; the cause for this pattern is

The interim remedial action objectives for the 200-UP-1 Operable Unit (ROD 1997) are:

- ***Reduce contamination in the areas with the highest concentration to below 480 $\mu\text{g/L}$ for uranium and 9,000 pCi/L for technetium-99.***
- ***Reduce potential adverse human health risks through reduction of contaminant mass.***
- ***Prevent further movement of these contaminants from the highest contamination area.***
- ***Provide information that will lead to the development and implementation of a final remedy that will protect human health and the environment.***

With the exception of wells 299-W19-36 and 299-W19-37, most uranium and technetium-99 concentration trends within the pump-and-treat area were stable or declining during the fiscal year.

not known. Only wells 299-W19-35, 299-W19-36, and 299-W19-43 exceeded the drinking water standard (900 pCi/L) for technetium-99.

For most wells, the secondary contaminants of concern, carbon tetrachloride and nitrate, did not exhibit responses to restart of the pump-and-treat system; concentration trends after the resumption of groundwater extraction were consistent with the trends observed during the rebound study. Carbon tetrachloride concentrations at all wells exceeded the 5 µg/L drinking water standard. Carbon tetrachloride at well 299-W19-36 displays an increasing trend and had reached 350 µg/L by the end of the fiscal year. Well 699-38-70B has consistently had the highest carbon tetrachloride concentrations of the rebound study wells; the FY 2007 sample results were 690 and 460 µg/L. Carbon tetrachloride concentrations were stable at well 299-W19-37 at an average value of 42 µg/L for the fiscal year. The source of the carbon tetrachloride is waste sites in the 200-ZP-1 operable unit near the Plutonium Finishing Plant.

Nitrate may have a local source in the pump-and-treat area.

Nitrate concentrations were above the drinking water standard of 45 mg/L in 6 of 11 wells monitored for the pump-and-treat area, two of which yielded nitrate concentrations consistently above 200 mg/L. The nitrate concentration at extraction well 299-W19-43 was at 930 mg/L in September 2007, but had declined from 1,540 mg/L in February 2007 (Figure 2.9-15). Concentrations in well 299-W19-37 increased to 633 mg/L in April 2007 but then declined to 268 mg/L in September 2007. Concentrations in well 299-W19-36 increased throughout the year from 76 mg/L in December 2006 to 214 mg/L in September 2007. The presumed source for the nitrate is the 216-U-1,2 cribs, although there may be a local source in the vicinity of the pump-and-treat area.

2.9.3 Facility Monitoring

This section describes the results of monitoring individual facilities such as treatment, storage, and disposal units, including tank farms. Some of these facilities are monitored under the requirements of RCRA for hazardous waste constituents and the AEA for source, special nuclear and by-product materials. Data from facility-specific monitoring are also integrated into the CERCLA groundwater investigations. Hazardous constituents and radionuclides are discussed jointly in this section to provide comprehensive interpretations of groundwater contamination for each facility. As discussed in Section 1.2 pursuant to RCRA, the source, special nuclear, and by-product material component of radioactive mixed waste are not regulated under RCRA and are regulated by DOE acting pursuant to its AEA authority.

Detailed groundwater monitoring is conducted at five facilities within the 200-UP-1 Operable Unit. Four of these sites were monitored in accordance with RCRA regulations. Assessment monitoring was conducted at Waste Management Areas U and S-SX and the 216-U-12 crib, and detection monitoring was conducted at the 216-S-10 pond and ditch. The status of the 216-U-12 crib was changed from a RCRA treatment, storage, and/or disposal site to a RCRA past-practice site. Therefore, FY 2007 was the last year of RCRA assessment monitoring at this site. Groundwater monitoring at the Environmental Restoration Disposal Facility is conducted in accordance with a CERCLA record of decision (ROD 1995b). Groundwater data for these facilities are available from the Hanford Environmental Information System (HEIS 1994) and the data files accompanying this report.

2.9.3.1 Single-Shell Tank Waste Management Area U

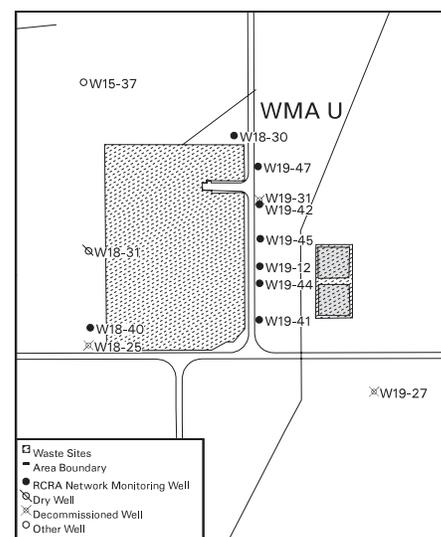
The objective of RCRA monitoring at this waste management area is to assess the nature and extent of groundwater contamination with hazardous constituents and determine their rate of movement in the aquifer (40 CFR 265.93(d) and WAC 173-303-400). Groundwater monitoring under the AEA tracks radionuclides in the waste management area and surrounding vicinity. Appendix B includes a well location map and lists of wells and constituents monitored for Waste Management Area U.

Waste Management Area U was placed into assessment status in 2000 when specific conductance in groundwater monitoring wells downgradient of the waste management area exceeded upgradient levels (PNNL-13185). An assessment of that finding determined that the waste management area had affected groundwater quality as evidenced by elevated concentrations of nitrate and possibly chromium in wells downgradient of the waste management area (PNNL-13282). Contaminant concentrations did not exceed their respective drinking water standards, and the area affected appeared to be limited to the southeast corner of the waste management area. Groundwater quality is assessed at Waste Management Area U according to PNNL-13612. At the start of the fiscal year, the monitoring network included nine wells sampled quarterly consisting of two upgradient wells and seven wells downgradient of the waste management area. One upgradient well (299-W18-31) went dry during the fiscal year and was not sampled during the fourth quarter (but was sampled during the other three quarters). All other wells were sampled as scheduled in FY 2007. The monitoring network is adequate to assess the impact of the waste management area on groundwater quality beneath the site.

Groundwater Flow. Groundwater flow conditions at Waste Management Area U have varied greatly over the past several decades because of changing wastewater disposal in areas surrounding the waste management area, but groundwater flow has been generally to the east since 1996. During FY 2007, the water-table elevation declined at an average rate of 0.36 meter/year in the monitoring wells, but the long-term rate of decline since 2004 remains at 0.30 meter/year. Analysis of water-level data collected during March 2007 indicate the hydraulic gradient is 2.1×10^{-3} , and the groundwater flow rate (i.e., average linear velocity) ranges between 0.018 and 0.20 meter/day (6 and 73 meters/year), depending on the hydraulic conductivity and effective porosity. Using values believed to be most representative, 6.12 meters/day for the hydraulic conductivity and 0.17 for the effective porosity from a constant-rate pumping test conducted in well 299-W19-42 (PNNL-13378), the groundwater flow rate most representative for this site is 0.075 meter/day (27 meters/year).

Groundwater Contamination. Waste Management Area U has been identified as the source of groundwater contamination limited to the downgradient (east) side of the site (PNNL-13282). Constituents found in the groundwater originally included chromium, nitrate, and technetium-99, but chromium concentrations decreased in the past to near the analytical detection limit where they remained in FY 2007. Nitrate and technetium-99 appear to have different sources within the waste management area, because nitrate concentrations are highest along the south half of the site and technetium-99 concentrations are highest along the north half (Figure 2.9-16). These constituents are both mobile in groundwater and would be expected to travel together if they were from the same source.

Sources within Waste Management Area U have contaminated groundwater with nitrate and technetium-99.



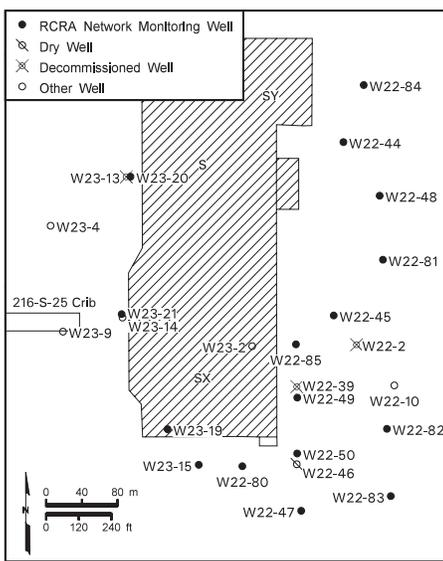
Technetium-99 concentrations are higher in the northern wells at Waste Management Area U while nitrate concentrations are higher in the southern wells.

**Sources within
Waste Management
Area S-SX have
contaminated
groundwater with
nitrate, chromium,
and technetium-99.**

During FY 2007, measured technetium-99 concentrations exceeded the drinking water standard (900 pCi/L) in at least one sample from wells 299-W18-30, 299-W19-42, 299-W19-45, and 299-W19-47, all along the north downgradient side of the waste management area. FY 2007 was the first year in which concentrations at 299-W19-42 exceeded the drinking water standard. In 299-W18-30, the concentration increased sharply from 591 pCi/L in December 2006 to 933 pCi/L during February 2007, and then declined slightly to ~850 pCi/L for the remainder of the fiscal year. Concentrations are generally increasing at 299-W18-30, 299-W19-42, and 299-W19-47. At 299-W19-45, the concentration is decreasing and was below the drinking water standard in the August 2007 sample (866 pCi/L). The maximum technetium-99 concentration measured at the waste management area was 1,600 pCi/L in well 299-W19-47 during August 2007.

Nitrate concentrations continued to increase in all but one monitoring well at Waste Management Area U, including the two upgradient wells. Concentrations are higher in the downgradient wells compared to the upgradient wells, confirming that the waste management area is a source of nitrate to the aquifer. However, nitrate from an upgradient source is also affecting the groundwater quality. During FY 2007, nitrate concentrations were above the drinking water standard (45 mg/L) in at least one sample from upgradient well 299-W18-31, and from the downgradient wells 299-W19-12, 299-W19-41, and 299-W19-44. The concentration at 299-W19-12 increased to above the drinking water standard for the first time during the fiscal year, reaching a maximum value of 50 mg/L during August 2007. Concentrations are declining at 299-W19-41, but are still above the drinking water standard at ~60 mg/L. The maximum nitrate concentration measured at the waste management area was 89 mg/L in 299-W19-44 during August 2007.

Carbon tetrachloride is found in groundwater beneath Waste Management Area U at concentrations above its drinking water standard of 5 µg/L. Well 299-W18-30 is the only well in which samples are analyzed for carbon tetrachloride, and it contained a concentration of 140 µg/L in August 2007, down from 165 µg/L in August 2006. The regional carbon tetrachloride distribution (see Figure 2.8-3 in Section 2.8) indicates that the carbon tetrachloride found in the Waste Management Area U vicinity originates from liquid waste disposal sites at the Plutonium Finishing Plant located northwest of the waste management area.



2.9.3.2 Single-Shell Tank Waste Management Area S-SX

The objective of RCRA monitoring at this waste management area is to assess the nature and extent of groundwater contamination with hazardous constituents and determine their rate of movement in the aquifer. Groundwater monitoring under the AEA tracks radionuclides in the waste management area and surrounding vicinity. Appendix B includes a well location map and lists of wells and constituents monitored for Waste Management Area S-SX.

