

2.9 200-UP-1 Operable Unit

J. P. McDonald, D. B. Erb, R. M. Smith, R. L. Weiss, and B. A. Williams

The scope of this section is the 200-UP-1 groundwater interest area, which includes the 200-UP-1 groundwater operable unit (Figure 2.1-1). Figure 2.9-1 shows facilities and groundwater monitoring wells in this region. Technetium-99, uranium, tritium, iodine-129, nitrate, and carbon tetrachloride are the contaminants of greatest significance in groundwater and form extensive plumes within the region. Groundwater is monitored (1) to assess the performance of an interim action pump-and-treat system for technetium-99 and uranium; (2) to track existing contaminant plumes within the operable unit; (3) for the Environmental Restoration Disposal Facility under a *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA)^(a) record of decision (ROD 1995b); and (4) for the *Resource Conservation and Recovery Act* (RCRA) units at Waste Management Areas S-SX and U, 216-U-12 crib, and 216-S-10 pond and ditch. In addition to the above mentioned plumes, contaminants of concern include strontium-90, trichloroethene, chloroform, chromium, cadmium, and arsenic. While not listed as a contaminant of concern, 1,4-dioxane was detected in groundwater in this region during fiscal year 2003.

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

CERCLA Monitoring

- *Four wells are sampled annually at the pump-and-treat area.*
- *Three extraction wells are sampled annually and semiannually at the pump-and-treat area.*
- *One newly installed monitoring well is sampled quarterly at the pump-and-treat area.*
- *Twenty-nine wells are sampled annually, semiannually, and biennially for 12 constituents of concern throughout the remainder of the 200-UP-1 Operable Unit (outside of the pump-and-treat area).*
- *Four wells are sampled semiannually at the Environmental Restoration Disposal Facility.*
- *In fiscal year 2003, three wells were not sampled as scheduled because they were dry (see Appendix A).*

RCRA Monitoring

- *Two wells are sampled quarterly at the 216-U-12 crib.*
- *Eight wells are sampled quarterly at Waste Management Area U.*
- *Sixteen wells are sampled quarterly at Waste Management Area S-SX.*
- *Four wells are sampled semiannually, including one newly installed well, for the 216-S-10 pond and ditch.*
- *In fiscal year 2003, one well (299-W26-7) was not sampled as scheduled because it was dry (see Appendix B).*
- *Sampling is coordinated with other programs to avoid duplication.*

AEA Monitoring

- *Four wells are sampled annually for contaminants, radionuclides, and general chemistry not otherwise scheduled under CERCLA and RCRA.*
- *In fiscal year 2003, one well (699-37-82A) was not sampled as scheduled because it was dry.*
- *Sampling is coordinated with CERCLA and RCRA sampling to avoid duplication.*

(a) Past-practice monitoring in this operable unit is regulated under RCRA past-practice, which follows the same groundwater monitoring activities as CERCLA. This report uses the term CERCLA for simplicity.

Groundwater flows primarily to the east within the 200-UP-1 groundwater interest area (Figure 2.8-2). Water levels have been falling in this area since the 1980s, and flow directions have changed from southeast to east during this time. From March 2002 to March 2003, the water-table elevation fell by an average of 0.21 meter. Groundwater flow is not significantly influenced by the pump-and-treat system at the 200-UP-1 operable unit. There are only two extraction wells associated with this system, so the hydraulic effect is localized.

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

2.9.1 Groundwater Contaminants

The following sections give an overview of the contaminant plumes and contaminants of concern for the 200-UP-1 groundwater interest area. It is a summary of the combined results of CERCLA, RCRA, and AEA monitoring performed in this area.

2.9.1.1 Technetium-99

Technetium-99 occurs in two regions of the 200-UP-1 groundwater interest area: an extensive plume downgradient from the 216-U-1,2 cribs and two small plumes at Waste Management Area S-SX (Figure 2.9-2). The large plume originated from the 216-U-1,2 cribs, which were active in the 1950s and 1960s. When effluent was disposed at the nearby 216-U-16 crib in the mid-1980s, it migrated north along a caliche layer and mobilized the technetium-99 and uranium in the soil column beneath the 216-U-1,2 cribs further adding to the plume. During fiscal year 2003, concentrations continued to decline in this plume due to the operation of an interim remedial action pump-and-treat system. The maximum annual average concentration associated with this plume was 11,000 pCi/L found in well 299-W19-43 (the maximum annual average during fiscal year 2002 was 18,000 pCi/L). This well replaced well 299-W19-36 as an extraction well in May 2003. By the end of the fiscal year, all measured concentrations in this plume were below the remedial action objective of 9,000 pCi/L. At well 699-38-70, downgradient of the pump-and-treat system, the technetium-99 concentration fell below the drinking water standard (900 pCi/L), which suggests that the pump-and-treat system has been successful at hydraulically containing the high concentration portion of this plume. Refer to Section 2.9.2 for a more thorough discussion of this technetium-99 plume and the pump-and-treat remediation system.

At Waste Management Area S-SX, a narrow plume of technetium-99 originates from the southwest corner of the waste management area. During the fiscal year, technetium-99 concentrations at well 299-W23-19 (at the southwest corner of this waste management area near the source of this plume) rose above the U.S. Department of Energy (DOE) derived concentration guide of 100,000 pCi/L (Figure 2.9-3). The peak concentration during the year was 188,000 pCi/L measured in January (the highest technetium-99 concentration in groundwater ever measured at Hanford), and the annual average concentration was 118,000 pCi/L. By the end of the fiscal year, the concentration had fallen to ~75,000 pCi/L, which is below the DOE derived concentration guide. This plume continues to migrate to the east-southeast. The front of the plume has entered a region of sparse well coverage and cannot be tracked further. Refer to Section 2.9.4.2 for more information about this technetium-99 plume.

2.9.1.2 Uranium

Within the 200-UP-1 groundwater interest area, uranium primarily occurs in an extensive plume downgradient from the 216-U-1,2 cribs (Figure 2.9-4). The plume extends a total of ~1.5 kilometers to the east and northeast. The uranium originated from the 216-U-1,2

Technetium-99 concentrations declined downgradient of the 216-U-1,2 cribs due to the effects of a pump-and-treat system.

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

Chromium — 1.08
Iodine-129 — 4.74
Nitrate — 6.88
Strontium-90 — <0.01
Technetium-99 — 0.05
Trichloroethene — 0.07
Tritium — 8.21
Uranium — 0.66

**Carbon tetrachloride included in Section 2.8.*

cribs, which were active in the 1950s and 1960s. Additional mass was added to the plume when effluent disposed of at the nearby 216-U-16 crib in the mid-1980s migrated north along a caliche layer and mobilized the technetium-99 and uranium in the soil column beneath the 216-U-1,2 cribs.

