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 (Figure 2.1-1). 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. 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 (e.g., cribs and trenches). Remediation of other groundwater contaminants will be determined through the Remedial Investigation/Feasibility Study Process. A Remedial Investigation/Feasibility Study Work Plan for the 200-ZP-1 Operable Unit will be prepared in fiscal year 2004.

Groundwater flows primarily to the east in the 200-ZP-1 groundwater interest area (Figure 2.8-2). The water table in the 200 West Area was raised by past discharge of

Groundwater monitoring in the 200-ZP-1 groundwater interest area includes CERCLA, RCRA, WAC, and AEA monitoring:

CERCLA Monitoring

- ***Five extraction wells are sampled monthly (when operating).***
- ***Three wells are sampled quarterly.***
- ***Fourteen wells are sampled semiannually.***
- ***Twenty-nine wells are sampled annually.***
- ***Twelve wells are sampled biennially.***
- ***In fiscal year 2003, four wells were not sampled as scheduled (see Appendix A).***

RCRA Monitoring

- ***Thirteen wells are sampled semiannually for Low-Level Waste Management Area 3.***
- ***Seven wells are sampled semiannually for Low-Level Waste Management Area 4.***
- ***Thirteen wells are sampled quarterly to semiannually for Waste Management Area T.***
- ***Sixteen wells are sampled quarterly to semiannually for Waste Management Area TX-TY.***
- ***In fiscal year 2003, four RCRA wells were not sampled as scheduled (see text and Appendix B).***

WAC 173-216 Monitoring

- ***Nineteen wells are sampled quarterly to semiannually for the State-Approved Land Disposal Site.***
- ***In fiscal year 2003, two wells were not sampled as scheduled (see Appendix C).***

Other AEA Monitoring

- ***Thirteen wells are sampled semiannually for performance assessment at Low-Level Waste Management Area 3.***
- ***Thirteen wells are sampled semiannually for performance assessment at Low-Level Waste Management Area 4.***
- ***Fourteen wells are sampled quarterly to annually.***
- ***In fiscal year 2003, one well was not sampled as scheduled (see Appendix C).***

wastewater and the aquifer is still responding to the termination of discharges. The flow direction is thus changing with time, particularly in the north part of the area.

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

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 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 easterly direction. This is due to decreased effluent discharges to the soil column in the 200 West Area, which is causing flow to return to its pre-Hanford direction.

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 *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), RCRA, 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 sampling and analysis plan (DOE/RL-2002-17). In addition to the contaminants of concern on this list, a fluoride plume has been defined within the 200-ZP-1 Operable Unit and will be discussed in this section.

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

****Carbon tetrachloride — 10.6***
Chromium — 0.05
Fluoride — 0.02
Iodine-129 — 0.66
Nitrate — 6.16
Technetium-99 — 0.01
Trichloroethene — 0.80
Tritium — 0.79
Uranium — 0.14
****Also includes portion of plumes beneath 200-UP-1 Operable Unit.***

2.8.1.1 Carbon Tetrachloride

Carbon tetrachloride contamination is found at levels greater than the 5 µg/L drinking water standard 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 is discussed in Section 3.1.3. The maximum carbon tetrachloride levels are found near the Plutonium Finishing Plant and range up to 6,200 µg/L.

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 are summarized in Section 2.8.2.

Significant features of the carbon tetrachloride plume 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 a new monitoring well, 299-W15-43, where the average concentration was 1,900 µg/L. This well was drilled early in fiscal year 2003. Sampling for carbon tetrachloride at well 299-W15-44 located northeast of extraction well 299-W15-34 showed a concentration of 2,900 µg/L in August 2003. The carbon tetrachloride contamination reaches the

north part of Waste Management Area TX-TY where concentrations in well 299-W15-765 averaged 3,200 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).

- Carbon tetrachloride extends beyond the 200 West Area boundary in several directions. The concentration is increasing in well 699-48-71 as the plume moves to the northeast (Figure 2.8-4). Concentrations in wells to the southeast, downgradient of the Environmental Restoration Disposal Facility, remain fairly steady at levels around the drinking water standard.
- 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 downgradient.
- In the past several years, increasing concentrations of carbon tetrachloride have been seen west and south 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 are declining in several wells west of Low-Level Waste Management Area 4. Some of this decline is due to injection of treated water from the 200-ZP-1 remediation system; however, some of the decline may be due to changing plume dimensions beyond the area where injected water is displacing the plume.
- Although data from wells completed above the Ringold lower mud unit at the base of the unconfined aquifer typically show low carbon tetrachloride concentrations, data from vertical profile sampling often show the highest concentrations are not at the water table but at intermediate depths in the aquifer.

The area of carbon tetrachloride >4,000 µg/L is decreasing due to remediation. However, the contamination at levels above 2,000 µg/L extends beyond the capture zone of the remediation system.

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 fiscal year 2003 was 18 µg/L in extraction well 299-W15-34, where the annual average concentration was 7.2 µg/L.

Data from vertical profile sampling often show the highest concentrations of carbon tetrachloride are at intermediate depths in the aquifer.

2.8.1.3 Chloroform

Chloroform concentrations in the 200-ZP-1 wells remained below the 80 µg/L drinking water standard. The maximum concentration detected was 31 µg/L. Possible chloroform sources include biodegradation of carbon tetrachloride and as a by-product of water treatment.

2.8.1.4 Nitrate

Nitrate continued to be present in groundwater at concentrations in excess of the 45 mg/L drinking water standard beneath much of the 200-ZP-1 Operable Unit (Figure 2.8-6). The maximum concentration in this vicinity during fiscal year 2003 (omitting suspect values) was 2,160 mg/L in well 299-W10-4 near the 216-T-36 crib, south of Waste Management Area T. The 216-T-32 and 216-T-7 cribs, west of Waste Management Area T, also appear to contribute to the high nitrate concentrations. The nitrate contamination is more widespread than the iodine-129, technetium-99, or tritium contamination discussed in Sections 2.8.1.9, 2.8.1.10 and 2.8.1.8, respectively. There probably are multiple sources of nitrate in this area, including disposal facilities farther south.

A well near the 216-T-36 crib has the highest nitrate concentration on the Hanford Site, >2,000 mg/L.

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.

Nitrate is found at concentrations greater than the drinking water standard at considerable depth within the unconfined aquifer in the north part of the operable unit. For example, 394 mg/L of nitrate was detected in fiscal year 2002 in a sample from well 299-W6-3 that is completed ~60 meters below the water table. This well is completed above the top of the Ringold Formation lower mud unit and was not sampled in fiscal year 2003. Nitrate contamination is found at levels above the drinking water standard in the 200-ZP-1 extraction wells. Since nitrate is not removed in the treatment system, it is re-injected into the aquifer upgradient of the 200 West Area.

Elevated nitrate levels are found in the west part of the Hanford Site. This contamination is believed to be due to offsite agriculture. One well (699-36-93, see Figure 2.1-2 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 fiscal year 2003.

2.8.1.5 Chromium

Chromium contamination is found at levels above the 100 µg/L drinking water standard 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. The highest levels are found near the 216-T-36 crib, upgradient of Waste Management Area T, in well 299-W10-4 where the annual average concentration was 330 µg/L.

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. Chromium from these facilities would have been moving north across well 299-W10-1 prior to 1997 and then east across the north part of the waste management area after 1997. The Waste Management Area T tank farm does not appear to be a source of chromium in this area as discussed in more detail in Section 2.8.3.1.

Chromium contamination originated at cribs and trenches west of T Tank Farm.

Chromium is also elevated east of Waste Management Area TX-TY in well 299-W14-13. The concentrations detected in this well in fiscal year 2003 were variable, ranging from 427 to 592 µg/L in filtered samples. Chromium concentrations are increasing in well 299-W14-15, indicating the contamination may be migrating to the south. The chromium contamination is associated with elevated nitrate, tritium, technetium-99, and iodine-129. The contamination is discussed further in Section 2.8.3.2.

In late fiscal year 2002, an elevated chromium result for a filtered sample was reported on the north side of Low-Level Waste Management Area 3. This result was considered suspect and investigated in fiscal year 2003. The investigation is described in further detail in Section 2.8.2.3 and was determined to be probably caused by a sampling issue such as a filter failure.

2.8.1.6 Arsenic and Cadmium

Arsenic is listed as a contaminant of concern in the 200-ZP-1 sampling and analysis plan (DOE/RL-2002-17), and sampling for arsenic is specified for six wells. Arsenic was not detected at levels above the 10 µg/L drinking water standard in any of the samples.

Cadmium is also listed as a contaminant of concern; sampling for cadmium in filtered samples is specified for 22 wells. Three of those wells, 299-W6-2, 299-W6-7, and 299-W18-24, were not sampled because they have gone dry. Several other wells were also analyzed for cadmium because they were sampled for other metals. Cadmium was below the 5 µg/L drinking water standard in all samples.

2.8.1.7 Fluoride

Fluoride contamination at levels greater than the primary drinking water standard of 4 mg/L is restricted to a small area around Waste Management Area T (Figure 2.8-8). Fluoride contamination from the tank farm has not been ruled out, but the nearby cribs are believed to be a more likely source.

2.8.1.8 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. 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 2.8.5.

Tritium contamination originated from waste disposal facilities near Waste Management Areas T and TX-TY.

The highest tritium concentrations were in well 299-W14-13, located east of Waste Management Area TX-TY, where the annual average concentration was 1.9 million pCi/L. The maximum tritium concentration detected in this well was 2.17 million pCi/L, which is greater than the DOE derived concentration guide. Well 299-W14-13 replaced well 299-W14-12, and the trend plot for these two wells indicates that the high contamination levels at this location are a recent phenomenon (Figure 2.8-10). High levels of chromium, nitrate, technetium-99, and iodine-129 are associated with the tritium contamination. The contamination is migrating to the south and beginning to impact well 299-W14-15. This contamination is discussed further in Sections 2.8.3.2 and 2.8.4.2.

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 fiscal year 2003. Aside from wells 299-W14-13 and 299-W14-15, well 299-W11-12 had an average tritium concentration of 52,100 pCi/L and well 299-W6-10 had an average tritium concentration of 35,000 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.

2.8.1.9 Iodine-129

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 fiscal year 2003 was in well 299-W14-13, where the maximum concentration was 36.7 pCi/L. The interpretation of iodine-129 is hampered by several samples being reported as non-detect at values greater than the drinking water standard. This occurs because high technetium-99 concentrations in the well require the laboratory's use of small sample volumes for iodine-129 analyses. The small sample volumes result in non-confirmation of a secondary iodine-129 gamma energy peak needed to confirm the presence of iodine-129. The iodine-129 plume is drawn conservatively by including these values that have elevated detection limits. The values occur in wells that often show detected values at approximately the same levels and appear to form a consistent plume, suggesting that iodine-129 may actually be present. Iodine-129 contamination at levels above the drinking water standard does not appear to extend beyond the 200 West Area boundary.

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

2.8.1.10 Technetium-99

Technetium-99 within the 200-ZP-1 Operable Unit is found at levels above the 900 pCi/L drinking water standard 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 (Figure 2.8-13). The increase is most notable in the wells along the southeast edge of the waste management area where concentrations increased by 50% to 60% in fiscal year 2003. Well 299-W11-39, near the

northeast corner of the waste management area, had the highest concentration in the area with values in fiscal year 2003 ranging from 6,790 to 10,500 pCi/L.

Although technetium-99 is also increasing upgradient of Waste Management Area T, near the 216-T-36 crib, levels remain below the drinking water standard and far lower than found on the downgradient side of the waste management area. The increase in technetium-99 near the 216-T-36 crib corresponds to an increase in chromium and nitrate. Thus, the increase in technetium-99 is also likely attributed to the 216-T-5, 216-T-7, or 216-T-36 cribs. The higher levels of contamination on the downgradient side are likely attributable to sources within the tank farm. Technetium-99 contamination around Waste Management Area T is discussed in greater detail in Section 2.8.4.1.

Technetium-99 exceeds the drinking water standard in only a few wells in the 200-ZP-1 Operable Unit. Concentrations increased in some wells during fiscal year 2003.

Technetium-99 concentrations east of Waste Management Area TX-TY in well 299-W14-13 continue to be much higher than in surrounding wells and show 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 2.8.4.1.

In the past, technetium-99 concentrations were greater than the drinking water standard on the south side of Waste Management Area TX-TY, but concentrations decreased in fiscal year 2003. This area is within the capture zone of the 200-ZP-1 extraction wells so the flow direction is approximately to the south. Some technetium-99 is detectable in the 200-ZP-1 extraction wells. Levels average less than half the drinking water standard. Since technetium 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 136 pCi/L in July 2003. This change suggests that injected water is flowing toward this monitoring well. The increase in technetium-99 at this well has accompanied a marked decrease in carbon tetrachloride concentrations, from 1,125 µg/L in May 1994, and a maximum of 1,850 µg/L in January 1997 to 24 µg/L in July 2003. The technetium-99 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 the possibility that part of the technetium may be from an upgradient source. Technetium-99 may have moved to the west under past flow conditions and be re-entering the area under present flow conditions. Well 299-W18-23 is located closer to the injection wells but has lower technetium-99 concentrations.

2.8.1.11 Uranium

Few analyses for uranium were performed on groundwater samples from the 200-ZP-1 Operable Unit during fiscal year 2003 because most wells showed insignificant levels in previous monitoring. Some wells monitored near the single-shell tank farms 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 well 299-W11-37 and near the southwest corner (upgradient) of Low-Level Waste Management Area 4 in well 299-W18-21. The uranium is detected far from major disposal facilities, so the source of the contamination is unknown. The uranium concentration detected in well 299-W11-37 ranged from 192 to 367 µg/L. The concentration in well 299-W18-21 was barely above the drinking water standard (30.1 to 30.7 µg/L).

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

2.8.2 CERCLA Interim Groundwater Remediation for Carbon Tetrachloride

The pump-and-treat system for the 200-ZP-1 Operable Unit is successfully containing and capturing the high concentration portion of the carbon tetrachloride plume near the

top of the aquifer in the vicinity of the 216-Z cribs and trenches. The pump-and-treat system for the 200-ZP-1 Operable Unit was implemented in three phases as an interim remedial action.

Contamination in the groundwater was reduced in the area of highest concentrations through mass removal. Hydraulic control of the plume is being maintained by the extraction and injection system. Additional information was collected through the drilling of new boreholes, hydraulic monitoring, contaminant monitoring, and treatment system operations. The current remediation system is designed to capture the baseline 2,000- to 3,000-µg/L plume depicted in the record of decision (ROD 1995a).

A summary of the remediation activities and progress is given in the following sections. For more details, see DOE/RL-2003-58.

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.

2.8.2.1 Progress During Fiscal Year 2003

A new sampling and analysis plan (DOE/RL-2002-17) was implemented for the 200-ZP-1 Operable Unit during fiscal year 2003. It specified annual or semiannual sampling schedules for wells with stable and changing contaminant trends, respectively. New wells are sampled quarterly for the first year and semiannually the second year. Wells in areas with very slowly changing concentrations are sampled biennially. This sampling schedule is being revised in the remedial investigation/feasibility study work plan for the 200-ZP-1 Operable Unit (to be published) to support fiscal year 2004 sampling.

Carbon tetrachloride contamination was reduced in the area of highest concentrations through mass removal. Approximately 253.6 million liters of contaminated groundwater were treated in fiscal year 2003 at an average flow rate of 513 liters per minute. New extraction wells to replace wells 299-W15-32 and 299-W15-33 will become operational during fiscal year 2004 and will be equipped with larger screened intervals to increase production rate. Extraction well concentrations ranged from 900 to 6,200 µg/L, while influent concentrations measured at the influent tank ranged from 2,800 to 4,300 µg/L. The pump in well 299-W15-33 broke down at the end of July 2002 and was replaced at the end of November. Thereafter, it was operated on a limited basis through January 1, 2003. Since January 1, the well has operated continuously. Well 299-W15-32 was off-line from mid-December 2002 to mid-February 2003 due to a leak detection system problem.

During fiscal year 2003, the pump-and-treat system extracted ~254 milion liters of groundwater, removing ~819 kilograms of carbon tetrachloride.

Treatment of 253.6 million liters of groundwater resulted in the removal of 819.3 kilograms of carbon tetrachloride during fiscal year 2003. Since startup of pump-and-treat system operations in August 1994, treatment of almost 2.15 billion liters of groundwater has led to the removal of over 7,668 kilograms of carbon tetrachloride.