Waste Management Area S-SX was placed into assessment status (40 CFR 265.93(d) and WAC 173-303-400) in 1996 at the direction of Ecology because of elevated specific conductance and technetium-99 (not regulated by RCRA) in downgradient monitoring wells. An assessment of the waste management area determined (first determination) that multiple sources within the waste management area had affected groundwater quality with elevated concentrations of nitrate, technetium-99, and chromium in

wells downgradient of the waste management area (PNNL-11810). Groundwater is monitored according to PNNL-12114.

The monitoring network at Waste Management Area S-SX consists of 19 wells: 2 upgradient wells, 16 downgradient wells, and 1 well located within the waste management area. All the wells in the network are scheduled for quarterly sampling, and all were sampled as scheduled during the fiscal year, except the fourth quarter sampling of 299-W23-19 was delayed until October 1, 2007.

Groundwater Flow. During FY 2007, the water-table elevation declined at an average rate of 0.25 meter/year in the monitoring wells, equal to the long-term rate of decline since 2004. Analysis of water-level data collected during March 2007 indicate the hydraulic gradient is 1.8×10^{-3} , and the groundwater flow rate (i.e., average linear velocity) ranges between 0.012 and 0.29 meter/day (4 and 104 meters/year), depending on the hydraulic conductivity and effective porosity. Using values of 6.1 meters/day for the hydraulic conductivity and 0.12 for the effective porosity (average values from multiple constant-rate pumping tests in wells at the waste management area [PNNL-13514, PNNL-14113, PNNL-14186]), the groundwater flow rate most representative value is 0.094 meter/day (34 meters/year). This is consistent with prior estimates of 0.07 to 0.14 meter/day (25 to 50 meters/year) based on the movement of tritium between wells (PNNL-12114, PNNL-13441).

Groundwater Contamination. Groundwater beneath this waste management area is contaminated with nitrate, chromium, and technetium-99 attributed to two general source areas within the waste management area. One source area is in the S Tank Farm and the other is located to the south in the SX Tank Farm. Nitrate also has other sources in the vicinity, most notably the 216-S-25 crib. The nitrate, chromium, and technetium-99 plumes are depicted in Figures 2.9-17, 2.9-18, and 2.9-19, which show average concentrations for the fiscal year. Carbon tetrachloride (see Figure 2.8-3 in Section 2.8) is also present in groundwater beneath the waste management area, but the sources are waste sites in the vicinity of the Plutonium Finishing Plant (PNNL-13441). Tritium is also present beneath the waste management area as seen in Figure 2.9-6, but its source is the 216-S-25 crib located just west (upgradient) of the SX Tank Farm (PNNL-13441).

In the north plume downgradient from the S Tank Farm, concentrations of the mobile tank waste constituents nitrate, chromium, and technetium-99 increased significantly in well 299-W22-44 during the fiscal year (Figure 2.9-20). During September 2007, total chromium increased to 345 $\mu\text{g/L}$ (filtered) and 352 $\mu\text{g/L}$ (unfiltered), nitrate increased to 146 mg/L, and technetium-99 increased to 10,000 pCi/L. These are the highest concentrations for these constituents ever measured in groundwater downgradient from the S Tank Farm. Concentrations of these constituents in the upgradient well for the S Tank Farm, 299-W23-20, were either non-detects or well below the drinking water standards indicating that the tank farm is the source. Tank S-104 is the only tank within the S Tank Farm known to have leaked. A surface electrical-resistivity survey conducted during FY 2006 indicated that a portion of the vadose zone plume beneath tank S-104 at the 2 to 5 ohm-meter level had apparently reached groundwater (RPP-RPT-30976). This is the presumed source of the north groundwater plume.

Groundwater beneath the SX Tank Farm in the south portion of the waste management area is also contaminated with nitrate, chromium, and technetium-99. These plumes extend from the source area near well 299-W23-19 toward the east-southeast about 500 meters (Figure 2.9-19). There are low concentration areas

Concentrations of the mobile tank waste constituents nitrate, chromium, and technetium-99 increased significantly downgradient from the S Tank Farm during FY 2007.

Nitrate, chromium, and technetium-99 concentrations in well 299-W23-19 at Waste Management Area S-SX were stable during the fiscal year.

depicted in these plumes around wells 299-W22-80 and 299-W23-15. In well 299-W22-80, an in-well tracer test as well as time-series sampling during extensive purging has indicated that relatively clean water may be migrating into the bottom of the well, moving up the wellbore, and diluting plume concentrations in the upper part of the plume (PNNL-15070). A similar process is assumed to be occurring at well 299-W23-15. In the source area, concentrations of all three constituents were generally stable in well 299-W23-19 during the fiscal year. The average concentrations for the fiscal year were 385 mg/L for nitrate, 730 µg/L for filtered total chromium, and 41,000 pCi/L for technetium-99 (Figure 2.9-3).

Constituent concentrations in the south plumes at well 299-W22-50, about 150 meters downgradient from the source area, continued on the same trends as reported in FY 2006. Constituent concentrations in this well reached a peak in FY 2003 and have continued to decrease or remain stable throughout FY 2007 (Figure 2.9-21). Farther downgradient at well 299-W22-83, the nitrate and technetium-99 concentrations may have reached peak values during the fiscal year (Figure 2.9-21). This suggests a 4-year travel time between wells 299-W22-50 and 299-W22-83, which are ~115 meters apart. This yields a groundwater flow velocity of ~0.08 meter/day (~30 meters/year), consistent with the flow velocity estimates given above.

Groundwater Treatment. The feasibility of using well 299-W23-19 as a pump-and-treat extraction well to remediate the south plume from the SX Tank Farm was investigated in 2001. After performing an aquifer test in this well, it was concluded that the production capacity was too small for a pump-and-treat system (RPP-10757). To remove some technetium-99 from the groundwater, the practice of extended purging while sampling at well 299-W23-19 was agreed to by DOE and Ecology and began in 2003. After samples are collected from this well each quarter, purging of the well is continued at a higher flow rate until a minimum of 3,785 liters of water is removed from the aquifer. This water is transferred to the Effluent Treatment Facility for treatment and disposal. Table 2.9-2 presents the date, amount of water collected, and a calculation of the mass and activity of technetium-99 removed from the aquifer. A total of ~0.00083 curie (~0.049 gram) of technetium-99 was recovered during FY 2007. Since the start of this treatment in 2003, a total of ~0.0053 curie (~0.31 gram) of technetium-99 has been recovered.

In-situ bioremediation is another remediation option being investigated as part of the 200-UP-1 Operable Unit activities. A treatability test of a technology known as Enhanced Anaerobic Reductive Precipitation/Enhanced Reductive Dechlorination developed under the (DOE's) Advanced Reradiation Technologies program is being planned for FY 2009. The test will be conducted near existing well 299-W-22-47, southeast of the SX Tank Farm, and the target analytes are technetium-99, chromium, nitrate, and carbon tetrachloride. A carbohydrate substance (e.g., molasses) will be injected into the aquifer to enhance microbial activity, which will generate reducing conditions. This will lead to the consumption of nitrate by the microbes, the precipitation of metals (technetium-99 and chromium), and the dechlorination of chlorinated hydrocarbons (carbon tetrachloride).

2.9.3.3 216-S-10 Pond and Ditch

The 216-S-10 pond and ditch was active from 1951 through 1991 and received effluent primarily from the REDOX Plant chemical sewer. The site is monitored semiannually under RCRA interim status indicator parameter monitoring (40 CFR 265.93(b) and WAC 173-303-400) to detect any effect on groundwater from past

In 2003, DOE and Ecology agreed to the practice of extended purging during sampling at well 299-W23-19 to remove technetium-99 from the groundwater. This practice continued during FY 2007.

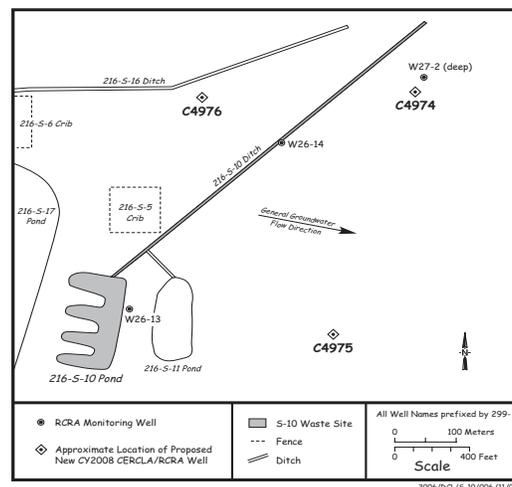
facility operations. Groundwater monitoring under the AEA tracks radionuclides in the waste management area and surrounding vicinity. Appendix B includes a well location map and lists of wells and constituents monitored for the 216-S-10 pond and ditch.

RCRA groundwater monitoring has been conducted under interim status requirements since 1991. The 216-S-10 pond and ditch unit has not received liquid waste since October 1991. The treatment, storage, and disposal unit will be closed under RCRA and the Washington State Hazardous Waste Management Act (RCW 70.105). The RCRA closure plan for the 216-S-10 pond and ditch is being coordinated with the CERCLA 200-CS-1 source operable unit in accordance with Tri-Party Agreement Milestone M-15-39C.

The current RCRA monitoring network consists of two downgradient wells (the others having gone dry): well 299-W26-13 located near the pond and well 299-W26-14 located just east of the central portion of the ditch. Upgradient well 299-W26-7 went dry in 2003. The network also includes one deep downgradient well, 299-W27-2, which is screened at the bottom of the uppermost unconfined aquifer. RCRA requirements for interim status monitoring specify that a minimum of one upgradient and three downgradient monitoring wells are needed to monitor the site. All new RCRA wells installed at Hanford are negotiated annually by Ecology, DOE, and the U.S. Environmental Protection Agency (EPA) and approved under the Tri-Party Agreement (Ecology et al. 1989) Milestone M-24-00. One new upgradient well and two downgradient wells are currently planned under the Tri-Party Agreement Milestone M-24-57 to be installed in FY 2008. During FY 2007, all wells were sampled as scheduled.

Groundwater Flow. Groundwater flow conditions beneath the 216-S-10 pond and ditch have varied greatly over the past several decades because of changing wastewater disposal in areas surrounding the site, but groundwater flow has been generally to the east-southeast for the last several years. During FY 2007, the direction and velocity of groundwater flow have remained the same as in the previous year. The rate at which the water table is dropping has also remained constant at ~0.3 meter/year in all of the monitoring wells during FY 2007. Therefore, the hydraulic gradient has not changed. The average linear velocity has remained essentially the same as in FY 2006 and ranges from 0.08 to 2.25 meters/day or 29 to 820 meters/year (see Appendix B).

Groundwater Sampling. The comparison of RCRA indicator parameters (specific conductance, pH, total organic carbon, and total organic halides) between upgradient and downgradient wells was conducted using the most recent collected background values of contaminant indicator parameters from well 299-W26-7 before it went dry in 2003 (see Appendix B). One new upgradient and two downgradient wells have been approved for installation surrounding the 216-S-10 pond and ditch in 2008 per Tri-Party Agreement Milestone M-24-57. When data from the new upgradient well become available, new background values will be calculated and used for the required upgradient/downgradient comparisons. Based on statistical evaluations of contamination indicator parameters conducted during FY 2007, there were no



All but three of the monitoring wells for the 216-S-10 pond and ditch have gone dry. New wells are planned for installation in FY 2008.

No exceedances of an indicator parameter were found during FY 2007, so the 216-S-10 pond and ditch remain in detection monitoring.

statistically significant differences (i.e., constituents in the downgradient wells were not elevated compared to the upgradient well). Therefore, this site remains in detection monitoring.