An interim remedial action pump-and-treat system continued to operate during fiscal year 2003, and measured concentrations in this plume generally declined or remained stable. By the end of the fiscal year, measured uranium concentrations were at or below the remedial action objective of 480 µg/L for all wells within the pump-and-treat area, although additional data are needed to confirm these trends. The maximum annual average concentration associated with this plume during fiscal year 2003 was 835 µg/L in well 299-W19-43 (the maximum annual average during fiscal year 2002 was 1,720 µg/L in well 299-W19-36). By July 2003, the measured concentration at well 299-W19-43 was down to 480 µg/L. Due to the tendency for uranium to sorb to soil particles, uranium concentrations are not falling as rapidly as the technetium-99 concentrations have, and all measured uranium concentrations remain above the drinking water standard (30 µg/L).

A small uranium plume is depicted in Figure 2.9-4 beneath the 216-S-13 crib. This facility was active in the 1950s and 1960s, resulting in significantly high uranium concentrations in well 299-W22-21, which monitored the groundwater beneath the crib. This well was periodically sampled up until 1997, but has since gone dry. Uranium concentrations in this well were frequently above the drinking water standard, suggesting residual uranium was leaching from the soil column beneath this crib. It is reasonable to assume this leaching continues.

2.9.1.3 Tritium

Disposal facilities associated with the Reduction Oxidation (REDOX) Plant are the primary sources of tritium in the 200-UP-1 groundwater interest area. The REDOX Plant operated from 1952 until 1967, although effluent releases continued to occur after this time. A large tritium plume emanates from the south part of the 200 West Area to the east and northeast (extending ~4 kilometers), and a small tritium plume extends ~550 meters to the east-southeast from the vicinity of the 216-S-25 crib (Figure 2.9-5).

Eleven wells within the large plume were sampled for tritium during fiscal year 2003; concentrations declined in seven of the wells, increased in three, and were unchanged in one. The overall picture is of a plume that has nearly stopped spreading in most directions and is contracting in some areas as radioactive decay dominates over advective transport. At the east edge of the plume, concentrations increased in well 699-36-61A (from 49,400 pCi/L in fiscal year 2000 to 52,900 pCi/L in fiscal year 2003) indicating that the plume is continuing to move farther east, although at a slow rate. Movement within this plume is slow because of low-permeability sediment in the aquifer. Along the north and central parts of the plume, concentrations declined during the fiscal year. The peak concentration measured in this plume during the fiscal year was 634,000 pCi/L in well 299-W22-9, which is down from 914,000 pCi/L in the same well the year before. (The tritium drinking water standard is 20,000 pCi/L, and the DOE derived concentration guide is 2 million pCi/L.)

The tritium plume from the vicinity of the 216-S-25 crib continues to migrate to the east-southeast, passing beneath Waste Management Area S-SX. Wells 299-W22-49, 299-W22-82, and 299-W22-83, downgradient of this tank farm, all had increasing tritium concentrations during the fiscal year. Tritium exceeded the drinking water standard in wells 299-W22-82 and 299-W22-83 during the year. The front of this plume has now entered an area of sparse well coverage and will not be able to be tracked further (the next downgradient well is ~600 meters away).

2.9.1.4 Iodine-129

Iodine-129 plumes in the 200-UP-1 groundwater interest area originate from both U Plant and REDOX Plant disposal facilities (Figure 2.9-6). One plume emanates from

Uranium responds more slowly than technetium-99 to the pump-and-treat system.

The tritium plume emanating from the southeast 200 West Area has nearly stopped spreading in most directions and is contracting in some areas.

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

Carbon tetrachloride is widespread in the 200-UP-1 groundwater interest area. The plume originated in the 200-ZP-1 groundwater interest area.

the vicinity of the 216-U-1,2 cribs, while another originates from the south part of the 200 West Area. At the current level of monitoring detail, these plumes merge downgradient and become indistinguishable. This combined plume (as denoted by the 1-pCi/L contour level) extends to the east and northeast a total distance of ~3.5 kilometers.

Sixteen wells within the iodine-129 plume were sampled during fiscal year 2003. Concentrations generally increased in the north and central part of the plume outside of the 200 West Area boundary. Concentrations within the south part generally declined or were unchanged. This indicates that a high concentration portion of this plume is migrating to the east out of the 200 West Area into the surrounding 600 Area. The maximum iodine-129 concentration measured within the 200-UP-1 groundwater interest area was 35.3 pCi/L in well 699-35-70. (The drinking water standard for iodine-129 is 1 pCi/L, and the DOE derived concentration guide is 500 pCi/L.)

2.9.1.5 Strontium-90

During the fiscal year, 11 analyses for strontium-90 were performed on samples collected from 9 wells within the groundwater interest area. Strontium-90 was found above detection limits in only one well: 299-W22-10, located downgradient of the 216-S-1,2 cribs. The result was 54 pCi/L, which is above the 8 pCi/L drinking water standard, but below the DOE derived concentration guide of 1,000 pCi/L. The previous sample result was 76 pCi/L collected during fiscal year 2002.

The 216-S-1,2 cribs received highly acidic, REDOX Plant waste from 1952 to 1956. In 1955, the waste is believed to have corroded the casing of a nearby well (299-W22-3), which allowed the effluent to bypass the soil column and flow down the well directly into groundwater. Because strontium-90 is not very mobile in groundwater, this plume has remained in the vicinity of these cribs.

2.9.1.6 Chlorinated Hydrocarbons

Carbon tetrachloride is widespread in the 200-UP-1 groundwater interest area. The maximum measured concentration was 690 µg/L in well 299-W19-9 at the 216-U-1,2 cribs. Carbon tetrachloride originates from disposal facilities associated with the Plutonium Finishing Plant, which is part of the 200-ZP-1 groundwater interest area. For a more thorough discussion of carbon tetrachloride in the 200 West Area, see Section 2.8.

Chloroform is a degradation product of carbon tetrachloride. A total of 70 chloroform analyses were performed on samples from 48 wells within the 200-UP-1 groundwater interest area, and there were no exceedances of the 100 µg/L drinking water standard. The maximum measured concentration was 20 µg/L in well 299-W18-40, an upgradient well for Waste Management Area U.

Trichloroethene is found within the 200-UP-1 groundwater interest area above the drinking water standard (5 µg/L) in two small plumes – one near the pump-and-treat system and another downgradient of the 216-S-20 crib. The peak measured concentration at the pump-and-treat system during the fiscal year was 7 µg/L in 299-W19-35, which is largely unchanged from the year before. The peak measured concentration downgradient of the 216-S-20 crib was 11 µg/L in well 299-W22-20, down from 15 µg/L the year before. There were no other exceedances of the drinking water standard. In fiscal year 2002, trichloroethene exceeded the drinking water standard at well 299-W19-34B (6 µg/L), completed deep in the aquifer at the pump-and-treat site, but this well was not sampled during fiscal year 2003 (it is scheduled for biennial sampling).