Well 299-W15-37, formerly an extraction well, was converted to a monitoring well during fiscal year 2001. Concentrations of carbon tetrachloride decreased to 73 µg/L in March 2003, indicating there is no loss of control of the plume in the southern-most part of the plume. Carbon tetrachloride concentrations at extraction well 299-W15-36 have been consistently below the remedial action objective of 2,000 µg/L since May 1998. As shown in Figure 2.8-3, continued pumping at this well is drawing a portion of the plume to the southeast, away from the main body of carbon tetrachloride contamination. For these reasons, consideration is being given to shutting down this extraction well.

Technetium-99 samples are collected to ascertain if the pump-and-treat system is being affected by radiological contamination. Technetium-99 is not retained in the treatment system and none of the values observed anywhere in the system exceed the drinking water

standard of 900 pCi/L for technetium-99. Technetium-99 acts as a tracer and is detected in injection well samples and at surrounding monitoring wells. As discussed in Section 2.8.1.10, technetium-99 in monitoring wells on the east side of Low-Level Waste Management Area 4, near the injection wells, appears to be due to the injection of treated water.

2.8.2.2 Influence on Aquifer Conditions

During fiscal year 2003, the >2,000-µg/L center of the carbon tetrachloride plume maintained a similar shape and size to that of fiscal year 2002 (see Figure 2.8-3). The 4,000-µg/L-plume contour has shrunk as shown by declining concentrations at extraction well 299-W15-33 and monitoring well 299-W15-31A. Well 299-W15-33 was off-line between August and November 2002, awaiting a replacement pump, and then ran on a limited schedule through December 2002. This change in pumping is believed to have enhanced the declining concentrations at this well. During fiscal year 2002, wells 299-W15-31A, 299-W15-33, 299-W15-34 and 299-W15-1 defined the >4,000-µg/L contour; during fiscal year 2003, only two wells (299-W15-1 and 299-W15-34) now define that plume. The center of the contaminant mass is being drawn toward well 299-W15-34.

During fiscal year 2003, the >2,000-µg/L center of the carbon tetrachloride plume maintained a similar shape and size to that of fiscal year 2002. The 4,000-µg/L-plume contour has shrunk.

Concentration trends at the extraction wells imply that the center of the dissolved mass arrived at the extraction wells several years ago. For example, carbon tetrachloride concentrations have declined dramatically from >8,000 µg/L in 1997 to 2,200 µg/L in 2003 at extraction well 299-W15-32, located near the 216-Z-9 trench, regarded as the primary source of the carbon tetrachloride contamination (Figure 2.8-14).

Monitoring wells between the injection and extraction wells at the 200-ZP-1 Operable Unit have declining carbon tetrachloride concentrations. At well 299-W15-16, concentrations have declined from 7,800 µg/L in October 1997 to 1,800 µg/L in July 2003. Similarly, at well 299-W15-31A, concentrations have declined from 7,500 µg/L in October 1999 to 3,450 µg/L in July 2003.

Regional groundwater flow in the vicinity of the extraction wells is still to the east-northeast in the 200-ZP-1 Operable Unit pump-and-treat system (Figure 2.8.2). Water levels continue to decline at an annual rate of ~0.36 meter per year (DOE/RL-2003-58). Locally, within the extraction/injection system, the flow seems to be more to the northeast and north-northeast. The extraction wells influence water levels and flow direction north of the extraction wells. The >2,000-µg/L plume area north of the extraction wells is attributed to either another source of carbon tetrachloride west of the plume or a part of the original plume not detected in baseline evaluations.

The high concentration part of the plume (>4,000 µg/L) in the immediate vicinity of the 216-Z cribs and trenches was contained hydraulically during fiscal year 2003. This conclusion is based on the measured radius of influence of the pumping wells across the high concentration area and in monitoring wells situated between the pumping wells. The pumping influence extends over 124 meters from extraction well 299-W15-33 to monitoring well 299-W15-31A where a negligible drawdown of 0.01 meter was observed, down from 0.08 meter during fiscal year 2002. The smaller drawdown was probably due to less pumping time at well 299-W15-33.

2.8.3 RCRA Groundwater Monitoring

The 200-ZP-1 Operable Unit contains four RCRA sites with groundwater monitoring requirements. This section summarizes the results of detection monitoring at two sites and the status of assessment monitoring at the other two sites. RCRA groundwater data are available in the Hanford Environmental Information System 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 Waste Management Area T

The objective of RCRA groundwater monitoring at Waste Management Area T is to assess the extent and rate of movement of dangerous wastes in groundwater that have a source from the waste management area. 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. A well location map for this waste management area is shown in Appendix B. This site continued to be monitored under an assessment program during fiscal year 2003. The well and analyte lists for this unit are given in Appendix B.

Calculated average linear 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 velocities as determined from aquifer tracer tests range between 0.022 and 0.024 (PNNL-13378; PNNL-14113). Groundwater flow direction at the waste management area is between 85 and 98 degrees from north as determined by trend surface analyses (PNNL-13378; PNNL-14113). Details concerning groundwater flow rate and direction are in Appendix B.

The monitoring network for Waste Management Area T includes eleven wells that are sampled quarterly and two wells sampled semiannually. One new RCRA assessment monitoring well is planned to be installed in calendar year 2004. The new well is to assess the vertical extent of contamination near the northeast corner of the waste management area.

Waste Management Area T was originally placed in 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). Carbon tetrachloride, trichloroethene, chromium, nitrate, and fluoride are found in groundwater beneath Waste Management Area T. However, the results of groundwater monitoring in fiscal year 2003 continue to suggest that the waste management area has not contributed to dangerous waste contamination of the uppermost aquifer in the area. Carbon tetrachloride and trichloroethene contamination is attributed to Plutonium Finishing Plant operations and is discussed in Section 2.8.1. Nitrate contamination also is attributed to Plutonium Finishing Plant operations as well as past-practice disposal to crib and trenches near Waste Management Area T. Chromium and fluoride contamination is attributed to cribs and trenches upgradient of the waste management area.

Assessment monitoring at Waste Management Area T suggests that the waste management area has not contributed to dangerous waste contamination of the uppermost aquifer in the area.

A plume map depicting the fiscal year 2003 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 are in upgradient wells 299-W10-28 and 299-W10-4 where chromium reached 215 and 347 μg/L, respectively, in 2003. Figure 2.8-15 shows trend plots for chromium in upgradient wells at the waste management area. Prior to about 1997 when groundwater flow direction was toward the north, several wells on the north (then downgradient) side of the waste management area had relatively high chromium concentrations. Also, prior to 1997, well 299-W10-1, which was lateral to the tank farm with respect to groundwater flow direction but downgradient of the 216-T-5 trench and the 216-T-7 crib and tile field, had chromium concentrations exceeding 200 μg/L. After flow direction changed toward the east in about 1997, chromium concentrations dropped to <40 μg/L in well 299-W10-1, decreased in all of the north wells (Figure 2.8-16), and began increasing in well 299-W10-4. Finally, since December 2000, chromium has exceeded the drinking water standard in two downgradient wells, 299-W11-41 (average for fiscal year 2003, 141 μg/L) and 299-W11-42 (average for fiscal year 2003, 132 μg/L).

Considering the above history, 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: the 216-T-5 trench, the 216-T-7 crib and tile field, and 216-T-36 crib. Chromium from these facilities would have been moving north across well 299-W10-1 prior to 1997 and then east across the north wells and the rest of the waste management area after 1997.

The most likely source of chromium in the downgradient wells 299-W11-41 and 299-W11-42 at Waste Management Area T is one or more of the facilities upgradient of the waste management area. Figure 2.8-17 shows the trend plot for chromium and technetium-99, a non-RCRA-regulated constituent, for the two wells. The most likely source for the technetium-99 is the waste management area. The figure shows that the concentrations of technetium-99 and chromium do not track each other through time. If the technetium-99 is from the waste management area, a different source for the chromium is indicated. The most likely source or sources are past-practice facilities located upgradient of the waste management area.

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.

Fluoride exceeded the primary drinking water standard of 4 mg/L in three wells at Waste Management Area T during 2003 and exceeded the secondary drinking water standard of 2 mg/L in four additional wells. Fluoride contamination in the 200-ZP-1 groundwater interest area is discussed in Section 2.8.1.7.

2.8.3.2 Waste Management Area TX-TY

The objective of RCRA groundwater monitoring at Waste Management Area TX-TY is to assess the extent and rate of movement of dangerous wastes in groundwater that have a source from the waste management area. 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.

Waste Management Area TX-TY was originally placed in RCRA assessment monitoring because of elevated specific conductance in downgradient wells 299-W10-27 and 299-W14-12 (WHC-SD-EN-AP-132). A well location map for this waste management area is shown in Appendix B. This site continued to be monitored under an assessment program in fiscal year 2003. The well and analyte lists for this unit are also given in Appendix B.

The monitoring network for Waste Management Area TX-TY includes fourteen wells that are sampled quarterly and two wells sampled semiannually. One well, 299-W10-27, was not sampled during the second quarter of 2003 because of pump problems. Also, two of the quarterly wells, 299-W14-19 and 299-W15-44, are new wells and were added to the monitoring network during May 2003. One new RCRA assessment monitoring well is planned to be installed during calendar year 2004. The new well is to assess the vertical extent of contamination downgradient of the waste management area.

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 0.041 and 0.311 (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 (PNNL-13378). Farther south, along the downgradient side of TX Tank Farm, groundwater flow direction changes from 108 degrees at well 299-W14-13 to 133 degrees 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. In the north part of the waste

management area, flow direction generally follows the pre-Hanford Site direction of east to southeast. In the south part of the site, groundwater flow direction is greatly influenced by the pump-and-treat extraction wells. Details concerning groundwater flow rate and direction are in Appendix B.

Carbon tetrachloride, trichloroethene, chromium, and nitrate are the only dangerous waste constituents found in groundwater at Waste Management Area TX-TY. Carbon tetrachloride and trichloroethene contamination is attributed to Plutonium Finishing Plant operations and is discussed in Section 2.8.1. Nitrate contamination also is attributed to Plutonium Finishing Plant operations as well as past-practice disposal to crib and trenches in the area. Some nitrate contamination may be from Waste Management Area TX-TY, although distinguishing the different sources is extremely difficult.

Chromium was detected above the drinking water standard of 100 μg/L only in well 299-W14-13 at Waste Management Area TX-TY during fiscal year 2003 (Figure 2.8-7). Figure 2.8-18 shows a time series plot of chromium concentration in the well. The maximum chromium concentration found in fiscal year 2003 was 592 pCi/L. 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. However, chromium concentration increased from 27 to 90 μg/L before falling during fiscal year 2003 to 69 μg/L in well 299-W14-15, located south of well 299-W14-13, suggesting that the chromium contamination may be moving southward. Further analytical results are needed to confirm this during fiscal year 2004.

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

The most likely source for the chromium in well 299-W14-13 is Waste Management Area TX-TY. However, the series of cribs 216-T-26 through 216-T-28, located north of well 299-W14-13, are also a potential source for, or at least may have contributed to, the contamination.

2.8.3.3 Low-Level Waste Management Area 3

Groundwater monitoring under interim status requirements continued at this RCRA site during fiscal year 2003. The well network was sampled semiannually for indicator and site-specific parameters (see Appendix B). All 11 wells attempted for sampling in fiscal year 2003 were successfully sampled.

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 1994). 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) with a calculated gradient of 0.0014. The flow direction is returning to pre-Hanford conditions, and it will change until the direction is predominantly west to east. The estimated flow rate at Low-Level Waste Management Area 3, using this gradient is 0.001 to 0.14 meter per day (see Appendix B).

Under current flow directions, 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 due to plumes originating from sources to the south and are not believed to be a result of waste disposal at this site. Because the contamination is due to upgradient sources, these wells continue to be treated as upgradient wells for statistical purposes.

Indicator parameter (specific conductance, pH, total organic carbon, and total organic halides) data from designated upgradient wells were statistically evaluated and values from

downgradient wells were compared to values established from the upgradient wells. Statistical comparison values were not exceeded in any wells monitoring the waste management area during fiscal year 2003.

In late fiscal year 2002, an elevated chromium result for a filtered sample from well 299-W7-7 was reported on the north side of Low-Level Waste Management Area 3. This result was considered suspect and investigated in fiscal year 2003. Time series samples were collected for filtered metals, unfiltered metals, and hexavalent chromium during purging. Only the first sample, prior to purging, showed significantly elevated hexavalent chromium. Chromium was elevated in all unfiltered samples. Turbidity was ~4 to 5 NTU during sampling, showing that the elevated unfiltered chromium is not a function of high turbidity. Thus, the earlier anomalous result was likely caused by a sampling issue such as a filter failure. This well is nearly dry and produces very little water, which may also influence the chromium results, particularly the unfiltered values.

Nickel concentrations continue to increase in well 299-W7-1, on the north side of Low-Level Waste Management Area 3 (Figure 2.8-19). This increase was first seen early in fiscal year 2000. Manganese and iron are also elevated in this well, although iron concentrations declined below the secondary drinking water standard in fiscal year 2003. Corrosion of well materials is suspected to be the cause of the increase in these metals. Like other wells on the north side of Low-Level Waste Management Area 3, this well is nearly dry.

2.8.3.4 Low-Level Waste Management Area 4

Groundwater monitoring under interim status requirements continued at this RCRA site in fiscal year 2003. The well network was sampled semiannually for indicator and site-specific parameters (see Appendix B). Of the seven wells where sampling was attempted during fiscal year 2003, sampling was successful in six of the wells. Only a partial sample was obtained in the first round of sampling from well 299-W18-24, and it was flagged as dry and removed from the sample schedule prior to the second sampling event. This leaves only one downgradient well completed at the top of the uppermost aquifer and one downgradient well at the bottom of the unconfined aquifer. The other four wells in the network are upgradient wells.

Most of the downgradient wells for Low-Level Waste Management Area 4 have gone dry. One shallow and one deep downgradient well remain.

An application was submitted to Ecology in June 2002 to incorporate the low-level burial grounds into the Hanford Facility RCRA Permit (Ecology 1994). 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 0.003. 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 0.7 meter per day (see Appendix B).

Downgradient well 299-W15-16 continued to exceed the statistical comparison value for total organic halides. 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. The U.S. Department of Energy reported the exceedance to the U.S. Environmental Protection Agency and Ecology in August 1999. The elevated total organic halide concentrations are attributed to carbon tetrachloride from Plutonium Finishing Plant operations (see Section 2.8.1.1). However, potential sources of carbon tetrachloride and other volatile organic compounds were detected in the trenches and vadose zone within the 218-W4-C burial ground during fiscal year 2002. Investigation of the vadose zone continued in fiscal year 2003 as part of the 200-PW-1 Operable Unit (see Section 3.1). Statistical comparison values for fiscal year 2004 are listed in Appendix B.

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 fiscal year 2003 average nitrate concentration in this well was 100 mg/L. Only a few trenches have received waste in this part of the burial ground, so it is unlikely that the contamination is related to the burial ground itself.

2.8.4 AEA Monitoring

AEA groundwater monitoring is performed throughout the 200-ZP-1 groundwater interest area. This section provides information on monitoring of radionuclides from Waste Management Areas T and TX-TY because radionuclide releases from these sites are not regulated under RCRA. Performance assessment groundwater monitoring at Low-Level Burial Grounds 3 and 4 is also discussed.

2.8.4.1 Waste Management Areas T and TX-TY

Technetium-99 contamination at the northeast corner of Waste Management Area T in fiscal year 2003 is described in Section 2.8.1.10. Most of the technetium-99 at this location is believed to be from the waste management area. The abrupt appearance of technetium-99 in groundwater at the northeast corner of the waste management area has been attributed to elimination of water leaking from a pipeline at the northeast corner of the waste management area in 1995 (PNNL-11809). Prior to 1995, existing contaminants would have been diluted by the leaked water.

Groundwater beneath Waste Management Areas T and TX-TY is contaminated with technetium-99.