There are several constituents detected in wells near the 216-S-10 pond and ditch that are being tracked by the monitoring network. Chromium is being tracked because it was elevated above the drinking water standard for several years in upgradient well 299-W26-7, which is now dry. Also, elevated concentrations of nickel (145 µg/L) and carbon tetrachloride (7.0 µg/L) have been detected again this year in the deep monitoring well 299-W27-2. Because there have been no detections of nickel in the shallow monitoring wells, the 216-S-10 pond and ditch is not believed to be the source of this constituent. Carbon tetrachloride concentrations in well 299-W27-2 have averaged above the drinking water standard (5 µg/L) since 2001. The source is believed to be liquid waste disposal sites at the Plutonium Finishing Plant.

Elevated chromium concentrations at well 299-W26-7 (now dry) had exceeded the drinking water standard (100 µg/L) during the past 10-year life of the well. This may have been caused by short-term releases migrating through the vadose zone from past effluent releases to the pond or from upgradient sources. Historical records document a 1983 release to the 216-S-10 ditch of a high-salt waste (simulated tank waste) containing hexavalent chromium. Although well 299-W26-7 was designated as an upgradient well, it is located very close to one lobe of the pond system and may have been affected by drainage spreading laterally in the vadose zone or by a mound on the water table when the facility was in operation (see Appendix B). A REDOX Plant disposal pond, which is located immediately upgradient of the 216-S-10 pond and ditch, is also a potential source of the chromium contamination. Chromium is a hazardous waste constituent for the treatment, storage, and disposal unit, and the 216-S-10 pond and ditch cannot currently be ruled out as the source of the contamination.

Nitrate concentrations were covariate with chromium concentrations in wells 299-W26-7, 299-W26-9, 299-W26-10, and 299-W26-12, which are now dry. The upgradient well 299-W26-7 had the highest nitrate concentrations. These and other data presented in PNNL-14070 suggest that the 216-S-10 pond could be the source of this nitrate and chromium increase. Although chromium and nitrate were elevated in the upgradient well 299-W26-7 prior to when it went dry, significant concentrations of these constituents have not been detected in the downgradient wells. But, well 299-W26-13 which is located downgradient of the pond and replaced well 299-W26-9, shows increasing levels of chromium (from 5 up to 15 µg/L) and nitrate (from 6.6 up to 10.2 mg/L), but not yet near their respective drinking water standards. By comparison chromium in the other down gradient well 299-W26-14, located away from the pond and centered along the ditch portion of the facility, remains essentially undetected. This difference could suggest that a localized source is present near the pond.

The 216-U-12 crib contributed to nitrate and technetium-99 contamination.

2.9.3.4 216-U-12 Crib

The 216-U-12 crib is located ~600 meters south of U Plant in the southeast portion of the 200 West Area. The crib is an unlined, gravel-bottom, percolation crib 3 meters by 30 meters, and 4.6 meters deep. The crib received process effluent from U Plant, including corrosive liquid condensate from the 224-U Building, and operated from 1960 through 1972 and again from 1981 until it was permanently retired in February 1988. A yearly average of over 10.2 million liters of effluent was disposed to the

crib from 1960 through 1972 (RHO-CD-673). Total volume disposed to the 216-U-12 crib exceeded 133 million liters from 1960 through 1972.

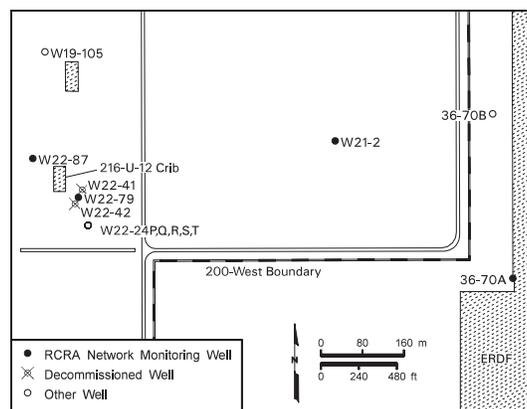
The objective of RCRA monitoring at the 216-U-12 crib was to assess the nature and extent of groundwater contaminated with hazardous constituents and determine their rate of movement in the aquifer. The site was in assessment for elevated specific conductance, and nitrate and was sampled quarterly. Groundwater monitoring under the AEA tracks radionuclides at this crib and surrounding vicinity. Appendix B includes a well location map and lists the wells and constituents monitored for the 216-U-12 crib.

In May 2005, DOE requested that the 216-U-12 crib be administratively closed because historical records demonstrated that hazardous waste was not discharged to the 216-U-12 crib after July 27, 1987. The agreed upon date between Ecology and DOE when the mixed waste rule applies is August 19, 1987. Therefore, on June 14, 2007, the Tri-Parties approved two Tri-Party Agreement (Ecology et al. 1989) change requests (B-05-01 and C-05-01) reclassifying the crib from a RCRA treatment, storage, or disposal unit to a RCRA past-practice unit. Based on this approval, RCRA groundwater monitoring will be discontinued for FY 2008 and RCRA groundwater sampling will not continue past the last planned sampling date in September 2007. The groundwater in the vicinity of the crib will continue to be monitored as part of the CERCLA 200-UP-1 Operable Unit.

During FY 2007, the 216-U-12 crib was regulated under a RCRA interim status assessment program (40 CFR 265.93(d) and WAC 173-303-400). The network included one upgradient and three downgradient wells sampled quarterly (see Appendix B).

The objective of RCRA interim status assessment monitoring was to assess the migration of hazardous waste constituents out of the vadose zone into groundwater and to support the delineation of the existing known plumes that, through RCRA/CERCLA integration, will move forward under the CERCLA and AEA 200-UP-1 Operable Unit monitoring program. The existing 216-U-12 crib plumes co-mingle with plumes from other U Plant and REDOX Plant source areas, making it difficult to distinguish the areal extent of specific plumes originating from the crib.

Groundwater Flow. Based on the water-level elevations in the surrounding wells, the direction of groundwater flow beneath the 216-U-12 crib continued relatively unchanged toward the east-southeast to east (see Figure 2.8-2 Section 2.8). The pre-Hanford flow direction in the vicinity of the 216-U-12 crib is believed to have been from west to east, and it is expected that groundwater flow will eventually return to a more eastward direction. The water-table elevation continued to decline around the 216-U-12 crib and vicinity. Annual water-level declines in the monitoring wells ranged between ~0.21 to 0.38 meter. Average linear groundwater flow velocities remained essentially the same as last year, ranging from ~0.03 to ~0.05 meter/day or 11 to 18 meters/year (see Appendix B). The hydraulic gradient was calculated between new well 299-W22-87 and existing well 299-W22-79.



The 216-U-12 crib was reclassified from a RCRA treatment, storage, or disposal unit to a RCRA past-practice unit. Because of this change, RCRA groundwater monitoring will be discontinued for FY 2008.

**Results of
groundwater
monitoring at the
Environmental
Restoration Disposal
Facility continued
to indicate that
the facility has not
adversely affected
groundwater quality.**

Groundwater Contamination. During FY 2007, the key indicator parameter, specific conductance, continued to decline in the near field downgradient monitoring well 299-W22-79, and in the far field downgradient wells 299-W21-2 and 699-36-70A. Specific conductance is below the former critical mean (457.8 $\mu\text{S}/\text{cm}$) and declining in wells 299-W22-79 and 699-36-70A. Specific conductance remains just slightly above the former critical mean in 299-W21-2. Specific conductance in the upgradient well (299-W22-87) remained stable for the year at a concentration around 220 $\mu\text{S}/\text{cm}$. The data from these wells indicate that nitrate concentrations have peaked and are now decreasing downgradient from the 216-U-12 crib, suggesting that the bulk of the nitrate contamination has migrated to the groundwater and moved downgradient beyond the facility.

The regional nitrate and technetium-99 plumes are a co-mingled series of smaller plumes with sources from several cribs (216-U-1,2; 216-U-8; and 216-U-12) in the U Plant area. During FY 2007, nitrate concentrations decreased in all downgradient network wells, but remained above the drinking water standard in far-field wells 699-36-70A and 299-W21-2. Nitrate in the upgradient well (299-W22-87) was ~ 3 mg/L. The co-contaminant, technetium-99 (which is not regulated under RCRA), continued to be detected in all downgradient network wells but at levels well below the drinking water standard of 900 pCi/L. Technetium-99 was also found in upgradient well 299-W22-87 but at very low concentrations (~ 10 pCi/L). All other constituents remained on trend or near background throughout the year.

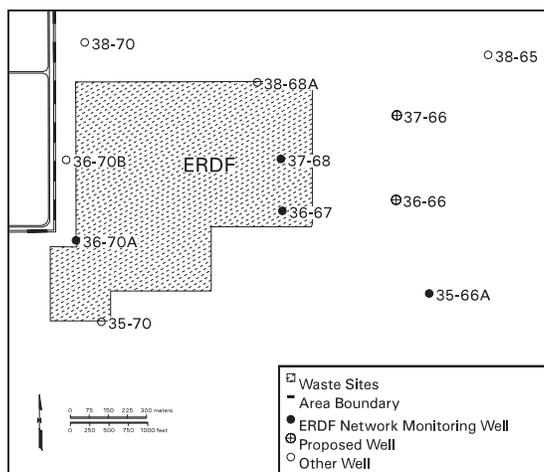
2.9.3.5 Environmental Restoration Disposal Facility

The Environmental Restoration Disposal Facility is a low-level radioactive mixed waste facility where waste from surface remedial actions on the Hanford Site is disposed. Groundwater monitoring is regulated under a CERCLA record of decision (ROD 1995b). The record of decision states that groundwater monitoring will be conducted according to RCRA regulations. Thus, the site was designed to meet RCRA standards, although it is not actually permitted as a RCRA facility. The groundwater flow direction beneath the site is toward the east-northeast. One upgradient well (699-36-70A) and three downgradient wells (699-37-68, 699-36-67,

and 699-35-66A) are sampled semiannually, typically in March and September. All four wells were sampled as planned during FY 2007. Appendix B contains additional information regarding the Environmental Restoration Disposal Facility. For a discussion of leachate monitoring at this facility, see Section 3.1 and see WCH-189 for calendar year 2006 groundwater and leachate monitoring results. Calendar year 2007 results will be described in an upcoming report. See BHI-00873 for the groundwater sampling and analysis plan.

During FY 2007, an amendment to the Environmental Restoration Disposal Facility record of decision was issued (ROD 2007). The amendment allows several other Hanford programs to dispose waste to the Environmental Restoration Disposal Facility. No changes were made to the specific contaminants or concentrations allowed; the amendment

essentially allows the same types of waste currently being disposed at the facility to be sent from additional Hanford Site sources.



Prior to sampling in FY 2008, the downgradient wells 699-36-67 and 699-37-68 will be decommissioned to allow for the next Environmental Restoration Disposal Facility expansion to the east. Two new downgradient wells will be constructed during FY 2008 as replacements, and these wells will be point-of-compliance wells along the downgradient boundary when the facility expansion is completed.