2.9.1.7 Chromium

Chromium is found in four regions of the 200-UP-1 groundwater interest area: at Waste Management Area S-SX, at the 216-S-10 pond and ditch, downgradient from the 216-S-20 crib, and in the 600 Area east and southeast of the 200 West Area. During the

fiscal year, samples from three wells exceeded the drinking water standard of 100 µg/L: well 299-W26-7 at the 216-S-10 pond and ditch, well 299-W22-50 at Waste Management Area S-SX, and well 699-32-62 in the 600 Area. The maximum measured concentration was 209 µg/L at well 299-W26-7. Chromium was not analyzed for at well 299-W22-20 downgradient of the 216-S-20 crib during the fiscal year, but the result for fiscal year 2002 was 381 µg/L. Chromium at Waste Management Area S-SX is discussed in Section 2.9.3.3, and chromium at the 216-S-10 pond and ditch is discussed in Section 2.9.3.4.

Chromium is frequently detected in filtered samples east and southeast of the 200 West Area. The concentration in well 699-32-62 was 174 µg/L in fiscal year 2003, down from 201 µg/L in fiscal year 2000. The chromium concentrations have declined slowly since chromium was first analyzed at this well in 1992. The sources and extent of this contamination are uncertain. The location of this plume is consistent with disposal to the REDOX ponds/ditches south and southwest of the 200 West Area. Chromium is detected in several other wells in this area, but its extent to the south of well 699-32-62 is poorly defined.

2.9.1.8 Nitrate

Nitrate plumes in the 200-UP-1 groundwater interest area originate from both U Plant and REDOX Plant disposal facilities and are widespread throughout the area. The multiple sources of nitrate from U Plant include the 216-U-1,2; 216-U-8; and 216-U-12 cribs. The nitrate plumes from these and other sources merge downgradient into a single large plume, which extends to the east and northeast a total distance of ~4 kilometers (Figure 2.9-7). Nitrate sources from the REDOX Plant disposal facilities may also have contributed to this plume. This plume continues to migrate slowly to the east, as evidenced by increasing nitrate concentrations in well 699-40-62 (82 mg/L in fiscal year 2003, up from 69 mg/L in fiscal year 2000). The nitrate drinking water standard is 45 mg/L. Waste Management Area U is also a source of nitrate. Nitrate concentrations rose above the drinking water standard for the first time at this site in fiscal year 2003 (53 mg/L annual average concentration in well 299-W19-41). The peak measured nitrate concentration in the 200-UP-1 groundwater interest area was 1,930 mg/L in well 299-W19-43, an extraction well at the 200-UP-1 pump-and-treat system.

Nitrate also occurs in two small plumes associated with REDOX Plant disposal facilities: one near the 216-S-20 crib and another near the 216-S-25 crib. In well 299-W22-20, downgradient of the 216-S-20 crib, the measured nitrate concentration this fiscal year was 92 mg/L, up from 73 mg/L the year before. From 1952 through 1972, this crib received waste from laboratory hoods and decontamination sinks in the 222-S Building, along with laboratory waste from the 300 Area.

There is a nitrate plume associated with the tritium plume emanating from the vicinity of the 216-S-25 crib. In well 299-W23-9, at the downgradient end of this crib, nitrate concentrations have been increasing over the past 3 years. The fiscal year 2003 concentration was 480 mg/L, up from 350 mg/L the year before. Nitrate also appears to be associated with the technetium-99 plume in this vicinity. The peak nitrate concentration in this area occurred in well 299-W23-19 at the southwest corner of Waste Management Area S-SX; the January 2003 sample yielded a nitrate concentration of 1,680 mg/L. This is much higher than the nitrate concentrations upgradient around the 216-S-25 crib, so Waste Management Area S-SX is also a source of nitrate.

2.9.1.9 Other Constituents

1,4-dioxane was detected in a sample collected from well 299-W22-20, which is located downgradient from the 216-S-20 crib. The well was sampled in January 2003, and the result was 160 µg/L for field duplicate samples. This result was confirmed by a laboratory re-analysis of both samples. An examination of the laboratory analysis method (gas chromatography/mass spectrometry) output data for previous annual samples back to fiscal

Multiple sources of nitrate created a large plume, which is moving to the east.

1,4-dioxane was detected in a single well downgradient of the 216-S-20 crib.

The 200-UP-1 pump-and-treat system is remediating technetium-99 and uranium contamination.

year 2000, showed that 1,4-dioxane was detected in 2002 (at 110 µg/L), but not in the earlier samples. During the fiscal year, 46 analyses for 1,4-dioxane were performed on samples from 43 wells within the entire groundwater interest area, and there were no other detections of this constituent.

1,4-dioxane is typically used as a solvent stabilizer and is added to solvents such as 1,1,1-trichloroethane or trichloroethene. It is classified as a probable human carcinogen, and it is highly soluble and mobile in groundwater. The U.S. Environmental Protection Agency (EPA) has not established a drinking water standard, but has estimated that consumption of drinking water with a concentration of 3 µg/L would result in a lifetime cancer risk of 1.0×10^{-6} . The state of Washington has established a groundwater quality standard of 7 µg/L (WAC 173-200). The probable source appears to be the 216-S-20 crib, but this has not been confirmed. From 1952 through 1972, this crib received waste from laboratory hoods and decontamination sinks in the 222-S Building, along with laboratory waste from the 300 Area.

Arsenic and cadmium are both listed as contaminants of concern for the 200-UP-1 Operable Unit. During the fiscal year, there were no arsenic results for a filtered sample above the 10 µg/L drinking water standard; however, arsenic was detected above the drinking water standard in one unfiltered sample – 12.3 µg/L in well 699-36-67 at the Environmental Restoration Disposal Facility. For cadmium, there were no results above the 5 µg/L drinking water standard.

2.9.2 CERCLA Groundwater Monitoring

Within the 200-UP-1 groundwater interest area, CERCLA groundwater monitoring is conducted for the 200-UP-1 Operable Unit as well as the Environmental Restoration Disposal Facility. The results of this monitoring are described in the following sections.

2.9.2.1 Interim Groundwater Remediation for Technetium-99 and Uranium

During the fiscal year, the 200-UP-1 Operable Unit was monitored in accordance with a sampling and analysis plan issued during June 2002 (DOE/RL-2002-10). The objectives of this monitoring are to determine the spatial extent of existing contaminant plumes within the operable unit and to assess the performance of an interim remedial action pump-and-treat system. Appendix A presents the monitoring well network for the 200-UP-1 Operable Unit, including a well list, sampling frequencies, and analyte lists. Well locations

within the 200 West Area are shown in Figure 2.9-1. This network was revised in the *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit* (DOE/RL-92-76) to support fiscal year 2004 sampling by increasing the frequency of sampling in the vicinity of the pump-and-treat system and reducing the frequency in other areas.