Data from wells drilled around the waste management areas in recent years show increasing trends in technetium-99. Well 299-W11-39, located south of well 299-W10-24, was drilled in 2001. Technetium-99 concentration has subsequently increased in the well to 10,500 pCi/L in mid-2003. Three wells were drilled south of well 299-W11-39 in late 2000 and early 2001. These wells had relatively low technetium-99 concentrations immediately after drilling (~300 to 400 pCi/L). Since that time, technetium-99 concentrations in the area have increased substantially. During fiscal year 2003, the highest technetium-99 concentration in those wells was 2,600 pCi/L in well 299-W11-41.

Apparently, technetium-99 is migrating toward the south along the east edge of the T Tank Farm from the northeast corner of the waste management area. This migration is coincident with a shift in groundwater flow direction from toward the northeast before 1996 to 1997 to toward the east or slightly southeast after 1997.

Vertical Sampling. Past analyses of depth-discrete sampling during drilling and comparison of samples from adjacent wells that sample different parts of the aquifer have shown that some contaminants are stratified in the upper most aquifer (PNNL-13441; PNNL-13929; PNNL-14099). Three efforts were undertaken at Waste Management Areas T and TX-TY during fiscal year 2003 to better define vertical concentration gradients for contaminants of concern in the upper most aquifer. These efforts included (1) specific conductance profiles, (2) depth-discrete sampling during drilling of two new wells, and (3) multi-level, depth-discrete sampling in the screened interval of a highly contaminated well.

Specific Conductance Profiles. Specific conductance measurements were taken at 0.5- to 1-meter intervals through the screened intervals of seven groundwater monitoring wells around the T, TX, and TY Tank Farms. Specific conductance provides an indicator

for contaminants such as nitrate and technetium-99 at the tank farm areas. Significant differences in specific conductance with depth were found in four of these wells.

The most pronounced difference was found at well 299-W10-28 (Figure 2.8-20), located upgradient of Waste Management Area T. The specific conductance data from the well show a marked increase through the upper 4 meters of the screened interval below which specific conductance remains unchanged. In general, specific conductance reflects high nitrate (and sodium and calcium) concentrations in the Waste Management Areas T and TX-TY vicinity. At well 299-W10-28, the data suggest the nitrate concentration increases downward in the aquifer from the water table to ~4 meters depth. This is consistent with previous investigations that suggest that nitrate is generally relatively deep in the aquifer and probably represents a regional nitrate plume in the area.

Also shown on Figure 2.8-20 are the values of specific conductance measured after purging the well for the four routine pumped quarterly groundwater samples taken prior to the specific conductance profile. The values are shown at the depth of the pump intake. The pumped values appear to be an average of the low conductance water at the water table and the relatively high conductance water deeper in the screened interval.

In fiscal year 2003, DOE used various techniques to study how contamination varies with depth in the aquifer.

Specific conductance profiles measured in wells 299-W11-39 and 299-W11-42 at Waste Management Area T shows similar trends to that of well 299-W10-28, but the magnitude of the changes are much less than that seen at well 299-W10-28.

Figure 2.8-21 shows a specific conductance profile measured in the screened interval of well 299-W14-13, a downgradient well at Waste Management Area TX-TY. Well 299-W14-13 is in a highly contaminated area, and the specific conductance profile looks much different that those from wells at Waste Management Area T (Figure 2.8-20).

Specific conductance in well 299-W14-13 decreases with depth between ~1 and 4 meters below the water table. However, there appears to be a maximum between 0.5 and 1.5 meters. The relatively shallow specific conductance plume suggests a nearby source for the contamination in the well because the contamination has not traveled far enough to vertically disperse throughout the aquifer. The specific conductance values near the bottom of the screened interval are still fairly high and probably reflect downward movement of high specific conductance water within the well bore. A downward flow rate of ~0.011 meter per minute was measured from vertical tracer tests and later confirmed by electromagnetic flow meter survey (PNNL-13378).

Also shown on Figure 2.8-21 are four specific conductance values measured during routine pumped quarterly sampling prior to the profile measurement. All of the pumped specific conductance values are less than the profile values measured under ambient flow conditions. The specific conductance of the pumped samples are lower that the specific conductance of the profile because the profile is affected by the downward flow of high specific conductance water found near the water table. After purging the well, the sampled water is a mixture of the high specific conductance water near the water table and lower specific conductance water from deeper in the aquifer.

Sampling During Drilling. Sampling of groundwater brought to the surface during drilling can give an indication of vertical chemical variations within the aquifer. Two new wells were sampled in this way during 2003. Air lifted samples of groundwater and cuttings were collected from wells 299-W14-19 and 299-W15-44 during drilling at TX Tank Farm in 2003. The samples were collected at 6-meter intervals below the water table. No high levels of contamination were encountered but several metals and anions showed concentration variations with depth in the aquifer. Of the analytes tested, nitrate is of the most interest. Additional samples were collected for analysis of nitrate in the field. The nitrate data from well 299-W15-44 are shown in Figure 2.8-22. Results from well 299-W14-19 are similar.

Figure 2.8-22 shows that nitrate in well 299-W15-44 is relatively high at the water table and decreases with depth to ~20 meters below the water table. This is followed by an increase in concentration at ~60 meters below the water table, below which nitrate concentrations remain fairly constant to the bottom of the borehole. In all wells that have been sampled during drilling at Waste Management Areas T and TX-TY, nitrate has been found to vary in concentration with depth in the aquifer (PNNL-12125; PNNL-12124; PNNL-13830; PNNL-13200; PNNL-14249). In most wells with sufficient samples to define a trend, nitrate concentrations increased with depth. The relatively high nitrate concentrations found near the water table in well 299-W15-44 are interpreted to be from nearby sources; the deeper nitrate probably represents a more regional and dispersed plume.

Multi-Level Dialysis Sampling. Well 299-W14-13 is located on the east (downgradient) side of Waste Management Area TX-TY in an area of high chromium, nitrate, technetium-99, iodine-129, and tritium groundwater contamination. A previous investigation indicated that vertical concentration gradients exist in the uppermost aquifer at this location (PNNL-14099). This is supported by the specific conductance profile of the well 299-W14-13 (Figure 2.8-21). Multi-level, depth-discrete sampling was done in the well during fiscal year 2003 to better define the vertical gradients and to help determine the source or sources of contamination in the well.

Nitrate and technetium-99 concentrations were highest in the shallowest samples.

A multi-level, dialysis sampling device was deployed in well 299-W14-13. The sampling device was left in the well for ~1 month to allow equilibration of the water in the dialysis tubes with the groundwater. Samples were obtained every 1.5 meters from ~1 meter below the top of the aquifer to the bottom of the well screen, which is ~9 meters below the water table. Samples were analyzed for major cations, anions, tritium, and technetium-99.

In addition, one sample was collected from ~4 centimeters below the water table using a mini-bailer. The bailed sample was analyzed for chromium and nitrate in the field and chromium and technetium-99 in the laboratory.

The analytical results from both the multi-level dialysis and the bailed samples are shown on Figure 2.8-23. The results show that, except for a zone at about 2.5 meters below the water table, the concentrations of most cations and anions are fairly constant throughout the screened interval of the aquifer. Neither the geologist's log nor the geophysical logs show any evidence of changes in the formation at 2.5 meters below the water table, so the reason for the increased concentrations at that depth is unknown.

Nitrate and technetium-99 show increases in concentration with decreasing depth from ~4 to 5 meters below the water table upward to the shallowest dialysis sample. For nitrate, there is an extremely large increase in concentration between the shallowest dialysis sample and the bailed sample near the water table (Figure 2.8-23). For technetium-99, there is a concentration decrease between the same two samples. It is not known whether the technetium-99 concentration decreases from 1 meter depth with decreasing depth or if the concentration continues to increase with decreasing depth to some unknown depth before dropping to the value in the bailed sample.

Pumped concentrations of calcium, chromium, and technetium-99 are substantially less than the ambient concentrations. For nitrate, the opposite is true.

The squares on Figure 2.8-23 represent the concentrations of the various constituents in routine pumped quarterly samples collected during the quarters prior to and after the dialysis samples were collected. The data show that for most cations and anions, the concentrations in the pumped samples are similar to the dialysis concentrations throughout the screened interval. Exceptions are calcium, chromium, nitrate, and technetium-99. The pumped concentrations of calcium, chromium, and technetium-99 are substantially less than the concentrations under ambient flow conditions. For nitrate, the opposite is true.

Well 299-W14-13 has a downward flow gradient within the well bore (PNNL-13378). This implies a possible zone of lower permeability near the top of the screened interval and relatively higher permeability near the bottom of the screened interval. Alternatively, the downward flow may, in part, be driven by differences in density. If the major cation and

anion concentrations at 1 meter depth are increased proportionally to the nitrate concentration at 4 centimeters depth, the resulting salinity of the water at 4 centimeters is 2.3 per thousand. This is in contrast to the estimated salinity from the deepest dialysis sample, which is 0.63 per thousand. The difference in salinity between the top and bottom of the screened interval may be sufficient to cause a downward, density driven flow within the well bore. Whatever the mechanism of downward flow, it appears that contaminants in a zone of relatively high concentration near the water table are transported downward in the well to become diluted with less contaminated water at depth. This is important because the well itself is helping spread contamination.

When well 299-W14-13 is purged, all the water standing in the wellbore is removed. Subsequently, the pumped samples consist of relatively high concentrations of contaminants from a zone near the water table diluted with a greater volume of less contaminated water from a less concentrated zone at depth. This yields the weighted average concentrations in the pumped samples shown on Figure 2.8-23.

2.8.4.2 Low-Level Waste Management Area 3

Performance assessment monitoring of radionuclides at Low-Level Waste Management Area 3 is designed to complement the 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.

There is no evidence that Low-Level Waste Management Areas 3 or 4 have contaminated groundwater with radionuclides or hazardous constituents.

Section 2.8.3.1 discusses flow conditions and chemical constituents monitored under RCRA requirements at Low-Level Waste Management Area 3. There is no evidence that Low-Level Waste Management Area 3 has contaminated groundwater with radionuclides or hazardous constituents.

Contaminant characteristics for radionuclides 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 fiscal year 2003 was 66 pCi/L in well 299-W10-21, located on the south edge of the 218-W-3A burial ground. Although this well is currently downgradient of the 218-W-3A burial ground, it has likely been impacted by activities to the south that imposed northerly flow for a time. This contamination is not attributed to a burial ground source.
- Uranium concentrations at Low-Level Waste Management Area 3 are <3 μg/L. There is no evidence of a burial ground source.
- 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 were non-detect in most wells.

2.8.4.3 Low-Level Waste Management Area 4

Performance assessment monitoring of radionuclides at Low-Level Waste Management Area 4 is designed to complement the 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 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.

Section 2.8.3.2 discusses flow conditions and chemical constituents monitored under RCRA requirements at Low-Level Waste Management Area 4. Although carbon tetrachloride has been detected in the vadose zone, no link with groundwater contamination has yet been established. There is no evidence that Low-Level Waste Management Area 4 has contaminated groundwater with radionuclides.

Contaminant characteristics for radionuclides 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 2.8.1.10, 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 an upgradient source. 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.
- 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.

2.8.5 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 wastes derived 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. Through August 31 of fiscal year 2003, ~96 million liters of water were discharged to the State-Approved Land Disposal Site.

Groundwater monitoring for tritium and other constituents and water-level measurements are required by the state-issued permit at the State-Approved Land Disposal Site. The current network consists of 3 proximal monitoring wells and 16 tritium-tracking wells (Figure 2.8-24). Proximal wells were sampled in October 2002, and January, February, April, and September of 2003 (see Appendix C). Tritium-tracking wells were sampled in January and September 2003. 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 northeasterly flow predominates. This condition also places several wells south of the State-Approved Land Disposal Site hydraulically downgradient of the facility.

Some of the wells south of the State-Approved Land Disposal Site in the tritium-tracking network have gone dry or are projected to soon be dry. Well 299-W7-6 went dry, preventing collection of the September 2003 sample from this well. Likewise, difficulties in obtaining a sample from well 299-W7-9 suggest that this well may have produced its final sample in January 2003. So far, the tritium-tracking network remains adequate to track effluent from the State-Approved Land Disposal Site, but the loss of these wells could affect numerical modeling calibration.

Average tritium concentrations decreased in all three proximal wells at the State-Approved Land Disposal Site during fiscal year 2003.

Average tritium concentrations decreased in all three State-Approved Land Disposal Site proximal wells during fiscal year 2003 compared with fiscal year 2002 (Figure 2.8-24). Sporadic detections in well 299-W7-5 suggest that tritium from the State-Approved Land Disposal Site may be reaching the north edge of the 200 West Area (due south of the facility), or that this well is peripherally influenced by the tritium plume from the 200 West Area. During fiscal year 2003, maximum tritium concentrations for State-Approved Land Disposal Site proximal wells were 189,000 pCi/L in well 699-48-77A, (February 2003), 430,000 pCi/L in well 699-48-77C (October 2002), and 220,000 pCi/L in well 699-48-77D (October 2002).

Concentrations of all chemical constituents with permit limits were well within those limits during all of fiscal year 2003. Acetone, benzene, tetrahydrofuran, cadmium, chloroform, lead, and mercury were below method detection limits in all samples. Concentrations of major cations and anions are mostly below background concentrations due to dilution by the clean water discharged to the State-Approved Land Disposal Site.

Comparison of head distribution in March 2003 (Figure 2.8-2) and reported fiscal year 2003 tritium concentrations, with numerical predictions of these quantities for 2000 and 2005, suggests that modeling performed in 1997 slightly overestimated the areal spread of tritium around the State-Approved Land Disposal Site to date. Contouring of March 2003 groundwater flow potential near the site (but away from the mound) appears to show a more easterly component compared with both 2000 and 2005 model times and the fiscal year 2002 potential map.