Groundwater Sampling. Results of groundwater monitoring at the Environmental Restoration Disposal Facility continued to indicate that the facility has not adversely impacted groundwater quality. Several constituents (tritium, iodine-129, nitrate, and carbon tetrachloride) are present in the groundwater near or above drinking water standards, but these constituents are elevated in both the upgradient and downgradient wells. Figures 2.9-6, 2.9-8, and 2.9-10 in this section, and Figure 2.8-3 in Section 2.8 indicate that these plumes originated in the 200 West Area and have migrated into the vicinity of the Environmental Restoration Disposal Facility.

Both filtered and unfiltered samples are collected for metals (except for uranium samples, which are unfiltered). No sampling results were noted significantly out of trend during FY 2007. Overall, uranium appears to be continuing to trend downward in all wells. Both technetium-99 and gross beta appear to be continuing to trend upward in two downgradient wells (699-37-68 and 699-35-66A) and downward in the upgradient well (699-36-70A) and one downgradient well (699-36-67). Nitrate levels appear to be decreasing except for well 699-35-66A where nitrate concentrations are stable at a very low level. These trends will continue to be monitored. Overall, the FY 2007 results appear stable. High turbidity (suspended solids), a common source for variability in the analytical results, was not seen in the FY 2007 sampling.

Table 2.9-1. Summary of Contaminant Mass Removed from the Aquifer during Pump-and-Treat Operations at 200-UP-1 Operable Unit (FY 2007 and totals since startup of operations)

Contaminant	FY 2007	Since Startup (March 1994)
Uranium	1.13 kg	212.9 kg
Technetium-99	0.27 g (0.005 Ci)	119.1 g (2.03 Ci)
Carbon Tetrachloride	0.053 kg	34.6 kg
Nitrate	356 kg	35,072 kg

Table 2.9-2. Quantity of Treated Groundwater and Technetium-99 Mass Removed from the Aquifer during Extended Purging at Well 299-W23-19, FY 2007

Sample Date	Volume of Water Treated liters (gal)	Technetium-99 Concentration (pCi/L)	Activity of Technetium-99 Removed (Ci)	Mass of Technetium-99 Removed (g)
19-Jan-07	4,936 (1,304)	46,300	0.00023	0.013
30-Mar-07	5,451 (1,440)	40,800	0.00022	0.013
26-Jun-07	5,224 (1,380)	35,100	0.00018	0.011
1-Oct-07	4,315 (1,140)	46,000	0.00020	0.012
Totals	19,926 (5,264)	NA	0.00083	0.049
NA = Not applicable.				

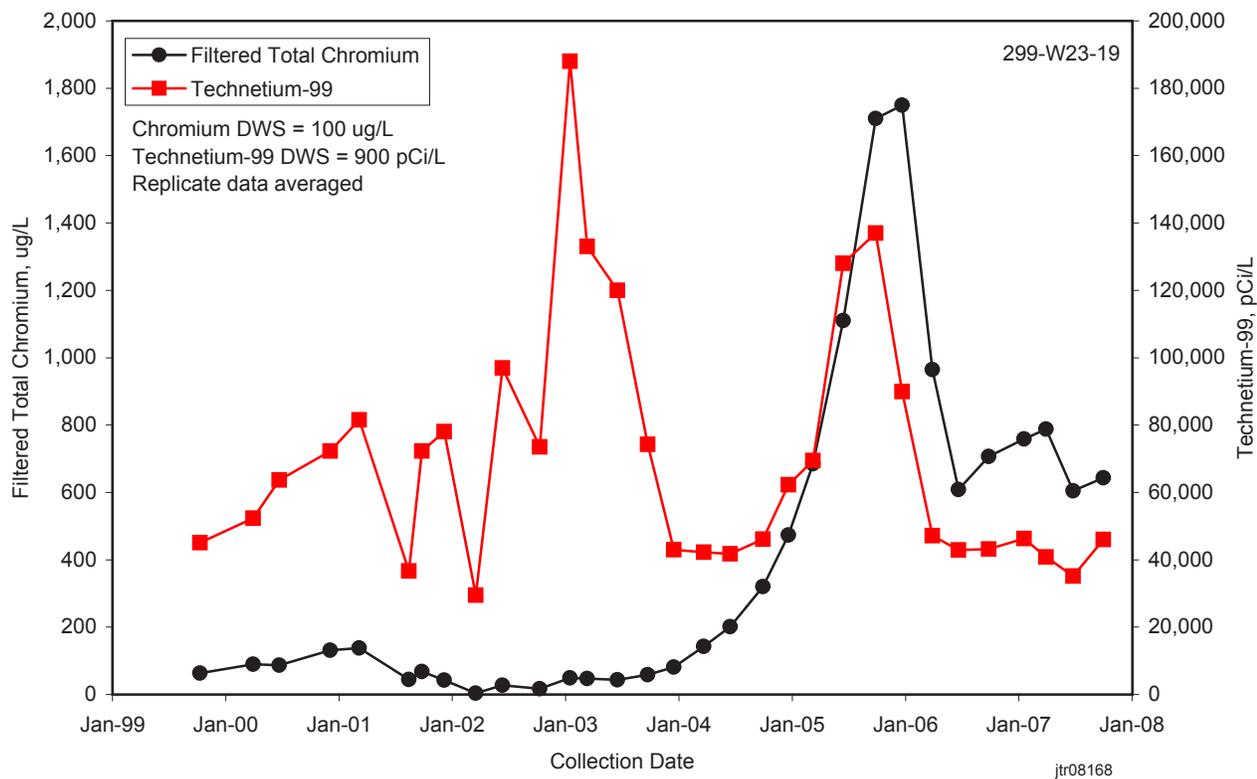


Figure 2.9-3. Chromium and Technetium-99 Concentrations in Well 299-W23-19 Near a Source Area Within the South Portion of Waste Management Area S-SX