During the fiscal year, three wells scheduled in the sampling and analysis plan were not sampled because they were dry: 299-W19-14 (~150 meters south of the 216-U-1,2 cribs), 299-W23-14 (upgradient well at Waste Management Area S-SX), and 299-W26-12 (at the 216-S-10 pond and ditch). Well 299-W23-21 was installed in 2000 as a replacement well for 299-W23-14, so it was sampled instead. Well 299-W19-20 (at the

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

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

EPA specified enhancements needed to the system in their 5-year review (EPA 2001).

pump-and-treat area) did not have sufficient water to operate the sampling pump, so a bailer was used to collect one last sample from this well, which is now considered dry.

The remainder of this section addresses monitoring performed to determine the effectiveness of the pump-and-treat system at the 200-UP-1 Operable Unit. Results of monitoring to determine the spatial extent of contaminant plumes is combined with other monitoring results and summarized in Section 2.9.1.

Progress During Fiscal Year 2003

The pump-and-treat system at the 200-UP-1 Operable Unit is designed to contain the high concentration portions of the technetium-99 and uranium plumes emanating from the 216-U-1,2 cribs, and to reduce the concentrations in these plumes. During the fiscal year, ~98.3 million liters of contaminated water from the 200-UP-1 Operable Unit were treated at the Effluent Treatment Facility. Almost 707.5 million liters have been treated since startup of remediation activities in fiscal year 1994. During the fiscal year, 21.2 kilograms of uranium and 11.8 grams (0.2 curies) of technetium-99 were removed from the aquifer. In addition, 2.8 kilograms of carbon tetrachloride and 4,158 kilograms of nitrate (secondary contaminants of concern) were removed from the aquifer. These values along with the amount of mass removed since startup of operations is given in Table 2.9-1.

The average extraction system pumping rate for the year was 178.2 liters per minute, which is below the remedial design of 189.3 liters per minute. Water was extracted from well 299-W19-39 all year. In May 2003, well 299-W19-43 replaced well 299-W19-36 as the second extraction well. This increased the total pumping rate to 195.7 liters per minute, which was maintained to the end of the fiscal year.

Due to declining groundwater levels, the capability for monitoring and tracking changes in plume configuration continues to be hampered by the loss of monitoring wells in the baseline plume area. Well 299-W19-20 went dry after being sampled in January 2003. This leaves only one monitoring well, 299-W19-37, in the baseline area. Two other nearby wells, 299-W19-35 and 299-W19-40, are compliance wells used to demonstrate control of the plume, but well 299-W19-40 is expected to go dry within the next 4 years.

A new monitoring well, 299-W19-46, was installed south of the baseline plume area to replace well 299-W19-38 that went dry in January 2001. This re-establishes a monitoring point at the south area of the baseline plumes. A new well is to be drilled upgradient of well 299-W19-20 in fiscal year 2004. For more detailed information about operations during fiscal year 2003, refer to DOE/RL 2003-58.

Influence on Aquifer Conditions

By the end of the fiscal year, all measured technetium-99 and uranium concentrations were at or below their respective remedial action objectives at all wells in the baseline plume area (i.e., that portion of the plume originally designed to be contained by the treatment system), although more sampling is required to confirm these trends. In addition, the high concentration portions of the technetium-99 and uranium plumes were hydraulically contained throughout the year. Figures 2.9-8 and 2.9-9 show measured technetium-99 and uranium concentrations for several wells in the pump-and-treat area. Figures 2.9-10 and 2.9-11 show the technetium-99 and uranium plumes at the pump and treat area, based on average concentrations for the fiscal year.

During the fiscal year, only well 299-W19-43 yielded technetium-99 and uranium sample results above their respective remedial action objectives. This well was sampled in January 2003 (prior to being converted to an extraction well), and the results were 18,200 pCi/L for technetium-99 and 1,190 µg/L for uranium. This well was sampled again in July after being converted to an extraction well, and concentrations declined to 3,390 pCi/L for technetium-99 (below the remedial action objective) and 480 µg/L for uranium (equal to the remedial action objective).

Since its inception, the pump-and-treat system has removed 102 grams of technetium-99 and 180 kilograms of uranium.

During the fiscal year, the high concentration portions of the plumes were hydraulically contained.

Contaminant concentrations declined below the cleanup target levels in monitoring wells sampled in fiscal year 2003. Many wells have gone dry, however.

Uranium concentrations declined to below the remedial action objective at well 299-W19-36, the other extraction well within the high concentration part of the plumes. The uranium concentration declined from 995 µg/L in August 2002 to 458 µg/L in January 2003. Technetium-99 concentrations declined from an average of 8,915 pCi/L in August 2002 to 4,600 pCi/L in January 2003. The area around wells 299-W19-36 and 299-W19-43 will require additional monitoring and sampling to determine if these declines continue. At downgradient extraction well 299-W19-39, technetium-99 and uranium concentrations have remained well below their respective remedial action objectives.

Technetium-99 concentrations in compliance wells 299-W19-40 and 299-W19-35, and in monitoring well 299-W19-37 midway between the extraction wells, remained below the drinking water standard throughout the fiscal year. Uranium concentrations in these wells showed variable to declining trends; however, concentrations at all wells remain above the drinking water standard (30 µg/L). At well 299-W19-46, groundwater was sampled at 6-meter intervals during installation of this well to establish a vertical profile of contaminant distributions. Only one sample exceeded the technetium-99 drinking water standard – 1,360 pCi/L at a depth of 12.8 meters below the water table. All quarterly sample results have averaged 158 pCi/L, well below the drinking water standard. The highest uranium concentrations were 131 and 134 µg/L at depths of 7.6 and 13.7 meters below the static water table. Quarterly analyses for the rest of fiscal year 2003 have averaged 146 µg/L.

During fiscal year 2003, the annual rate of water-level decline was ~0.38 meter, which is similar to the 0.36-meter decline observed in fiscal year 2002. The water-level decline has affected the pumping rates at the extraction wells, and thereby has affected the radius of influence of each well. The radius of influence for well 299-W19-39 is estimated at 180 meters, a slight decline from the fiscal year 2002 value of ~205 meters. This radius still appears to be adequate with respect to the baseline plume. The data from compliance well 299-W19-40 also supports the effectiveness of well 299-W19-39 at capturing the contaminants. The radii of influence at extraction wells 299-W19-36 and 299-W19-43 are smaller, but are adequately capturing contamination in the upgradient part of the plume.

2.9.2.2 Groundwater Monitoring at the Environmental Restoration Disposal Facility

The Environmental Restoration Disposal Facility is a low-level, mixed waste facility where waste from surface remedial actions on the Hanford site is disposed. The site is designed to meet RCRA standards, although it is not permitted as a RCRA facility. Groundwater monitoring is conducted in accordance with a CERCLA record of decision (ROD 1995b). One upgradient well (699-36-70A) and three downgradient wells (699-37-68, 699-36-67, and 699-35-66A) are sampled semiannually, typically in the second and fourth quarters of the fiscal year. All four wells were sampled as planned during fiscal year 2003, although some wells were sampled later than others due to maintenance issues. For a discussion of leachate monitoring at this facility, see Section 3.2.2. Appendix C contains additional information regarding the Environmental Restoration Disposal Facility. See BHI-01684 for calendar year 2002 groundwater and leachate monitoring results.

