2.8 200-ZP-1 Operable Unit

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The scope of this section encompasses the 200-ZP-1 Operable Unit and surroundings. This region is informally termed the 200-ZP-1 groundwater interest area (see Figure 2.1-1 in Section 2.1). The Groundwater Performance Assessment Project (groundwater project) defined groundwater interest areas informally to facilitate scheduling, data review, and interpretation. Figure 2.8-1 shows facilities and wells in this region. Groundwater is monitored to assess the performance of an interim action pump-and-treat system for carbon tetrachloride contamination, to track other contaminant plumes, and for four *Resource Conservation and Recovery Act* (RCRA) units and the State-Approved Land Disposal Site. Data from facility-specific monitoring are also integrated into the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) groundwater investigations. The major contamination plumes in this area include carbon tetrachloride, chloroform, trichloroethene, nitrate, chromium, fluoride, tritium, iodine-129, technetium-99, and uranium.

Carbon tetrachloride is the primary contaminant of concern in this operable unit.

Within the 200-ZP-1 Operable Unit, interim actions have been implemented for remediation of carbon tetrachloride, chloroform, and trichloroethene in the vicinity of the 216-Z liquid waste disposal units (216-Z cribs and trenches). Remediation of other groundwater contaminants will be determined through the remedial investigation/feasibility study (RI/FS) process per Section 5.5 of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989). A *Remedial Investigation/Feasibility Study Work Plan for the 200-ZP-1 Groundwater Operable Unit* was prepared in fiscal year (FY) 2004 (DOE/RL-2003-55).

Groundwater in the north portion of the 200 West Area predominantly flows toward the east-northeast but is locally influenced by the 200-ZP-1 Operable Unit pump-and-treat system and effluent discharges to the State-Approved Land Disposal Site (Figure 2.8-2). The water table in the 200 West Area was raised by past discharge of wastewater and the aquifer is still reequilibrating after the termination of discharges. Thus, the flow direction is changing with time. The flow direction in the north part of the operable unit has changed ~35 degrees over the past decade from a north-northeast direction to a more eastward direction.

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

CERCLA Monitoring

- ***Extraction wells are sampled monthly (when operating).***
- ***New wells are sampled quarterly for the first year, then wells are sampled semiannually to biennially.***
- ***In FY 2004, nine wells were not sampled as scheduled (see Appendix A).***

Facility Monitoring

- ***Wells are sampled semiannually for Low-Level Waste Management Area 3.***
- ***Wells are sampled semiannually for Low-Level Waste Management Area 4.***
- ***Wells are sampled quarterly to semiannually for Waste Management Area T.***
- ***Wells are sampled quarterly to semiannually for Waste Management Area TX-TY.***
- ***Wells are sampled quarterly to semiannually for the State-Approved Land Disposal Site.***
- ***In FY 2004, five RCRA wells were not sampled as scheduled (see text and Appendix B).***
- ***In FY 2004, three wells were not sampled as scheduled at the State-Approved Land Disposal Site.***

Groundwater flows west to east except where affected by pumping or injection.

Flow in the central part of the 200 West Area (the south part of the 200-ZP-1 Operable Unit) is heavily influenced by the operation of the 200-ZP-1 groundwater pump-and-treat remediation system. This system extracts water from the vicinity of the 216-Z cribs and trenches shown on Figure 2.8-1, treats it to remove carbon tetrachloride, then re-injects the water into the aquifer to the west of the area. A small groundwater mound is associated with the injection wells, and a region of drawdown is associated with the extraction wells, causing flow to converge on the extraction zone from all directions. These flow conditions are expected to continue until the end of the pump-and-treat program, at which time the flow direction will resume a west to east pattern.

The remainder of this section describes contaminant plumes and concentration trends for the contaminants of concern under CERCLA, RCRA, state permits, or *Atomic Energy Act of 1954* (AEA) monitoring.

2.8.1 Groundwater Contaminants

The groundwater contaminants of concern discussed below are defined in the 200-ZP-1 RI/FS work plan (DOE/RL-2003-55). The contaminants of concern and their preliminary target action levels, defined in the work plan, are listed in Table 2.8-1. In addition, the table summarizes the sampling results for each contaminant of concern in the 200-ZP-1 sampling and analysis plan (DOE/RL-2003-55; Appendix A) and other wells within the general area. The contaminants of concern that exceeded the preliminary target action levels are discussed below.

2.8.1.1 Carbon Tetrachloride

Carbon tetrachloride contamination is found at levels greater than the drinking water standard (5 µg/L) in the groundwater under most of the 200 West Area (Figure 2.8-3). The main sources are believed to be the 216-Z cribs and trenches that received waste from the Plutonium Finishing Plant. Other possible carbon tetrachloride sources exist in the north part of the operable unit and investigation of carbon tetrachloride in the vadose zone in Low-Level Waste Management Area 4, and waste retrieval is ongoing. The maximum carbon tetrachloride levels in groundwater are found near the Plutonium Finishing Plant and range up to 9,700 µg/L in individual samples. During FY 2004, extraction well 299-W15-34 had the highest average concentration (5,700 µg/L).

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

****Carbon tetrachloride — 10.93***
Chromium — 0.05
Iodine-129 — 0.65
Nitrate — 6.08
Technetium-99 — 0.11
Trichloroethene — 0.81
Tritium — 0.76
Uranium — 0.16
****Also includes portion of plume beneath 200-UP-1 Operable Unit.***

Carbon tetrachloride remediation is the subject of the 200-ZP-1 interim record of decision (ROD 1995a). The target for remediation is the area with concentrations >2,000 to 3,000 µg/L in the vicinity of the 216-Z cribs and trenches. The remediation activities and more details on the contaminant distribution are summarized in Section 2.8.2.

Significant features of the carbon tetrachloride plume at the top of the aquifer include:

- The area of carbon tetrachloride >4,000 µg/L in the vicinity of the 216-Z cribs and trenches is decreasing due to the remediation (see Section 2.8.2.1).
- An area of carbon tetrachloride at levels >2,000 µg/L extends north to the vicinity of Waste Management Area TX-TY. The west side of this lobe is defined by new monitoring well 299-W15-43, where the average concentration was 1,800 µg/L, slightly lower than in FY 2003. This well was drilled early in FY 2003. Sampling for carbon tetrachloride at well 299-W15-44 located northeast of extraction well 299-W15-34 showed an average concentration of 2,300 µg/L in FY 2004. The carbon tetrachloride contamination reaches the north part of Waste Management Area TX-TY where concentrations in well 299-W15-765 averaged 3,400 µg/L. Thus, the contamination at levels above 2,000 µg/L extends beyond the capture zone of the 200-ZP-1 remediation system (see Section 2.8.2.2).

- Levels of carbon tetrachloride >1,000 µg/L are seen in the north part of the operable unit. Well 299-W11-10 near the east boundary of the 200 West Area consistently shows high carbon tetrachloride concentrations. The extent beyond the area boundary for this high concentration has not been determined since there are no wells for ~2 kilometers downgradient.
- In the past several years, increasing concentrations of carbon tetrachloride have been seen in the vicinity of the tank farms in Waste Management Area S-SX (in the 200-UP-1 Operable Unit). Concentrations appear to have leveled off or declined in several wells in this area, but more time is needed to confirm the trends. Carbon tetrachloride concentrations continue to increase on the east side of Waste Management Area S-SX, indicating that the plume is moving downgradient.
- The extent of carbon tetrachloride at the drinking water standard (5 µg/L) shown in Figure 2.8-3 did not change significantly from the previous year.

Carbon tetrachloride contamination is found at levels greater than the drinking water standard (5 µg/L) in groundwater beneath most of the 200 West Area.

Carbon tetrachloride concentrations in some locations are higher at depth than at the top of the unconfined aquifer. Carbon tetrachloride may have moved deeper in the aquifer as a dense, non-aqueous liquid or under hydrodynamic gradients when dissolved. The depth distribution of carbon tetrachloride is part of an ongoing investigation under the 200-ZP-1 RI/FS. Recent information includes the following:

- Depth-discrete data collected during drilling of well 299-W13-1, located in east-central 200 West Area. The carbon tetrachloride concentration near the water table was 32 µg/L and increased with depth (Figure 2.8-4). The carbon tetrachloride concentrations peaked at 1,300 µg/L at the top of the lower mud unit. Samples collected below the lower mud unit had lower concentrations – from 643 µg/L just below the unit and declining to 132 µg/L at the top of basalt. Trichloroethene and chloroform showed similar trends with trichloroethene reaching a maximum concentration of 10.4 µg/L above the lower mud unit and chloroform reaching a maximum of 83 µg/L in the same interval. The concentrations above the lower mud unit are considerably higher than seen in other wells so the well was screened at that depth. The drilling samples confirm the relatively low concentrations at the water table in the east-central 200 West Area.
- Well 299-W17-1 was also sampled at intervals down to the lower mud unit during drilling in FY 2004. This well is located upgradient of the 200 West Area. No volatile organic compounds were detected in the depth-discrete samples.
- Carbon tetrachloride concentrations continue their overall upward trend in well 299-W15-17, located west of the 216-Z cribs and trenches and completed above the Ringold lower mud unit. The maximum concentration detected in FY 2004 was 28 µg/L, far below the concentration in nearby wells completed at the top of the unconfined aquifer.
- Monitoring wells completed at depth in the unconfined aquifer near the 200-UP-1 pump-and-treat system showed carbon tetrachloride levels of 130 µg/L in well 299-W19-34A at ~25 meters below the water table and 85 µg/L in well 299-W19-34B at ~50 meters below the water table (near the top of the Ringold lower mud unit).
- Information on the vertical distribution of carbon tetrachloride is also available from vertical profiling in wells with long screened intervals as reported previously (e.g., PNNL-11793; PNNL-12086; PNNL-13788; BHI-00952-01; BHI-01121; BHI-01311). These reports document areas where the maximum carbon tetrachloride concentration is lower at the water table than found at depth. However, the available data set is insufficient to map out the depth distribution of carbon tetrachloride.

Sampling during drilling of a well in the east part of the 200 West Area showed high carbon tetrachloride concentrations near the bottom of the unconfined aquifer.

2.8.1.2 Trichloroethene

Trichloroethene is also detected at levels above the drinking water standard in the 200-ZP-1 Operable Unit, and the contamination extends into the 200-UP-1 Operable Unit

(Figure 2.8-5). Levels are lower and the extent is generally less than for carbon tetrachloride. The maximum trichloroethene detected in FY 2004 routine monitoring was 15 µg/L in well 299-W15-44, south of Waste Management Area TX-TY. As stated in the discussion of carbon tetrachloride contamination, the trichloroethene in well 299-W13-1 reached a maximum near the top of the lower mud unit (bottom of the unconfined aquifer).

Trichloroethene is detected at levels above the drinking water standard in the 200-ZP-1 Operable Unit.

2.8.1.3 Chloroform

Chloroform concentrations in the 200-ZP-1 wells remained below the 80-µg/L drinking water standard (the standard is defined for total trihalomethane). The 200-ZP-1 RI/FS work plan (DOE/RL-2003-55) designates a preliminary target action level of 7.17 µg/L based on the cleanup levels and risk calculations under the *Model Toxics Control Act* (WAC 173-340) cleanup regulation methods. The maximum concentration detected in routine samples was 46 µg/L. One sample collected during drilling of well 299-W13-1 was above the chloroform drinking water standard. As stated in the discussion of carbon tetrachloride contamination, the chloroform in well 299-W13-1 reached a maximum of 83 µg/L near the top of the lower mud unit (bottom of the unconfined aquifer). One drilling sample from well 299-W15-46 in FY 2004 was also above the drinking water standard. Drilling of well 299-W15-46 continued into FY 2005, and the data will be integrated and evaluated after completion of the well. Possible chloroform sources include biodegradation of carbon tetrachloride.

2.8.1.4 Nitrate

Nitrate continued to be present in groundwater at concentrations in excess of the drinking water standard (45 mg/L) beneath much of the 200-ZP-1 Operable Unit (Figure 2.8-6). The maximum concentration in this vicinity during FY 2004 was 3,430 mg/L in well 299-W10-4 near the 216-T-36 crib, south of Waste Management Area T. Nitrate concentrations are increasing rapidly in this well as discussed in Section 2.8.3.3. The nitrate contamination is more widespread than the tritium, iodine-129, or technetium-99 contamination discussed in Sections 2.8.1.7, 2.8.1.8, and 2.8.1.9, respectively. There probably are multiple sources of nitrate in this area, including the 216-Z crib and trench disposal facilities.

A well near the 216-T-36 crib has the highest nitrate concentration (3,430 mg/L) on the Hanford Site.

Elevated nitrate on the east side of Waste Management Area TX-TY, in well 299-W14-13, is correlated with elevated chromium, tritium, iodine-129, and technetium-99. Because of the lower levels in surrounding wells, this contamination is interpreted as being from a nearby source and is discussed further in Section 2.8.3.4.

Elevated nitrate levels are found in the west part of the Hanford Site (see Figure 2.1-6 in Section 2.1). This contamination is believed to be due to offsite agriculture because it is persistent, far upgradient of the site waste disposal areas, and is not associated with other Hanford contaminants. Other constituents indicative of Hanford contamination, such as tritium, are low in this area. One well (699-36-93, see Figure 2.1-2 in Section 2.1 for location) in the west part of the Hanford Site had nitrate levels (49 mg/L) above the drinking water standard (45 mg/L) in FY 2003. Most wells in the west part of the site, upgradient of the production areas, were not scheduled for sampling in FY 2004.

2.8.1.5 Chromium

Chromium contamination is found at levels above the drinking water standard (100 µg/L) in filtered samples in the immediate vicinity of Waste Management Areas T and TX-TY (Figure 2.8-7). The plume in the vicinity of Waste Management Area T has changed little in size over the past decade, although the extent of lower concentrations beyond the 200 West Area fence line is uncertain due to the lower density of monitoring wells. The highest levels are found near the 216-T-36 crib, upgradient of Waste Management Area T, in well 299-W10-4 where the highest concentration in FY 2004 was 686 µg/L and the average concentration was 460 µg/L. Chromium concentrations are increasing in this well, along with nitrate and technetium-99 concentrations. Chromium near Waste Management Area T is discussed in more detail in Section 2.8.3.3.

Chromium is also elevated east of Waste Management Area TX-TY in well 299-W14-13. The concentrations detected in filtered samples from this well in FY 2004 rose from 573 µg/L in November to 733 µg/L in August. The chromium contamination is associated with elevated nitrate, tritium, technetium-99, and iodine-129. The contamination is discussed further in Section 2.8.3.4.

2.8.1.6 Fluoride

Fluoride contamination at levels greater than the primary drinking water standard (4 mg/L) has been seen in a restricted area around Waste Management Area T in past years. However, all wells had average concentrations below the drinking water standard in FY 2004 (Figure 2.8-8) so the plume appears to be dissipating slowly. Two wells had individual results above the drinking water standard.

2.8.1.7 Tritium

Tritium contamination at levels greater than the drinking water standard in the 200-ZP-1 Operable Unit is mainly restricted to a plume extending northeast from waste disposal facilities in the vicinity of Waste Management Areas T and TX-TY. There are multiple potential sources of tritium in this vicinity. In addition, tritium from permitted discharge at the State-Approved Land Disposal Site is found in the groundwater (Figure 2.8-9). Tritium at the State-Approved Land Disposal Site is discussed in Section 2.8.3.5.

The highest tritium concentrations were in a well east of Waste Management Areas T and TX-TY where the average concentration was 1.7 million pCi/L.

The highest tritium concentrations were in well 299-W14-13, located east of Waste Management Area TX-TY, where the average concentration in FY 2004 was 1.7 million pCi/L, slightly lower than in FY 2003. The maximum tritium concentration detected in this well was 2.94 million pCi/L in FY 2000. Well 299-W14-13 replaced well 299-W14-12, and the trend plot for these two wells indicates that the high contamination levels arrived at this location in ~1999 (Figure 2.8-10). High levels of chromium, nitrate, technetium-99, and iodine-129 are associated with the tritium contamination. This contamination is discussed further in Section 2.8.3.4.

Overall, tritium levels in the 200-ZP-1 Operable Unit are fairly low with only four wells having average concentrations >30,000 pCi/L in FY 2004 (excluding the State-Approved Land Disposal Site wells). Aside from well 299-W14-13, well 299-W14-15 had an average tritium concentration of 33,000 pCi/L, well 299-W11-12 had an average tritium concentration of 49,000 pCi/L, and well 299-W11-14 had an average tritium concentration of 55,000 pCi/L. Well 299-W11-12 is located southeast of Waste Management Area T, so the waste management area is probably not a major tritium source. The tritium concentration in well 299-W11-12 is declining.

2.8.1.8 Iodine-129

Iodine-129 concentrations in one well in the 200-ZP-1 Operable Unit are among the highest on the Hanford Site.

An iodine-129 plume is found in the 200-ZP-1 Operable Unit emanating from the vicinity of Waste Management Area TX-TY and extending to the northeast (Figure 2.8-11). The highest concentration detected in FY 2004 was in well 299-W14-13, where the average concentration was 18 pCi/L. Iodine-129 near Waste Management Area TX-TY is discussed further in Section 2.8.3.4. Iodine-129 contamination at levels above the drinking water standard does not appear to extend beyond the 200 West Area boundary.

2.8.1.9 Technetium-99

Technetium-99 within the 200-ZP-1 Operable Unit is found at levels above the drinking water standard (900 pCi/L) only on the downgradient side of Waste Management Areas T and TX-TY (Figure 2.8-12). However, evidence points to multiple sources of technetium-99 within those areas.

Near Waste Management Area T, technetium-99 concentrations continued to increase in wells on the east side (downgradient) of the tank farm. Well 299-W11-39, near the northeast corner of the waste management area, had the highest concentration in the area with values in FY 2004 ranging from 10,000 to 21,400 pCi/L, approximately double the

FY 2003 concentration. Technetium-99 contamination around Waste Management Area T is discussed in greater detail in Section 2.8.3.3.

Technetium-99 within the 200-ZP-1 Operable Unit is found above the drinking water standard only on the downgradient side of Waste Management Areas T and TX-TY.

Technetium-99 concentrations east of Waste Management Area TX-TY in well 299-W14-13 continued to be much higher than in surrounding wells and showed a generally increasing trend. The fiscal year average concentration in this well was 8,280 pCi/L. This contamination is associated with elevated levels of chromium, nitrate, tritium, and iodine-129. Contamination exhibited in this area is discussed further in Section 2.8.3.4.

The maximum technetium-99 detected in 200-ZP-1 extraction wells was in well 299-W15-35 where the concentrations in FY 2004 ranged from 280 to 360 pCi/L. Since technetium-99 is not removed by the treatment system, technetium-99 is being re-injected to the aquifer in the treated water. Well 299-W15-15, lying north-northeast of the injection wells, has exhibited increasing technetium-99 concentrations, rising from 18 pCi/L in May 1994 to 170 pCi/L in July 2004. This change suggests that injected water may be flowing toward this monitoring well. However, the concentrations are over one-third the highest technetium-99 concentration in any extraction well. This, and the distance of the wells in question from the injection wells, suggests the possibility that part of the technetium may be from upgradient. Technetium-99 may have moved to the west under past flow conditions and be re-entering the area under present flow conditions. The increase in technetium-99 at well 299-W15-15 has accompanied a marked decrease in carbon tetrachloride concentrations, from a maximum of 1,850 µg/L in January 1997 to 21 µg/L in July 2004.