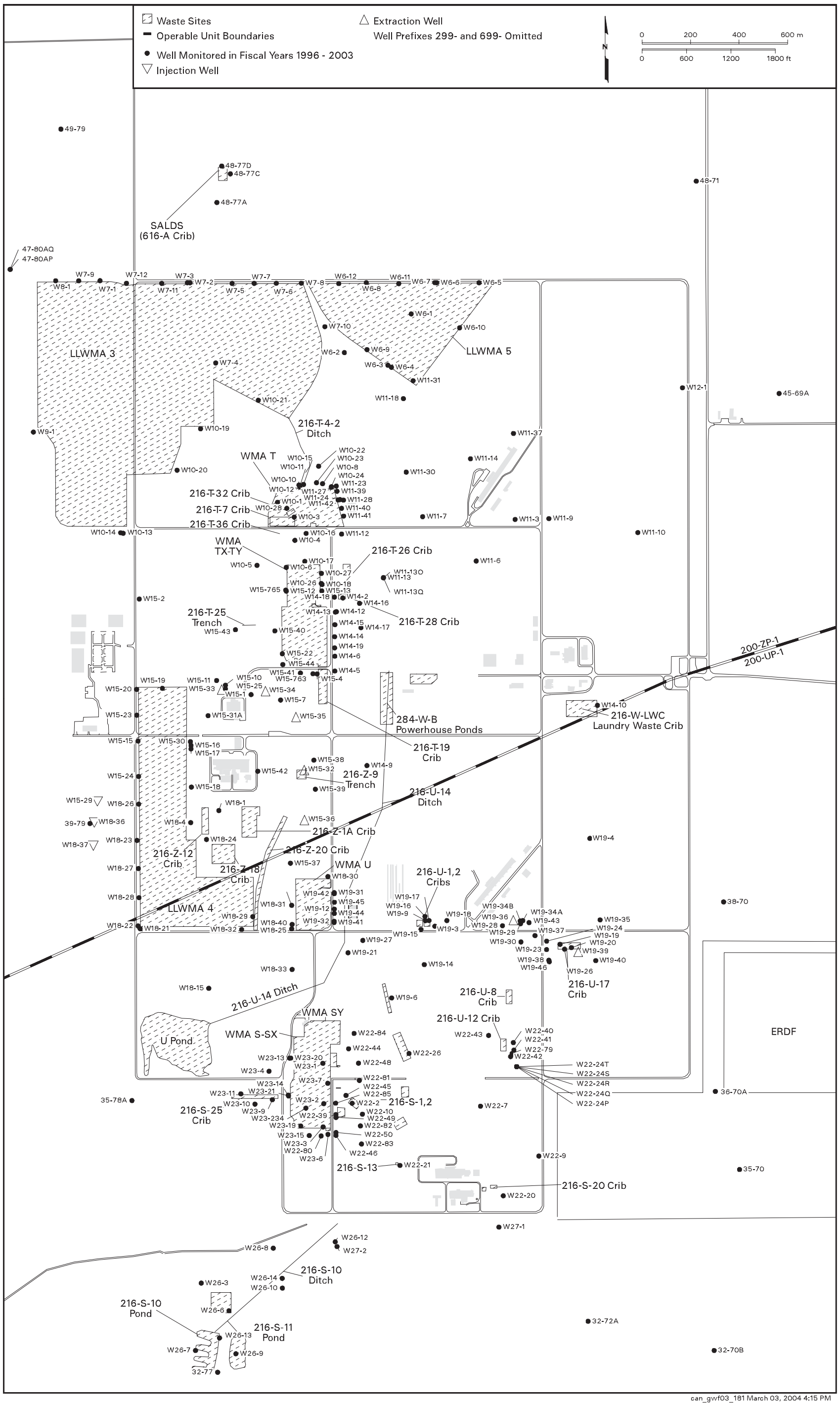

Figure 2.8-1. Groundwater Monitoring Wells in the 200 West Area

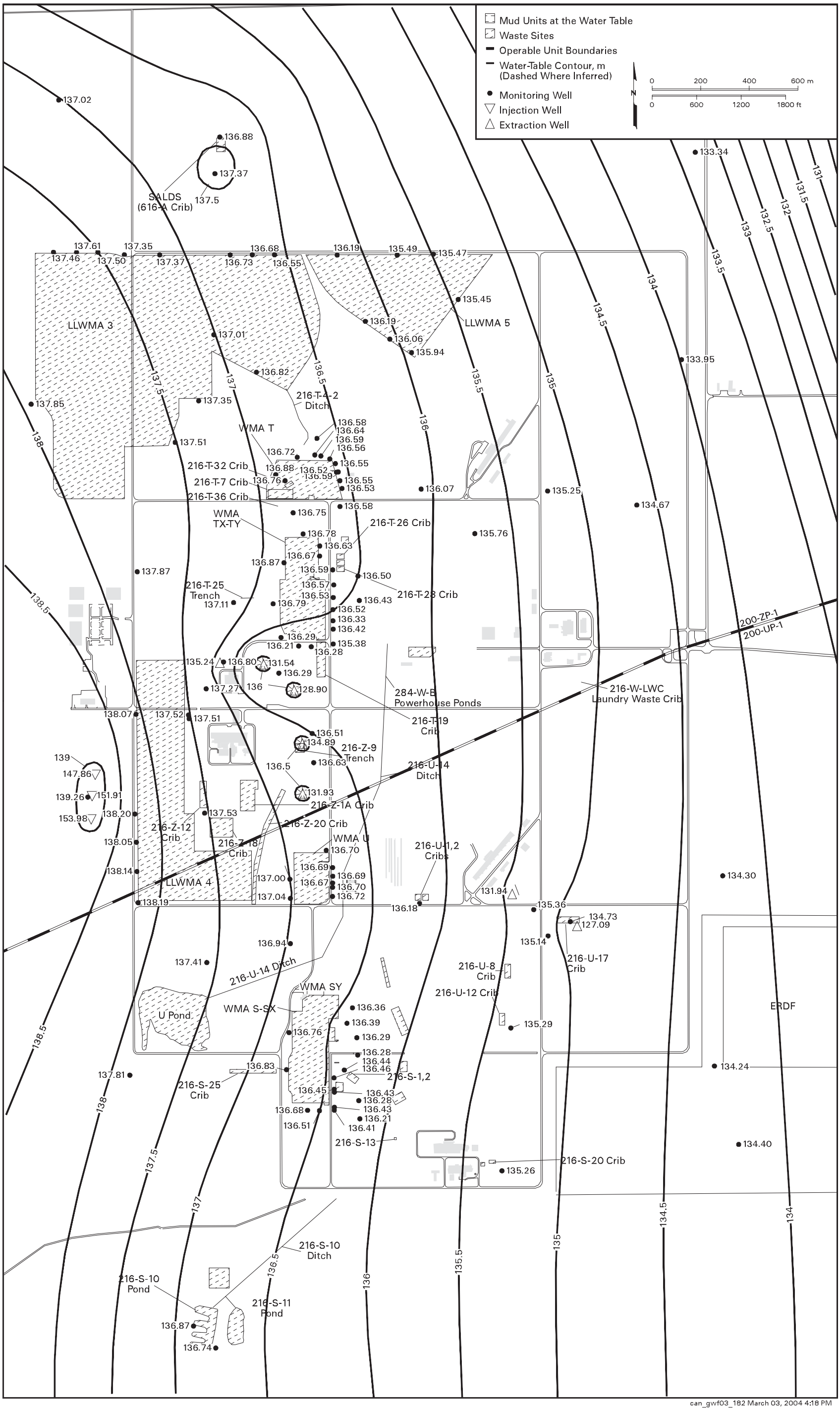

Figure 2.8-2. Water-Table Contours in the 200 West Area

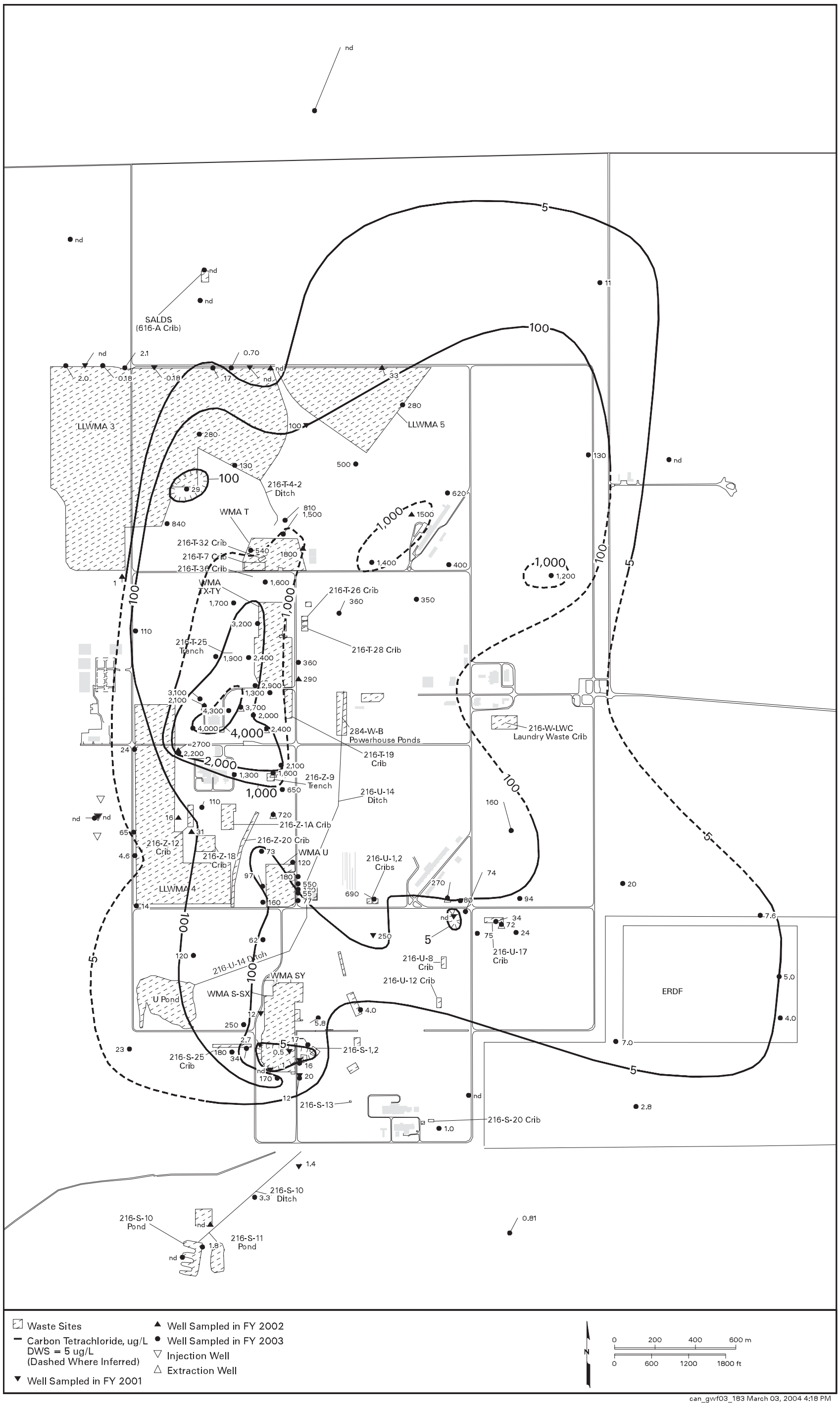

Figure 2.8-3. Average Carbon Tetrachloride Concentrations in 200 West Area, Top of Unconfined Aquifer

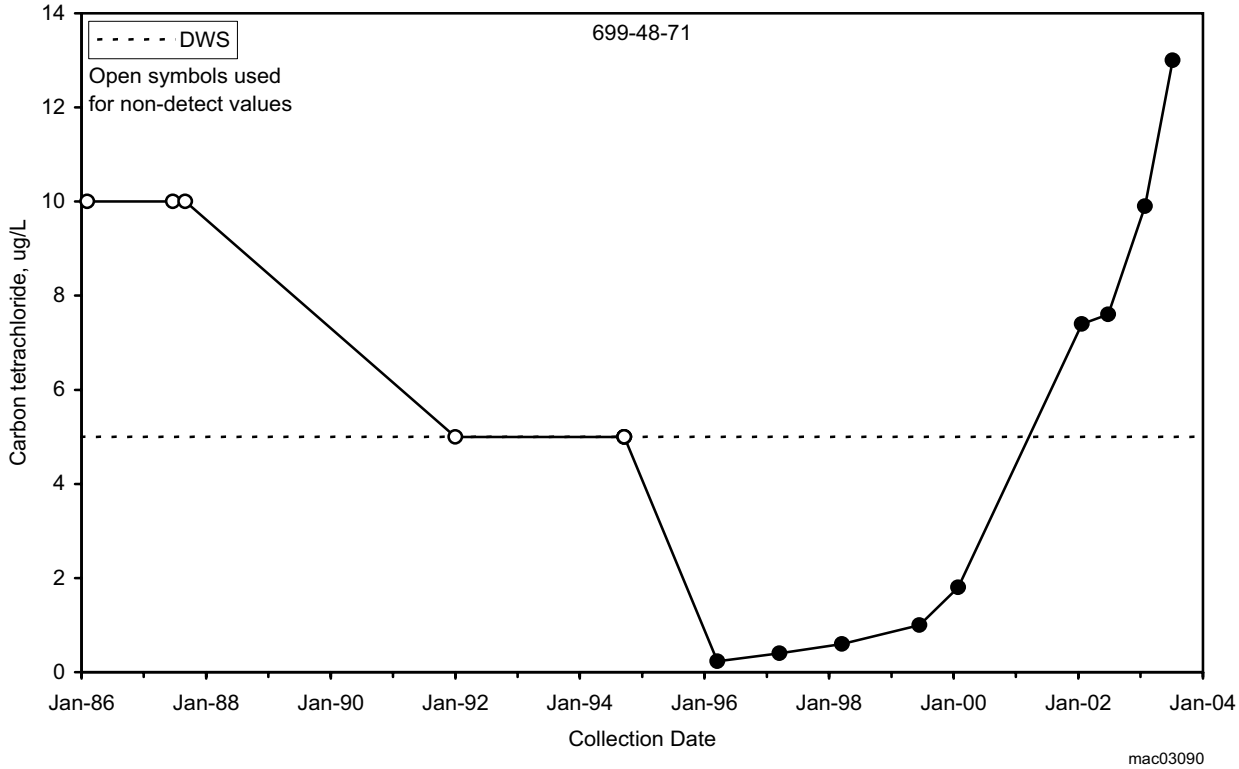

Figure 2.8-4. Carbon Tetrachloride Concentration Northeast of the 200 West Area in Well 699-48-71

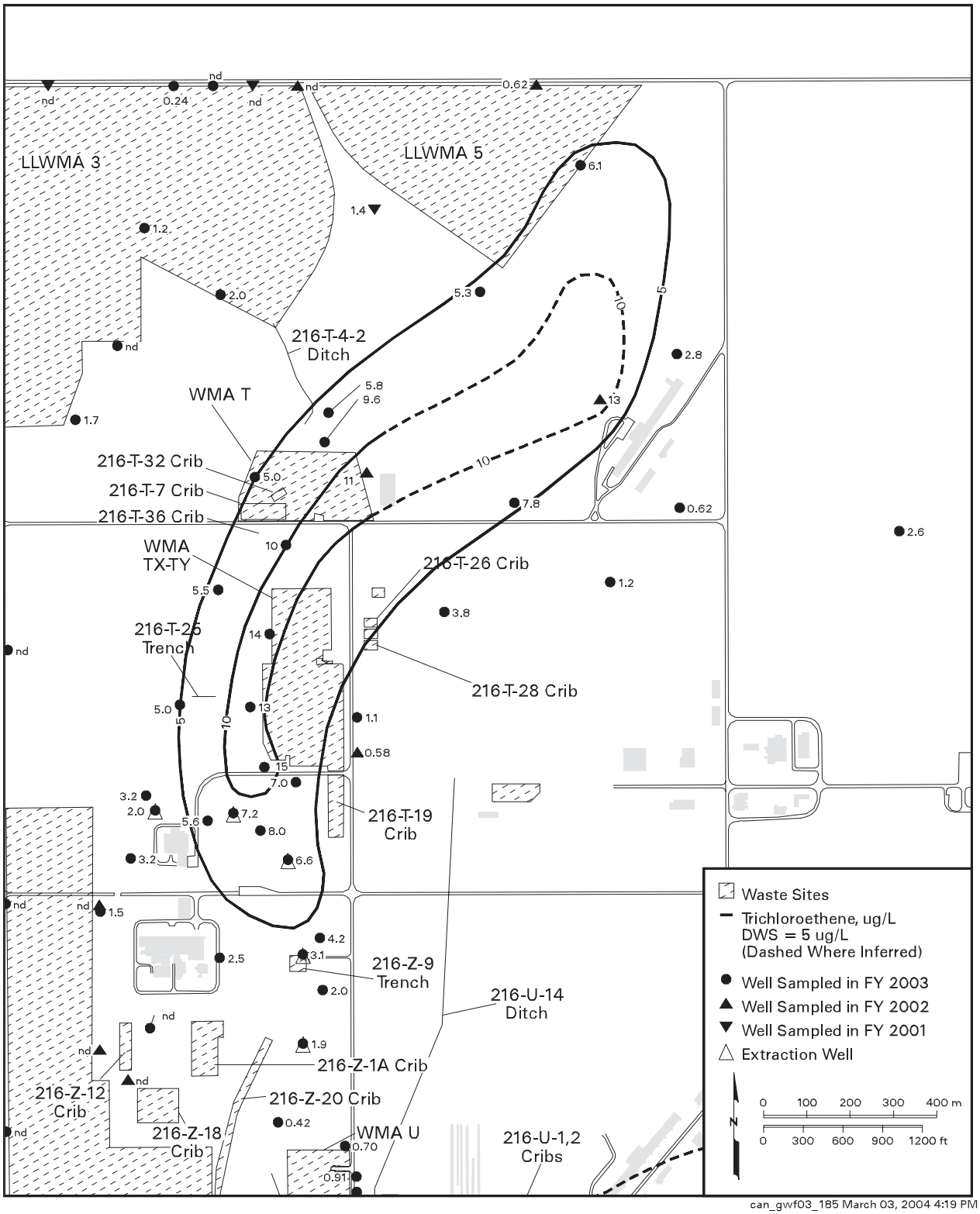

Figure 2.8-5. Average Trichloroethene Concentrations in Central and North 200 West Area, Top of Unconfined Aquifer