Results of groundwater monitoring at the Environmental Restoration Disposal Facility continue to indicate that the facility has not adversely impacted groundwater quality. Several constituents are present in the groundwater at or above drinking water standards (tritium, iodine-129, nitrate, and carbon tetrachloride), but these results are due to plumes originating from the 200 West Area. Potential out of trend values (high) were noted for two downgradient wells during the fiscal year: gross beta in 699-35-66A, and gross beta, unfiltered chromium, and possibly unfiltered zinc in 699-37-68. These high trend results for gross beta and chromium continue from the previous sampling events and look like actual increasing trends. Future results will be evaluated to confirm this. The unfiltered zinc

results for well 699-37-68 have been somewhat erratic, possibly due to variability of suspended solids in the sample. Early zinc values for this well were elevated (~400 to ~2,000 µg/L) and were assumed to result from galvanic corrosion of well components. After repairs in 2000, initial results showed much lower zinc values. Future results will be evaluated to determine if upward trends continue. Some erratic results were noted for other metals results from unfiltered samples. Variability due to suspended solids likely accounts for the results seen. All filtered samples were much more consistent and showed values within the variability seen historically.

2.9.3 RCRA Groundwater Monitoring

Groundwater monitoring in accordance with RCRA regulations is performed at four sites within the 200-UP-1 groundwater interest area. Assessment monitoring is conducted at three of these sites (216-U-12 crib, Waste Management Area S-SX, and Waste Management Area U), and detection monitoring is conducted at one site (216-S-10 pond and ditch). RCRA groundwater monitoring is limited to hazardous waste constituents. Radio-nuclide releases from these sites are tracked under AEA monitoring and are discussed in Section 2.9.4.

2.9.3.1 216-U-12 Crib

The 216-U-12 crib is located ~600 meters south of U Plant in the southeast portion of the 200 West Area. The crib is an unlined, gravel-bottom, percolation crib 3 meters by 30 meters, and 4.6 meters deep. The crib received process effluent from U plant, including the 224-U Building, and operated from 1960 through 1972 and from 1981 until February 1988. A map of this facility, the well sampling and constituent list, and sampling frequency is provided in Appendix B.

The number of network monitoring wells remains the same as last year. Declining water levels in the 200 West Area have reduced the 216-U-12 crib monitoring network from the original four wells to just two downgradient wells (299-W22-79 and 699-36-70A), which is fewer than the minimum required number of wells. These wells are sampled quarterly for the constituents of interest (see Appendix B). The Washington State Department of Ecology (Ecology), EPA, and DOE annually negotiate installation of future monitoring wells under Tri-Party Milestone M-24-00 (Ecology et al. 1998).

The current objectives of interim status assessment monitoring for the 216-U-12 crib include the following:

- Continue groundwater monitoring to assess the migration of potential dangerous waste constituents out of the vadose zone into the groundwater.
- Monitor the known contaminants until a near-term interim corrective action is defined.
- Monitor under interim status assessment until a final status monitoring plan is implemented following closure of the facility.

These objectives do not include delineating the existing known plumes. The existing plumes co-mingle with plumes from other U Plant and REDOX Plant area sources, making it difficult to distinguish the specific plumes emanating from the 216-U-12 crib. In addition, the existing groundwater plumes are already being delineated by CERCLA and AEA monitoring.

Based on a revised and updated groundwater monitoring assessment plan for the 216-U-12 crib (PNNL-14301), closure of the crib will be coordinated with and conducted under CERCLA per the U Plant waste sites closure area focused feasibility study (DOE/RL-2003-23) and proposed plan (DOE/RL-2003-24). RCRA groundwater monitoring objectives will remain the same from now until closure of the crib and then shift to a final status post-closure plan that is outlined in the revised groundwater monitoring

The 216-U-12 crib contributed to nitrate contamination. A new monitoring plan was published in fiscal year 2003.

RCRA monitoring shows that Waste Management Area U contaminated groundwater with nitrate.

assessment plan. The updated groundwater monitoring assessment plan (PNNL-14301) proposes a revised well network and a list of constituents based on the knowledge gained from monitoring data collected over the past 11 years for this site. It also provides the current interpretation of groundwater flow and contamination occurrence. Additionally, a conceptual model of contaminant transport through the vadose zone beneath the crib is presented in the plan to assist in developing an appropriate and cost-effective monitoring and clean up approach for this facility.

The 216-U-12 crib was placed into assessment status due to elevated specific conductance downgradient of the facility. Elevated calcium and nitrate are the major contributors to the specific conductance. These constituents are being evaluated through quarterly groundwater monitoring. The regional nitrate and technetium-99 plumes are a co-mingled series of smaller plumes with sources from several cribs (216-U-1,2; 216-U-8; and 216-U-12) in the U Plant area.

The key indicator parameter, specific conductance, continued to decline in both wells. Nitrate remains above the 45 mg/L drinking water standard in both wells but is declining as expected. A co-contaminant, technetium-99 (which is not regulated under RCRA), remains elevated slightly above background but is declining similar to nitrate in the network wells. Sulfate was elevated above the background trend during the September sampling in well 699-36-70A; this measurement will be compared to future results to determine if it is real. All other constituents remained on trend at or near background throughout the year.

Based on regional groundwater elevations, the direction of groundwater flow continues relatively unchanged to the east-southeast to east (Figure 2.8-2). The pre-Hanford flow direction in the vicinity of the 216-U-12 crib is believed to have been from west to east, and it is expected that groundwater flow will eventually return to a more easterly direction. Average linear velocities have declined slightly since last year and range from 0.01 to 0.003 meter per day (see Appendix B).

2.9.3.2 Waste Management Area U

The objective of RCRA groundwater monitoring at Waste Management Area U is to assess the rate of movement and extent of hazardous waste constituents in groundwater beneath the site. Waste Management Area U was placed into assessment status in 2000 when specific conductance in groundwater monitoring wells downgradient of the waste management area exceeded upgradient levels (PNNL-13185). An assessment of that finding determined that the waste management area had affected groundwater quality with elevated concentrations of nitrate and possibly chromium in wells downgradient of the waste management area (PNNL-13282). The contaminant concentrations did not exceed their respective drinking water standards, and the area affected appeared to be limited to the southeast corner of the waste management area. A groundwater quality assessment plan (PNNL-13612) was prepared in 2001. The plan was modified in 2003 (PNNL-13612-ICN-1) to include monitoring of new wells 299-W18-40, 299-W19-44, and 299-W19-45 and to remove volatile and some radioactive constituents from the analyte list. The plan as modified serves as the current plan by which groundwater quality is assessed at Waste Management Area U. Results of radionuclide monitoring of Waste Management Area U are discussed in Section 2.9.4.