2.8.1.10 Uranium

Few analyses for uranium were performed on groundwater samples from the 200-ZP-1 Operable Unit during FY 2004 because most wells showed insignificant levels in previous monitoring. Some wells monitored near the single-shell tank farms and low-level burial grounds are sampled for gross alpha measurements, which would show an increase if uranium contamination appeared. Uranium was detected above the 30-µg/L drinking water standard in wells 299-W11-14 and 299-W11-37 in northeast 200 West Area. The uranium concentration detected in well 299-W11-37 ranged from 194 to 250 µg/L. Uranium was also above the drinking water standard near the southwest corner (upgradient) of Low-Level Waste Management Area 4 in well 299-W18-21. The concentration in well 299-W18-21 ranged from 25.4 to 32.5 µg/L in FY 2004.

2.8.1.11 Other Contaminants of Concern

Most of the other contaminants of concern in the 200-ZP-1 RI/FS work plan (DOE/RL-2003-55) were not detected in FY 2004 sampling (see Table 2.8-1). Other contaminants of concern that were detected are discussed in this section.

Arsenic is listed as a contaminant of concern in the 200-ZP-1 RI/FS work plan (DOE/RL-2003-55). Arsenic was not detected at levels above the 10-µg/L drinking water standard/preliminary target action level in any of the routine samples. One of two samples from well 299-W10-4 had an arsenic level of 10 µg/L reported, while the other was 1.8 µg/L. However, a sample collected from drilling of well 299-W15-46, near the 216-Z-9 trench had a reported arsenic concentration of 38.7 µg/L. That sample was not filtered and turbidity was not reported.

Manganese was detected at levels above the 50-µg/L preliminary target action level in well 299-W10-27, but not in any wells sampled under the RI/FS work plan. Manganese levels in well 299-W10-27 declined from 239 µg/L in November 2003 to 172 µg/L in August 2004. Manganese concentrations have declined overall since this well was installed and first sampled in 2001. It is not uncommon for new wells on the Hanford Site to have elevated manganese values in the first few years of sampling.

Antimony was detected in three wells at levels above the 10-µg/L preliminary target action level. Antimony was not detected in subsequent samples so these results are considered

to be false positives. Analytical problems with antimony have recently been identified (see Appendix C) and the groundwater project is working with the laboratory to institute corrective measures.

Iron was present at levels above the 300-µg/L preliminary target action level in one unfiltered sample from well 699-48-77A, near the State-Approved Land Disposal Site. Iron is a naturally occurring component of the aquifer sediment and is found in well materials so seeing elevated iron levels in unfiltered samples is not surprising.

Silver was reported above the 80 µg/L preliminary target action level in one sample from well 299-W15-44, south of Waste Management Area TX-TY. Silver was not detected in previous and subsequent samples so this is considered to be a false positive sample.

The pump-and-treat system is successfully containing and capturing the highest concentration portion of the carbon tetrachloride plume near the top of the aquifer.

2.8.2 Interim Groundwater Remediation for Carbon Tetrachloride

A pump-and-treat system is in operation for the 200-ZP-1 Operable Unit to contain and capture the high concentration portion of the carbon tetrachloride plume located in the vicinity of the 216-Z cribs and trenches and the Plutonium Finishing Plant. The pump-and-treat system for the 200-ZP-1 Operable Unit was implemented in three phases as a CERCLA interim remedial action starting in 1996.

The remedial action objectives for the interim action pump-and-treat system are to capture the high concentration area of the carbon tetrachloride plume and to reduce contaminant mass (ROD 1995a). The high concentration area is defined as that area inside the 2,000- to 3,000-µg/L plume contour. More recently, carbon tetrachloride concentrations have been detected above the remedial action goal north of the Plutonium Finishing Plant, just west of the TX-TY Tank Farm. Because of these changes, plans are now underway to expand the pump-and-treat system by adding additional extraction wells in this area. Also, concentrations near the remedial action goal have been found in the east-central 200 West Area, suggesting that additional characterization of the deeper aquifer should be performed. Contamination deeper in the aquifer is being addressed in the CERCLA investigations.

The remedial action objectives for the 200-ZP-1 Operable Unit (ROD 1995a) are:

- ***Reduce contamination in the area of highest concentration of carbon tetrachloride.***
- ***Prevent further movement of these contaminants from the highest concentration area.***
- ***Provide information that will lead to development of a final remedy that will protect human health and the environment.***

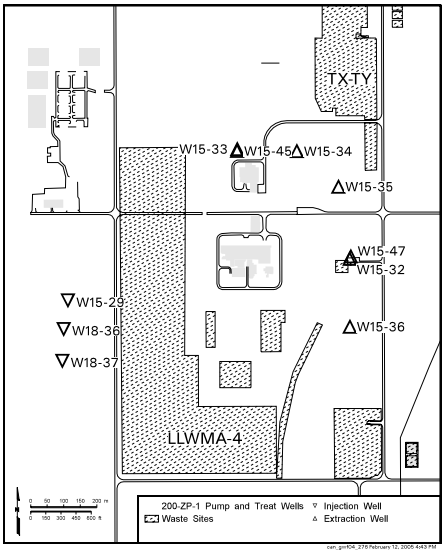
EPA specified enhancements needed to the system in their 5-year review (EPA 2001). The record of decision for the interim remedial measure states the high concentration portion of the plume corresponds to the area within the 2,000- to 3,000-µg/L contour of carbon tetrachloride.

A summary of the remediation activities and progress is given in the following sections. For more details on pump-and-treat results for FY 2003, see DOE/RL-2004-72. Results for 2004 will be published in an upcoming report on the 200 West Area remedial actions. Sampling for the groundwater remediation is integrated with the RI/FS work plan (DOE/RL-2003-55).

During FY 2004, the pump-and-treat system extracted ~274 million liters of groundwater, removing ~840 kilograms of carbon tetrachloride.

2.8.2.1 Progress During FY 2004

Carbon tetrachloride contamination was reduced in the area of highest concentrations through mass removal. Approximately 274.5 million liters of contaminated groundwater were treated in FY 2004 at an average flow rate of ~540 liters per minute (includes all downtime). Two of the extraction wells were replaced this year because of decreased production under a declining water table. The new extractions wells, which became operational in April and August 2004, respectively, are 299-W15-45 (replacing 299-W15-33) and 299-W15-47 (replacing 299-W15-32). These new wells boosted the overall system production rate to ~785 liters per minute for the last 2 months of the fiscal year.



Extraction well concentrations ranged from 560 to over 5,000 µg/L, while influent concentrations measured at the influent tank ranged from 2,500 to 3,700 µg/L. Carbon tetrachloride trends in extraction wells are shown in Figure 2.8-13. Treatment of the 274.5 million liters of groundwater resulted in the removal of 840.4 kilograms of carbon tetrachloride during FY 2004. Since startup of pump-and-treat system operations in August 1994, treatment of >2.4 billion liters of groundwater has led to the removal of >8,500 kilograms of carbon tetrachloride.

Technetium-99 samples are collected to ascertain if the pump-and-treat system is being affected by radiological contamination. No technetium-99 concentrations were above the drinking water standard (900 pCi/L). The highest measured concentrations in the area of the pump-and-treat system were 242 and 380 pCi/L at extraction wells 299-W15-32 and 299-W15-35, respectively. Technetium-99 acts as a tracer and has been detected in wells downgradient from the injection wells. At well 299-W15-15, the measured technetium-99 concentration has increased from 18.5 pCi/L in 1994 to 170 pCi/L while carbon tetrachloride concentrations have simultaneously decreased from 1,400 to 21 pCi/L

2.8.2.2 Influence on Aquifer Conditions

During FY 2004, the >2,000-µg/L center of the carbon tetrachloride plume near the top of the unconfined aquifer continued to shrink in the original target area of the plume (beneath the Plutonium Finishing Plant) (Figure 2.8-3). The 4,000-µg/L-plume contour has also been shrinking and at the end of the fiscal year only encompassed extraction well 299-W15-34. During FY 2002, four wells defined the >4,000-µg/L contour: 299-W15-1, 299-W15-31A, 299-W15-33, and 299-W15-34; and in FY 2003 only two wells: 299-W15-1 and 299-W15-34.

During FY 2004, the >2,000-µg/L center of the carbon tetrachloride plume at the top of the aquifer continued to shrink in the plume beneath the Plutonium Finishing Plant.

Concentrations of carbon tetrachloride continued to decline to the west of the Plutonium Finishing Plant in response to pumping from the extraction wells and the arrival of clean groundwater from the injection wells. In this area, well 299-W15-30 reached a concentration of 6,500 µg/L in 1997. By August 2004, carbon tetrachloride concentrations had decreased to 1,300 µg/L.

Carbon tetrachloride levels in former southernmost extraction well 299-W15-37 are still low at 84 µg/L indicating there is no loss of control of the plume at the south edge. At extraction well 299-W15-36, 190 meters farther north, concentrations have declined to 820 µg/L. This value is well below 2,000 µg/L. These changes show that the pump-and-treat system is having the desired remediation effect. Further consideration is being given to shutting down this extraction well to ensure that higher concentrations are not pulled to the south.

Recently installed monitoring wells have revealed that carbon tetrachloride concentrations are above 2,000 µg/L north of the pump-and-treat system and west of the TX-TY Tank Farm. This area is outside the capture zone of the pump-and-treat system. For this reason, plans are in place to expand the pump-and-treat system to this north area in FY 2005. It is likely that wells 299-W15-765, 299-W15-40, 299-W15-43, and 299-W15-44 will be brought on line as additional extraction wells.

In addition, vertical profile sampling at new monitoring well 299-W13-1, installed in the east-central 200 West Area in December 2003, demonstrated the presence of carbon tetrachloride at above drinking water standard to concentrations near the remedial action goal throughout the thickness of the aquifer (see Section 2.8.1). Following well installation, carbon tetrachloride concentrations have increased to 1,900 µg/L. Additional wells have been proposed for aquifer monitoring between the 216-Z-9 crib and this well along a track predicted by particle tracking models.

Regional groundwater flow in the vicinity of the pump-and-treat system is still to the east-northeast (Figure 2.8-2). Water levels continued to decline at an annual rate of ~0.37 meter per year (DOE/RL-2004-72). This rate of decline is equivalent to the FY 2003 rate. The declining water levels will continue to be an issue as additional monitoring wells go dry. Numerous wells monitored for the 200-ZP-1 Operable Unit have gone dry in recent years. Six wells scheduled for sampling under the 200-ZP-1 plan were dry (Appendix A). Well decommissioning is discussed in Chapter 5.

In conclusion, the pump-and-treat system appears to be hydraulically containing the high-concentration portion of the target carbon tetrachloride plume and reducing contaminant mass in the baseline area. Contaminant concentrations have decreased most notably in the monitoring wells, but also in the extraction wells. An existing plume north of the pump-and-treat system will require additional extraction wells for containment and mass removal. This system upgrade is planned for FY 2005. Additional characterization may be required to evaluate the distribution of carbon tetrachloride deeper in the aquifer.

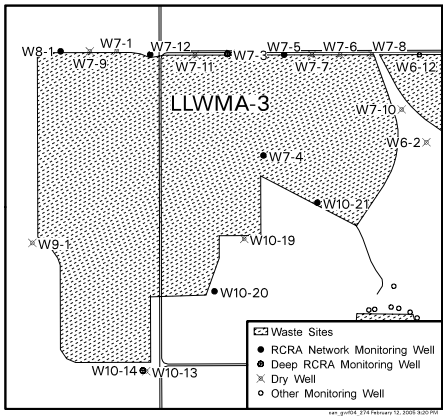
Carbon tetrachloride contamination at levels above 2,000 µg/L extends beyond the capture zone of the current remediation system. System upgrades to address this are planned for FY 2005.

2.8.3 Facility Monitoring

This section describes results of monitoring individual facilities such as treatment, storage, and disposal units or tank farms. Some of these facilities are monitored under the requirements of RCRA for hazardous waste constituents and AEA for source, special nuclear, and by-product materials. Hazardous constituents and radionuclides are discussed jointly in this section to provide comprehensive interpretations of groundwater contamination for each facility. As discussed in Section 2.1 for RCRA sites, DOE has sole and exclusive responsibility and authority to regulate source, special nuclear, and by-product materials. 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.

2.8.3.1 Low-Level Waste Management Area 3

Groundwater at Low-Level Waste Management Area 3 continued to be monitored under RCRA and AEA. Under 40 CFR 265.93(b) as referenced by WAC 173-303-400, the well network was sampled semiannually for RCRA indicator and site-specific parameters (WHC-SD-EN-AP-015; see Appendix B). Eight of 11 wells attempted for sampling in FY 2004 were successfully sampled. Wells 299-W10-19, 299-W7-1, and 299-W7-7 went dry this year and have been removed from the sampling schedule. Well decommissioning is discussed in Chapter 5. New downgradient well locations have been identified and prioritized under the Tri-Party Agreement (Ecology et al. 1989) M-24 milestone. Well installation at Low-Level Waste Management Area 3 is scheduled to begin in calendar year 2005.



Initial analysis of the April samples from well 299-W7-12 indicated total organic carbon exceeded the statistical comparison value since the average of the quadruplicates was 1,500 µg/L. The samples were re-analyzed and the results came back much lower. Confirmation sampling was performed in June, and the average value was less than the comparison value at 650 µg/L. Thus, the original results are interpreted as being due to laboratory error.

An application was submitted to the Washington State Department of Ecology (Ecology) in June 2002 to incorporate the low-level burial grounds into the Hanford Facility RCRA Permit (Ecology 1994a). This would have the effect of changing the groundwater monitoring requirements for the burial grounds from interim status monitoring to final status monitoring. As part of the application, new groundwater monitoring wells, constituents, and statistical evaluations are proposed. Workshops with Ecology to address this application are in progress.

The groundwater flow in this portion of the 200 West Area is to the east-northeast (70 degrees), based on trend surface fit to water-level measurements, with a calculated gradient of 0.0013. The estimated flow rate at Low-Level Waste Management Area 3, using this gradient is 0.0001 to 0.2 meter per day (see Appendix B).

Under current flow directions, previously designated upgradient wells 299-W10-19 and 299-W10-20 remain upgradient of the east portion of the waste management area, but are downgradient of the southwest part of the waste management area. Nitrate and carbon tetrachloride routinely exceed drinking water standards in these wells. Flow and monitoring data since RCRA monitoring was instituted in the 1980s indicate that these constituents are from plumes originating from sources to the south. Currently, there are no monitoring wells on the west (upgradient) side of Low-Level Waste Management Area 3. If wells 299-W10-19 and 299-W10-20 are used for statistical comparisons, then no downgradient wells exceed the statistical comparison value for the indicator parameters, pH, specific conductance, total organic carbon, and total organic halides. Past carbon tetrachloride results from well 299-W9-1, on the west side of Low-Level Waste Management 3, are all less than 10 µg/L. This well has gone dry.

New monitoring wells will be installed during 2005 to replace wells that have gone dry in Low-Level Waste Management Areas 3 and 4.

Performance assessment monitoring of radionuclides at Low-Level Waste Management Area 3 is designed to complement RCRA detection monitoring and is aimed specifically at monitoring radionuclide materials that are not regulated under RCRA. The current goal of performance assessment monitoring at Low-Level Waste Management Area 3 is to gather data to assess changes in concentrations at downgradient wells using statistical tests and to provide sufficient supporting information from upgradient wells to interpret the changes. Under the current monitoring plan (DOE/RL-2000-72), technetium-99, iodine-129, and uranium are monitored specifically for performance assessment.

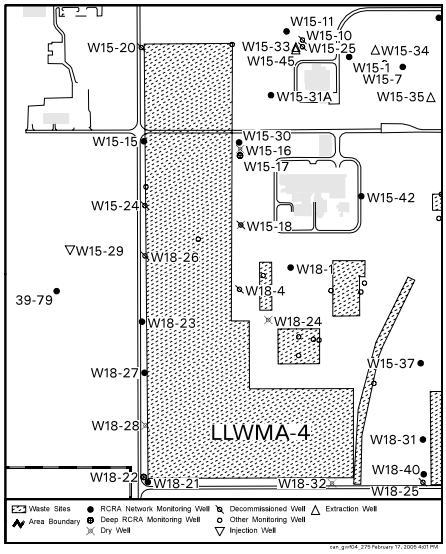
Contaminant characteristics in groundwater at Low-Level Waste Management Area 3 include the following:

- Technetium-99 concentrations are all <100 pCi/L and generally show steady or declining trends. The highest concentration in FY 2004 was 58 pCi/L in well 299-W10-21, located on the south edge of Low-Level Waste Management Area 3. Although this well is currently downgradient of part of the burial ground, it has likely been impacted by activities to the south that imposed northward flow for a time. Technetium-99 was also detected in wells 299-W7-4, 299-W7-12, and 299-W10-20 in FY 2004. The technetium-99 distribution in the 200-ZP-1 Operable Unit is discussed in Section 2.8.1.9.
- Uranium concentrations at Low-Level Waste Management Area 3 are <3 µg/L.
- Iodine-129 was not detected in any wells at Low-Level Waste Management Area 3. The minimum detectable activity is ~0.3 pCi/L.
- Tritium concentrations were all less than the drinking water standard, and tritium was undetected in most wells.
- As discussed in Sections 2.8.1.1, 2.8.1.2, and 2.8.1.3, carbon tetrachloride and associated trichloroethene and chloroform concentrations in Low-Level Waste Management Area 3 wells are consistent with those seen in regional plumes.
- The nitrate distribution at Low-Level Waste Management Area 3 is consistent with regional plumes, as discussed in Section 2.8.1.4.

2.8.3.2 Low-Level Waste Management Area 4

Groundwater at Low-Level Waste Management Area 4 continued to be monitored under RCRA and AEA. Under 40 CFR 265.93(b) as referenced by WAC 173-303-400, the well network was sampled semiannually for RCRA indicator and site-specific parameters (WHC-SD-EN-AP-015; see Appendix B). Of the six wells where sampling was attempted

during FY 2004, sampling was successful in five of the wells. Sampling of well 299-W15-16 was unsuccessful in the second sampling event, and the well has been determined to have too little water for future sampling. Well 299-W15-30 will be used as a replacement for well 299-W15-16. New downgradient well locations have been identified and prioritized under the Tri-Party Agreement M-24 milestone. Well installation at Low-Level Waste Management Area 4 is scheduled to begin in calendar year 2005. Decommissioning of wells that are no longer needed is discussed in Chapter 5.



An application was submitted to Ecology in June 2002 to incorporate the low-level burial grounds into the Hanford Facility RCRA Permit (Ecology 1994a). This would have the effect of changing the groundwater monitoring requirements for the burial grounds from interim status monitoring to final status monitoring. As part of the application, new groundwater monitoring wells, constituents, and statistical evaluations are proposed. Workshops with Ecology to address this application are in progress.

The groundwater flow in this portion of the 200 West Area is generally to the east (90 degrees) with a calculated gradient of 0.002. The flow direction is affected to a large degree by the 200-ZP-1 pump-and-treat system, which has extraction wells to the east and injection wells to the west of this RCRA site. The estimated flow rate at Low-Level Waste Management Area 4 using this gradient is 0.02 to 0.5 meter per day (see Appendix B).