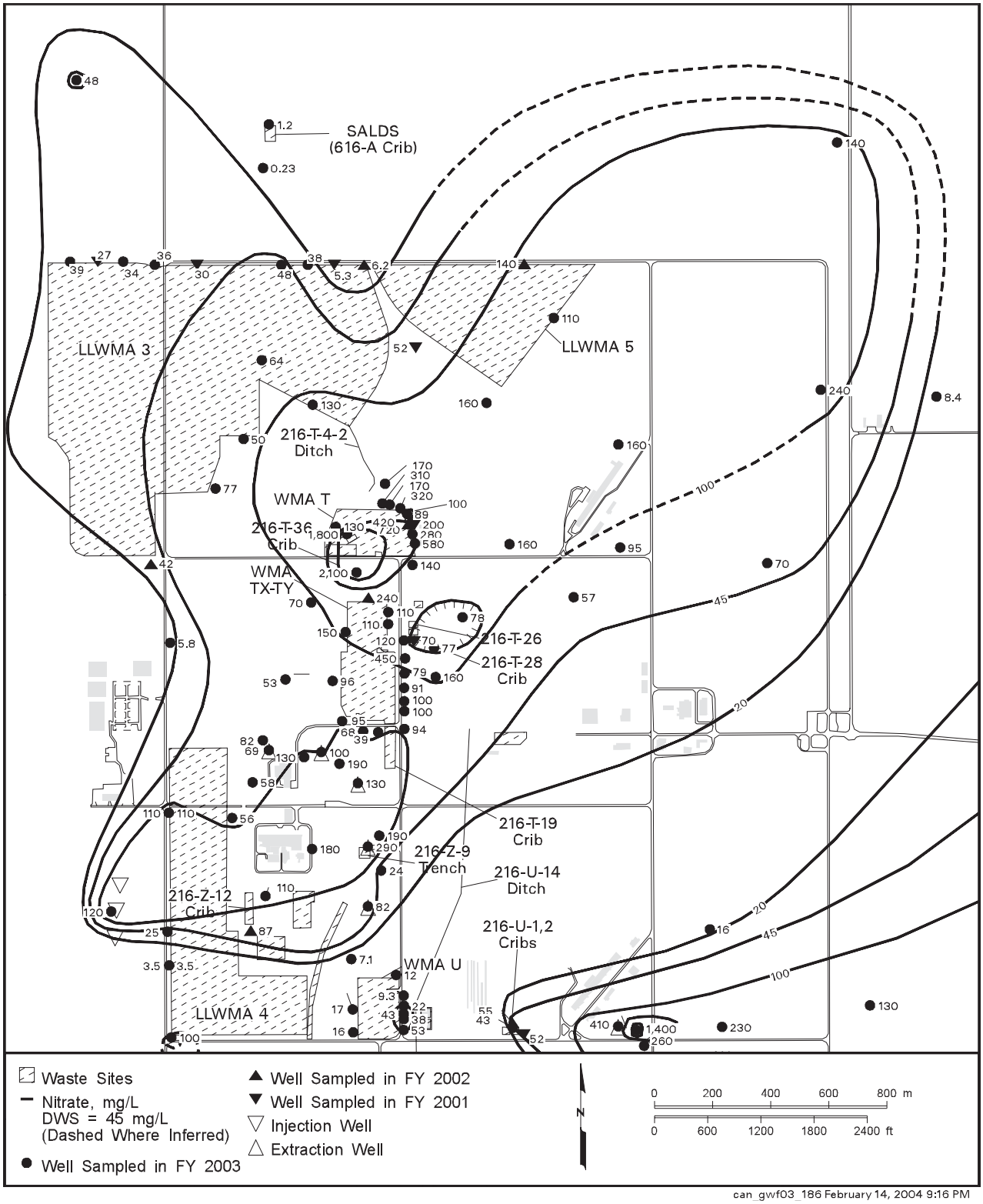

Figure 2.8-6. Average Nitrate Concentrations in the Central and North 200 West Area, Top of Unconfined Aquifer

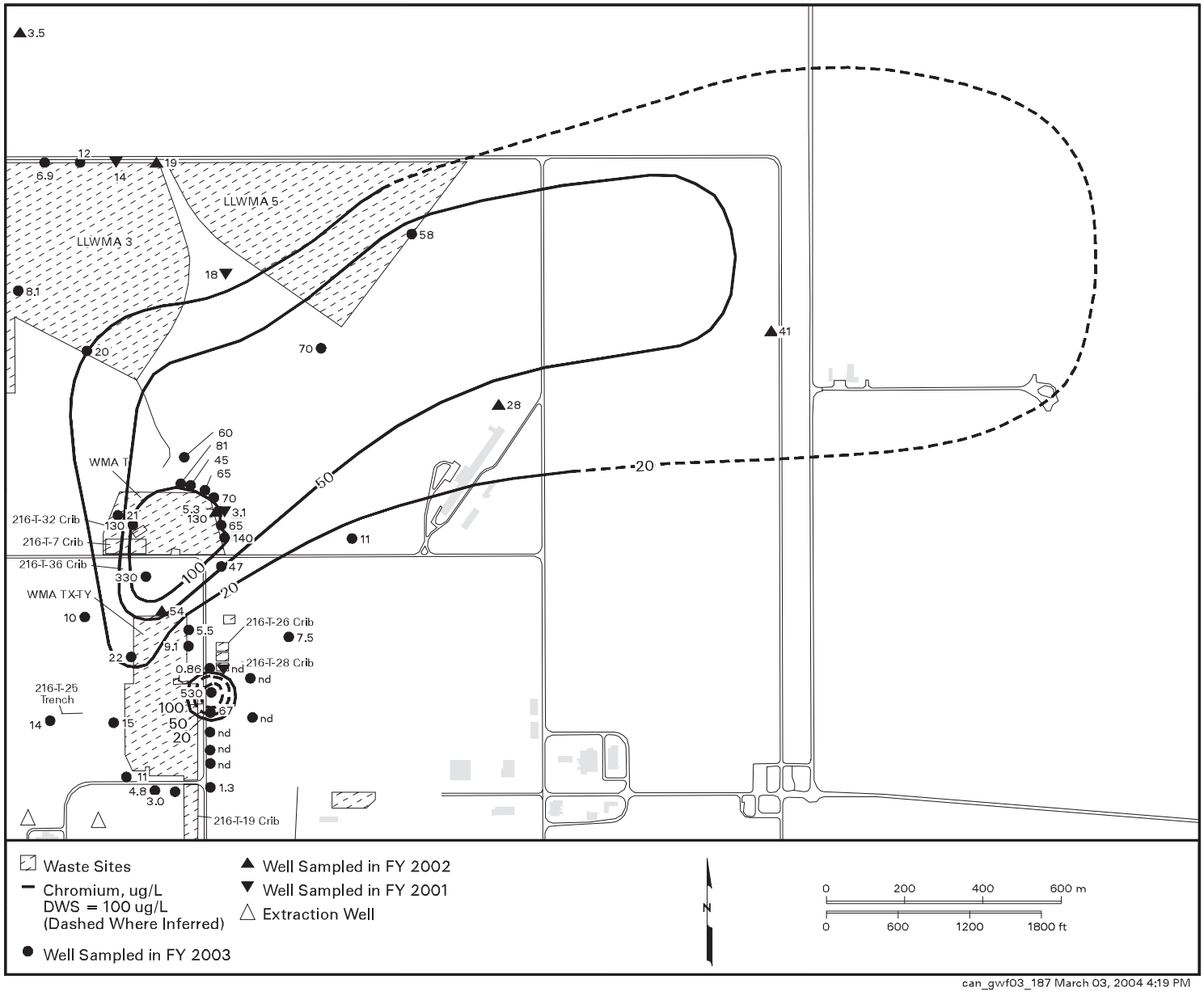

Figure 2.8-7. Average Dissolved Chromium Concentrations Near Waste Management Areas T and TX-TY, Top of Unconfined Aquifer

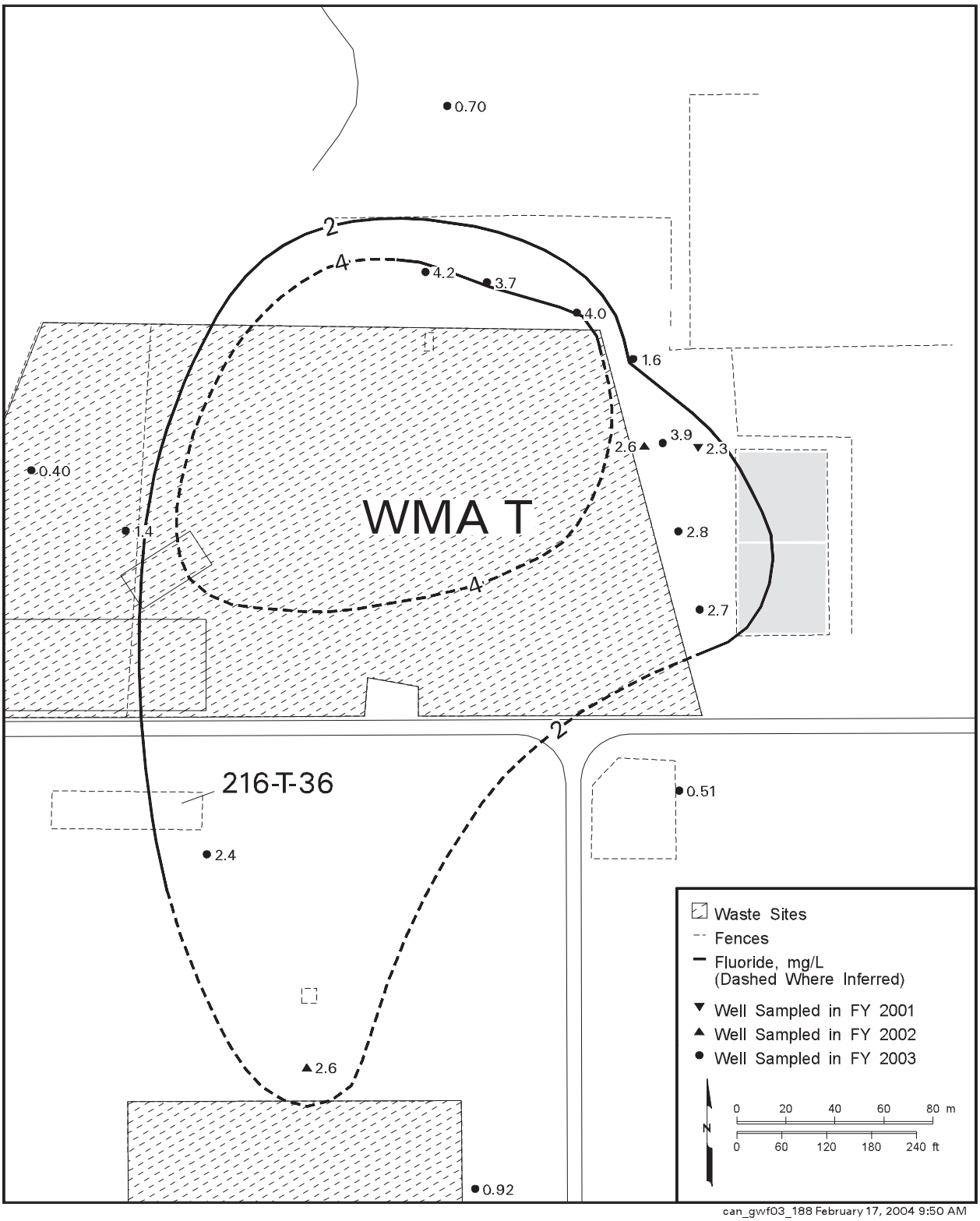

Figure 2.8-8. Average Fluoride Concentrations in North 200 West Area, Top of the Unconfined Aquifer

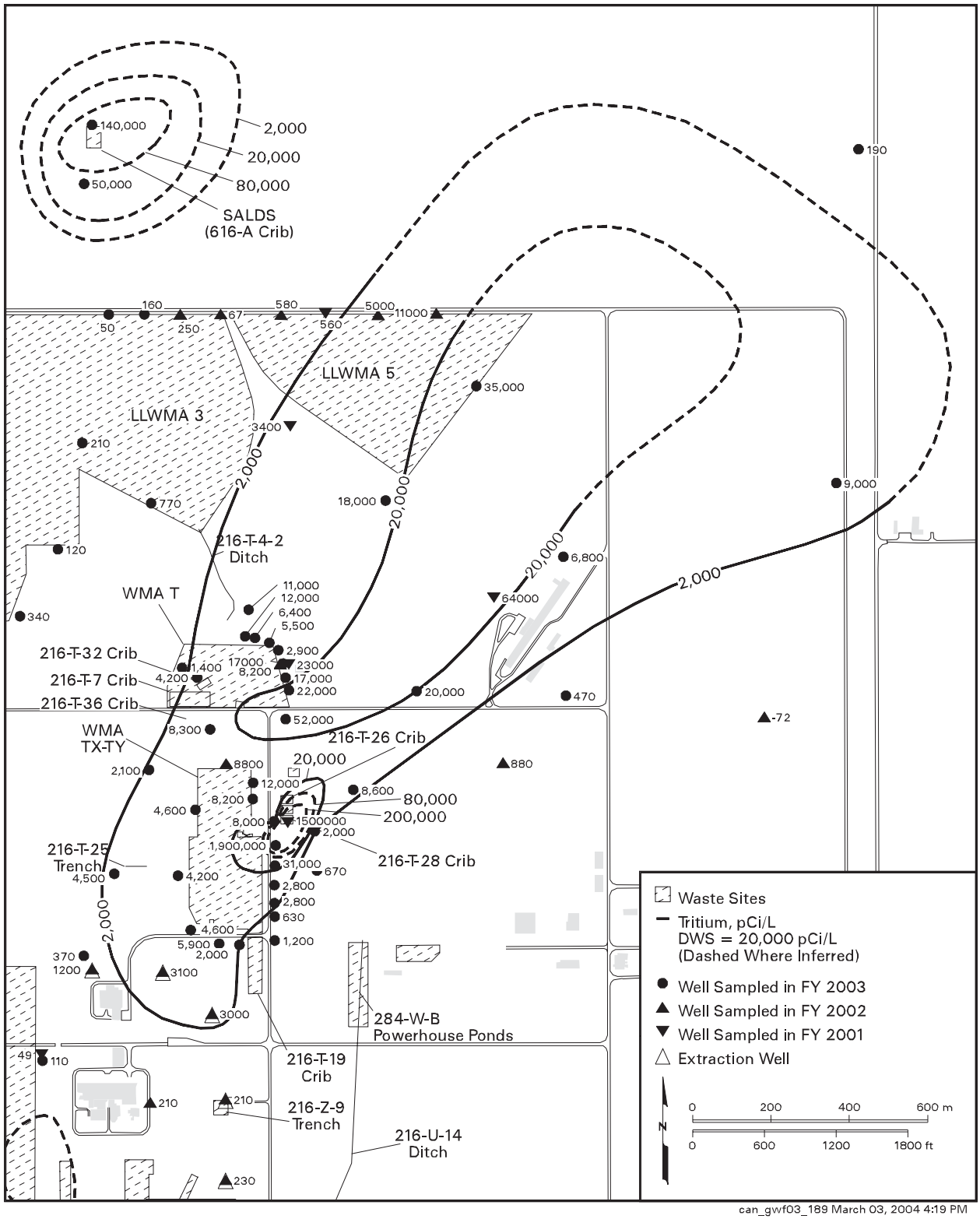

Figure 2.8-9. Average Tritium Concentrations in the North 200 West Area, Top of Unconfined Aquifer