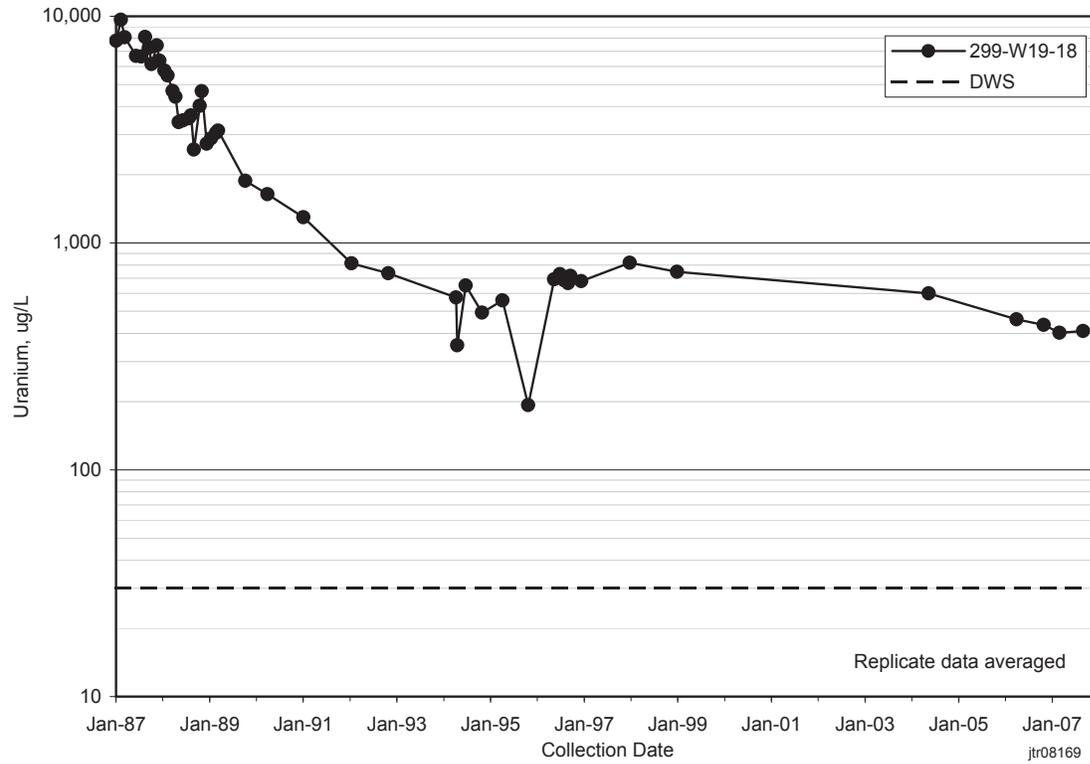


Figure 2.9-5. Uranium Concentrations in Well 299-W19-18 Near 216-U-1,2 Cribbs

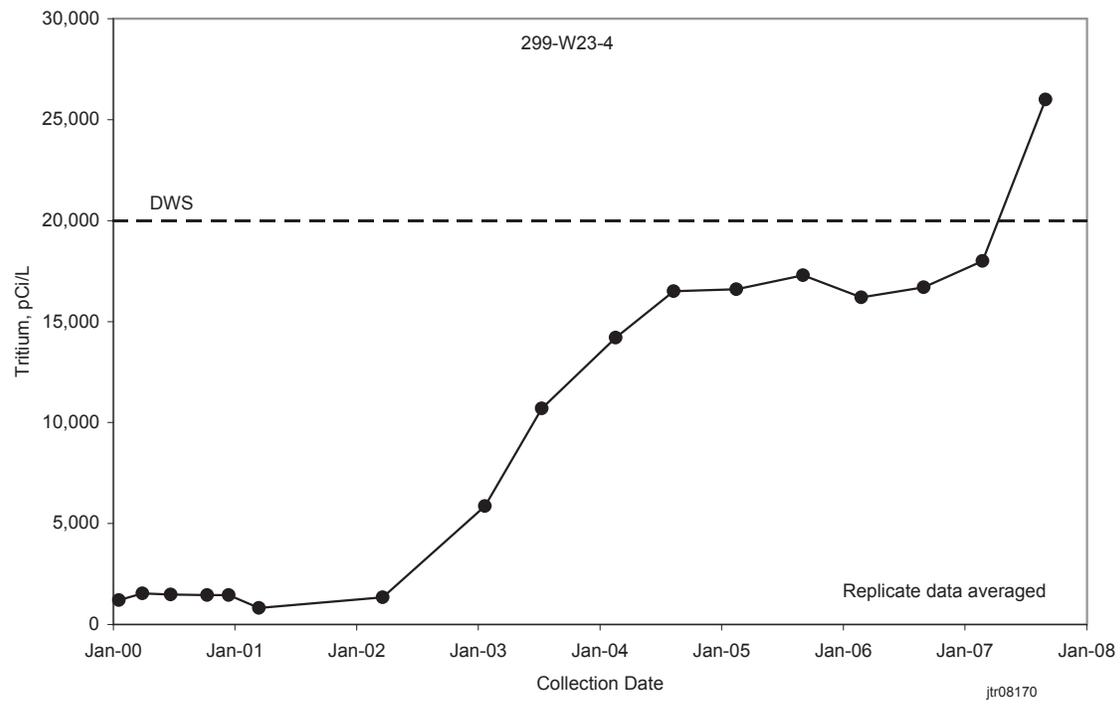


Figure 2.9-7. Tritium Concentrations in Well 299-W23-4 Near the 216-S-21 Crib

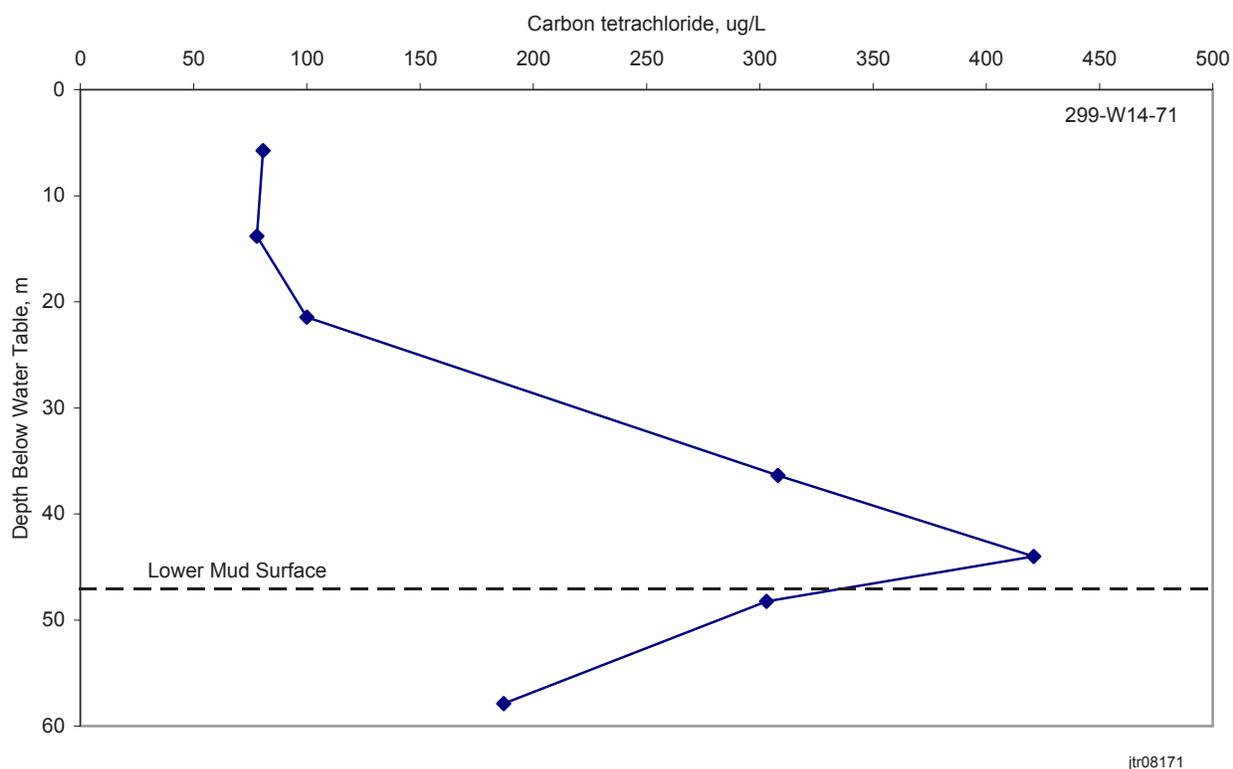


Figure 2.9-9. Depth-Discrete Sampling Results for Carbon Tetrachloride at New Well 299-W14-71 (Samples were collected during drilling between September 19, 2006 and October 13, 2006.)

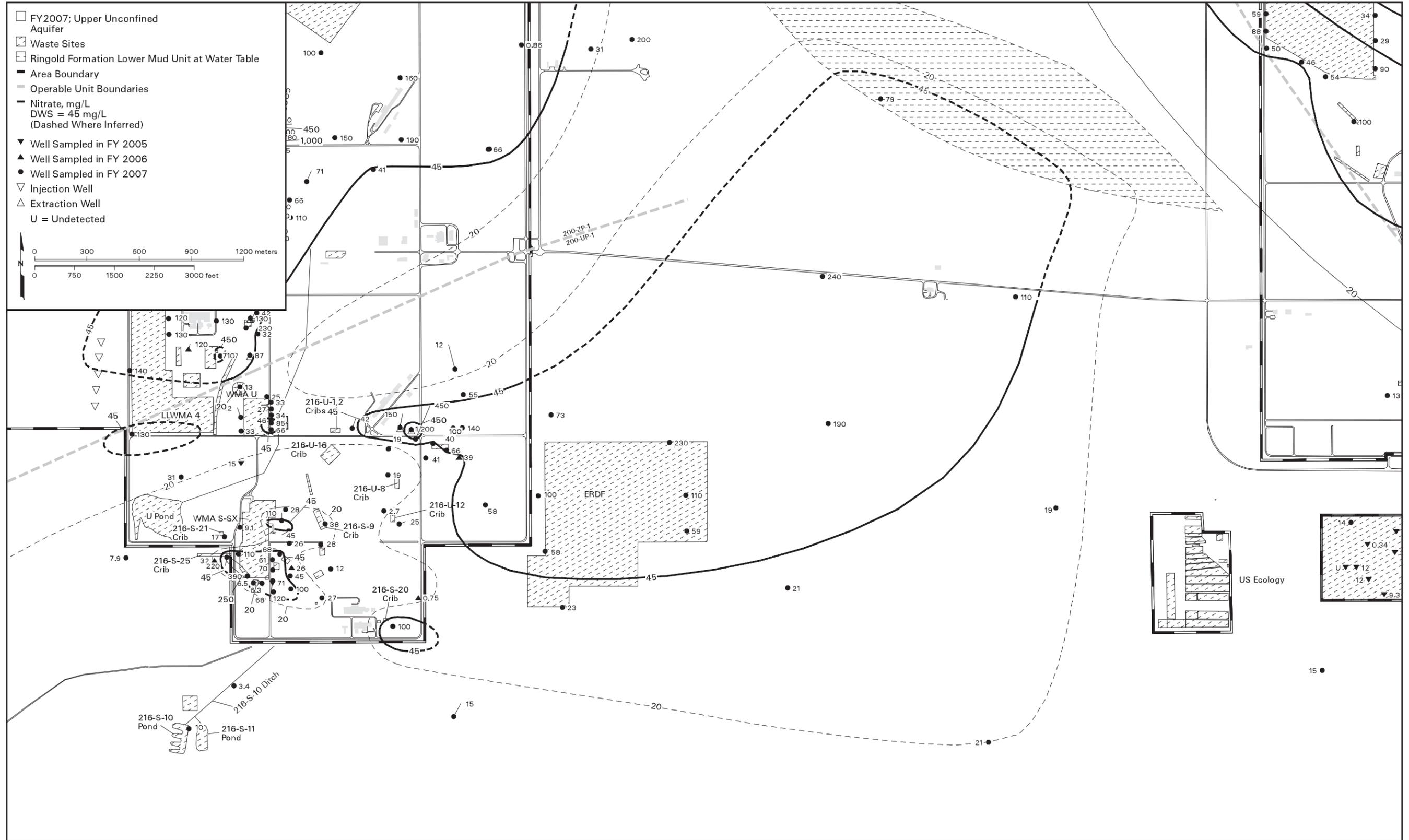
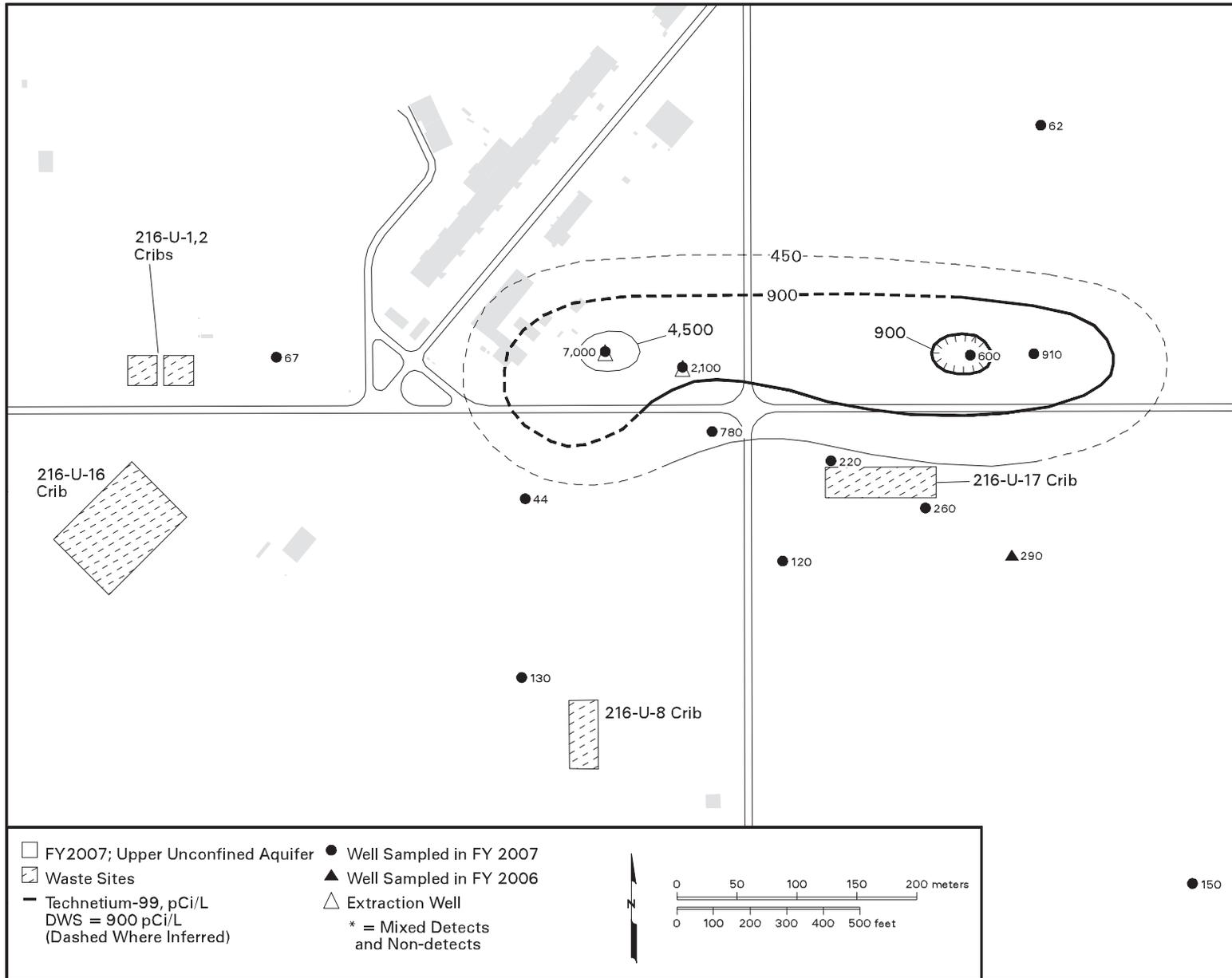