Downgradient well 299-W15-16 continued to exceed the statistical comparison value for total organic halides in the January 2004 sample. The well could not be sampled in June 2004 due to declining water levels. This well was originally an upgradient well under past flow conditions and is still affected by contamination from sources in or near the 216-Z cribs and trenches. DOE reported the exceedance to the U.S. Environmental Protection Agency and Ecology in August 1999. The elevated total organic halide concentrations are consistent with observed levels of carbon tetrachloride from Plutonium Finishing Plant operations (see Section 2.8.1.1). Carbon tetrachloride and other volatile organic compounds were detected in the trenches and vadose zone within Low-Level Waste Management Area 4 during FY 2002. Investigation of the vadose zone is ongoing in FY 2004 as part of the 200-PW-1 Operable Unit. Statistical comparison values for use in FY 2005 are listed in Appendix B.

Performance assessment monitoring of radionuclides at Low-Level Waste Management Area 4 is designed to complement the RCRA detection monitoring. The current goal of performance assessment monitoring at Low-Level Waste Management Area 4 is to gather data to assess changes in concentrations at downgradient wells using statistical tests and to provide sufficient supporting information from upgradient wells to interpret the changes. Under the current monitoring plan (DOE/RL-2000-72), technetium-99, iodine-129, and uranium are monitored specifically for performance assessment.

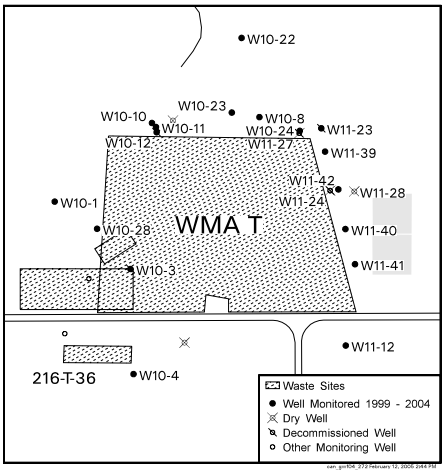
Contaminant characteristics at Low-Level Waste Management Area 4 include the following:

- Technetium-99 concentrations remained slightly elevated in two wells on the west (upgradient) of Low-Level Waste Management Area 4 (wells 299-W15-15 and 299-W18-23). Technetium-99 concentrations were all <150 pCi/L. As discussed in Section 2.8.1.9, this occurrence may result at least in part from technetium-99 in water injected by the 200-ZP-1 pump-and-treat system. However, the concentrations are over one-third the highest technetium-99 concentration in any extraction well. This, and the distance of the wells in question from the injection wells, suggests that part of the technetium-99 may be from upgradient. Technetium-99 may have moved to the west under past flow conditions and be re-entering the area under present flow conditions.

- Uranium concentrations are elevated in upgradient well 299-W18-21 in the southwest corner of the waste management area. Concentrations were just over the 30 µg/L drinking water standard in the January sample but less than the drinking water standard in July.
- Iodine-129 was not detected in Low-Level Waste Management Area 4 wells. The minimum detectable activity is ~0.3 pCi/L.
- Tritium levels were all less than the drinking water standard.
- Nitrate continues to exceed the drinking water standard at many monitoring wells in Low-Level Waste Management Area 4. This contamination is not believed to be related to waste disposal at the burial grounds. Some of the nitrate contamination is related to injection of 200-ZP-1 treated water upgradient of the burial ground. The treatment system does not remove nitrate from the water.
- In the southwest corner of Low-Level Waste Management Area 4, upgradient monitoring well 299-W18-21 has slowly increasing nitrate concentrations that have not been associated with the large contaminant plumes of the 200 West Area. The FY 2004 average nitrate concentration in this well was 112 mg/L.
- Carbon tetrachloride and associated trichloroethene and chloroform in the groundwater beneath Low-Level Waste Management Area 4 are consistent with regional plumes as shown in Sections 2.8.1.1, 2.8.1.2, and 2.8.1.3. Investigation of carbon tetrachloride in the vadose zone at Low-Level Waste Management Area 4 is continuing.

2.8.3.3 Waste Management Area T

Waste Management Area T is located in the north-central part of the 200 West Area and consists of the T Tank Farm and ancillary equipment (e.g., diversion boxes and pipelines). The tank farm contains twelve 2-million-liter tanks and four 208,000-liter tanks constructed between 1943 and 1944. Seven of the tanks in the waste management area are known or suspected to have leaked. This section describes groundwater monitoring at Waste Management Area T. A well location map and a table of wells and analytes for this waste management area are included in Appendix B. Section 3.1.2 discusses vadose zone characterization at the waste management area.



The objective of RCRA groundwater monitoring at Waste Management Area T is to assess the extent and rate of movement of dangerous waste in groundwater that have a source from the waste management area [40 CFR 265.93(d) as referenced by WAC 173-303-400]. The current groundwater assessment plan is PNNL-12057 and PNNL-12057-ICN-1. In addition to monitoring dangerous waste constituents for RCRA assessments, the site is monitored for CERCLA and AEA purposes. Waste Management Area T was originally placed in RCRA assessment monitoring because of elevated specific conductance in downgradient well 299-W10-15 (WHC-SD-EN-AP-132). However, it remained in assessment because of contaminants observed in downgradient well 299-W11-27 (PNNL-11809). Dangerous waste constituents found beneath Waste Management Area T in FY 2004 are chromium and nitrate. Other non-RCRA constituents found beneath the waste management area in FY 2004 include carbon tetrachloride, trichloroethene, tritium, and technetium-99. These constituents are attributed to Plutonium Finishing Plant operations and are discussed in Sections 2.8.1.1 and 2.8.1.2. The tritium is believed to be part of a large regional plume and is not attributed to the T Tank Farm. The technetium-99 plume, located east (downgradient) of the T Tank Farm, is attributed to the tank farm.

Calculated average linear flow velocities in wells at Waste Management Area T range from 0.017 to 0.28 meter per day with most values <0.1 meter per day. Groundwater flow direction beneath the waste management area is between 85 and 98 degrees from north as determined by trend surface analyses (PNNL-13378; PNNL-14113).

The monitoring network for Waste Management Area T includes eleven wells that are sampled quarterly and two wells sampled semiannually. Two new RCRA assessment monitoring wells (Figure 2.8-1) are planned to be installed in calendar year 2005. The first new well, 299-W11-25, is to assess the vertical extent of contamination near the northeast corner of the waste management area and will be drilled to 36 meters below the water table. The second new well has not been assigned a name. This second well will be ~75 meters downgradient of the waste management area and will assess the horizontal extent of contamination. The location and design for these wells were determined in Data Quality Objectives workshops with the regulatory agencies (CP-15329).

A plume map depicting the FY 2004 average chromium concentration in wells near the Waste Management Area T is shown in Figure 2.8-7. The map shows that chromium is elevated in several wells at the waste management area. The highest concentrations in FY 2004 were in upgradient well 299-W10-28 (average 270 μg/L) and well 299-W10-4 (average 460 μg/L) located south of the waste management area. The chromium concentration in FY 2004 also exceeded the drinking water standard in two downgradient wells, 299-W11-41 (average 150 μg/L) and 299-W11-42 (average 150 μg/L). The chromium concentration increased in all wells that exceed the drinking water standard (100 μg/L) during FY 2004. The largest increase was in well 299-W10-4, where the chromium concentration increased from 347 μg/L at the end of FY 2003 to 686 μg/L at the end of FY 2004.

The fluoride concentration, which had exceeded the primary drinking water standard (4 mg/L) in FY 2003, decreased to average less than 4 mg/L in all wells during 2004 (see Figure 2.8-8). Two wells had individual results above the standard. Well 299-W10-23 had a maximum concentration of 4.1 mg/L and well 299-W10-8 had a maximum concentration of 4.6 mg/L.

Nitrate concentration exceeded the drinking water standard of 45 mg/L in all wells in the waste management area monitoring network in FY 2004. Figure 2.8-6 shows a plume map for nitrate in the area. Nitrate concentrations remained fairly level in most wells at the waste management area during FY 2004. Nitrate concentrations increased, however, in three wells. By far the largest increase in nitrate concentration during the fiscal year was in well 299-W10-4 (Figure 2.8-14). Smaller increases in nitrate concentration were noted in downgradient wells 299-W11-41 and 299-W11-42. These latter two wells are downgradient of well 299-W10-4, and the most likely source for the increasing nitrate downgradient of Waste Management Area T is the source for the high nitrate in well 299-W10-4. A more detailed discussion of nitrate contamination in the north central part of 200 West Area is given in Section 2.8.1.4.

Tritium exceeded the interim drinking water standard (20,000 pCi/L) in one well, 299-W11-12, at Waste Management Area T. The well is located at the southwest corner of the waste management area, and the source of the tritium encountered at that location is thought to be farther south near the TX and TY Tank Farms. A more detailed discussion of tritium in the groundwater beneath the north part of 200 West Area is in Section 2.8.1.7.

Technetium-99 concentrations increased in four wells downgradient of Waste Management Area T in FY 2004.

Technetium-99 exceeded the interim drinking water standard (900 pCi/L) in five downgradient wells at Waste Management Area T in FY 2004. The technetium-99 concentration remained fairly level throughout the year in well 299-W10-24, located at the northeast corner of the waste management unit where the technetium-99 plume was first detected in late 1995 (in well 299-W11-27, now dry). The technetium-99 concentration increased in all four downgradient wells south of well 299-W10-24 during FY 2004. The largest increase and the highest concentrations are in well 299-W11-39 where the technetium-99 concentration increased from 9,140 pCi/L at the end of FY 2003 to 21,400 pCi/L at the end of FY 2004.

In 1998, a vertical profile of technetium-99 concentration was made in well 299-W10-24, located ~30 meters northwest of well 299-W11-39. That profile showed that the highest technetium-99 concentration was near the water table and that the concentration decreased

with depth in the aquifer. This suggests that the technetium-99 concentration in well 299-W11-39 may be greater than 21,400 pCi/L because of dilution with low technetium-99 bearing water from deeper in the aquifer. However, the situation is complicated by vertical changes in the formation permeability in the well screen interval. A tracer dilution test by Spane et al. (PNNL-14113) showed very little dispersion of the tracer in the lowermost two electrodes in well 299-W11-39, which was interpreted as "stagnant" lateral flow, or low permeability conditions, in the lowermost ~2.5 meters of the well screen section. Figure 2.8-15 shows technetium-99 concentration trends with time at selected Waste Management Area T wells.

The most likely source for the chromium at Waste Management Area T is one or more of the cribs and trenches west and southwest of the tank farm.

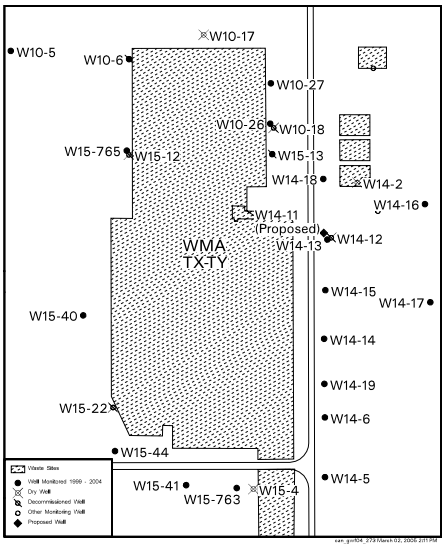
In 1998, Hodges (PNNL-11809) used tritium/technetium-99 and nitrate/technetium-99 ratios from groundwater samples in the area of Waste Management Area T to distinguish waste disposed to cribs and trenches in the area of the waste management area from evaporator condensate waste and waste discharged from the Plutonium Finishing Plant. In 2004, similar ratios were used to compare contaminant concentrations in groundwater, tank fluids leaked from tanks T-106 and T-101, and effluent compositions disposed to cribs and trenches in the T Tank Farm area. This was done to support the Waste Management Areas T and TX-TY field investigation report (PNNL-14849). That report found that the groundwater concentrations for technetium-99 and chromium behave quite differently at different areas around Waste Management Area T. The concentrations of both constituents track each other through time in upgradient wells at the waste management area (Figure 2.8-15a). The same relationship holds for wells north of the waste management area (Figure 2.8-15b). The technetium-99/chromium concentration relationship is different in wells located at the northeast corner of the waste management area (Figure 2.8-15c) and on the east, or downgradient, side of the waste management area (Figure 2.8-15d) where the two constituents do not track each other.

Figure 2.8-16 shows the technetium-99/chromium groundwater concentration ratios versus time for samples from selected wells at Waste Management Area T. The figure also shows the concentration ratios expected in the leaked tank waste from tanks T-101 and T-106 (RPP-7218) and the waste disposed to the cribs and trenches located west of Waste Management Area T (BHI-01496): 216-T-5, 216-T-7, and 216-T-32. The data plotted in Figure 2.8-16a show that the technetium-99/chromium ratio in samples from upgradient wells has a signature similar to the upgradient crib and trench disposal sites. Figure 2.8-16b shows that samples from wells north of the waste management area have a similar composition as those from upgradient wells. This information, and the information in Figure 2.8-15, suggest that the contamination detected in wells north of Waste Management Area T in the late 1990s is similar to that found upgradient of the waste management area today and is dominated by crib waste.

Figure 2.8-16c suggests a different source for the contamination at the northeast corner of Waste Management Area T. A technetium-99, chromium, nitrate, and tritium plume was first detected in this area in well 299-W11-27 in early 1996. Since that time, the technetium-99/chromium composition of the groundwater in that well has evolved toward tank waste compositions. Three other wells in the area also have tank waste compositions. The technetium-99/chromium ratios greater than the estimated tank waste ratios are similar to data from vadose zone pore water collected from the tank T-106 leak plume and probably reflect the slight retardation of chromium relative to technetium-99 (PNNL-14849).

At the beginning of monitoring the wells east of Waste Management Area T in 1997, the technetium-99/chromium ratios for groundwater in that area were the same as those from upgradient wells and wells at the northeast corner of the waste management area (Figure 2.8-16d). More recent samples from the east wells indicate that the tank waste initially identified at the northeast corner of the waste management area is now found along the east edge of the waste management area and mixing with the crib waste that was initially sampled in the east wells. This is coincident with a shift in groundwater flow direction from toward the north before 1997 to toward the east or slightly southeast after 1997.

2.8.3.4 Waste Management Area TX-TY



Waste Management Area TX-TY is located in the north-central part of the 200 West Area and consists of the TX and TY Tank Farms and ancillary equipment (e.g., diversion boxes and pipelines). The tank farms contain twenty-four 2.9-million-liter tanks constructed between 1944 and 1952. Twelve of the tanks in the waste management area are known or suspected to have leaked. A well location map and a table of wells and analytes for this waste management area are shown in Appendix B.

Waste management Area TX-TY was originally placed in RCRA assessment monitoring (40 CFR 265.93(d) as referenced by WAC 173-303-400) because of elevated specific conductance in downgradient wells 299-W10-27 and 299-W14-12 (WHC-SD-EN-AP-132). The current groundwater assessment plan is PNNL-12072 and PNNL-12072-ICN-1. The objective of RCRA groundwater monitoring at Waste Management Area TX-TY is to assess the extent and rate of movement of dangerous waste in groundwater that have a source from the waste management area. In addition to monitoring dangerous waste constituents for RCRA assessments, the site is monitored for AEA and CERCLA.

The monitoring network for Waste Management Area TX-TY includes sixteen wells that are sampled quarterly. Well 299-W14-5, which is located southeast of the waste management area, went dry in May 2004. One new RCRA assessment monitoring well, 299-W14-11 (Figure 2.8-1), is planned to be installed during calendar year 2005. The new well is to assess the vertical extent of contamination downgradient of the waste management area and will be drilled to 36 meters below the water table. The location and design of the new well were determined in Data Quality Objectives workshops with the regulatory agencies (CP-15329).

Calculated average linear flow velocities in wells at Waste Management Area TX-TY range from 0.0007 to 2.46 meters per day with most values <0.1 meter per day. Groundwater flow velocities as determined from aquifer tracer tests range between 0.191 and 1.1 meter per day (PNNL-13378; PNNL-14113; PNNL-14186). Groundwater flow direction varies beneath the site. Trend surface analysis for the northeast part of the waste management area, at the TY Tank Farm, shows a groundwater flow direction of 108 degrees, or to the east-southeast (PNNL-13378). Farther south, along the downgradient side of the TX Tank Farm, groundwater flow direction changes from 108 degrees at well 299-W14-13 to 133 degrees (southeast) at well 299-W14-14 (PNNL-13378; PNNL-14311; PNNL-14186). South of Waste Management Area TX-TY, groundwater flow direction, as determined by water-level measurements, is toward the south or southwest. The change in flow direction at Waste Management Area TX-TY is due to the 200-ZP-1 pump-and-treat system extraction wells located south of the waste management area. In the north part of the waste management area, flow direction generally follows the pre-Hanford Site direction of east to southeast.

Waste Management Area TX-TY may have contributed to chromium and radionuclide contamination in groundwater.

Dangerous waste constituents found beneath Waste Management Area TX-TY in FY 2004 are chromium and nitrate. Other non-RCRA constituents found beneath the waste management area in 2004 include carbon tetrachloride, trichloroethene, tritium, technetium-99, and iodine-129. The carbon tetrachloride and trichloroethene are attributed to Plutonium Finishing Plant operations and are discussed in Sections 2.8.1.1 and 2.8.1.2.

Nitrate concentrations exceeded the drinking water standard (45 mg/L) in all wells in the Waste Management Area TX-TY monitoring network in FY 2004. Figure 2.8-6 shows a plume map for nitrate in the area. The highest nitrate concentration at the waste management area was 580 mg/L at the end of the FY 2004 (August) in well 299-W14-13. This was an increase from 394 mg/L at the end of the previous fiscal year. Much of the nitrate contamination at Waste Management Area TX-TY is attributed to Plutonium Finishing Plant operations as well as past-practice disposal to cribs and trenches in the area. Some nitrate contamination may be from Waste Management Area TX-TY,

although distinguishing the different sources is extremely difficult. More discussion of nitrate in north-central 200 West Area is given in Section 2.8.1.4.

Chromium was detected above the drinking water standard (100 µg/L) only in well 299-W14-13 at Waste Management Area TX-TY during FY 2004. Figure 2.8-17 shows a time series plot for chromium concentration in the well. The figure shows that the chromium concentration increased substantially during FY 2004 from 540 µg/L in August 2003 to 733 µg/L in August 2004. Chromium concentrations in wells adjacent to well 299-W14-13 were all less than the drinking water standard during the fiscal year indicating that the chromium contamination is limited to the area of well 299-W14-13. The most likely source for the chromium in well 299-W14-13 is assumed to be Waste Management Area TX-TY because no alternative sources have been identified.