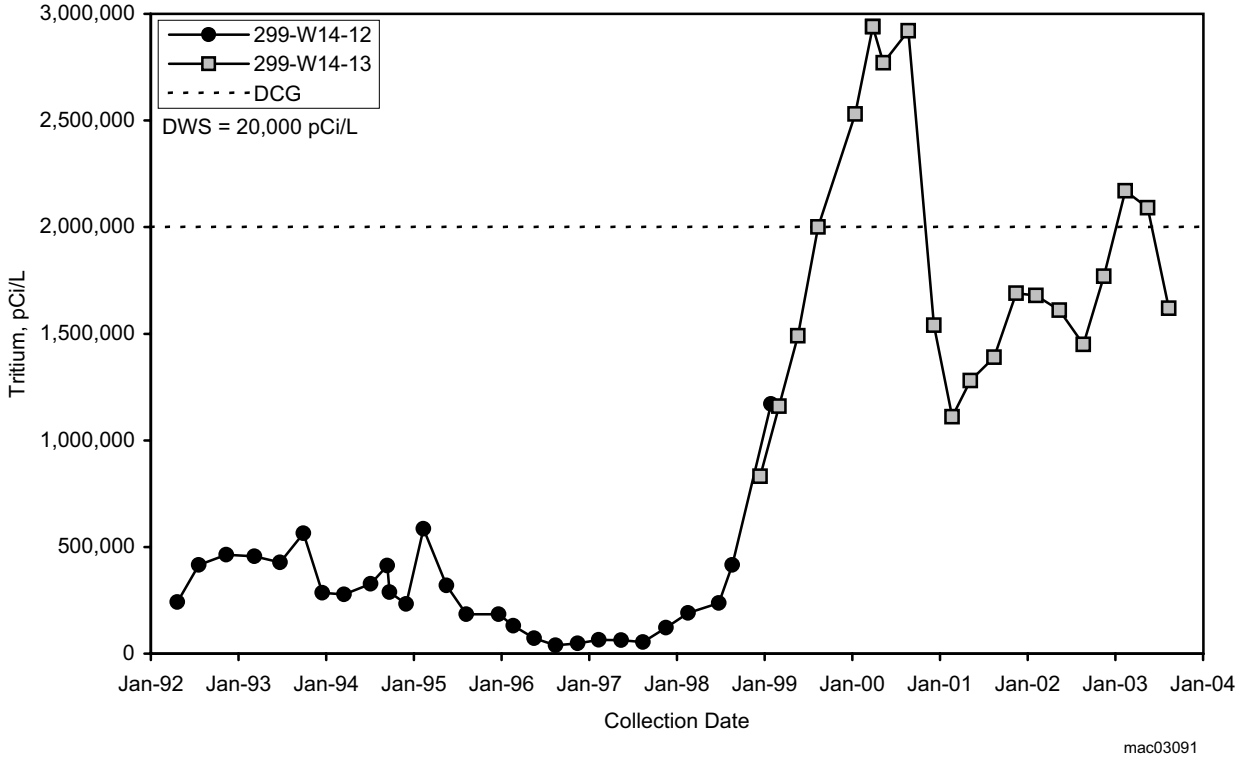

Figure 2.8-10. Tritium Concentrations versus Time in Wells 299-W14-12 and 299-W14-13 at Waste Management Area TX-TY

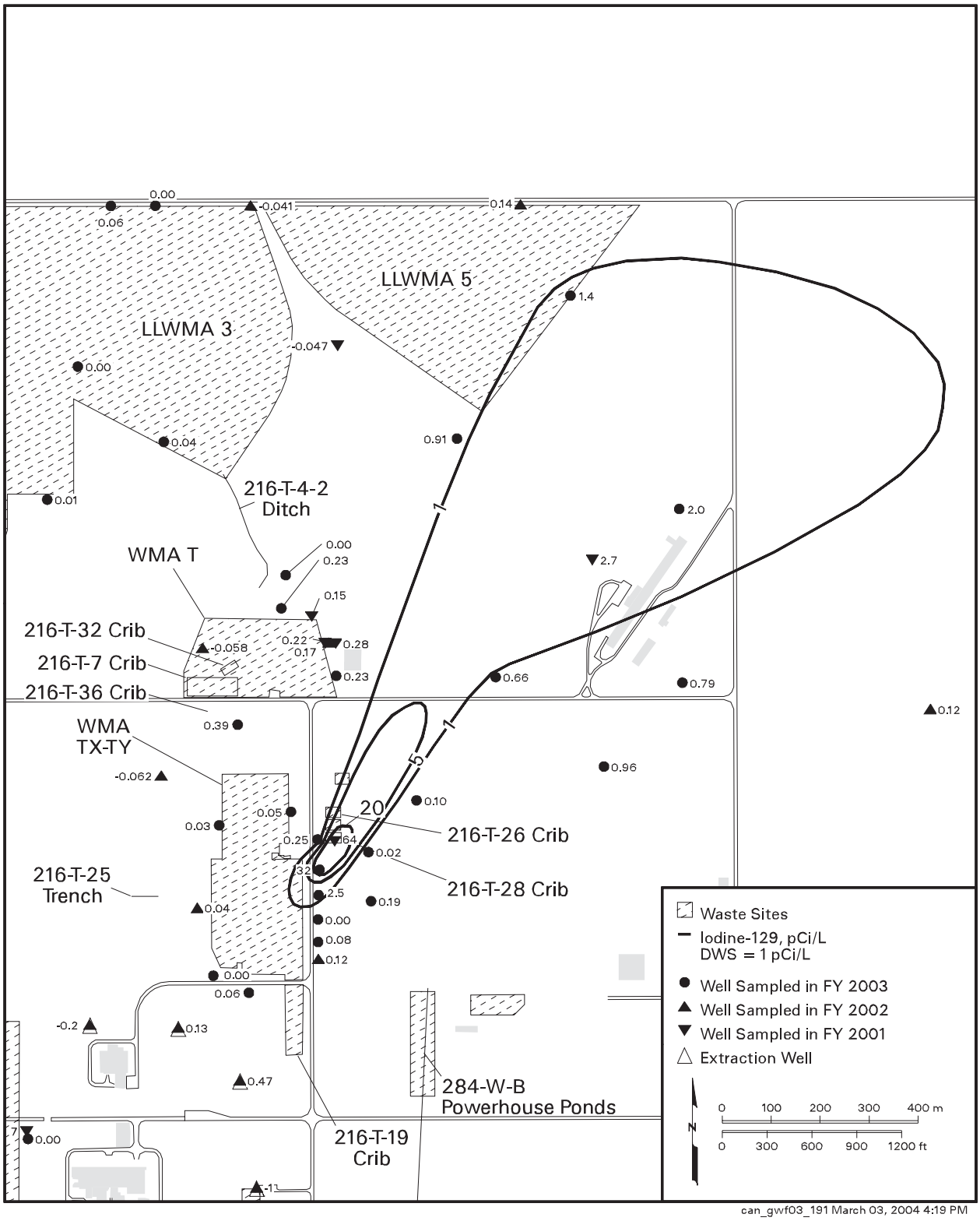

Figure 2.8-11. Average Iodine-129 Concentrations in the North 200 West Area, Top of Unconfined Aquifer

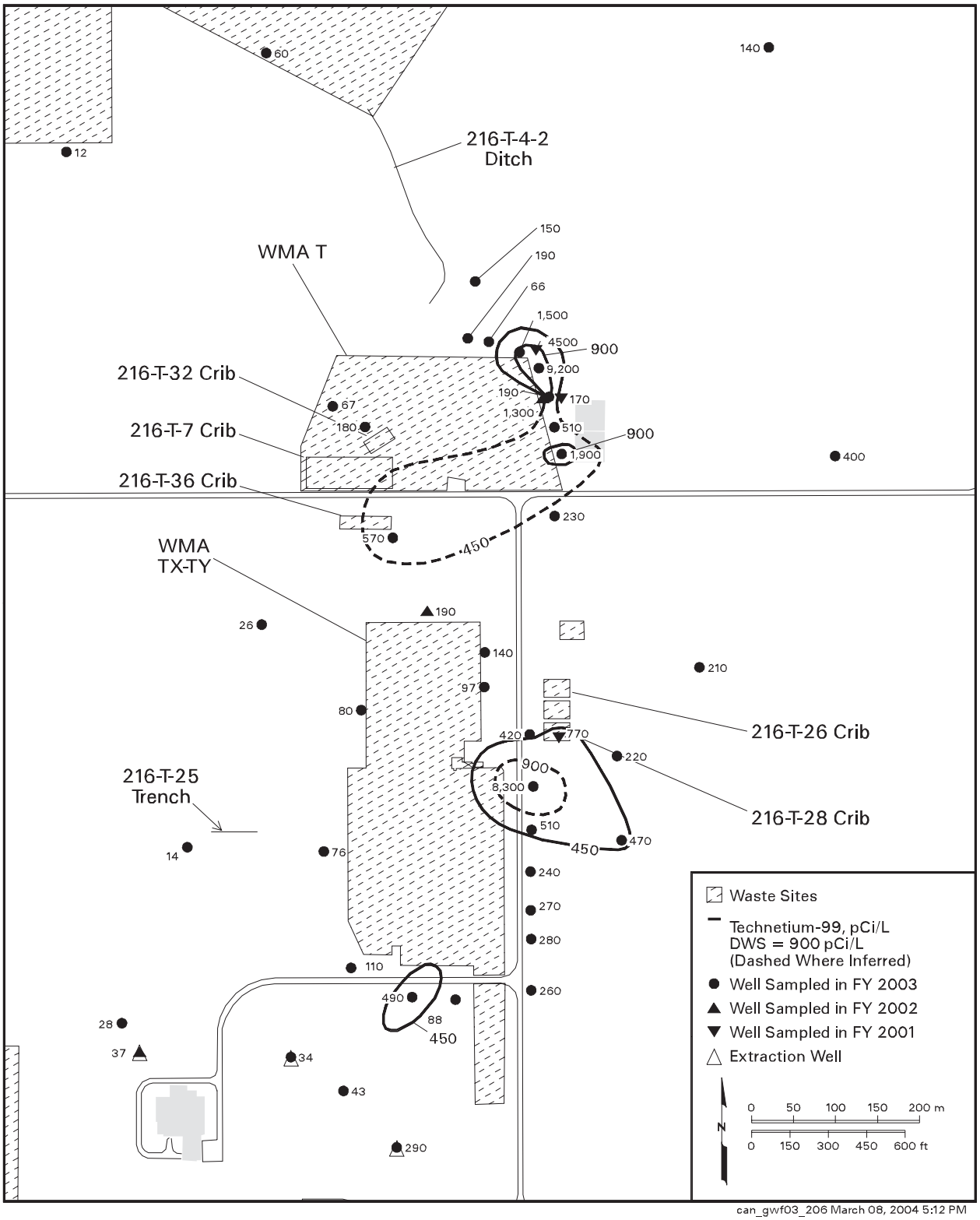

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Figure 2.8-12. Average Technetium-99 Concentrations in the North 200 West Area, Top of Unconfined Aquifer

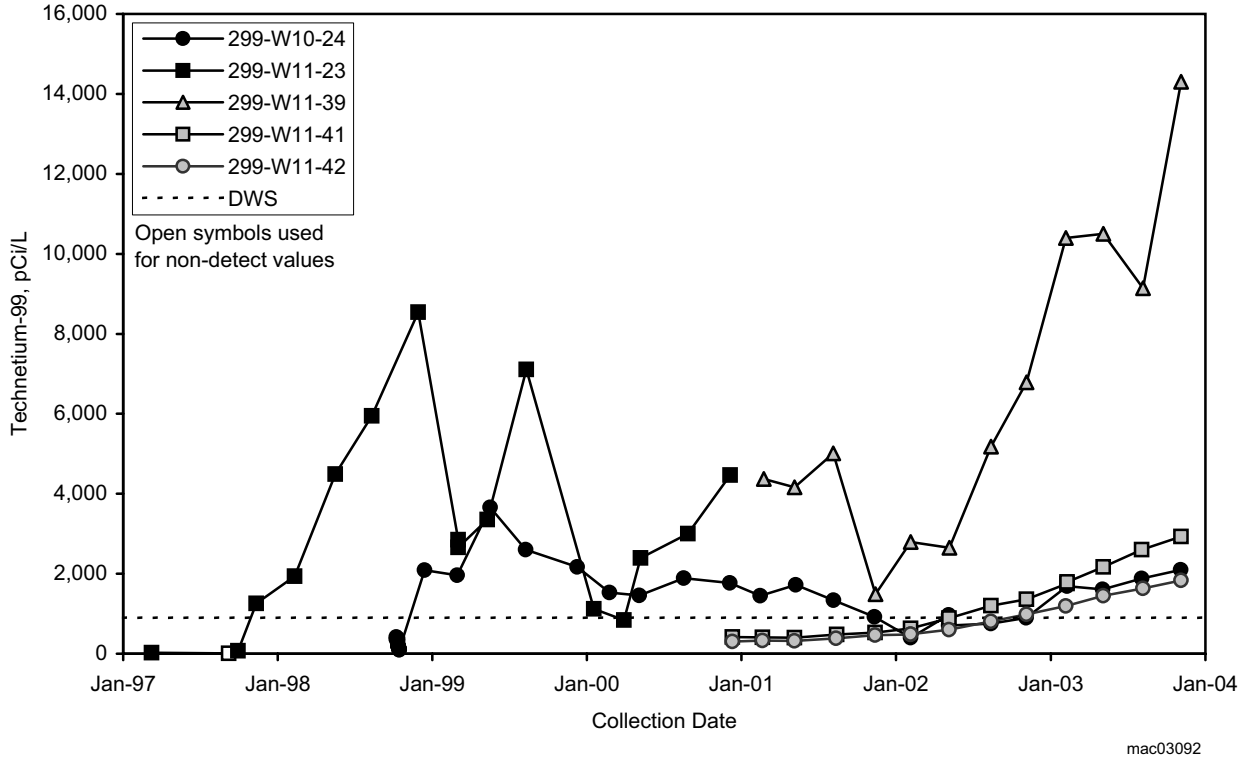

Figure 2.8-13. Technetium-99 Concentrations in Selected Wells at Waste Management Area T

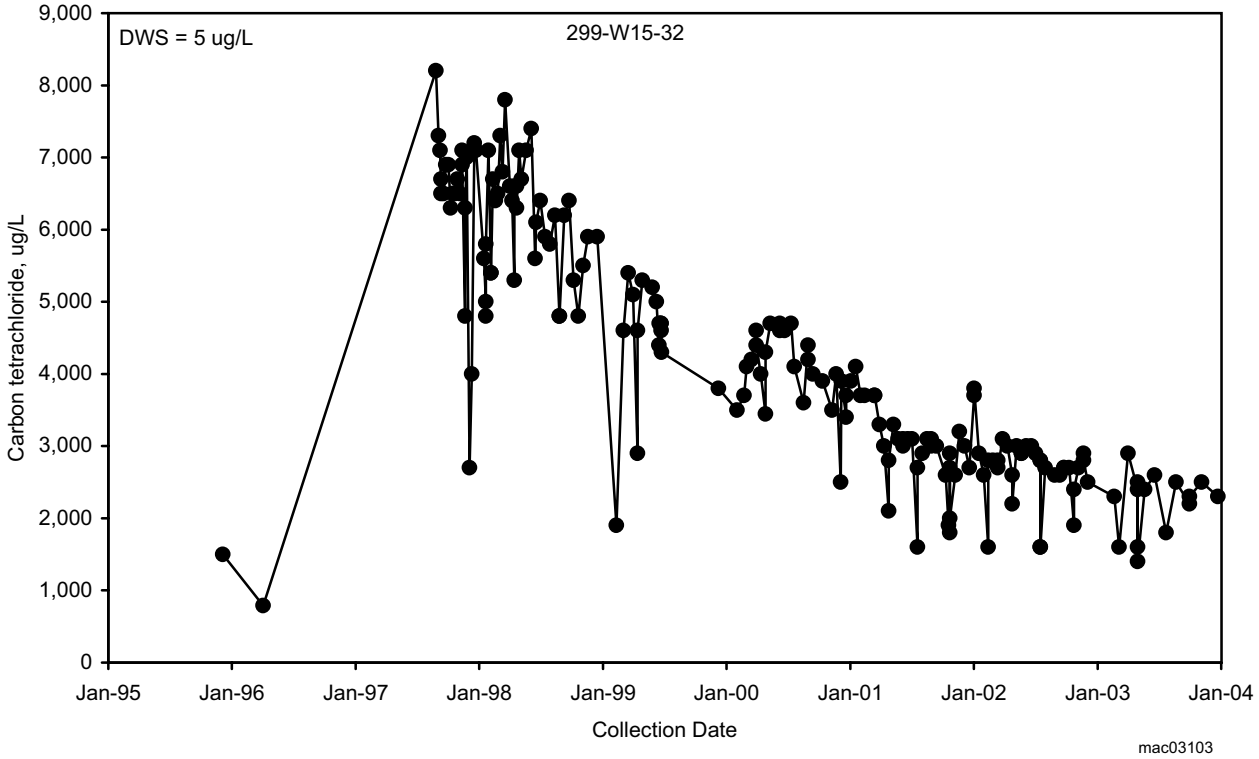

Figure 2.8-14. Carbon Tetrachloride Concentrations at Extraction Well 299-W15-32, Near the 216-Z-9 Trench