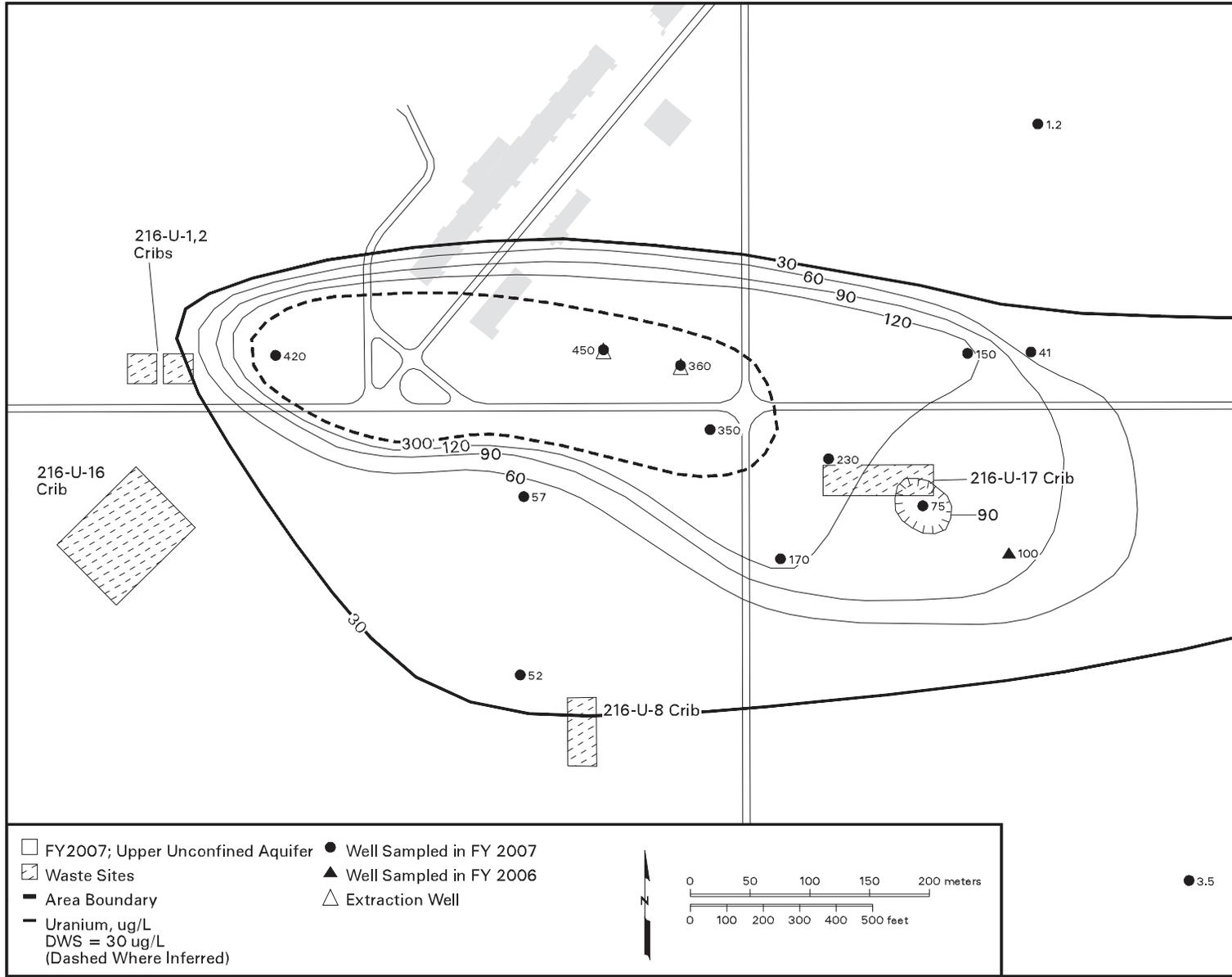
Figure2.9-10. Average Nitrate Concentrations in 200-UP-1 Groundwater Interest Area, Upper Part of Unconfined Aquifer

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Figure 2.9-11. Average Technetium-99 Concentrations in 200-UP-1 Pump-and-Treat Area, Upper Part of Unconfined Aquifer



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Figure 2.9-12. Average Uranium Concentrations in 200-UP-1 Pump-and-Treat Area, Upper Part of Unconfined Aquifer

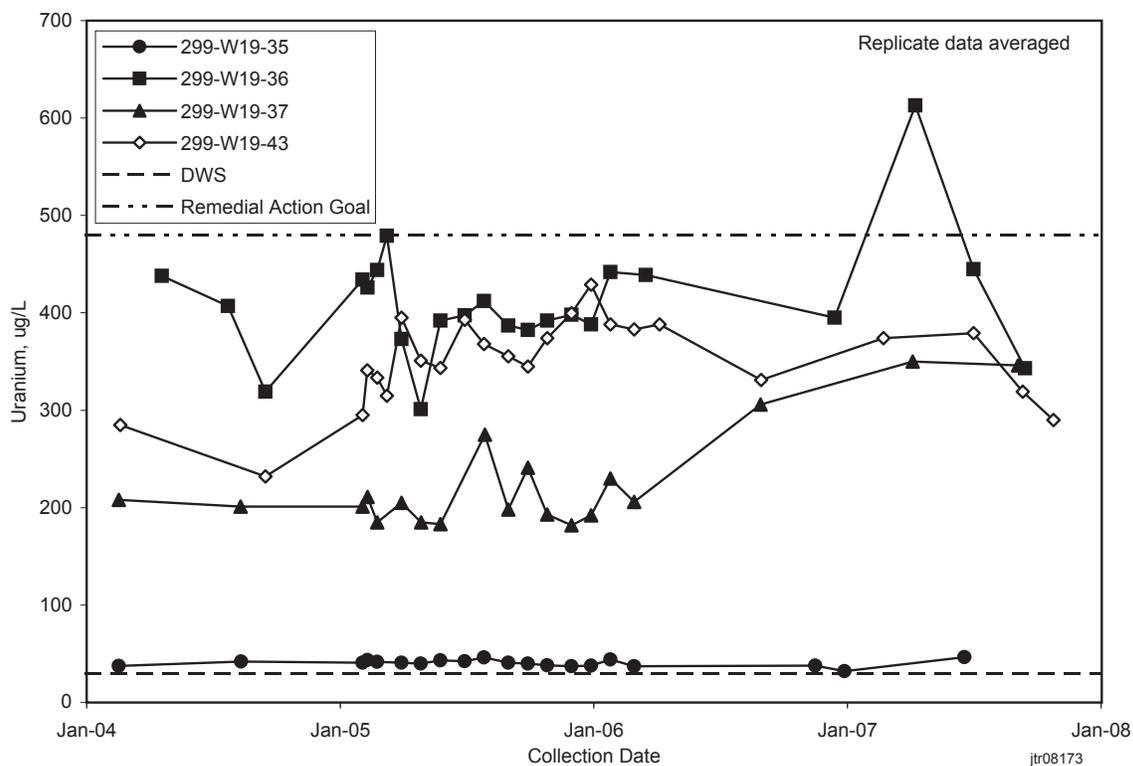


Figure 2.9-13. Uranium Concentrations in Selected Wells at 200-UP-1 Pump-and-Treat Area

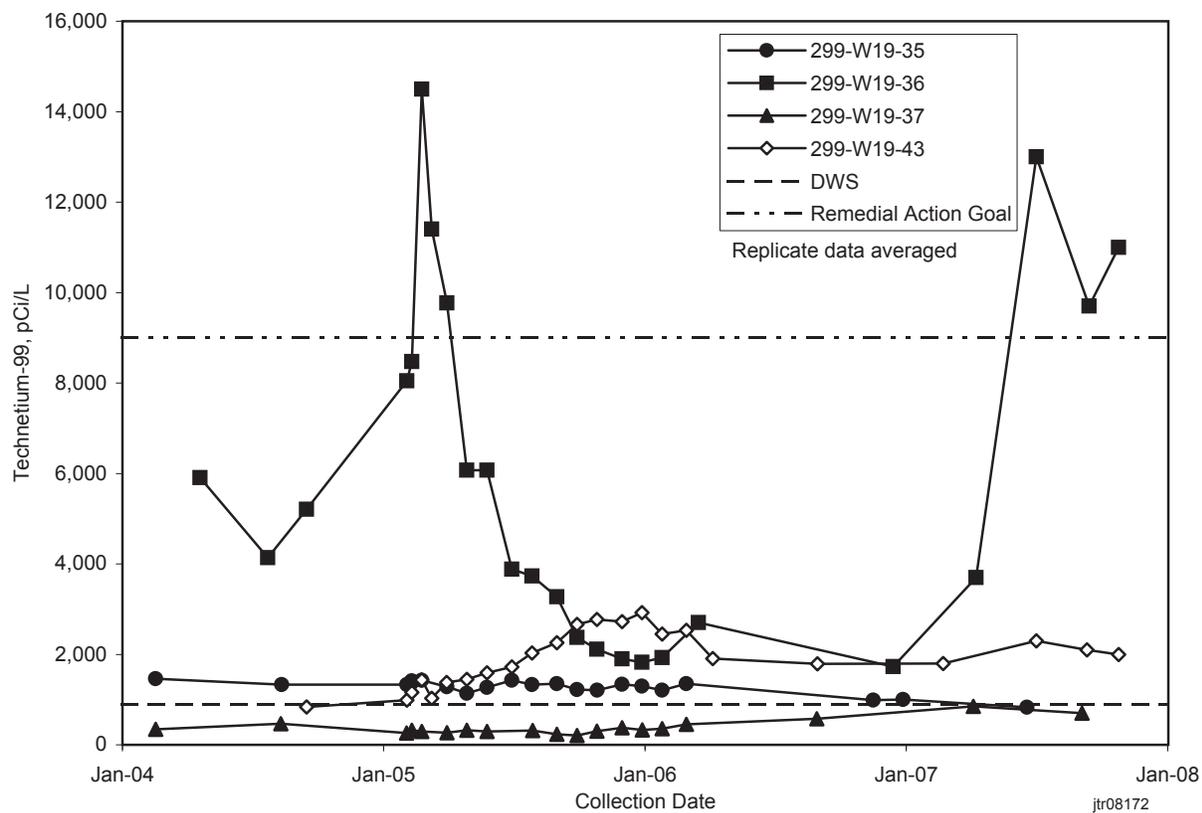


Figure 2.9-14. Technetium-99 Concentrations in Selected Wells at 200-UP-1 Pump-and-Treat Area