Tritium exceeded the interim drinking water standard (20,000 pCi/L) in two wells at Waste Management Area TX-TY. The tritium concentration in well 299-W14-13 in August 2004 was 1.82 million pCi/L, which is up from 1.62 million pCi/L at the end of FY 2003. Tritium also exceeded the interim drinking water standard in well 299-W14-15, located ~50 meters south of well 299-W14-13. The tritium concentration in the well at the end of FY 2003 was 38,500 pCi/L. The tritium concentration decreased during the first three quarters of FY 2004 to 23,100 pCi/L before increasing to 59,800 pCi/L in the last quarter of the fiscal year. The relatively large increase during the last part of the year may indicate that the contamination in well 299-W14-13 is now being encountered in well 299-W14-15 or may represent local fluctuations at well 299-W14-15. However, nitrate increased by 151 mg/L, technetium-99 increased by 266 pCi/L, and iodine-129 was detected for the first time since February 2003 very near the detection limit at 2.67 pCi/L in well 299-W14-15 during the last quarter of FY 2004. These changes are shown on Figure 2.8-18.

The source for the high tritium in well 299-W14-13 could be Waste Management Area TX-TY, the 242-T Evaporator, the 216-T-19 crib and tile field (which received evaporator condensate from the 242-T Evaporator), the 216-T-26 through 216-T-28 cribs, or a combination of these potential sources.

Technetium-99 exceeded the interim drinking water standard (900 pCi/L) in one well (299-W14-13) at Waste Management Area TX-TY in FY 2004. The technetium-99 concentration increased throughout the year from 7,910 pCi/L in August 2003 to 9,080 pCi/L in August 2004. This increase is part of a long-term trend. Figure 2.8-19 is a trend plot for technetium-99 in well 299-W14-13. The source for the technetium-99 in well 299-W14-13 could be Waste Management Area TX-TY or one of the past-practice disposal facilities in the area or both.

Iodine-129 was detected in two wells at Waste Management Area TX-TY during FY 2004. The highest iodine-129 concentration measured at the waste management area during the reporting periods was 24.8 pCi/L in the February 2004 sample from well 299-W14-13 (Figure 2.8-20). The interpretation of the iodine-129 data is hampered by several things. First, the preparation method for iodine-129 analyses was changed between May and August 2004. Second, relatively high non-detect values occurred periodically using the pre-May sample preparation method. Often non-detect values were as great or greater than previous or subsequent detectable values. Third, there is apparent poor precision associated with the new preparation method (16.2 and 28.6 pCi/L in the May 2004 duplicates). All of these factors make interpretation of the iodine-129 data difficult. The groundwater project is working to resolve these problems (see Appendix C).

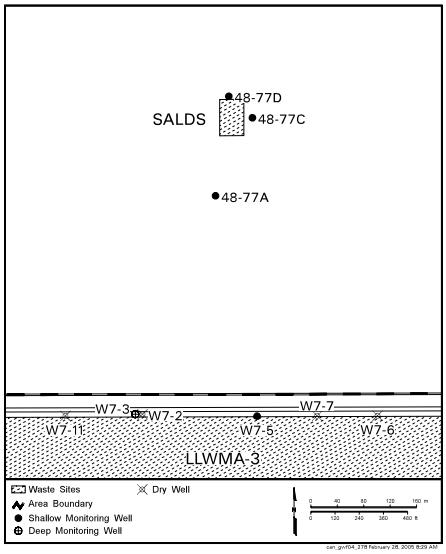
Iodine-129 was detected in a single sample from well 299-W14-15 with a concentration of 2.67 pCi/L in August 2004. This is the first detectable iodine-129 in the well since February 2003 (Figure 2.8-21).

2.8.3.5 Groundwater Monitoring for the State-Approved Land Disposal Site

The State-Approved Land Disposal Site is used for disposal of treated water that occasionally contains tritium.

The Hanford Site 200 Area Effluent Treatment Facility processes contaminated aqueous waste from Hanford Site facilities. The treated wastewater occasionally contains tritium, which is not removed by the Effluent Treatment Facility, and is discharged to the 200 Area State-Approved Land Disposal Site. During FY 2004 (through July 31) 70.3 million liters of water were discharged to the State-Approved Land Disposal Site as documented in the annual report for the site (WMP-22329).

A state waste discharge permit (WAC 173-216) requires groundwater monitoring at this site. The permit was granted in June 1995, and the site began to operate in December 1995. Groundwater monitoring requirements are described in the site monitoring plan (PNNL-13121). Groundwater monitoring for tritium only is conducted in 19 wells near the facility (Appendix B). The permit stipulates requirements for groundwater monitoring and establishes enforcement limits for concentrations of 15 constituents in 3 additional wells immediately surrounding the facility (Appendix B, Table B.44).



Wells immediately surrounding the facility were sampled in October 2003, and January, April, and September 2004 (see Appendix B). Tritium-tracking wells were sampled in January, March, April, and September 2004, although some of these events were scheduled for the 200-ZP-1 Operable Unit monitoring. Water-level measurements in three wells nearest the State-Approved Land Disposal Site indicate the continuation of a small hydraulic mound beneath the site as a result of discharges. This feature is directing groundwater flow radially outward a short distance before the regional northeastward flow predominates. This condition also places several wells south of the State-Approved Land Disposal Site hydraulically downgradient of the facility.

Many of the wells south of the State-Approved Land Disposal Site in the tritium-tracking network have gone dry. Specifically, wells 299-W7-1, 299-W7-6, 299-W7-7, 299-W7-9, and 299-W6-7 have gone dry in the past few years.

Average tritium concentrations decreased in all three State-Approved Land Disposal Site proximal wells during FY 2004 compared with FY 2003 (Figure 2.8-22; see also Figure 2.8-9 for tritium distribution contours). During FY 2004, maximum tritium concentrations for State-Approved Land Disposal Site proximal wells were 116,000 pCi/L in well 699-48-77A (April 2004), 229,000 pCi/L in well 699-48-77C (October 2003), and 95,000 pCi/L in well 699-48-77D (April 2004). Fluctuations in tritium concentrations in well 699-48-77A probably reflect changes in the amount of tritium in the discharge.

Concentrations of all chemical constituents with permit limits were within those limits during all of FY 2004. Benzene, tetrahydrofuran, copper, and mercury were below method detection limits in all samples. Lead and cadmium produced detectable concentrations of 2.3 and 0.085 µg/L, respectively, from the April 2004 sample of well 699-48-77A. Concentrations of major cations and anions continued below background concentrations observed prior to operation of the facility. This condition is due to dilution by the clean water discharged to the State-Approved Land Disposal Site.

Average tritium concentrations decreased in all three proximal wells at the State-Approved Land Disposal Site during FY 2004.

Hydraulic head in March 2004 (Figure 2.8-2) changed very little from that of March 2003 in the vicinity of the State-Approved Land Disposal Site. Head in well 699-48-77A for March 2004 was ~0.24 meter higher than for the same period in 2003, but this well responds rapidly to changes in discharge from the facility, and the overall trend for head remains downward.

Numerical flow-and-transport modeling of the State-Approved Land Disposal Site was conducted in August 2004, as required by the permit. Results of this model are summarized in Chapter 4.0.

Table 2.8-1. Contaminants of Concern in all Wells in the 200-ZP-1 Groundwater Interest Area

Constituent	Filtered	Wells	Results	Detects	Rejects	Minimum	Maximum	Average	Action Level	Action Level Source	Results Above Standard	Wells Above Standard
1,1,1-Trichloroethane, µg/L	N	46	109	8	0	0.19	1.2	0.44	200	MCL		
1,2-Dichloroethane, µg/L	N	46	109	5	0	0.089	0.22	0.14	5	CRDL		
2-Butanone, µg/L	N	46	130	1	0	1.4	1.4	1.40	4,800	CLARC		
4-Methyl-2-pentanone, µg/L	N	46	109	3	0	0.35	0.93	0.54	640	CLARC		
Acetone, µg/L	N	46	130	37	0	0.67	8.2	1.75	800	CLARC		
Antimony, µg/L	N	7	22	0	0	--	--	--	10	CRDL		
Antimony, µg/L	Y	31	166	3	1	40.9	46.2	43.77	10	CRDL	3	3
Arsenic, µg/L	Y	9	14	3	0	1.8	10	6.63	10	CRDL		
Benzene, µg/L	N	46	124	0	0	--	--	--	5	CRDL		
Cadmium, µg/L	N	7	28	1	0	0.085	0.085	0.09	5	MCL		
Cadmium, µg/L	Y	31	166	2	1	2.1	2.5	2.30	5	MCL		
Carbon disulfide, µg/L	N	46	109	8	0	0.24	2	0.78	800	CLARC		
Carbon tetrachloride, µg/L	N	46	200	180	7	0.19	9,700	2,001	3	CRDL	116	46
Carbon tetrachloride, µg/L	Y	2	11	0	0	--	--	--	3	CRDL		
Carbon-14, pCi/L	N	5	6	3	0	5.34	8.66	6.75	2,000	MCL		
Cesium-137, pCi/L	N	9	28	0	0	--	--	--	60	MCL		
Chlorobenzene, µg/L	N	6	19	0	0	--	--	--	100	MCL		
Chloroform, µg/L	N	46	200	175	0	0.075	82.3	15.47	7	CLARC	85	30
Chloroform, µg/L	Y	2	11	0	0	--	--	--	7	CLARC		
Chromium, µg/L	N	7	22	19	0	7.4	76.8	25.78	100	MCL		
Chromium, µg/L	Y	31	166	124	1	3.5	733	82.67	100	MCL	23	6
cis-1,2-Dichloroethene, µg/L	N	46	109	6	0	0.07	0.12	0.11	70	MCL		
Cyanide, µg/L	N	6	11	2	0	6	12.3	9.15	200	MCL		
Ethylbenzene, µg/L	N	46	107	1	0	0.2	0.2	0.20	700	MCL		
Fluoride, µg/L	N	47	208	208	0	170	4,600	864	4,000	MCL	2	2
Fluoride, µg/L	Y	1	3	3	1	260	1,300	920	4,000	MCL		
Hexavalent chromium, µg/L	N	3	3	3	0	3	8	6.00	48	CLARC		

Table 2.8-1. (contd)

Constituent	Filtered	Wells	Results	Detects	Rejects	Minimum	Maximum	Average	Action Level	Action Level Source	Results Above Standard	Wells Above Standard
Hexavalent chromium, µg/L	Y	8	9	8	0	4.4	75.9	22.04	48	CLARC	1	1
Iodine-129, pCi/L	N	27	78	8	2	0.765	26.8	12.61	1	MCL	5	3
Iron, µg/L	N	7	22	19	0	71.3	509	183	300	2nd MCL	3	3
Iron, µg/L	Y	31	166	63	1	11	228	53.95	300	2nd MCL		
Lead, µg/L	N	1	13	1	0	2.3	2.3	2.30	15	MCL		
Lead, µg/L	Y	13	29	0	0	--	--	--	15	MCL		
Lithium, µg/L	Y	5	6	2	0	9.7	12.7	11.20	--	TBD		
Magnesium, µg/L	N	7	22	22	0	4,110	19,800	11,164	--	TBD		
Magnesium, µg/L	Y	31	166	166	1	4,260	136,000	21,967	--	TBD		
Manganese, µg/L	N	7	22	19	0	0.97	10.1	3.64	50	2nd MCL		
Manganese, µg/L	Y	31	166	142	1	1	239	10.49	50	2nd MCL	4	1
Mercury, µg/L	N	1	13	0	0	--	--	--	2	MCL		
Mercury, µg/L	Y	13	29	0	0	--	--	--	2	MCL		
Methylene chloride, µg/L	N	46	130	27	0	0.31	5	1.37	5	MCL		
n-Butylbenzene, µg/L	N	6	7	0	0	--	--	--	320	CLARC		
Neptunium-237, pCi/L	N	5	6	0	0	--	--	--	15	MCL		
Nickel, µg/L	N	7	22	8	0	14.8	32.3	18.79	320	CLARC		
Nickel, µg/L	Y	31	166	17	1	10.1	63	23.09	320	CLARC		
Nitrate, µg/L	N	47	229	229	0	257	3,430,000	219,060	12,400	Background	193	69
Nitrate, µg/L	Y	1	3	3	1	4,870	96,900	64,023	12,400	Background	1	1
Nitrite, µg/L	N	47	208	8	1	32.8	1,250	310	3,268	MCL		
Nitrite, µg/L	Y	1	3	0	1	--	--	--	3,268	MCL		
Phenols (total):				0	0	--	--	--		TBD		
2,3,4,6-Tetrachlorophenol, µg/L	N	7	12	2	0	7.6	7.9	7.75				
2,4,5-Trichlorophenol, µg/L	N	7	12	0	0	--	--	--				
2,4,6-Trichlorophenol, µg/L	N	7	12	0	0	--	--	--				
2,4-Dichlorophenol, µg/L	N	12	18	0	0	--	--	--				

Table 2.8-1. (contd)

Constituent	Filtered	Wells	Results	Detects	Rejects	Minimum	Maximum	Average	Action Level	Action Level Source	Results Above Standard	Wells Above Standard
2,4-Dimethylphenol, µg/L	N	7	12	0	0	0	0	0				
2,4-Dinitrophenol, µg/L	N	7	12	0	0	0	0	0				
2,6-Dichlorophenol, µg/L	N	7	12	0	0	0	0	0				
2-Chlorophenol, µg/L	N	7	12	0	0	0	0	0				
2-Methylphenol (cresol, o-), µg/L	N	12	18	0	0	0	0	0				
2-Nitrophenol, µg/L	N	12	18	0	0	0	0	0				
2-secButyl-4,6-dinitrophenol (Dinoseb), µg/L	N	7	12	0	0	0	0	0				
3+4 Methylphenol (cresol, m+p), µg/L	N	12	18	0	0	0	0	0				
4,6-Dinitro-2-methylphenol, µg/L	N	7	12	0	0	0	0	0				
4-Chloro-3-methylphenol, µg/L	N	7	12	0	0	0	0	0				
4-Methylphenol (cresol, p-), µg/L	N	5	6	0	0	0	0	0				
4-Nitrophenol, µg/L	N	7	12	0	0	0	0	0				
Pentachlorophenol, µg/L	N	12	18	0	0	0	0	0				
Phenol, µg/L	N	12	23	0	0	0	0	0				
Protactinium-231, pCi/L	N	5	6	0	0	0	0	0	15	MCL		
Selenium-79, pCi/L	N	5	6	0	0	0	0	0		MCL		
Silver, µg/L	N	7	22	0	0	0	0	0	80	CLARC		
Silver, µg/L	Y	31	166	11	1	1.9	85	10.86	80	CLARC	1	1
Strontium-90, pCi/L	N	5	21		0	0	0	0	8	MCL		
Technetium-99, pCi/L	N	38	180	161	0	10.8	21,400	1,160	900	MCL	27	7
Technetium-99, pCi/L	Y	1	3	2	1	250	299	274	900	MCL		
Tetrachloroethene, µg/L	N	46	131	66	0	0.17	3	0.93	5	CRDL		
Tetrachloroethene, µg/L	Y	2	11	0	0	0	0	0	5	CRDL		
Toluene, µg/L	N	46	124	0	0	0	0	0	1000	MCL		
trans-1,2-Dichloroethene, µg/L	N	46	109	0	0	0	0	0	100	MCL		

Table 2.8-1. (contd)

Constituent	Filtered	Wells	Results	Detects	Rejects	Minimum	Maximum	Average	Action Level	Action Level Source	Results Above Standard	Wells Above Standard
Trichloroethene, µg/L	N	46	200	153	1	0.21	26	6.04	5	CRDL	49	18
Trichloroethene, µg/L	Y	2	11	0	0	0	0	0	5	CRDL		
Tritium, pCi/L	N	35	191	156	0	219	1,830,000	71,392	20000	MCL	28	9
Tritium, pCi/L	Y		2	0	0	0	0	0	20000	MCL		
Uranium, µg/L	N	20	46	46	0	0.0877	250	13.45	30	MCL	4	2
Vanadium, µg/L	N	7	22	22	0	16.4	63.8	37.30	112	CLARC		
Vanadium, µg/L	Y	31	166	165	1	5.9	77.7	30.57	112	CLARC		
Xylenes (total), µg/L	N	46	109	0	0	0	0	0	10000	MCL		

CLARC = Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation (Ecology 2001).
CRDL = Contract-required detection limit.
MCL = Maximum contaminant level.
TBD = To be determined.