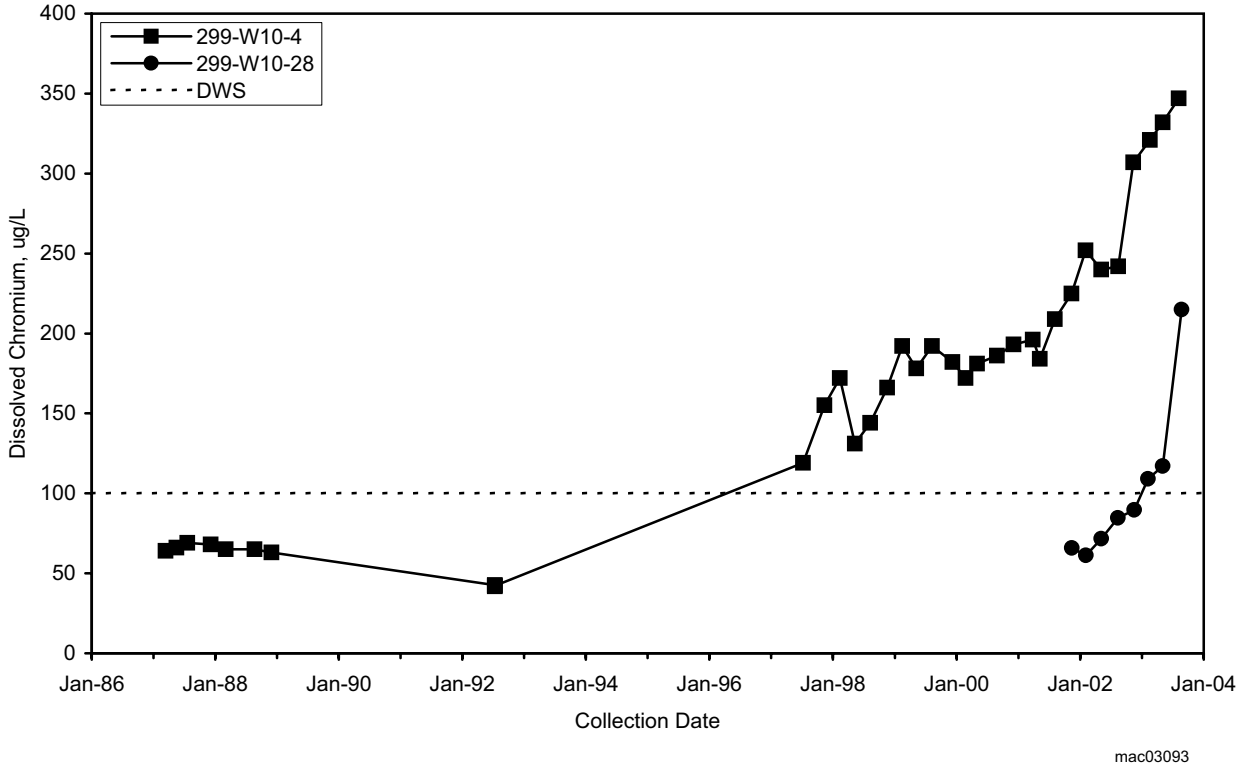

Figure 2.8-15. Chromium Concentrations versus Time for Selected Upgradient Wells at Waste Management Area T

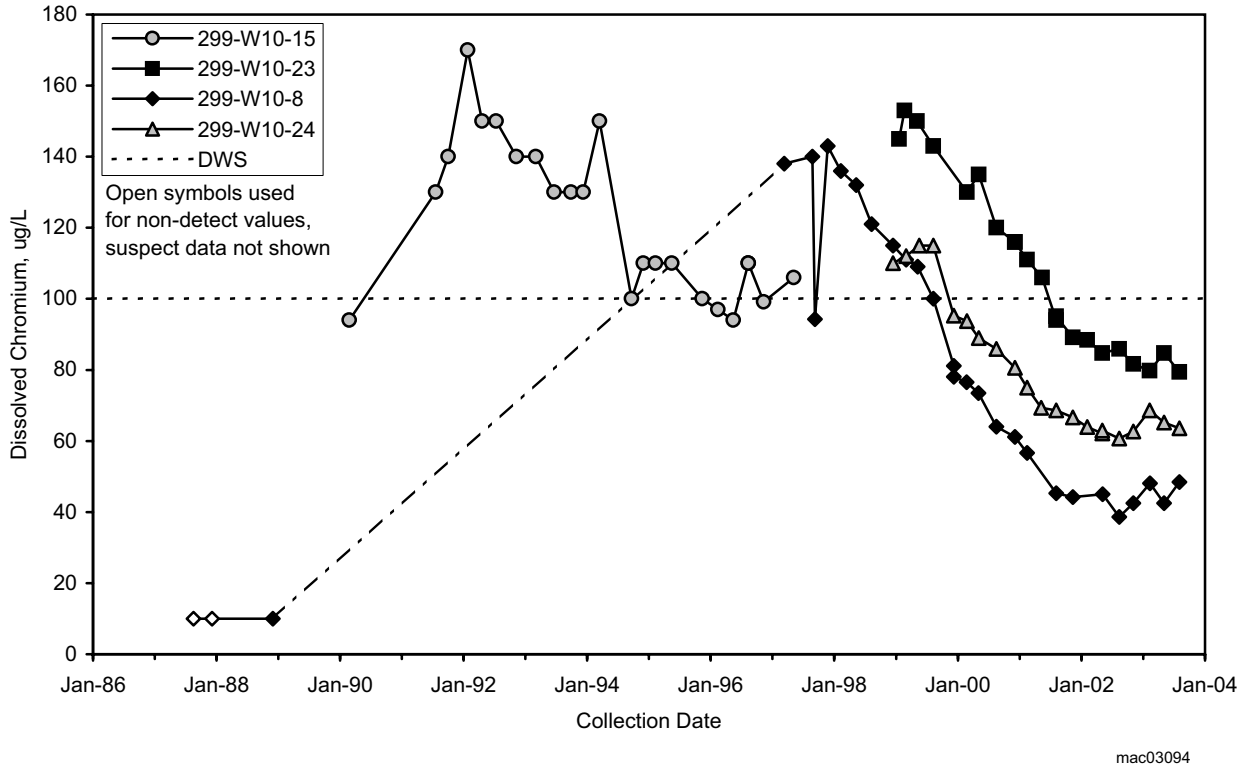

Figure 2.8-16. Chromium Concentrations versus Time for Selected Wells North of Waste Management Area T

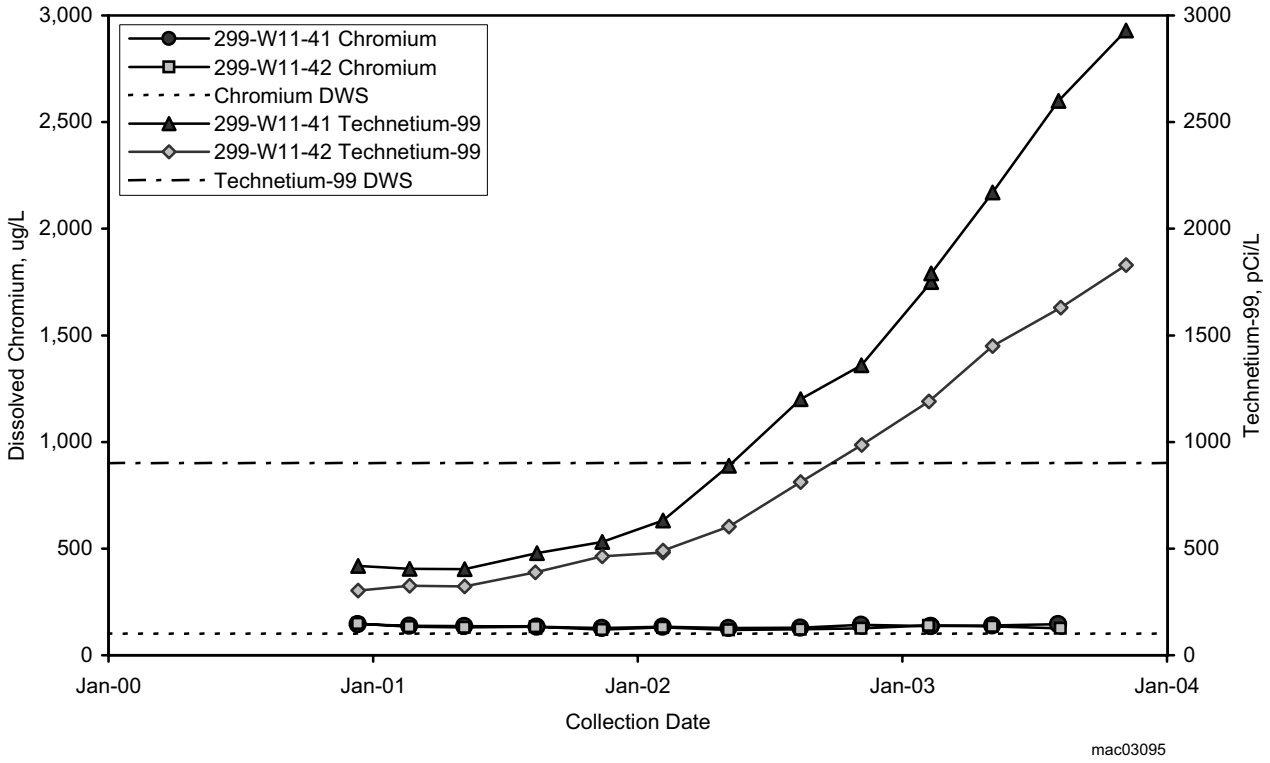

Figure 2.8-17. Chromium and Technetium-99 Concentrations versus Time for Selected Wells Downgradient of Waste Management Area T

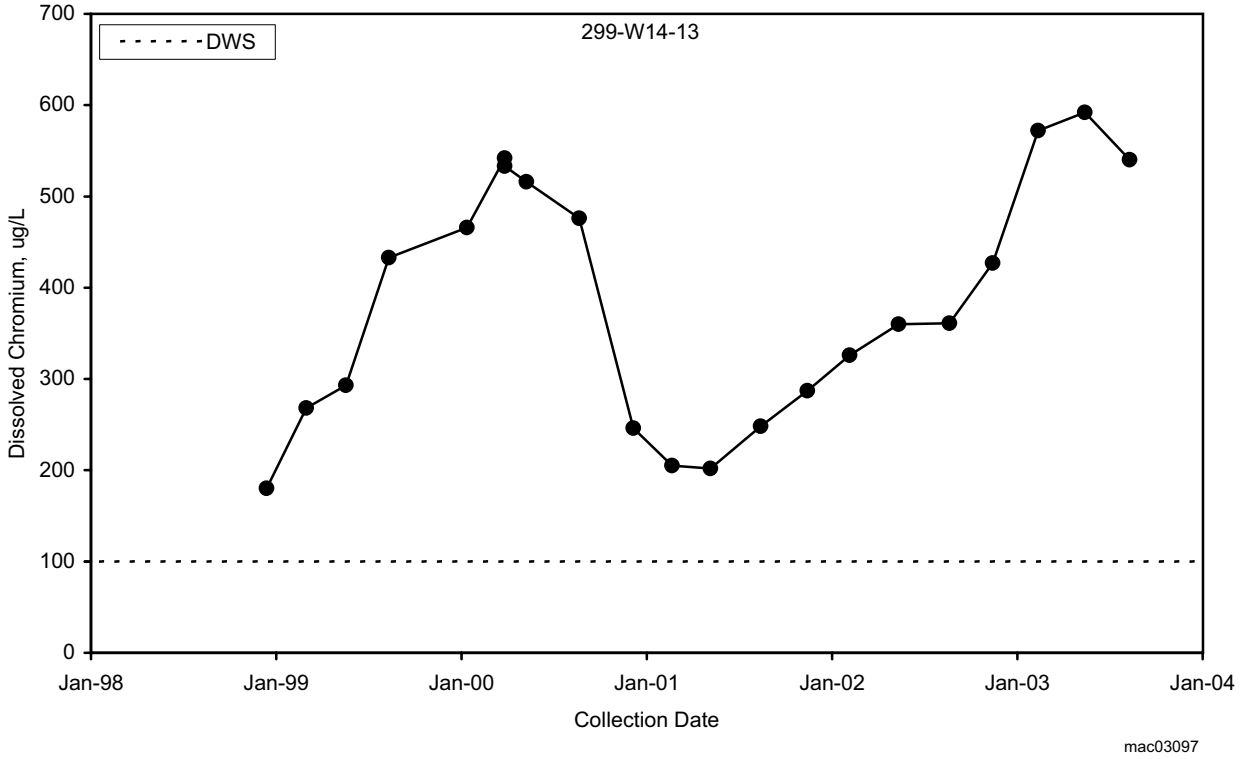

Figure 2.8-18. Chromium Concentrations in Well 299-W14-13, East of Waste Management Area TX-TY

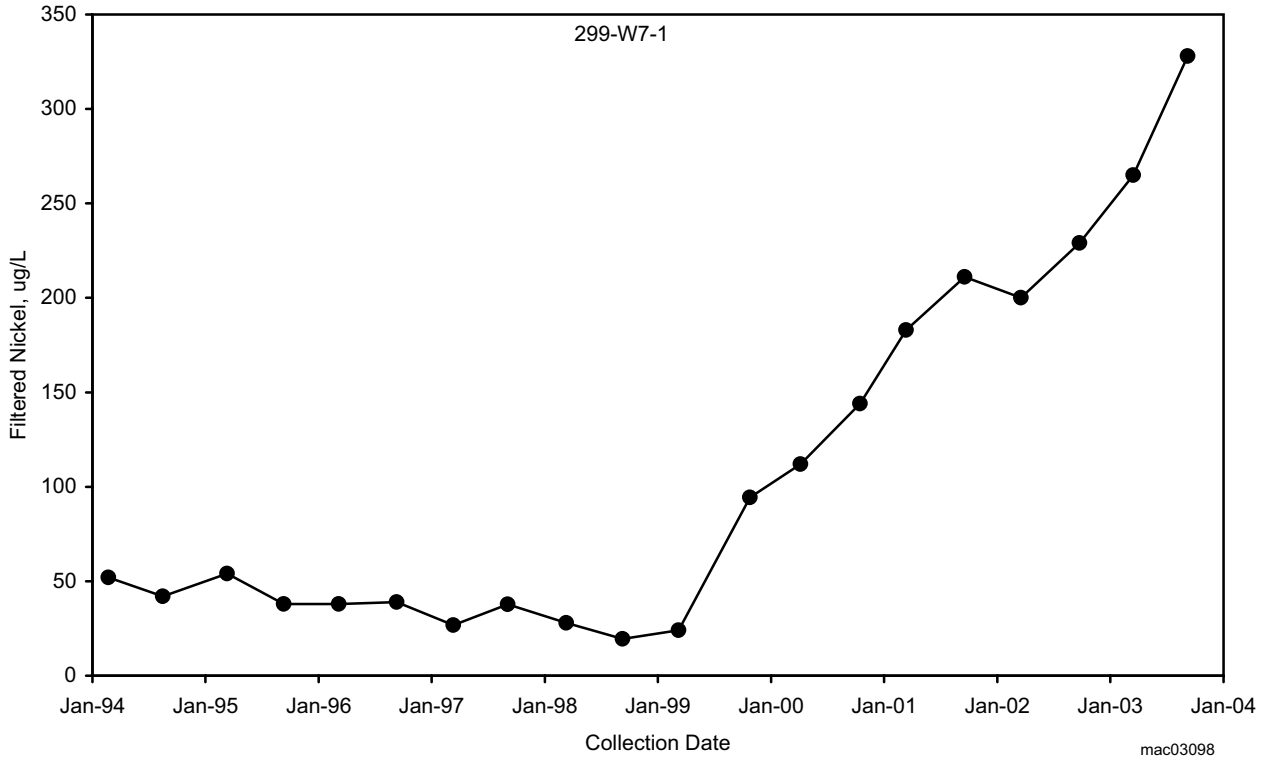

Figure 2.8-19. Nickel Concentrations in Well 299-W7-1, North of Low-Level Waste Management Area 3