The monitoring network includes eight wells, two upgradient and six downgradient of the waste management area, sampled quarterly (see Appendix B for the location map, well list, constituents, and sampling frequency). All eight wells were sampled each quarter during fiscal year 2003. As part of the Tri-Party Agreement M-24 milestone process for installation of new wells, it was decided to construct one additional well in 2004 on the northeast side of the waste management area, due east of the 244-UR vault.

Groundwater Flow. Groundwater flow conditions at Waste Management Area U have varied greatly over the past several decades because of changing wastewater disposal in areas surrounding the waste management area, but groundwater flow has been generally

to the east since 1996. During fiscal year 2003, the groundwater flow direction and velocity have remained the same as in the previous year. The rate at which the water table is dropping has also remained constant at ~0.3 meter per year during fiscal year 2003.

A gyroscope survey of well 299-W18-40 was conducted in January 2003 to determine if anomalous water level results were due to deviation of the well from vertical. The survey showed that the well had a 6.7-meter horizontal deviation from vertical at the water table, resulting in a 0.37-meter vertical error in water level measurements for the well. Once this correction was applied, the water-level data were consistent with regional water-level trends and historical trends for nearby well 299-W18-25, which went dry in 2001.

The average linear velocity calculated based on a hydraulic conductivity of 6.12 meters per day, a specific yield of 0.17 determined in well 299-W19-42 (PNNL-13378), and a gradient of 0.0021 is ~0.08 meter per day (see Appendix B). This rate is consistent with the regional groundwater flow interpretation.

Groundwater Contamination. Groundwater chemistry beneath Waste Management Area U in fiscal year 2003 has remained similar to that presented in past years for wells downgradient of the waste management area, but contaminant concentrations have begun to rise in upgradient wells. The waste management area has been identified as the source for a small contaminant plume that is limited to the south half of the downgradient (east) side of the site. This plume is delineated easily by the extent of elevated specific conductance because the plume contains soluble salts comprised of the anions nitrate, chloride, and sulfate that are accompanied by the cations calcium, magnesium, and sodium. Soluble radioactive species are also contained in the plume and are discussed in Section 2.9.4. Of the plume constituents, only nitrate and chromium are relevant to RCRA groundwater monitoring.

During fiscal year 2003, nitrate concentrations continued to increase in downgradient wells (299-W19-41, 299-W19-44, and 299-W19-12) on the south half of the waste management area, indicating that the site is still affecting groundwater quality. The nitrate distribution in the area is shown in Figure 2.9-7. Nitrate concentrations increased above the drinking water standard of 45 mg/L only in well 299-W19-41 where they remained above that limit for the entire year. Nitrate concentrations also continued to increase in both upgradient wells; by the end of the year, upgradient nitrate concentrations were ~25% to 50% of the concentration found in downgradient wells. These data indicate that regional upgradient plumes are encroaching into groundwater beneath the waste management area.

The only well with concentrations of chromium above the area background level of ~5 µg/L is well 299-W19-41 where chromium concentrations continued to decrease from 16 to 10 µg/L during the year. A water sample collected in August reportedly contained less than 4.4 µg/L chromium, but a drop of this magnitude is considered suspect. These chromium data indicate that the chromium source has been affected in some way to reduce or eliminate the amount of chromium reaching the water table. In addition, because chromium concentrations have decreased and nitrate concentrations have increased in this well, they clearly have different sources.

Other than nitrate in well 299-W19-41, carbon tetrachloride is the only other hazardous constituent found in groundwater beneath Waste Management Area U at concentrations above its drinking water standard of 5 µg/L. The regional carbon tetrachloride distribution (Figure 2.8-3) indicates that the source of carbon tetrachloride found in the Waste Management Area U vicinity is from liquid waste disposal sites from the Plutonium Finishing Plant located northwest of the waste management area.

2.9.3.3 Waste Management Area S-SX

The objective of RCRA groundwater monitoring at Waste Management Area S-SX is to assess the rate of movement and extent of hazardous waste constituents found in groundwater beneath the site. Waste Management Area S-SX was placed into assessment

Groundwater chemistry downgradient of Waste Management Area U was similar to the previous year.

Sources within Waste Management Area S-SX have contaminated groundwater with nitrate and chromium. The south portion of the plumes expanded in fiscal year 2003.

status in 1996 at the direction of Ecology because of elevated specific conductance and technetium-99 (not regulated by RCRA) in downgradient monitoring wells. A groundwater quality assessment plan (WHC-SD-EN-AP-191) was prepared in 1996 and the planned assessment work conducted in 1996 and 1997. An assessment of the waste management area determined (first determination) that multiple sources within the waste management area had affected groundwater quality with elevated concentrations of nitrate, technetium-99, and chromium in wells downgradient of the waste management area (PNNL-11810). A second groundwater quality assessment plan (PNNL-12114) was prepared in 1999 to further evaluate the contamination found. Since that time, two groundwater quality assessment reports were published (PNNL-13441; PNNL-13801) covering the time period from November 1997 through December 2001 and the assessment plan was revised twice (PNNL-12114-ICN-1; PNNL-12114-ICN-2) to account for new wells added to the monitoring network and revisions to the sampling and analysis schedule. The plan as modified serves as the current plan by which groundwater quality is assessed at Waste Management Area S-SX.

The monitoring network consists of 16 wells: two upgradient and 13 downgradient of the waste management area, and one well located within the area. The wells are sampled quarterly (see Appendix B for the location map, well list, constituents, and sampling frequency). All 16 wells were sampled each quarter during fiscal year 2003. As part of the Tri-Party Agreement M-24 milestone process for installation of new wells, it was decided to construct one additional well in 2004 southeast of the waste management area, due south of well 299-W22-46, to better define the south boundary of a contaminant plume in this area.

Groundwater Flow. During fiscal year 2003, the groundwater flow direction and velocity remained the same as in the previous year, in spite of the falling water table. The rate at which the water table is dropping remained the same as last year, which is estimated at ~0.3 meter per year. This decline was the same in all wells across the waste management area, so hydraulic gradients have remained stable. Estimates of groundwater flow velocity, using travel times for tritium and technetium-99 between monitoring wells in the vicinity of Waste Management Area S-SX, suggest groundwater flow rates of 25 to 50 meters per year or 0.07 to 0.14 meter per day. Calculated average linear velocities (using Darcy's method) based on hydraulic conductivity and tracer test data, also suggest similar flow rates (0.009 to 0.36 meter per day; see Appendix B).

The groundwater flow direction inferred from water-table elevation contours suggests an east-southeast flow direction over the larger area around the waste management area (Figure 2.8-2). This direction of flow is consistent with the shape of the contaminant plume on the south side of the waste management area and the direction in which it is expanding.