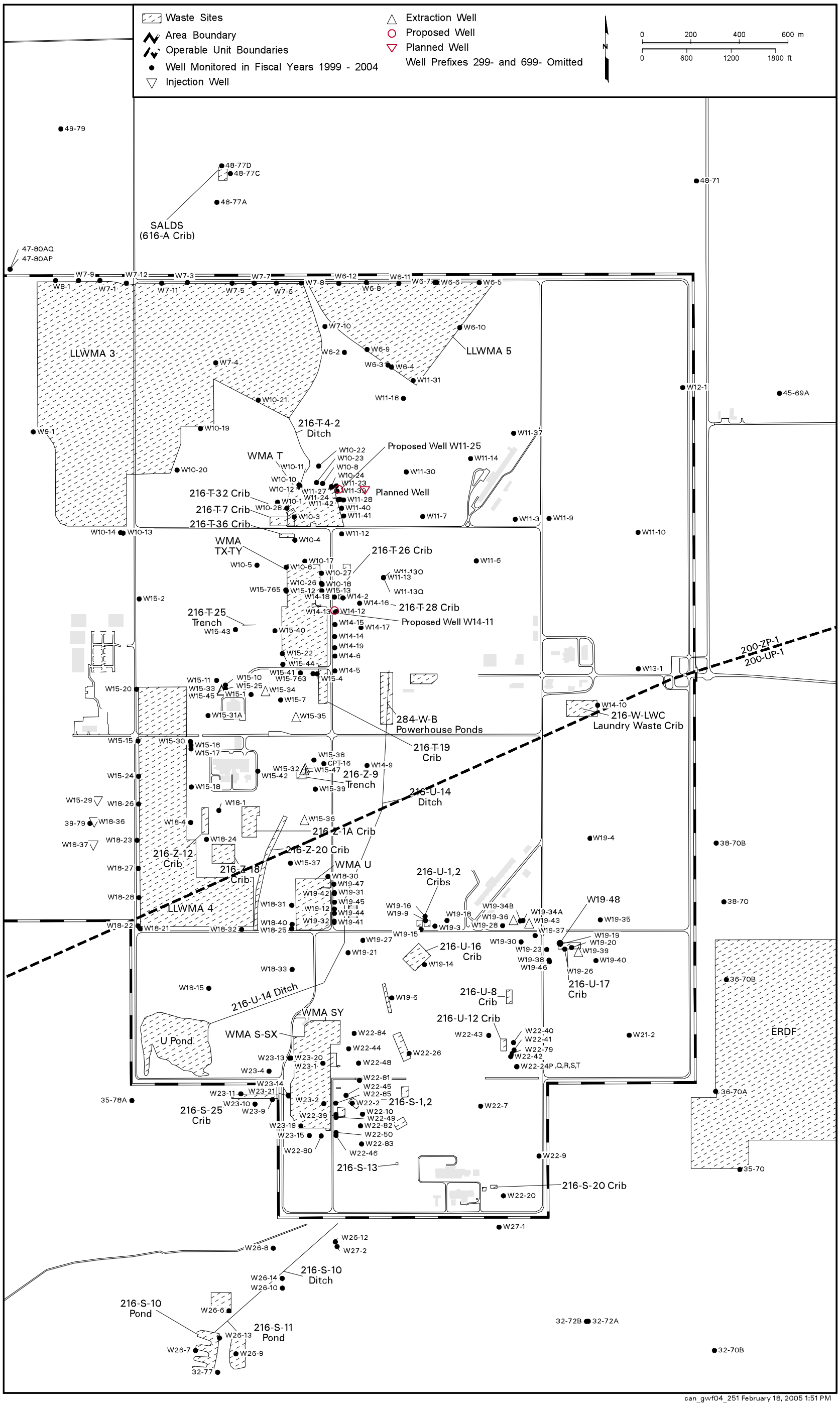


Figure 2.8-1. Groundwater Monitoring Wells in the 200 West Area

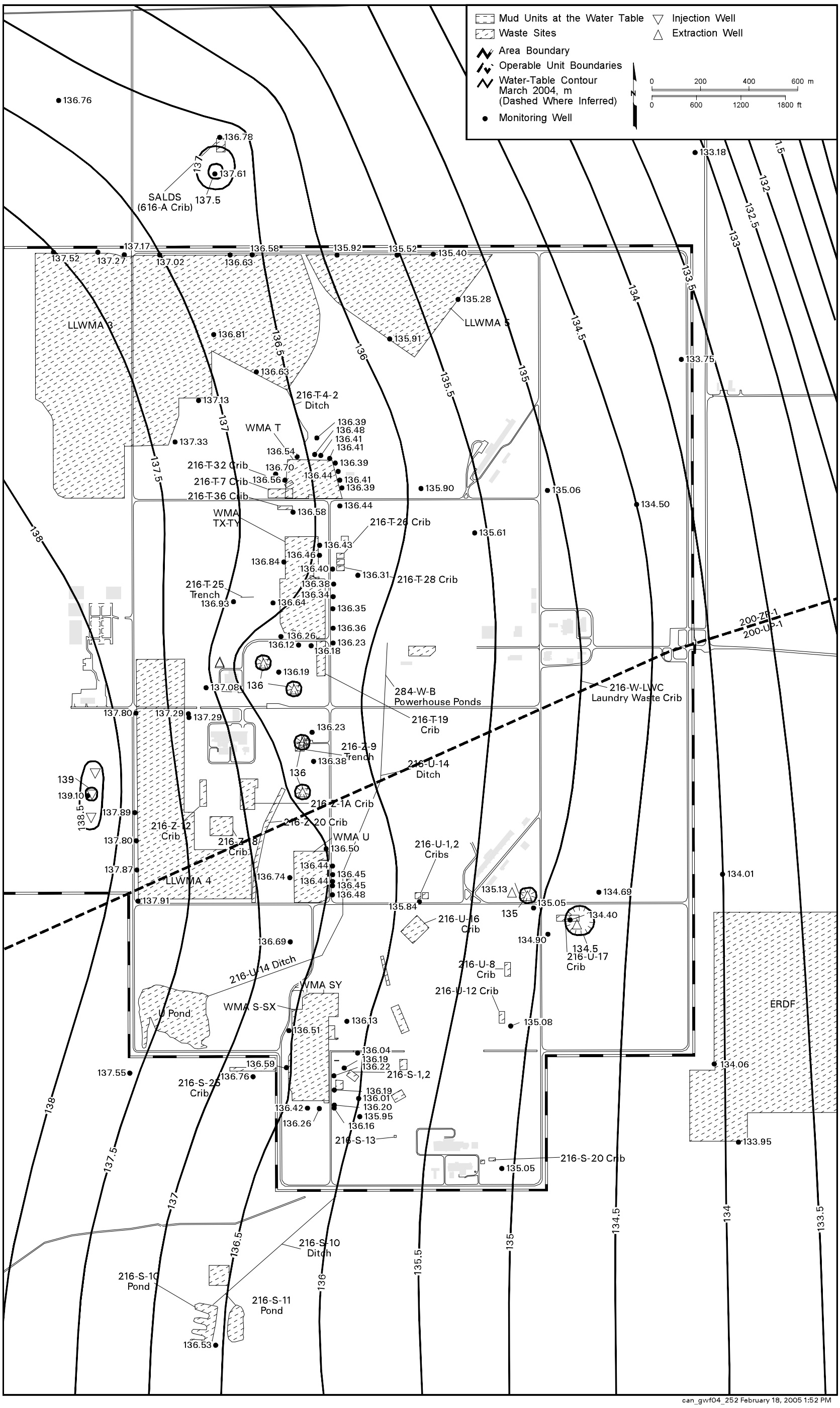


Figure 2.8-2. Water-Table Contours in the 200 West Area

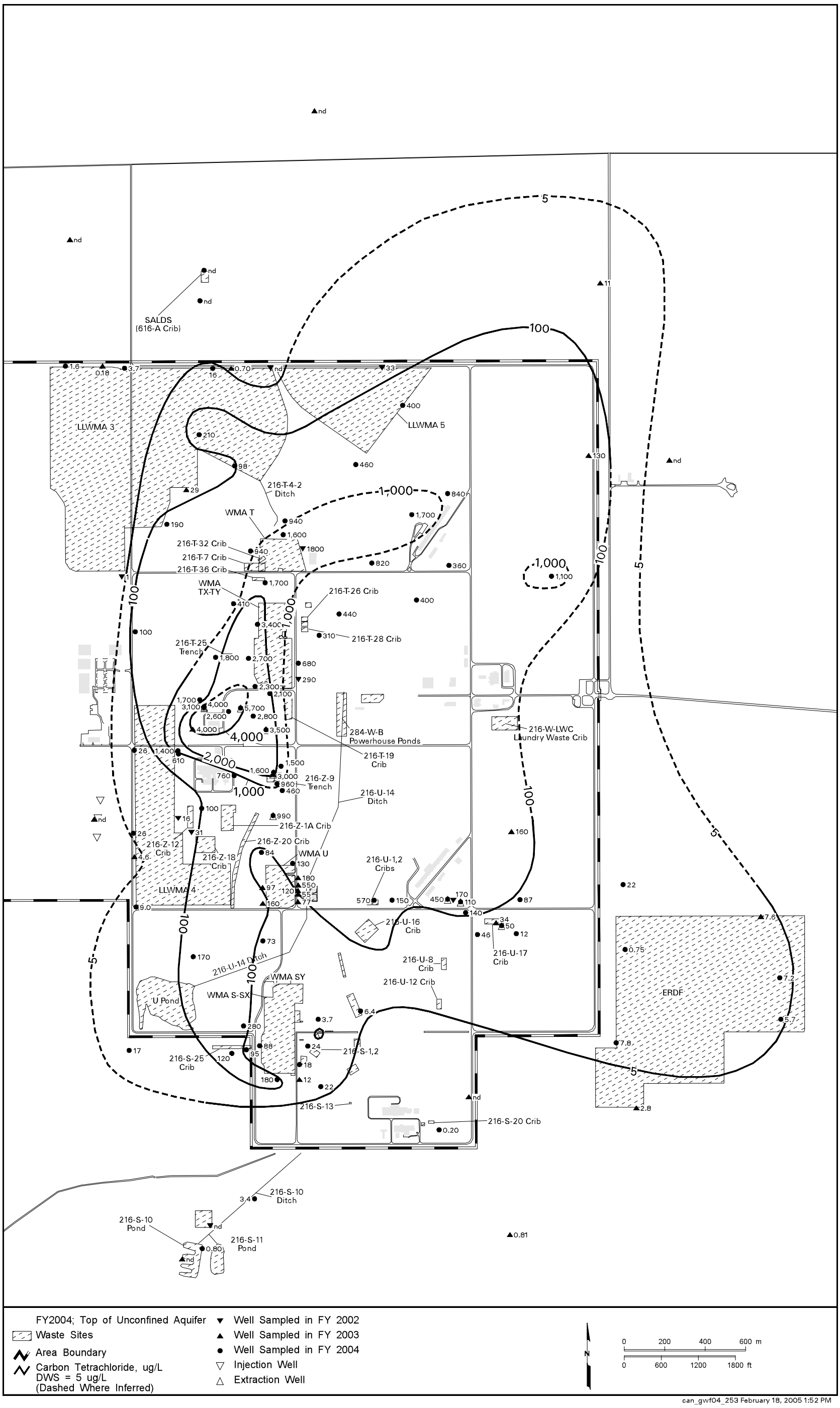


Figure 2.8-3. Average Carbon Tetrachloride Concentrations in 200 West Area, Top of Unconfined Aquifer

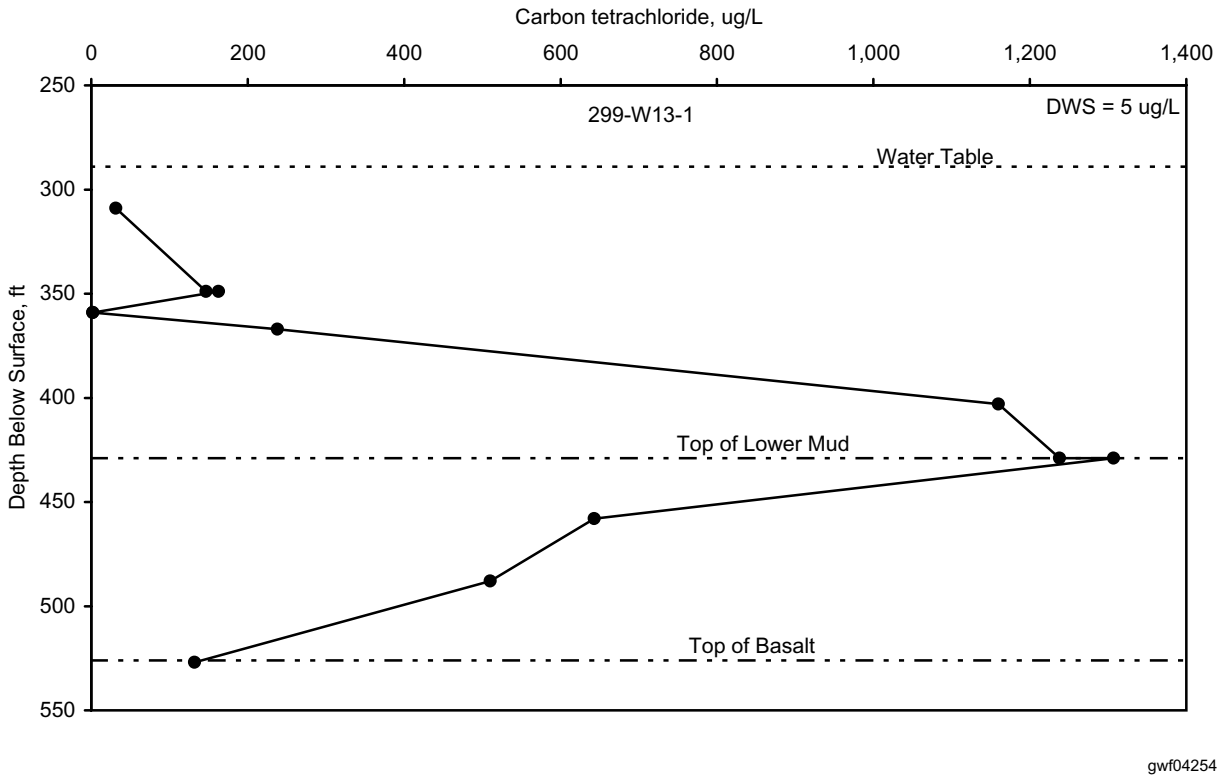


Figure 2.8-4. Carbon Tetrachloride Concentration with Depth during Drilling of Well 299-W13-1

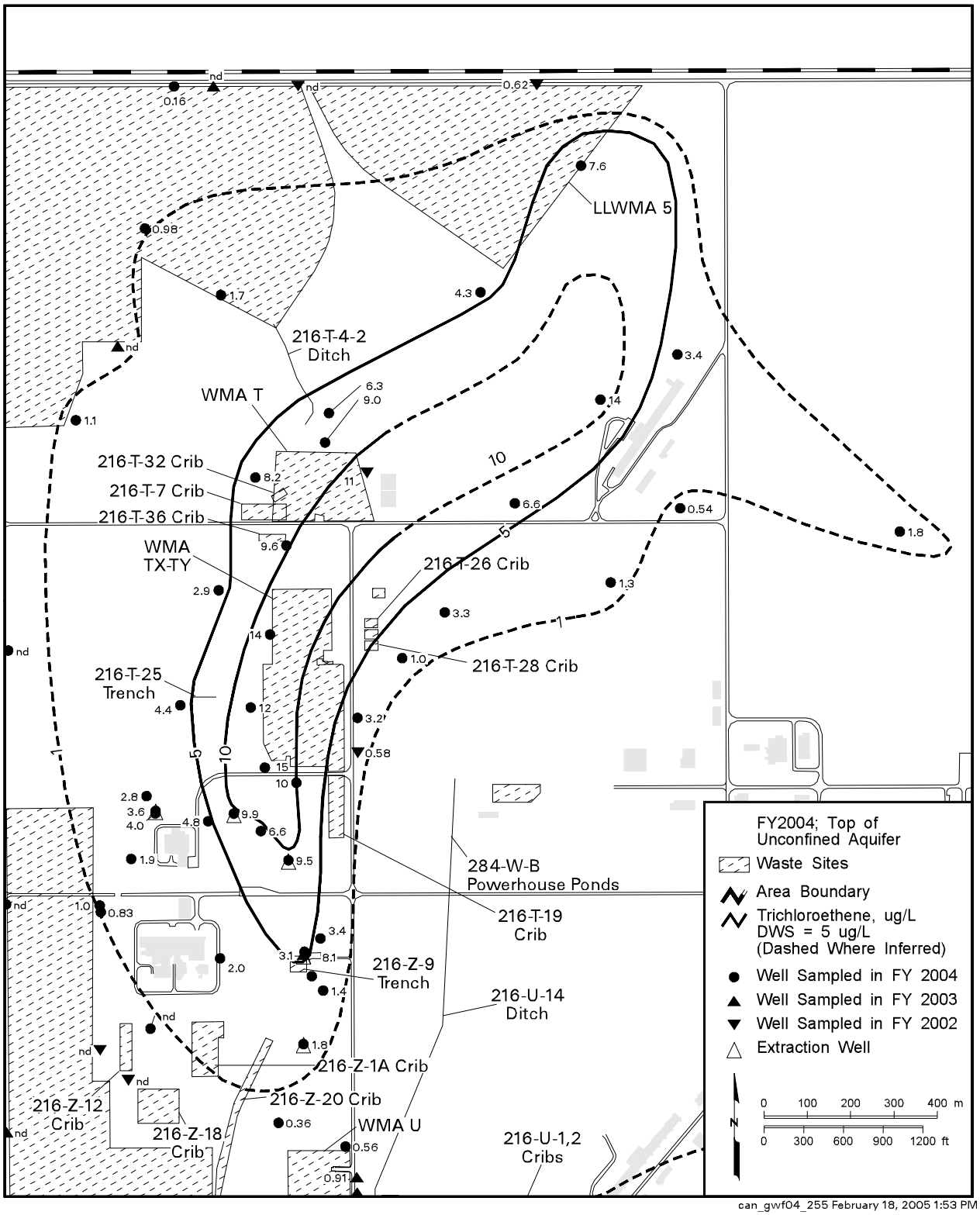


Figure 2.8-5. Average Trichloroethene Concentrations in Central and North 200 West Area, Top of Unconfined Aquifer

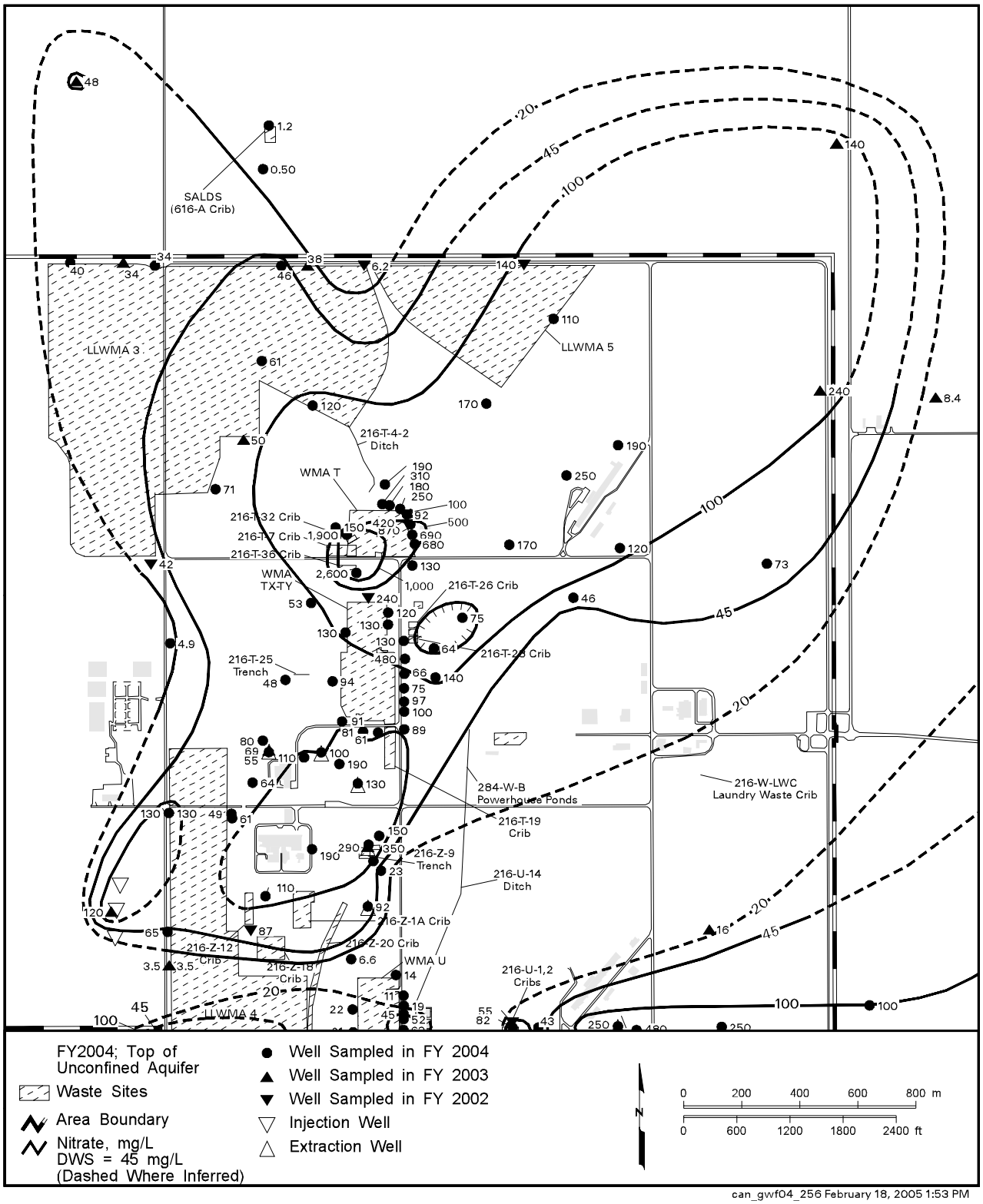


Figure 2.8-6. Average Nitrate Concentrations in Central and North 200 West Area, Top of Unconfined Aquifer