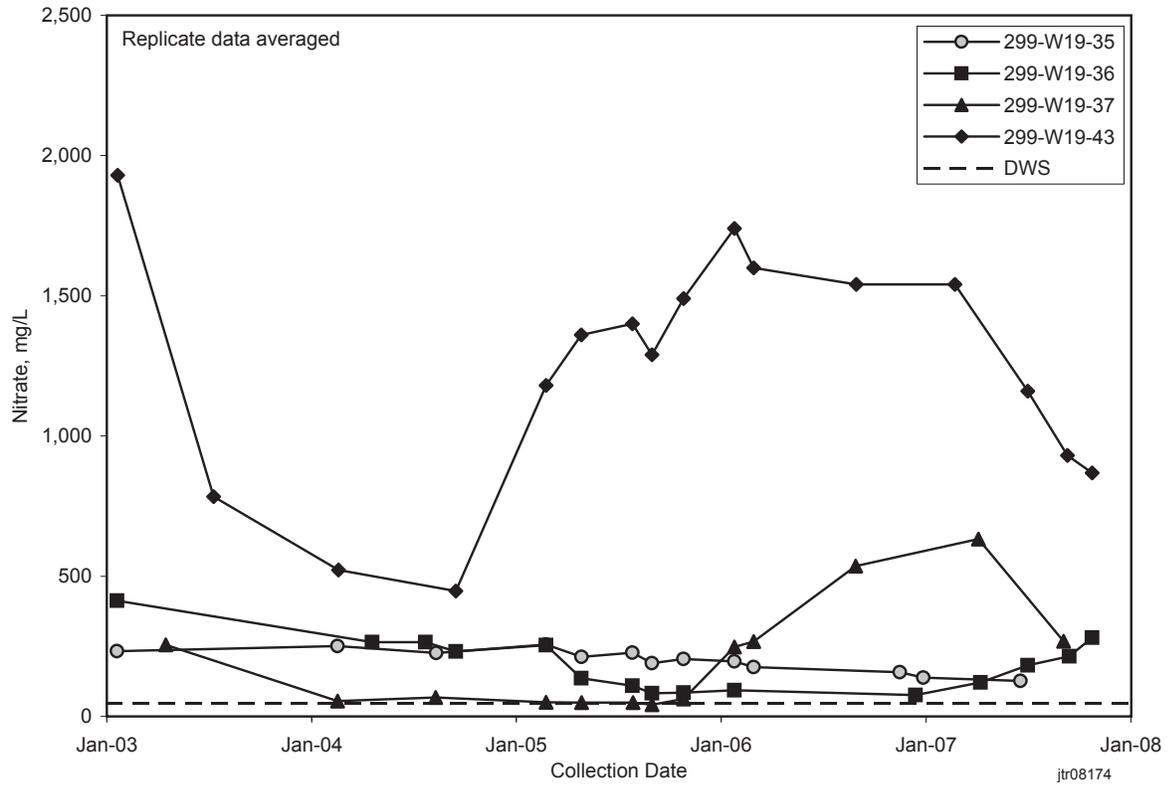
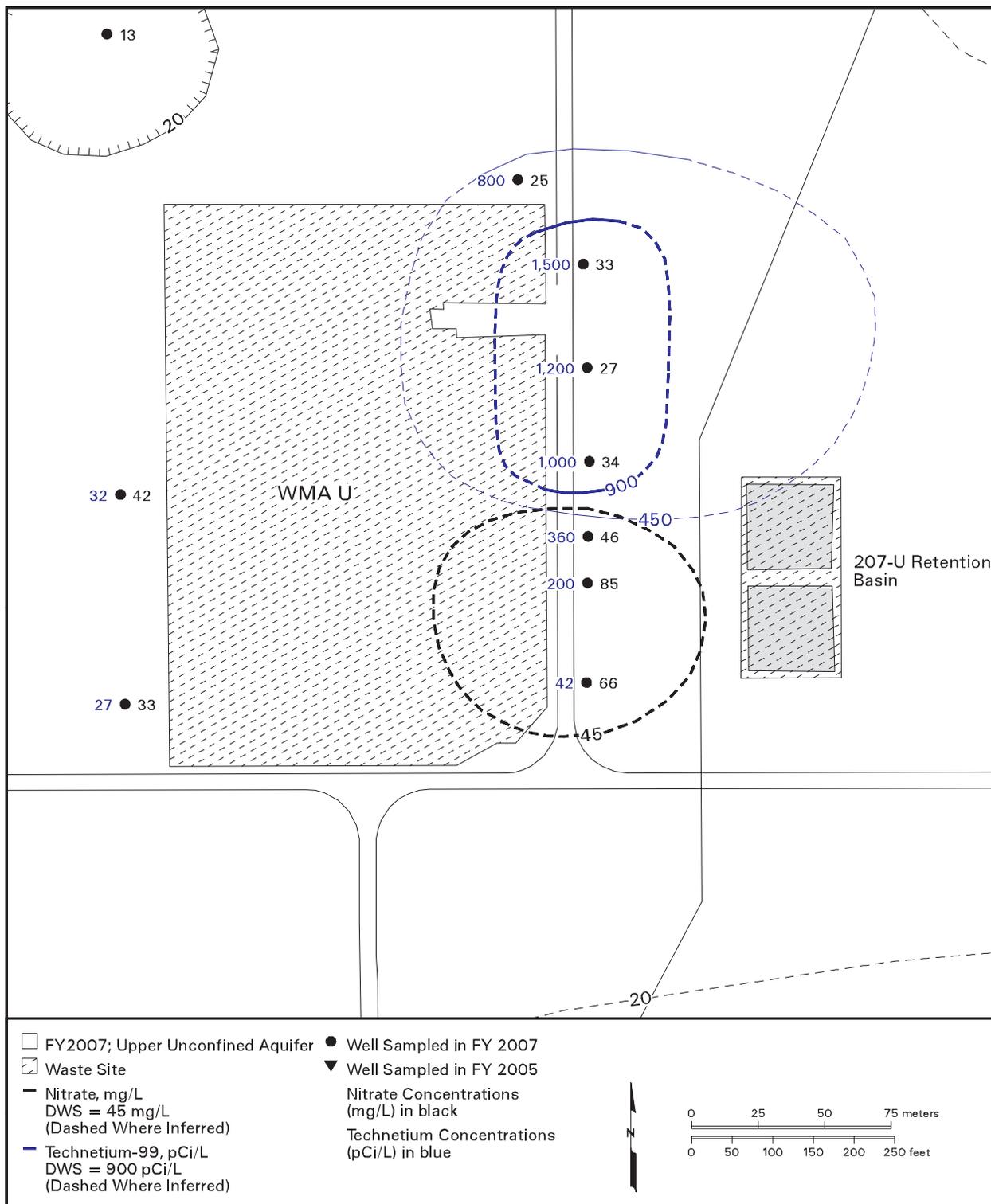
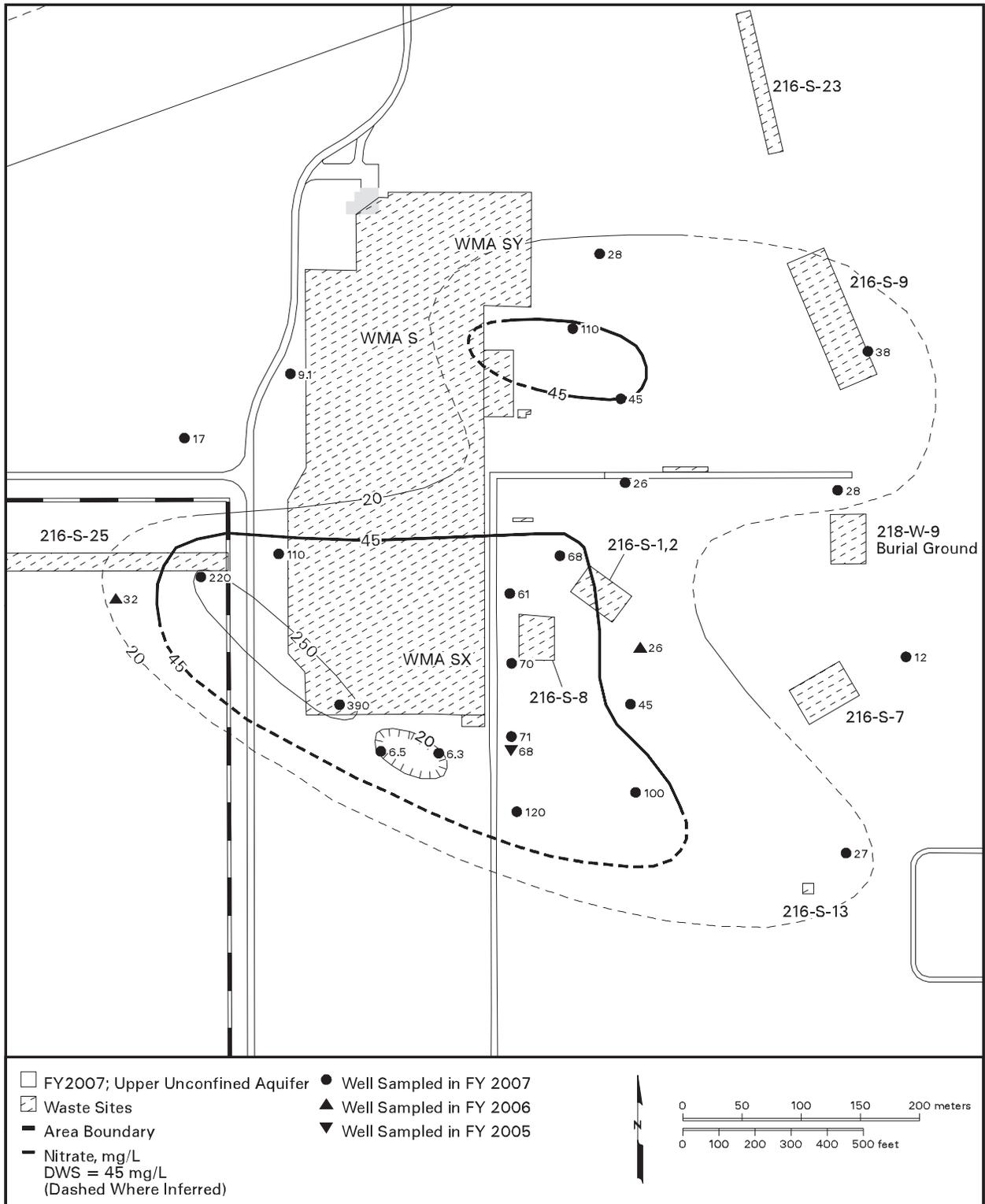


Figure 2.9-15. Nitrate Concentrations in Selected Wells at 200-UP-1 Pump-and-Treat Area



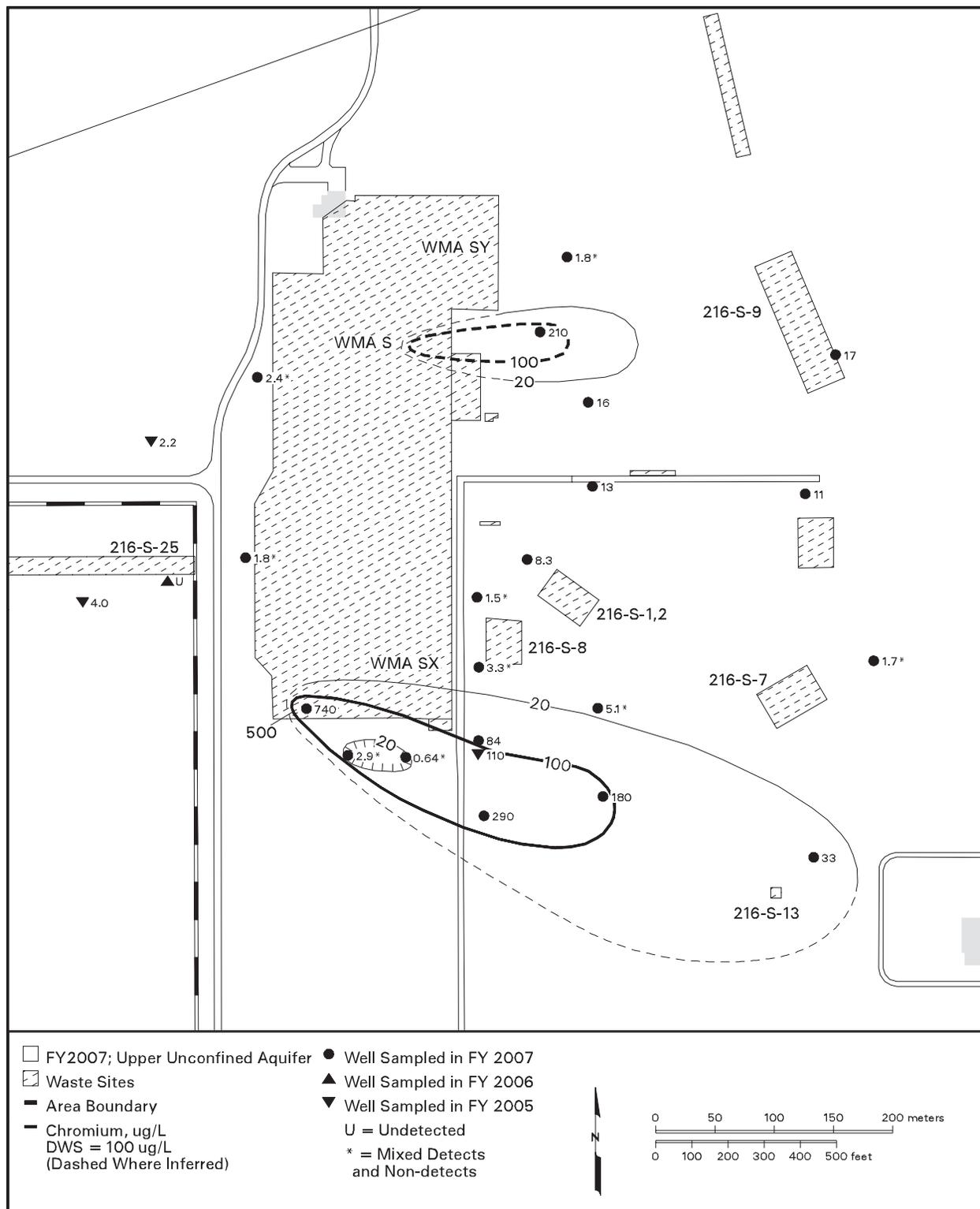
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Figure 2.9-16. Average Nitrate and Technetium-99 Concentrations at Waste Management Area U, Upper Part of Unconfined Aquifer