Groundwater Contamination. Groundwater beneath this waste management area is contaminated with nitrate, hexavalent chromium, and a radioactive constituent (discussed in Section 2.9.4) attributed to two general source areas within the waste management area. One source area is in the S Tank Farm and one is to the south in the SX Tank Farm. The nitrate and chromium plumes are depicted in Figures 2.9-12 and 2.9-13, which show average concentrations for the fiscal year. Carbon tetrachloride is also present in groundwater beneath the waste management area, but its source is upgradient of the waste management area (Figure 2.8-3). Tritium is also present beneath the waste management area, but it emanates from an upgradient source (see Section 2.9.4).

The north plume, with an apparent source in the S Tank Farm, has migrated eastward through well 299-W22-48, where chromium and nitrate concentrations have leveled-off and even decreased in the second half of the year at ~33 µg/L and 63.0 mg/L, respectively. The bulk of the contaminant plume responsible for these observations is limited to an area between well 299-W22-44 on the north and 299-W22-81 on the south, where chromium and nitrate concentrations are significantly less than in well 299-W22-48.

The contaminant plumes located in the south portion of the waste management area are comprised of nitrate, chromium, and a radioactive constituent just as in the S Tank Farm plume to the north. The nitrate originates from the tank farm as well as from the 216-S-25 crib, an upgradient source. A smaller plume originates from the north part of the SX Tank Farm, and appears to be merging with the larger plume due to lateral dispersion. The width of the larger plume has changed little during fiscal year 2003, but the longitudinal extent of the plume and internal plume concentrations have changed significantly. Figure 2.9-12 shows average concentrations for the fiscal year, but by the end of the year, the downgradient migrating front had moved through and beyond the farthest downgradient monitoring well 299-W22-83. Nitrate concentrations in this well more than doubled during the fiscal year to 45.2 mg/L, just greater than the drinking water standard of 45 mg/L. Chromium concentrations increased by more than five-fold to 41 µg/L, indicating that the distal end of the plume is expanding.

Within the south plume from the S-SX Tank Farm, concentrations of the major constituents (nitrate and chromium) also changed significantly in the source area as represented by well 299-W23-19 and in the middle of the plume as represented by wells 299-W22-46 and 299-W22-50. In well 299-W23-19, nitrate and chromium concentrations increased significantly during the year. Nitrate concentrations spiked to an all time high of 1,680 mg/L in January 2003 and have since that time decreased to 722 mg/L in September 2003. During the same time, chromium increased from a low of ~16 µg/L in October 2002 to a high of ~60 µg/L in September 2003. There are no known changes in tank farm operations or water releases at the site to account for these changes and earlier large fluctuations in concentrations.

In the middle of the south plume, both nitrate and chromium concentrations continued to increase so that by September 2003, concentrations of both constituents exceeded their respective drinking water standards. This south plume could be characterized as having a source nitrate concentration of ~1,000 mg/L that decreases to ~75 mg/L just beyond the downgradient margin of the waste management area, that further decreases to 45 mg/L at the farthest downgradient monitoring well. Chromium concentrations have a similar trend with the source concentration of 140 µg/L (in 2001) that decreases to ~120 µg/L just beyond the downgradient boundary of the waste management area, that further decreases to 40 µg/L at the farthest downgradient monitoring well.

Specific Conductance Measurements in Well 299-W23-19. Well 299-W23-19 was re-configured in February and March 2003 so samples could be obtained without entering the tank farm. At that time, a permanent sampling pump and four specific conductance probes were installed in the well. Also, at the request of Ecology, the practice of purging at least 3,785 liters of water from the well after each quarterly sampling event was started in March (see Section 2.9.4.2).

As reported in the fiscal year 2002 annual report, specific conductance was measured at half meter intervals through the screened interval in well 299-W23-19 using a specific conductance probe. This work was done to test the possibility that fluctuations in sample groundwater chemistry reflected actual variations in the plume. Specific conductance is a measure of the quantity of the major dissolved constituents such as calcium, magnesium, chloride, and nitrate in the water. Because these constituents are major components of the contaminant plume, specific conductance is an easily measured indicator of the plume location. Specific conductance profiles were developed on four dates from September 20, 2002 through March 11, 2003 (Figure 2.9-14). An original profile developed shortly after the well was completed in 1999 is provided for comparison. These data indicate that the aquifer chemistry differed between sampling dates. However, the three profiles measured in fiscal year 2003 all exhibit the same pattern of increasing specific conductance from the water table to between 3 and 4.5 meters below the water table where the measurements stabilized from that point to the bottom of the well. The range in specific conductance indicated by these profiles is consistent with the variations in groundwater chemistry measured in well 299-W23-19 in the past.

In fiscal year 2003, a permanent sampling pump and four specific conductance probes were installed in well 299-W23-19. Data from these probes indicates that contamination occurs primarily in the upper part of the aquifer.

The specific conductance profile measured on March 11, 2003, was obtained using the bottom specific conductance probe (# 4) while the pump and four-probe assembly was placed in the well. Specific conductance measurements have been recorded at intervals no longer than 30 minutes for each of the probes since that date. These data are presented in Figure 2.9-15. This figure shows that sampling on March 12, June 18, and September 23 greatly perturbed the water chemistry in the well and that dissolved solids (as indicated by specific conductance) in the well decreased ~40% to 50% during the 6 months. This decreasing trend is consistent with the drop in nitrate concentrations discussed previously. Figure 2.9-16 presents an expanded view of the data during the September 23 sampling and purging event.

Figure 2.9-16 shows the magnitude of the difference in groundwater composition between static and dynamic conditions in the well. Prior to 0800 hours, measurements were made under static conditions. When the pump was turned on, specific conductance increased in the upper three probes, but dropped in probe #4, the deepest probe located ~1 meter below the pump intake and ~0.7 meter above the bottom of the well. Probe locations are shown in Figure 2.9-14. Because the pump intake is set between probes #3 and #4, water pumped to the ground surface would have a composition that is a blend of water passing these two probes. However, because of the erratic responses observed in the data from probe #4, that data was not considered in the following assessment. For purposes of interpreting the data presented in Figure 2.9-16, it is assumed that the aquifer is isotropic and homogeneous; therefore, the amount of water entering the well would be the same at all vertical locations from the water table to the bottom of the well screen. Therefore, the amount of water produced by any interval of the well screen is only a function of the interval length. Based on these data and this assumption, an interpretation of the vertical distribution of plume compositions is presented in Table 2.9-2.