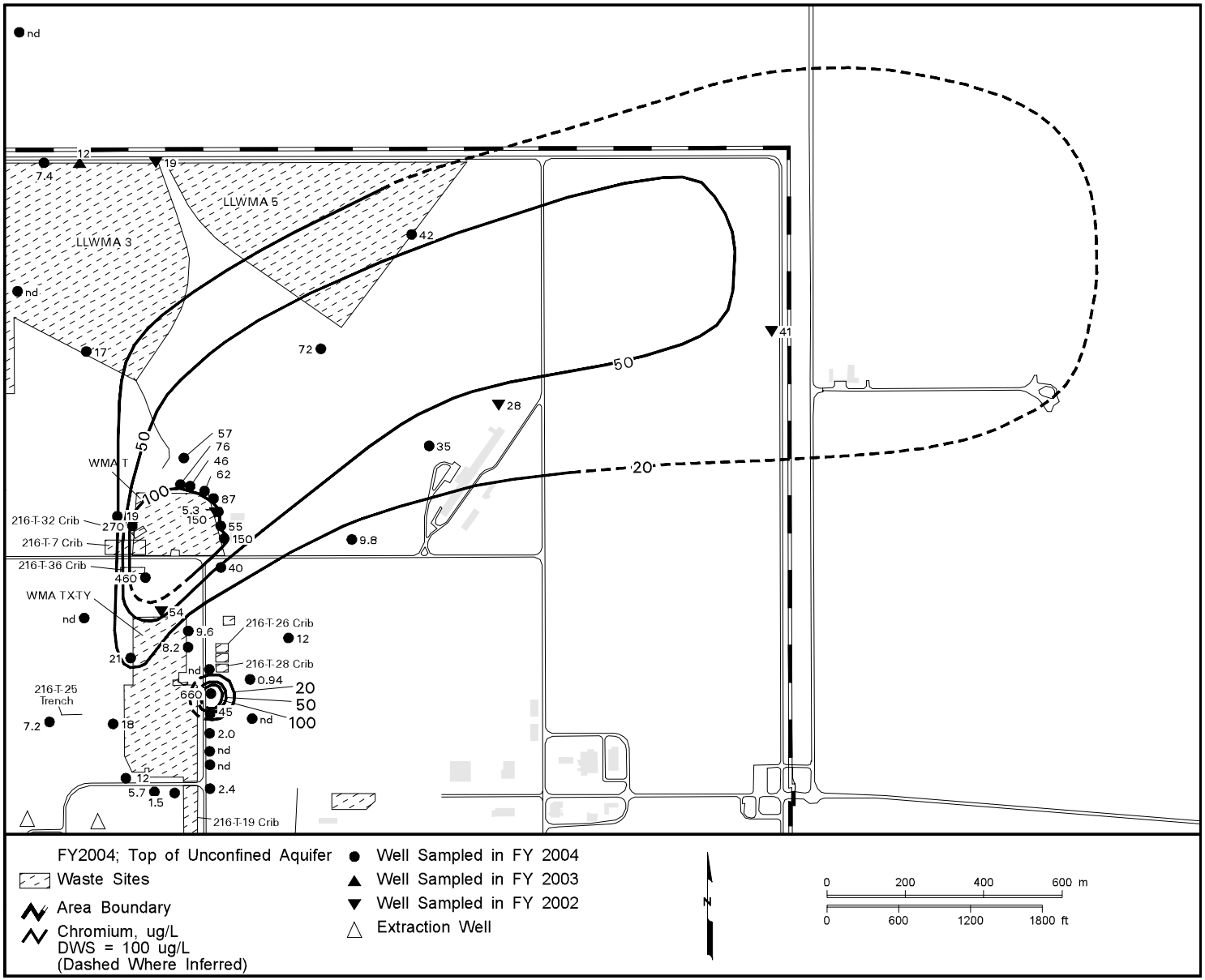


Figure 2.8-7. Average Dissolved Chromium Concentrations Near Waste Management Areas T and TX-TY, Top of Unconfined Aquifer

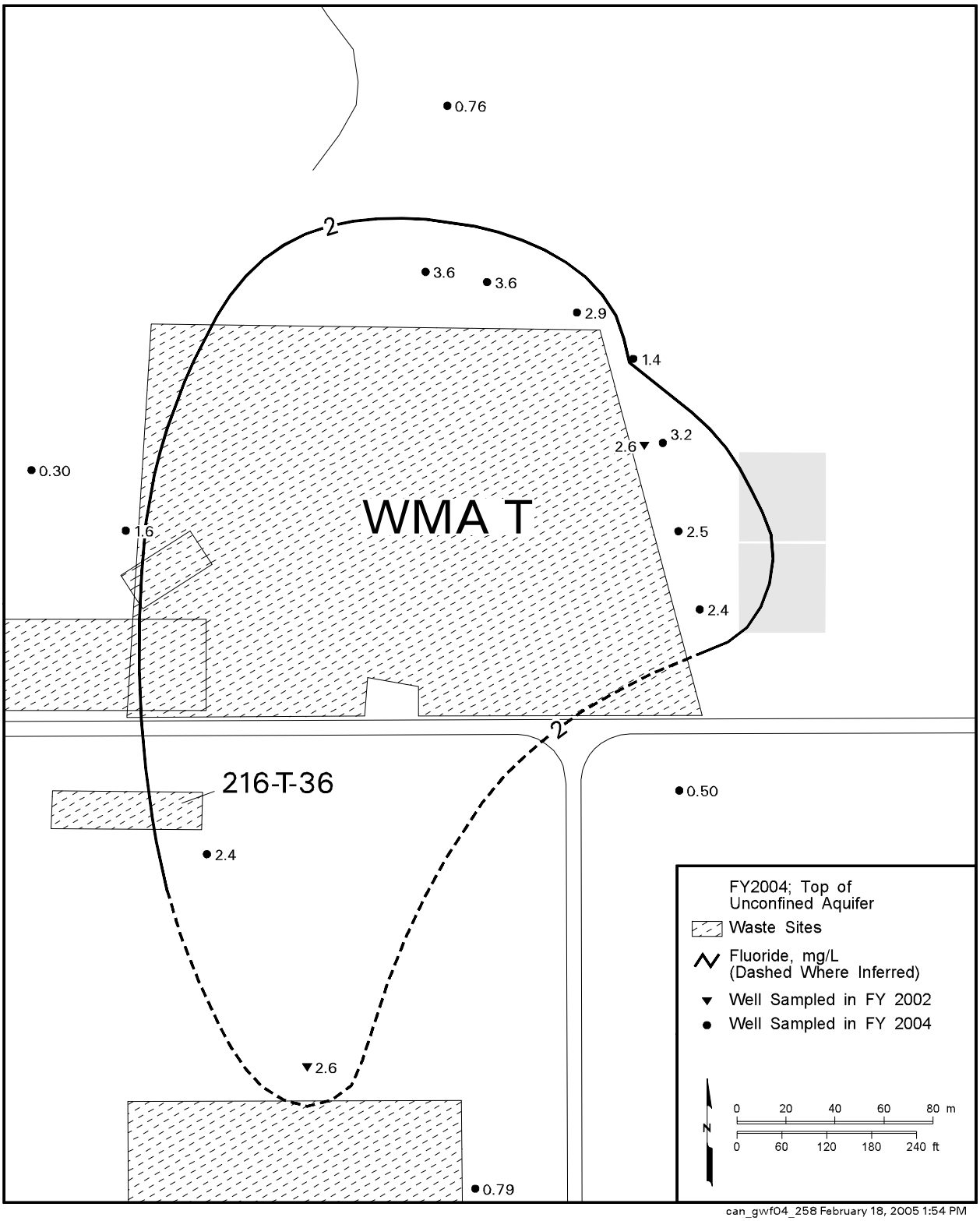


Figure 2.8-8. Average Fluoride Concentrations Near Waste Management Area T in North 200 West Area, Top of the Unconfined Aquifer

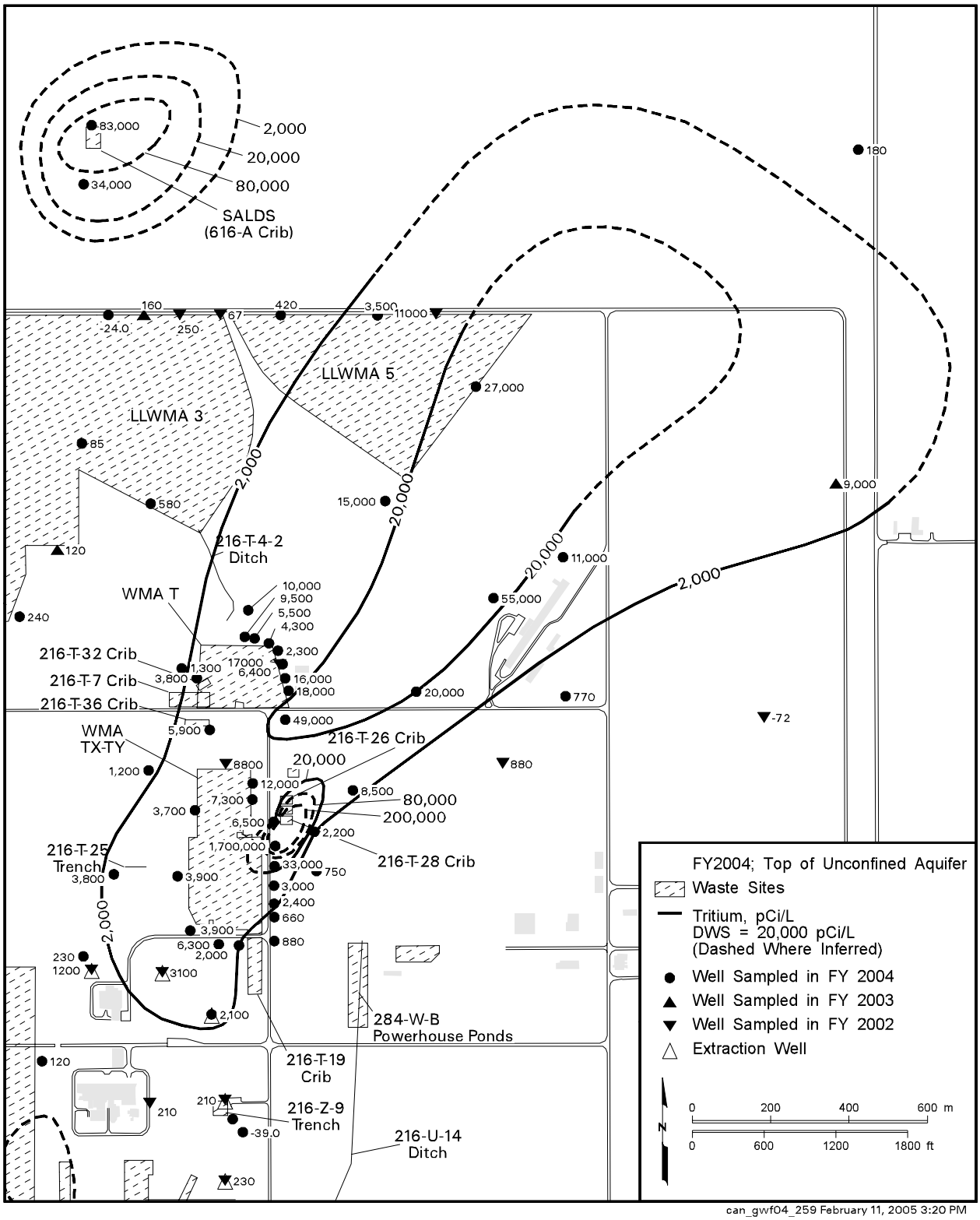


Figure 2.8-9. Average Tritium Concentrations in North 200 West Area, Top of Unconfined Aquifer

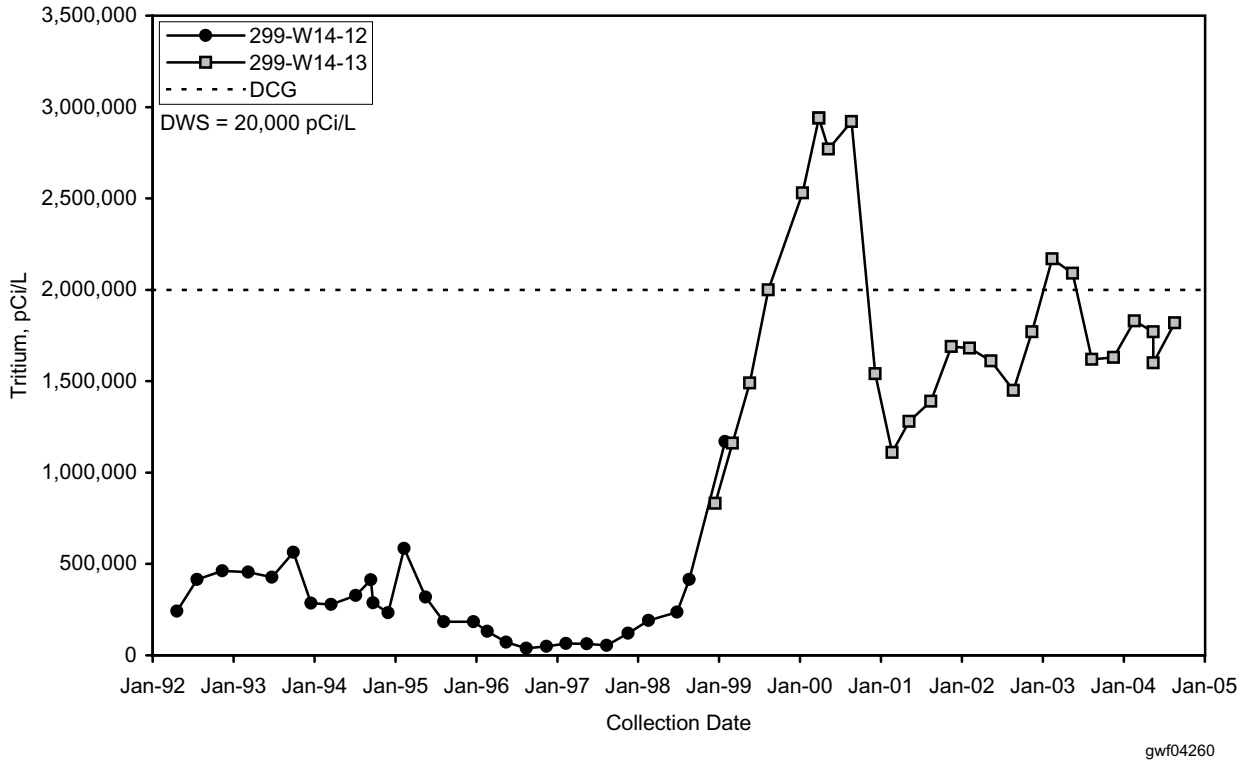


Figure 2.8-10. Tritium Concentrations versus Time in Wells 299-W14-12 and 299-W14-13 at Waste Management Area TX-TY

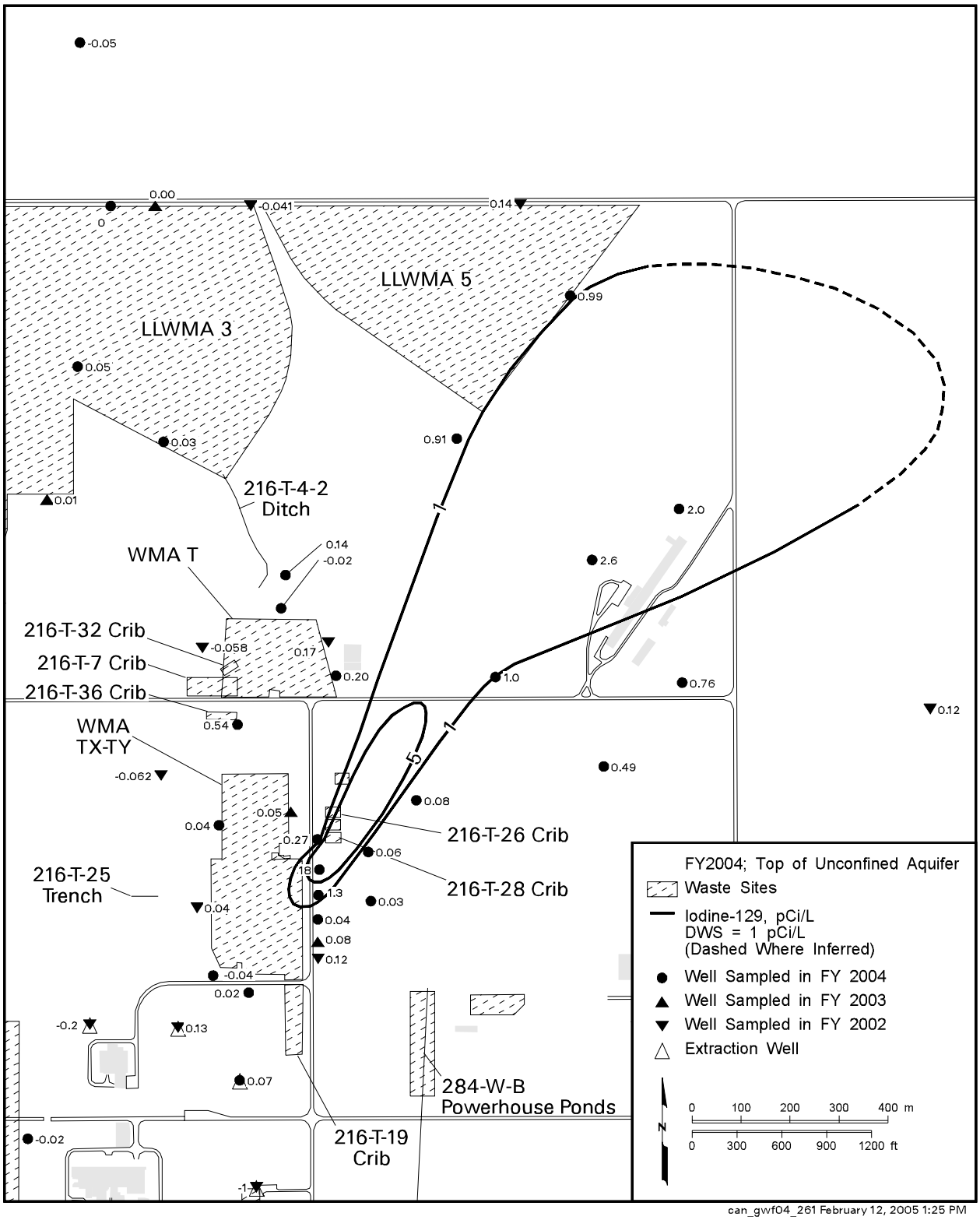


Figure 2.8-11. Average Iodine-129 Concentrations in North 200 West Area, Top of Unconfined Aquifer