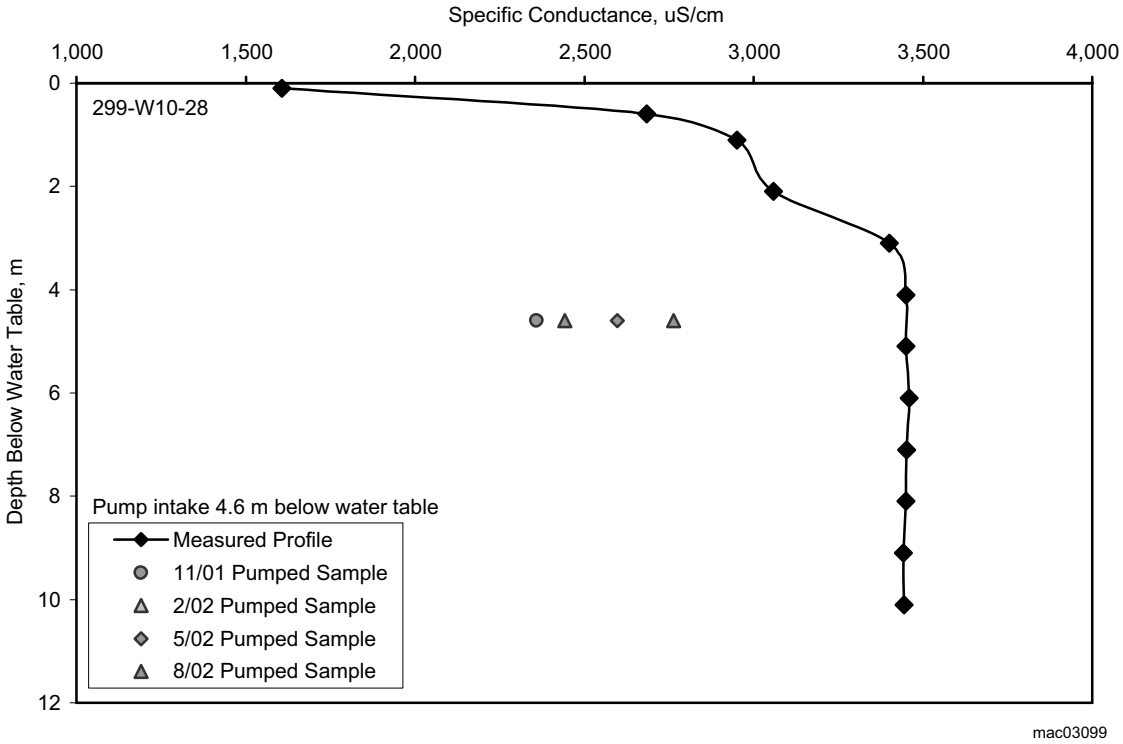

Figure 2.8-20. Specific Conductance versus Depth Below the Water Table in Well 299-W10-28

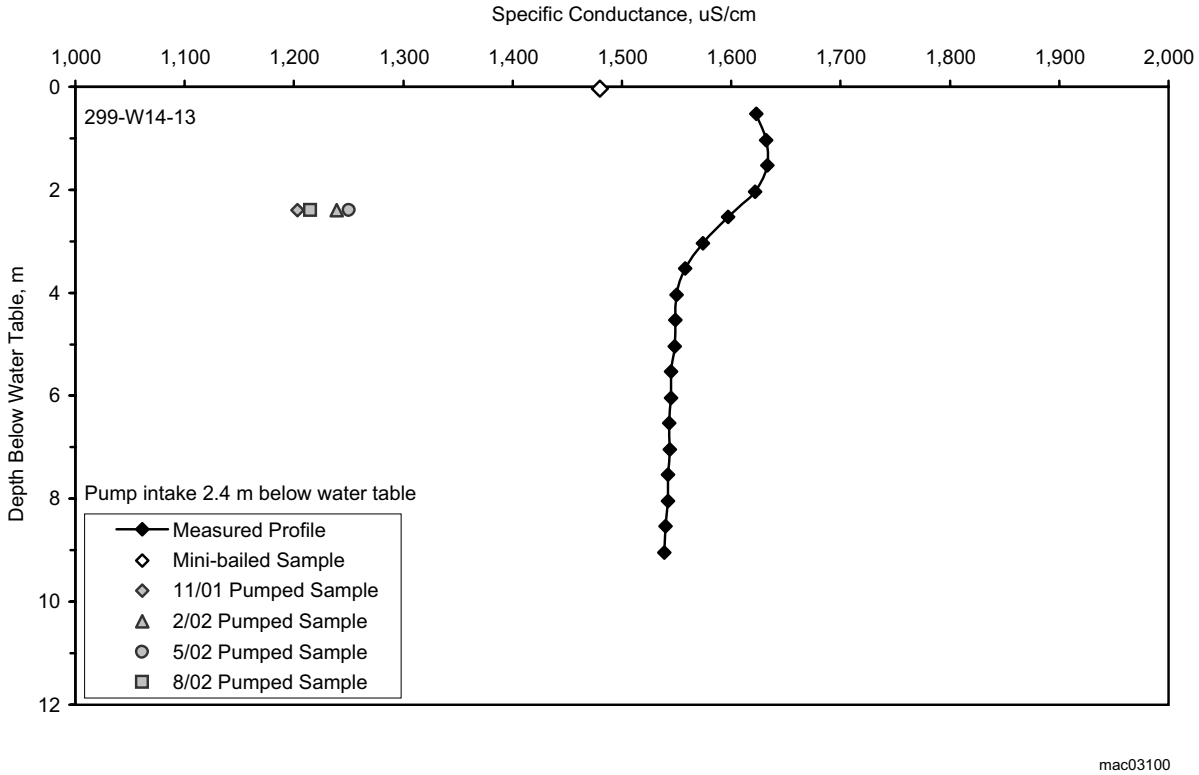

Figure 2.8-21. Specific Conductance versus Depth in the Screened Interval of Well 299-W14-13

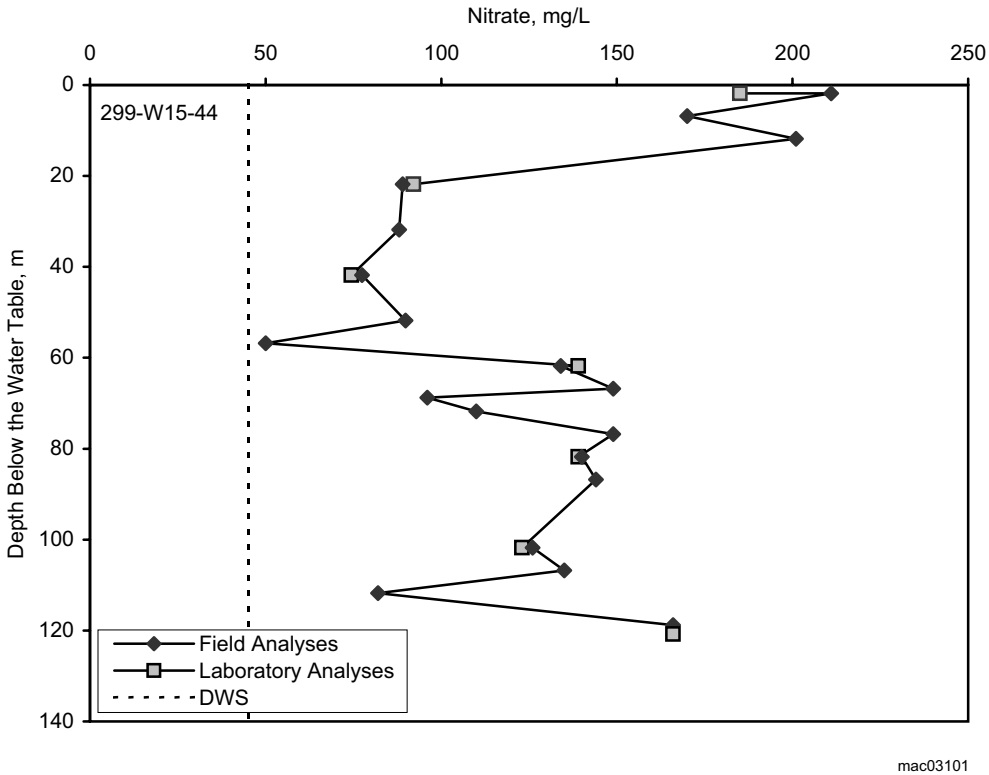

Figure 2.8-22. Nitrate Concentration in Groundwater Samples Collected During Drilling of New RCRA Well 299-W15-44, Waste Management Area TX-TY

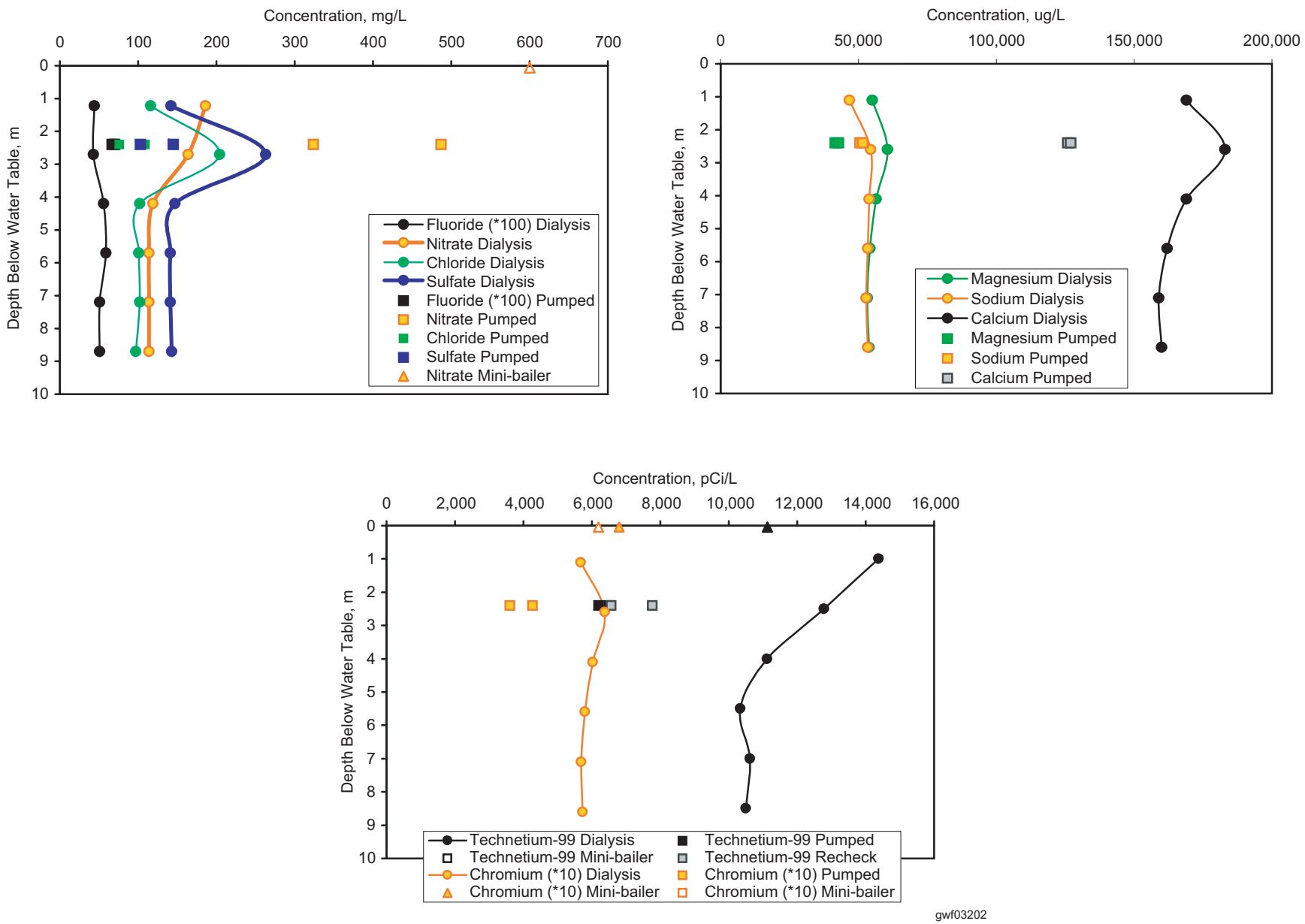

Figure 2.8-23. Concentrations of Selected Constituents versus Depth in the Screened Interval of Well 299-W14-13 at Waste Management Area TX-TY

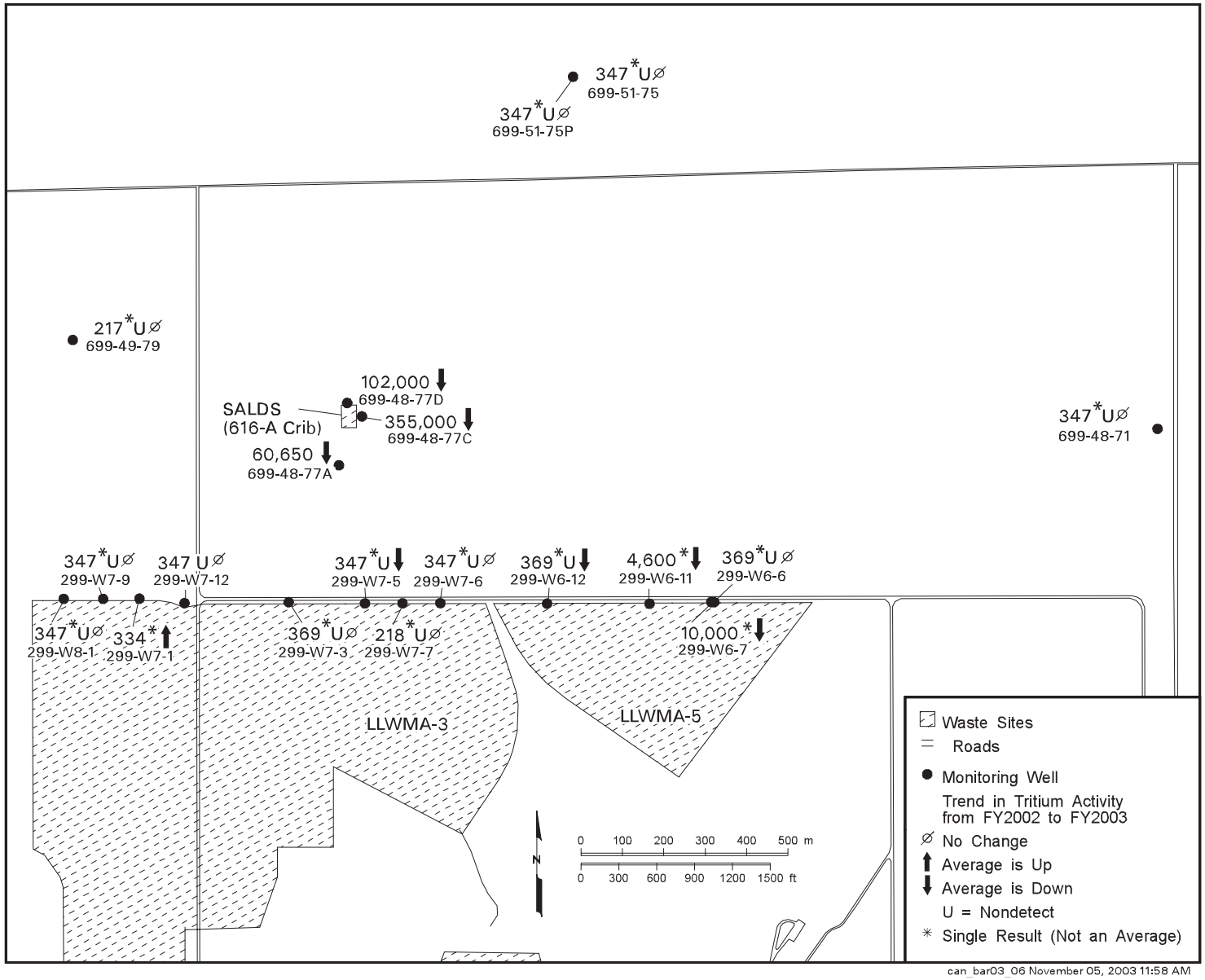

Figure 2.8-24. Tritium Concentrations in Groundwater for the SALDS Tritium-Tracking Network, Fiscal Year 2003, Indicating Change from Fiscal Year 2002 Results. (As indicated in the legend, these results are either averages for fiscal year 2003 or single results, i.e., sampled only once.)