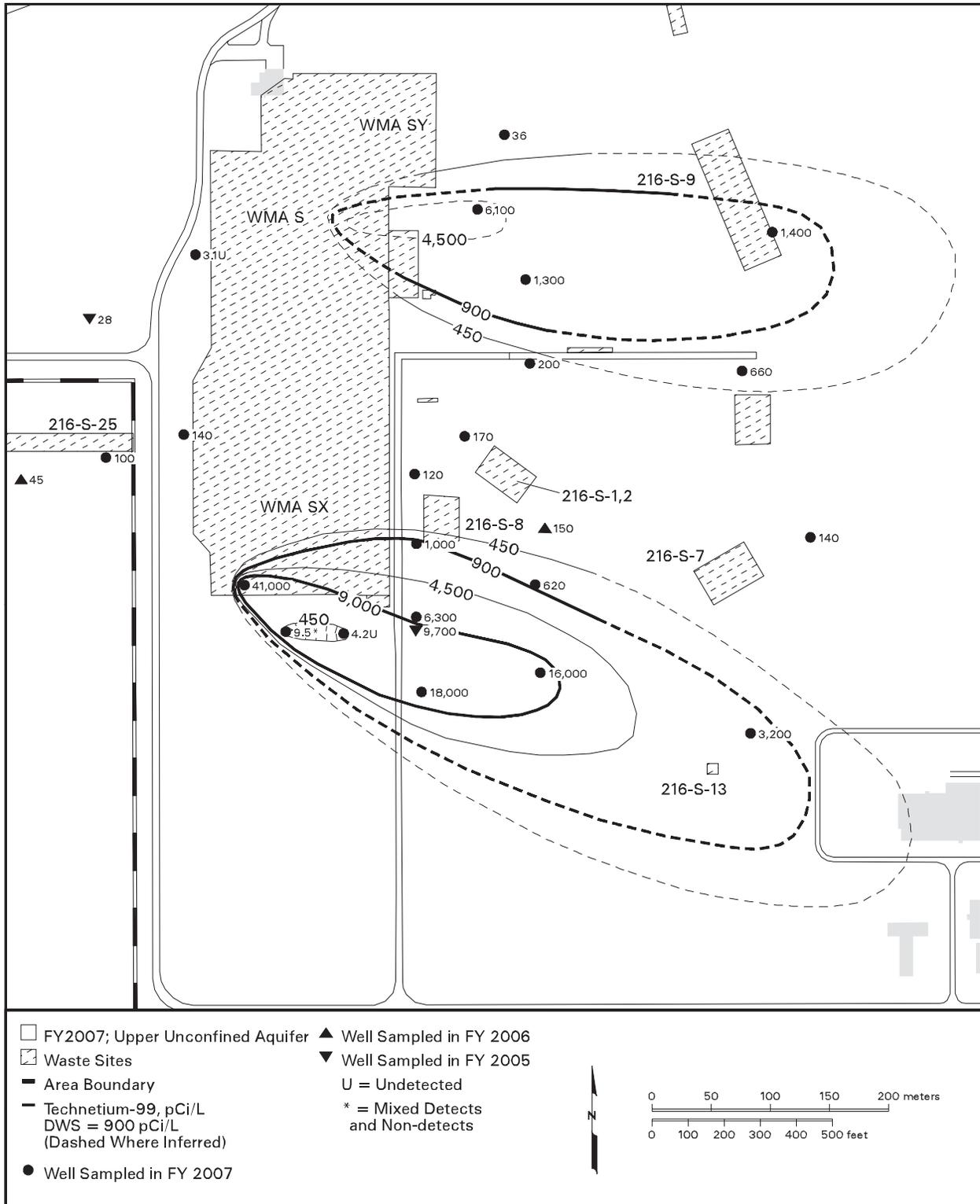
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Figure 2.9-17. Average Nitrate Concentrations at Waste Management Area S-SX, Upper Part of Unconfined Aquifer



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Figure 2.9-18. Average Chromium Concentrations at Waste Management Area S-SX, Upper Part of Unconfined Aquifer



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Figure 2.9-19. Average Technetium-99 Concentrations at Waste Management Area S-SX, Upper Part of Unconfined Aquifer

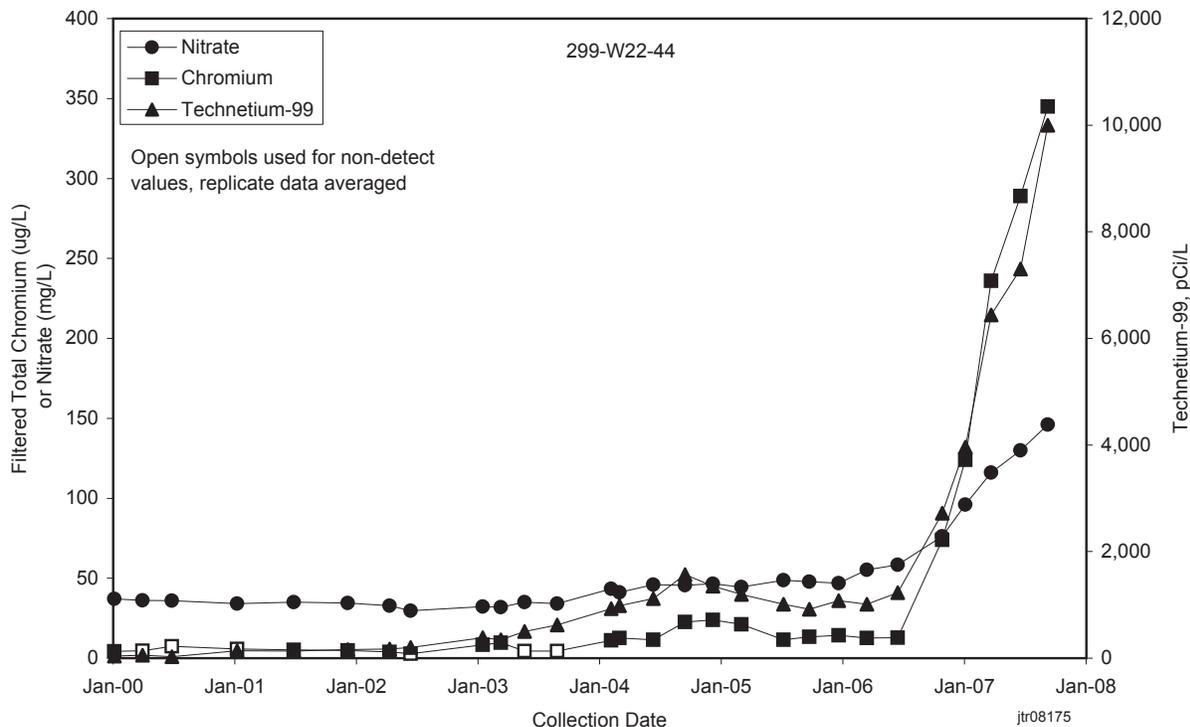


Figure 2.9-20. Concentrations of the Mobile Tank Waste Constituents Nitrate, Chromium, and Technetium-99 Downgradient from S Tank Farm

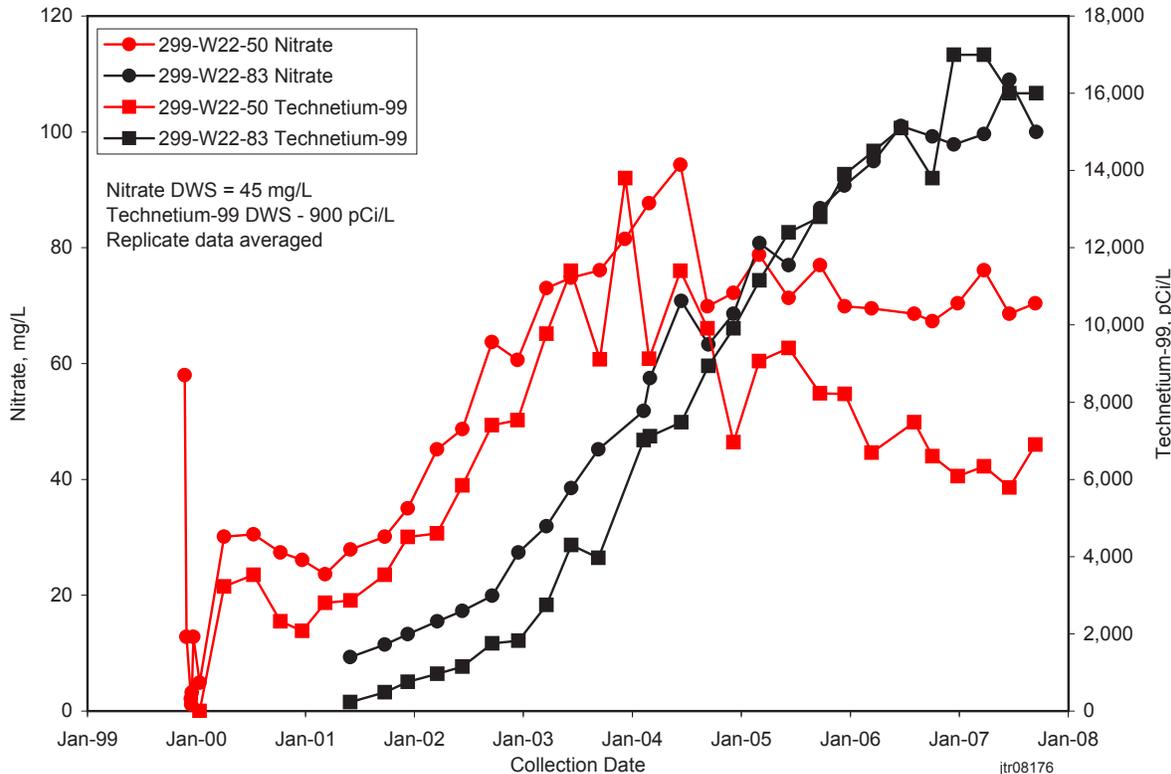


Figure 2.9-21. Nitrate and Technetium-99 Concentrations Within the South Plume Originating from Waste Management Area S-SX