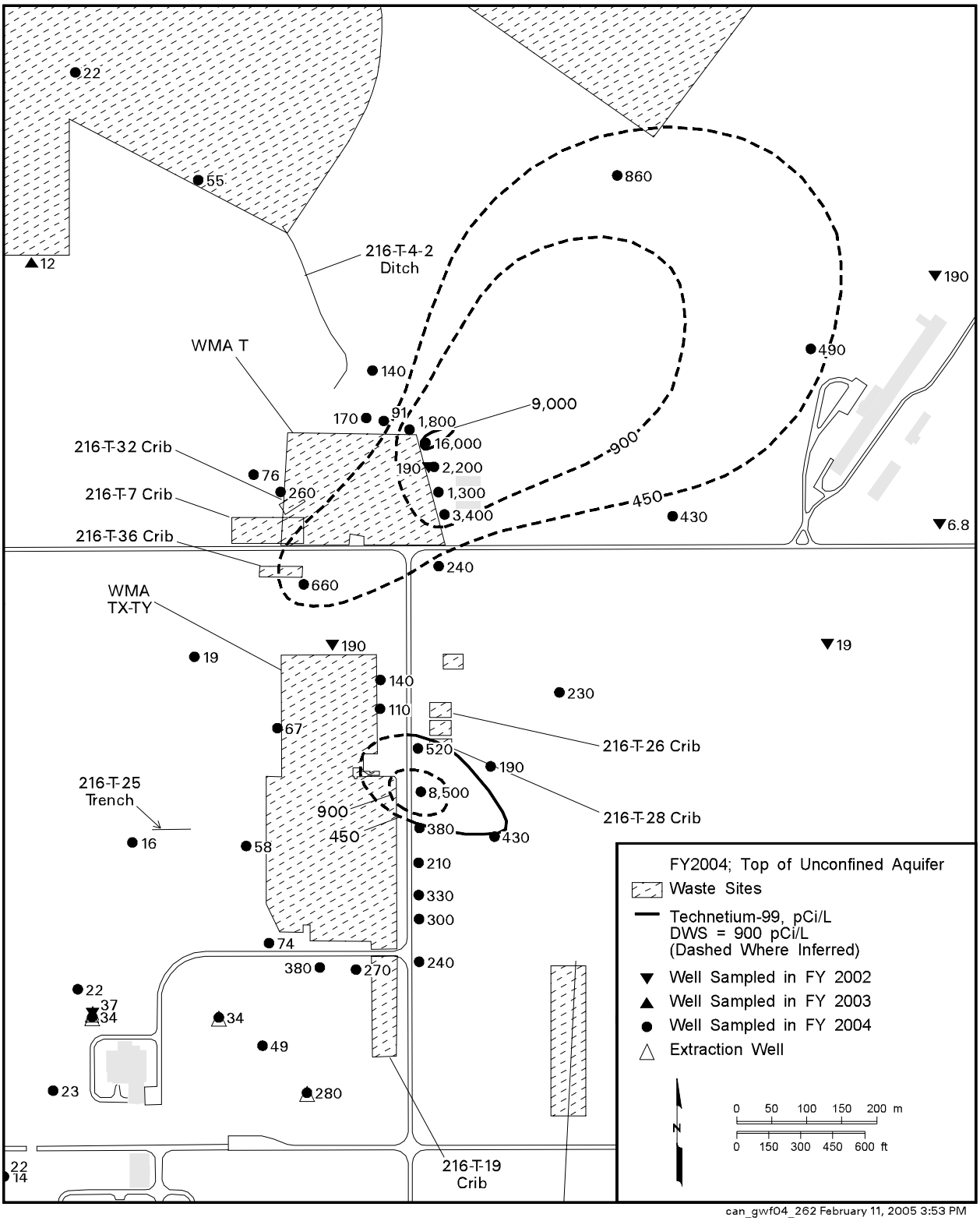


Figure 2.8-12. Average Technetium-99 Concentrations in North 200 West Area, Top of Unconfined Aquifer

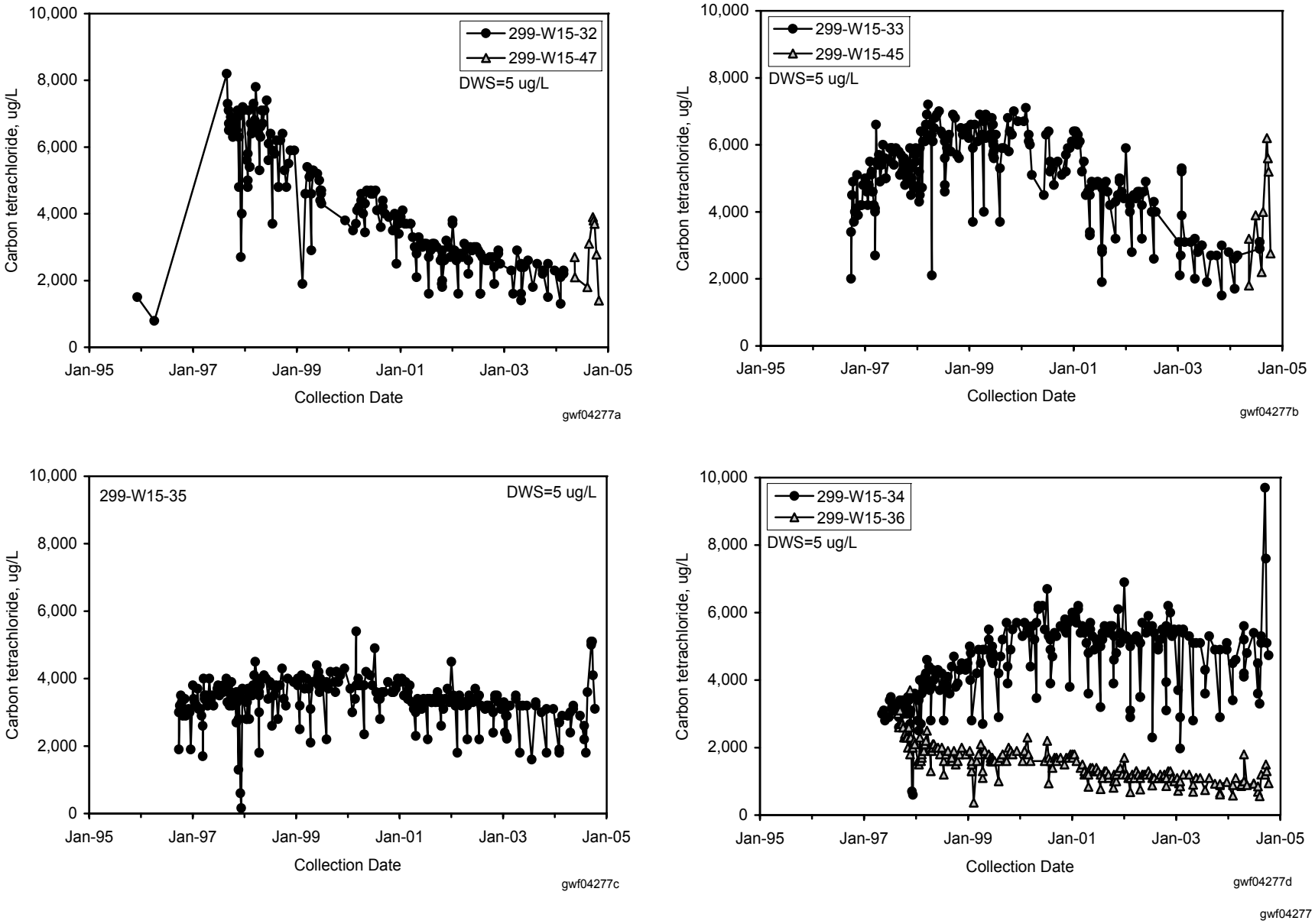


Figure 2.8-13. Carbon Tetrachloride Trends in Extraction Wells at the 200-ZP-1 Operable Unit

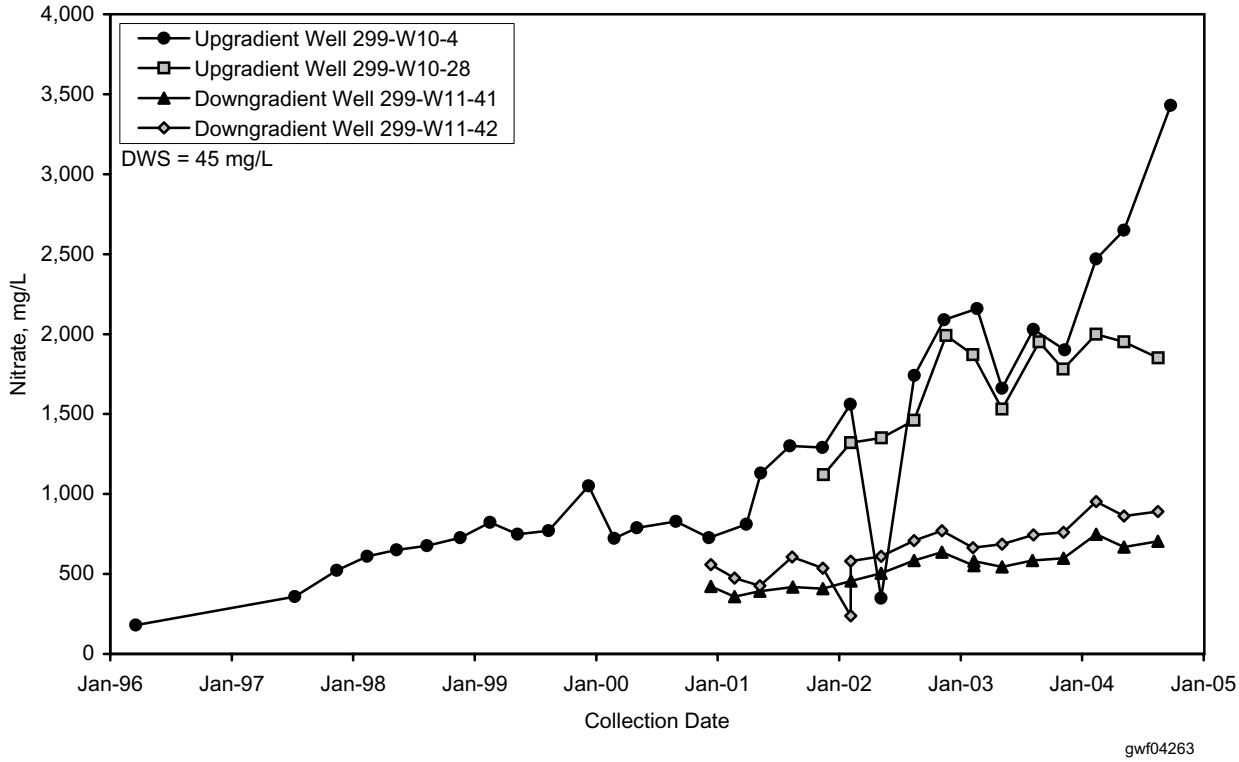


Figure 2.8-14. Nitrate Concentrations in Selected Wells at Waste Management Area T

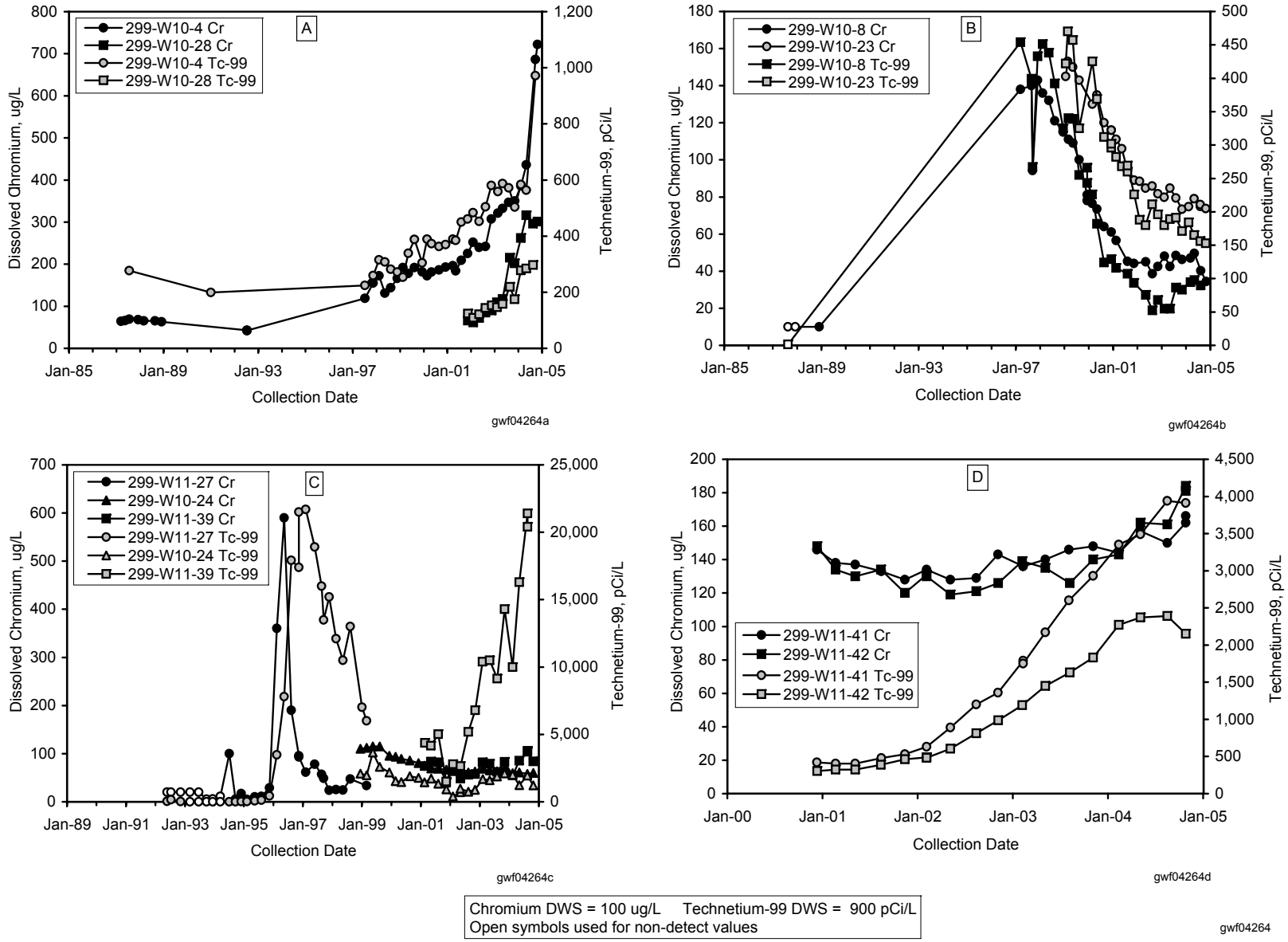


Figure 2.8-15. Chromium and Technetium-99 Concentrations in Selected Wells at Waste Management Area T (a) western (upgradient wells), (b) northern wells, (c) northeastern wells (downgradient), (d) eastern (downgradient) wells

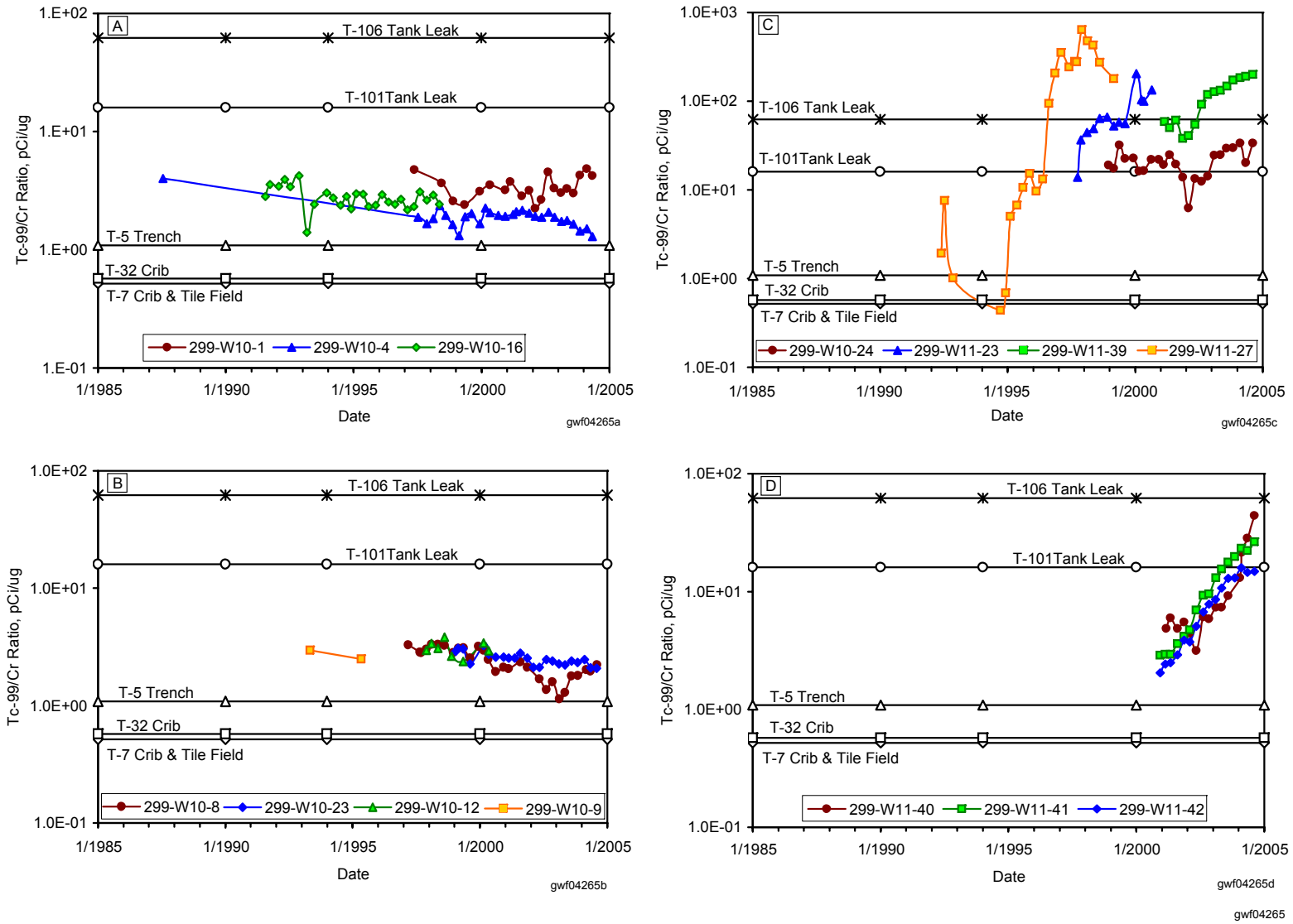


Figure 2.8-16. Technetium-99/Chromium Concentration Ratios in Samples from Selected Wells at Waste Management Area T (a) western (upgradient) wells, (b) northeastern wells (downgradient), (c) northern wells, and (d) eastern (downgradient) wells (modified from PNNL-14849)

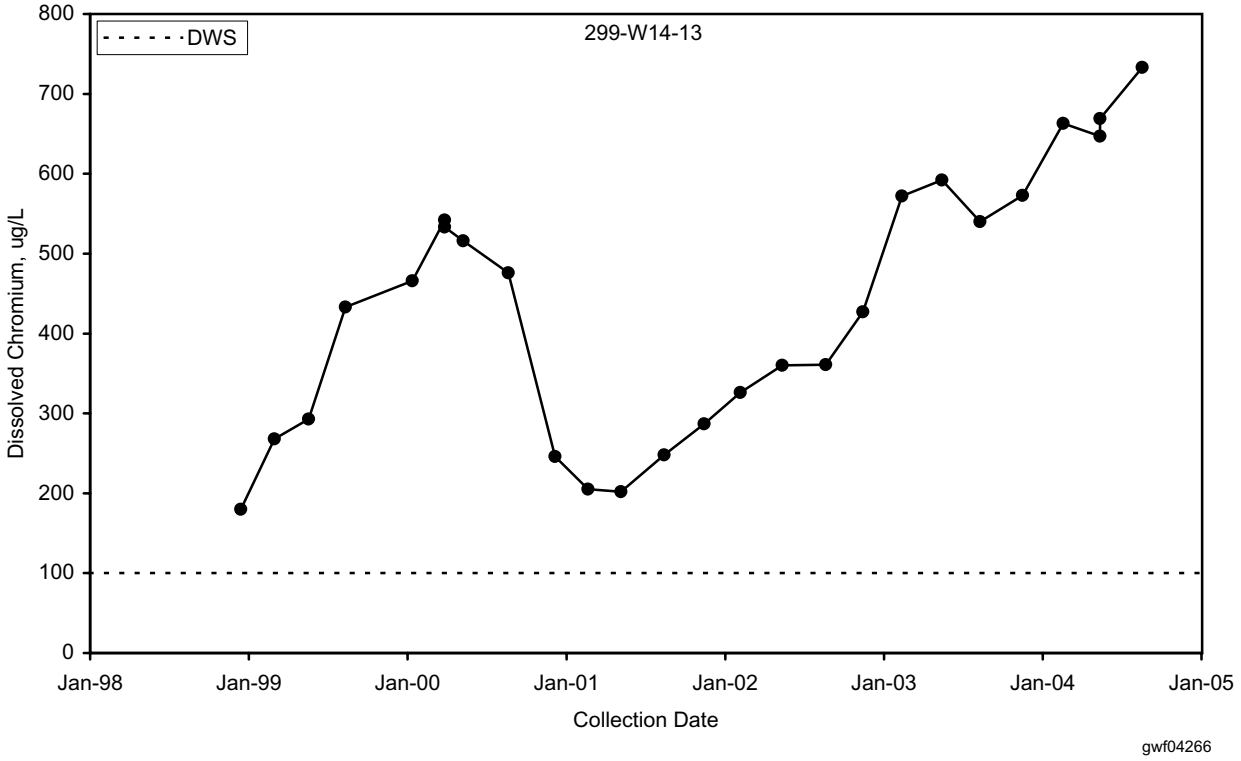


Figure 2.8-17. Chromium Concentrations in Well 299-W14-13, East of Waste Management Area TX-TY

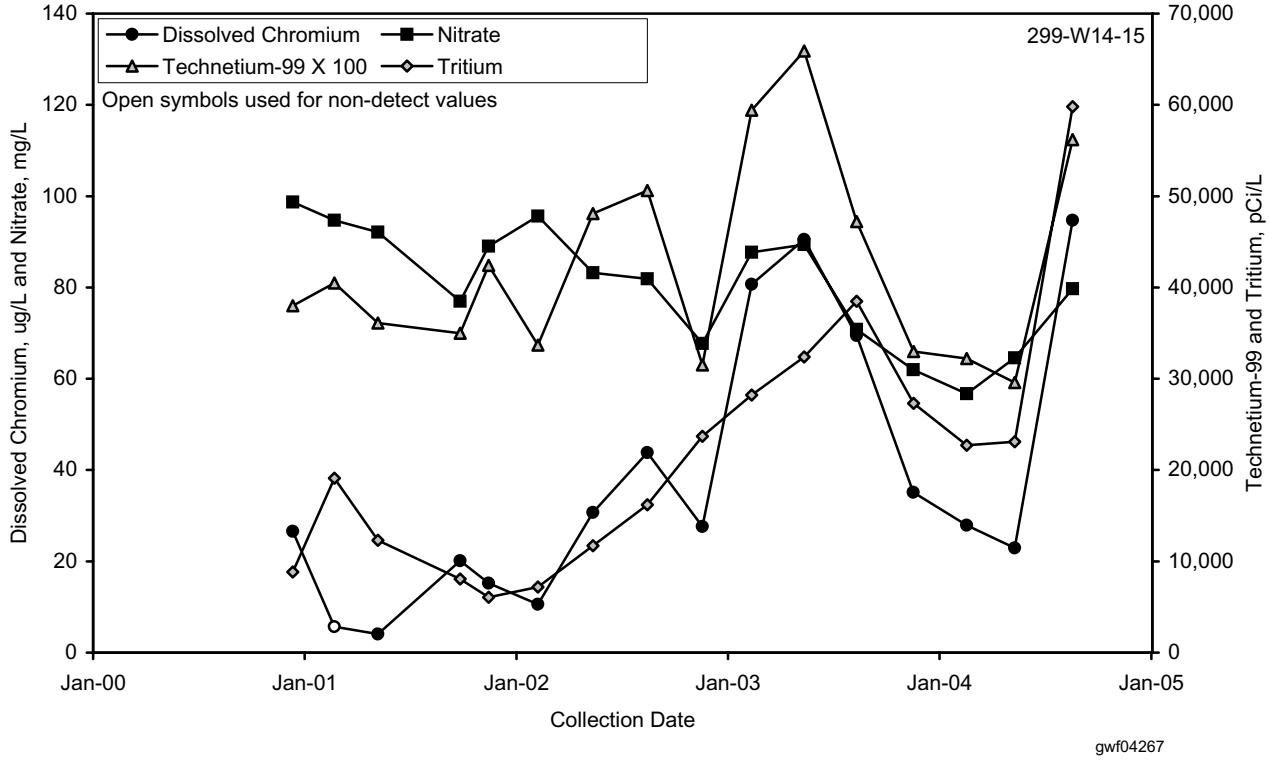


Figure 2.8-18. Concentrations of Chromium, Nitrate, Tritium, and Technetium-99 in Well 299-W14-15 at Waste Management Area TX-TY

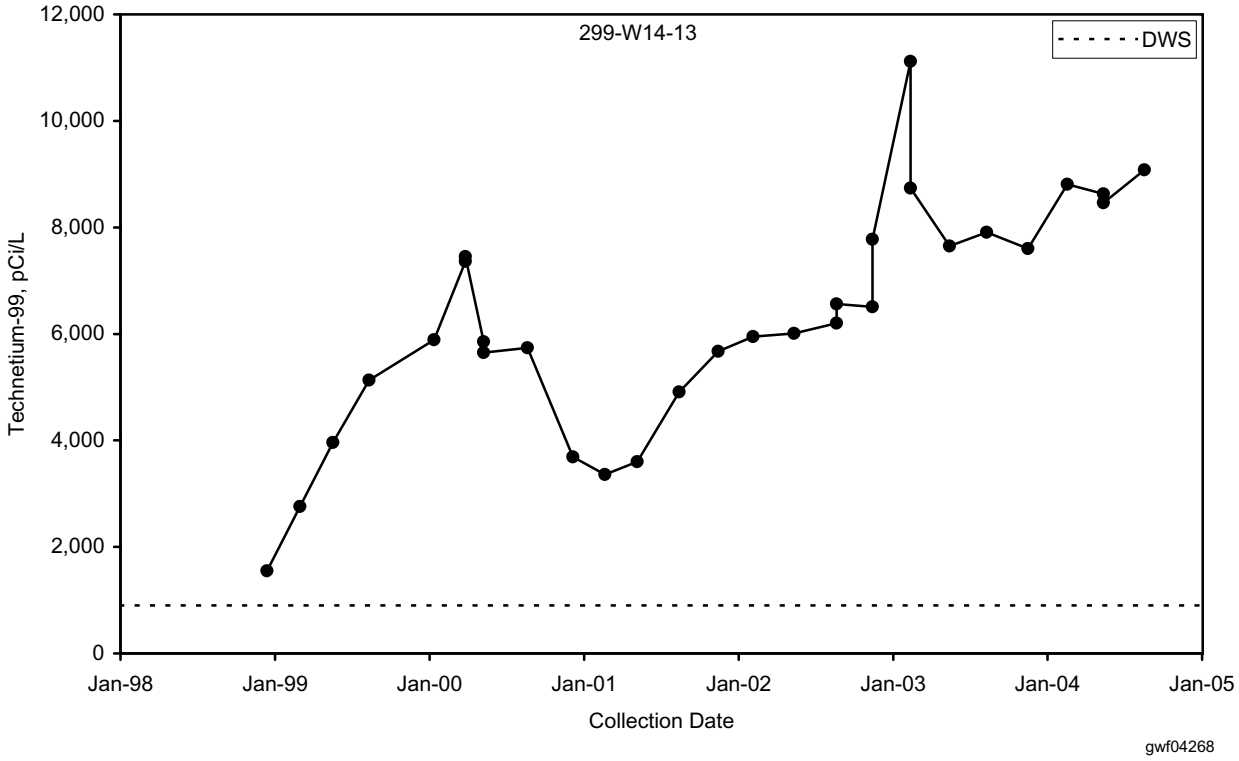


Figure 2.8-19. Technetium-99 Concentrations in Well 299-W14-13, East of Waste Management Area TX-TY

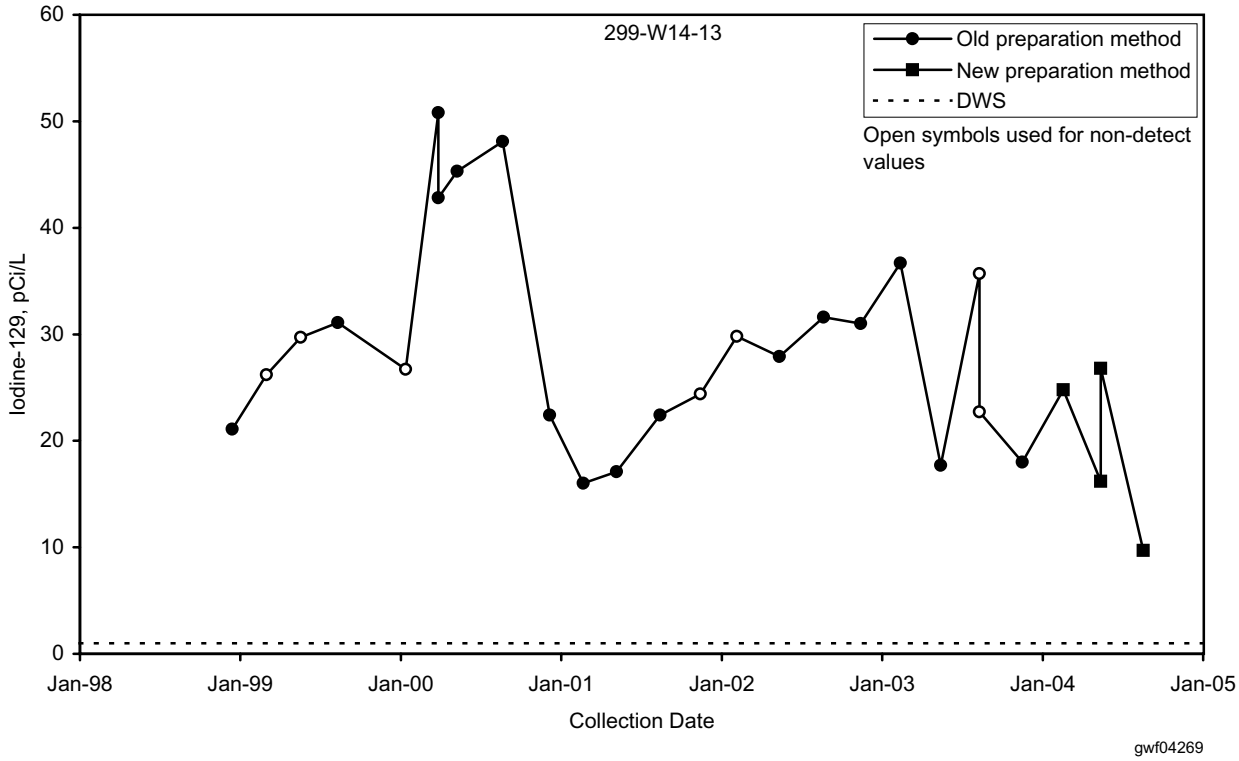


Figure 2.8-20. Iodine-129 Concentrations in Well 299-W14-13, East of Waste Management Area TX-TY

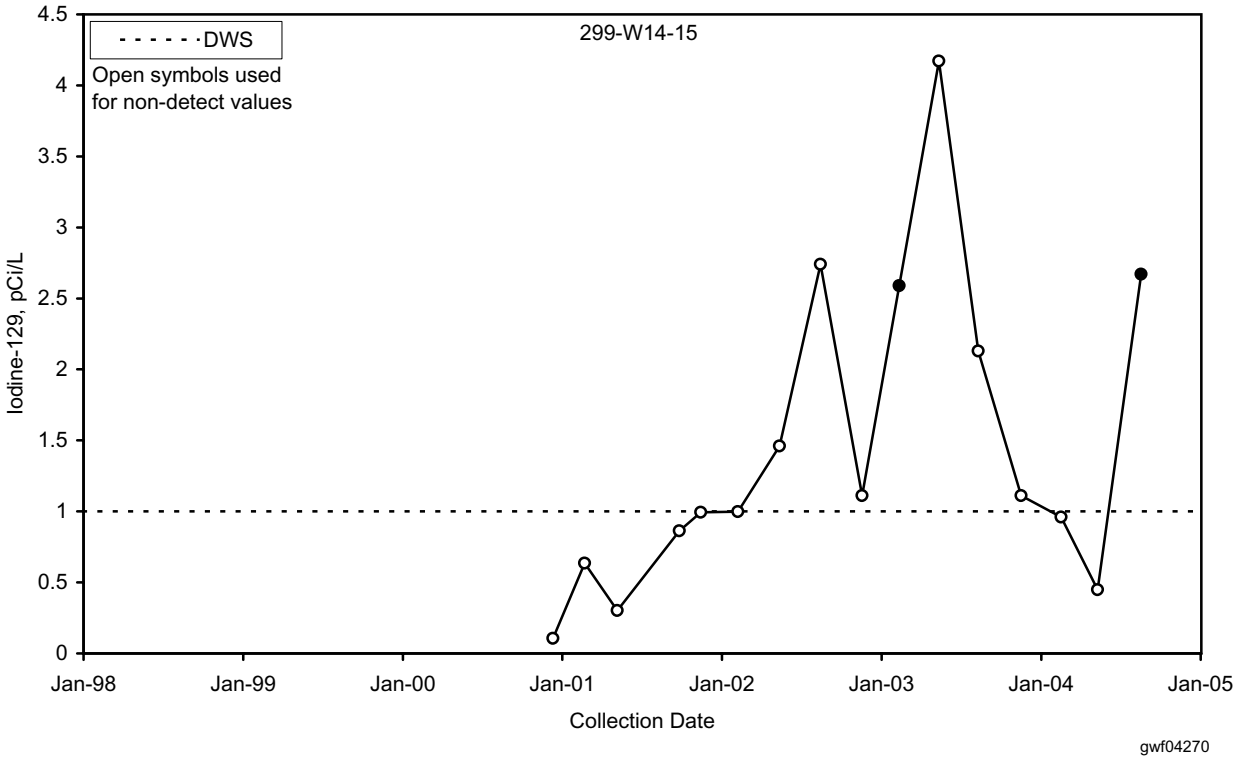


Figure 2.8-21. Iodine-129 Concentrations in Well 299-W14-15, East of Waste Management Area TX-TY

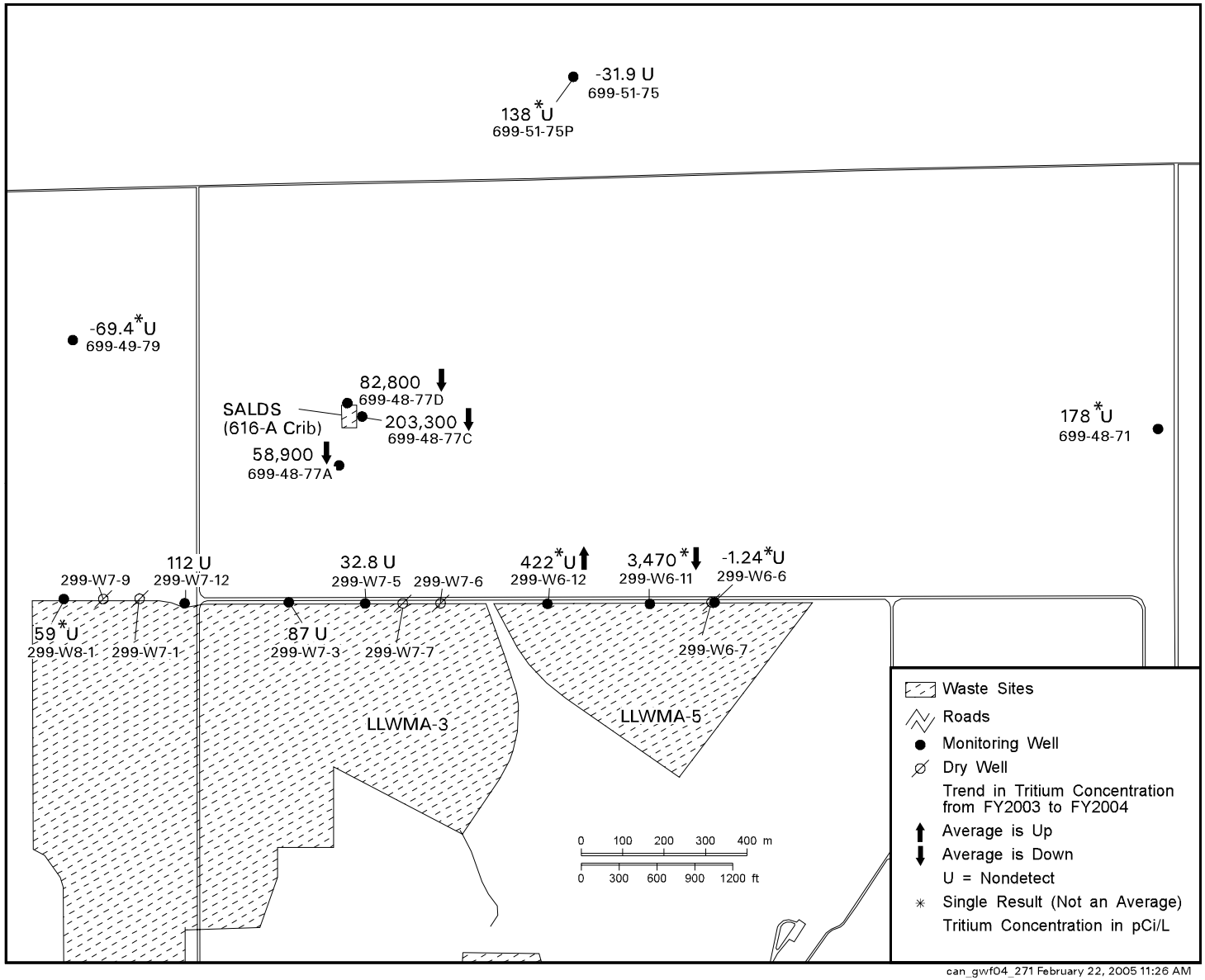


Figure 2.8-22. Tritium Concentrations in Groundwater for the SALDS Tritium-Tracking Network, FY 2004, Indicating Change from FY 2003 Results (As indicated in the legend, these results are either averages for FY 2004 or single results, i.e., sampled only once.)