As water is pumped from the well, the well is recharged with water from the aquifer. Because of the location of the pump intake, the composition of water passing probes #1, #2, and #3 is a blend of water entering the well above their respective locations. Using a simple mixing model, the average concentration of the water entering the well within a specific interval can be calculated. Probe #1 reflects the composition of water entering the uppermost 1.2 meters of the aquifer – ~2,100 $\mu\text{S}/\text{cm}$. Probe #2 represents a blend of water from the upper 3.1 meters of the aquifer, but the concentration of water entering the well between the two probes is considerably greater (2,915 $\mu\text{S}/\text{cm}$) than that entering above probe #1 in order to raise the mean composition of the water passing probe #2 by 500 $\mu\text{S}/\text{cm}$. Applying this same logic and simple mixing to the other intervals in the well, the specific conductance of the water entering from each interval is calculated and presented in Table 2.9-2. As previously stated, data from probe #4 were not used in this analysis. Therefore, the concentration of the deepest zone is an average of all water entering the well below probe #3. This assessment of the data indicates that the plume, as delineated by elevated specific conductance, is located mainly in the upper 3 to 4 meters of the aquifer. The lower plume boundary is reasonably sharp with the groundwater composition falling significantly over, at most, a 2-meter interval. Similar results were observed in the first two pumping events on March 12 and June 18.

These calculations assume that flow is uniform across the well screen. To test this assumption, a simple uncertainty analysis was performed by varying the assumed flow rate in each interval. Assuming higher flow from the upper part of the screen produces aquifer specific conductance estimates for the lower part that are not physically possible (i.e., less than zero). When flow was assumed to be higher in the lower part of the screen, the aquifer specific conductance estimates remained higher in the upper part. Therefore, the conclusion that the plume is located primarily in the upper part of the aquifer is considered valid, even under conditions of non-uniform flow.

These data show that the pumped water is a blend of water entering the well from all parts of the screened interval and not just that portion of the screen near the pump intake.

Results of recent studies in well 299-W23-19 show that the vertical location of the sample pump intake will not have a significant effect on measured constituent concentrations.

Therefore, the vertical location of the sample pump intake will not have a significant effect on measured constituent concentrations, as long as the well is purged adequately before a sample is collected. In addition, water samples collected from this well under static conditions, such as with a bailer or a low purge technique or with a down-well sensor, may not yield data that are representative of the aquifer. This is because the water composition within the well under static conditions is not representative of the vertical distribution of contaminants in the aquifer.

2.9.3.4 216-S-10 Pond and Ditch

The 216-S-10 pond and ditch was active from 1951 through 1991, and received effluent primarily from the REDOX Plant chemical sewer. The site is monitored semiannually under RCRA interim status indicator evaluation to detect any effect on groundwater that may occur from past facility operations. The list of monitored wells, sampling frequency, constituents, and the facility well location map are provided in Appendix B. An updated and revised RCRA groundwater monitoring plan (PNNL-14070) was published in 2002. RCRA groundwater monitoring has been conducted in accordance with interim status requirements since 1991. The 216-S-10 facility has not received liquid waste since October 1991 and is scheduled to be closed under a Part B Permit after 2006 in accordance with the Tri-Party Agreement (Ecology et al. 1998) permit modification schedule, and in accordance with a future CERCLA record of decision.

The water table beneath the 216-S-10 pond and ditch continued to decline in fiscal year 2003. The current RCRA monitoring network consists of only two downgradient wells (the others having gone dry): well 299-W26-13 located near the pond and new well 299-W26-14 located just east of the central portion of the ditch. The upgradient well, 299-W26-7, went dry sometime between June and September 2003. RCRA requirements for interim status monitoring specify that a minimum of one upgradient and three downgradient monitoring wells are needed to monitor the site. The updated groundwater monitoring plan (PNNL-14070) proposes to deepen two existing dry wells to bring the facility back in compliance with RCRA requirements. Ecology, DOE, and EPA will negotiate installations of future monitoring wells under the Tri-Party Agreement Milestone M-24-00 (Ecology et al. 1998).

The only exceedance of a drinking water standard occurred in the shallow upgradient well 299-W26-7 for hexavalent chromium (currently above the 100 µg/L drinking water standard), and in the deep well 299-W27-2 for carbon tetrachloride. Nickel also is elevated in well 299-W27-2. The carbon tetrachloride is believed to have come from an upgradient source. The source of nickel is unknown, but it might be related to corrosion of the well casing or screen. The long, gradual increase in nickel concentrations, followed by a downward trend, suggests this occurrence is not an analytical or sampling artifact. During the June 2003 sampling event, total organic carbon was reported elevated in all the network wells and has been flagged for further evaluation. This elevated total organic carbon appears to be a laboratory error.

Chromium concentrations at well 299-W26-7 have varied in the past 10 years (Figure 2.9-17). This may be caused by short-term releases migrating through the vadose zone. For example, historical records document a 1983 release to the 216-S-10 facility of a high-salt waste (simulated tank waste) containing hexavalent chromium. Although well 299-W26-7 was designated an upgradient well, it is located very close to one lobe of the pond system and could easily have been affected by drainage spreading laterally in the vadose zone (see Appendix B). The June 2003 chromium value was ~209 µg/L, up from the December 2002 value of ~200 µg/L; however, this well has gone dry, which could have affected the latest measured chromium concentrations. Chromium concentrations in new well 299-W26-13, located nearly downgradient of well 299-W26-7, to date have not been elevated.

Comparisons of RCRA indicator parameters at the 216-S-10 pond and ditch show no statistically significant differences, but elevated chromium and nitrate in the upgradient well 299-W26-7 could have come from this facility.

All but two of the monitoring wells for the 216-S-10 pond and ditch have gone dry.

Waste Management Area U has contaminated groundwater with technetium-99, although concentrations are below the drinking water standard.

Concentrations of technetium-99 in well 299-W23-19, at Waste Management Area S-SX, reached 188,000 pCi/L in January 2003, the highest value ever measured in Hanford groundwater.

Nitrate concentrations are covariate with chromium concentrations in wells 299-W26-7, 299-W26-9, 299-W26-10, and 299-W26-12 (e.g., Figure 2.9-18). The upgradient well 299-W26-7 had the highest nitrate concentrations. This and other data presented in PNNL-14070 suggests that the 216-S-10 pond could be the source of this latest nitrate and chromium increase. Although chromium and nitrate are elevated in the upgradient wells, significant concentrations of these constituents have not been detected in the downgradient wells. Comparisons of RCRA indicator parameters (specific conductance, pH, total organic carbon, and total organic halogens) at the 216-S-10 pond and ditch show no statistically significant differences (i.e., constituents in the downgradient wells are not elevated compared to the upgradient well). Therefore, this site remains in detection monitoring.

Based on regional groundwater elevations, the groundwater flow direction continues toward the east-southeast. The average linear velocity has not changed significantly since last year. Background values of contaminant indicator parameters for the facility have been re-calculated using values from the now dry upgradient well, 299-W26-7 (see Appendix B).

2.9.4 AEA Monitoring

AEA groundwater monitoring is performed throughout the 200-UP-1 groundwater interest area. This section provides information on monitoring of radionuclides from Waste Management Areas U and S-SX, because radionuclide releases from these sites are not regulated under RCRA.

2.9.4.1 Waste Management Area U

Technetium-99 has been detected in groundwater on the downgradient (east) side of Waste Management Area U, and its presence was attributed to the waste management area. During fiscal year 2003, technetium-99 concentrations have tended to decrease in those wells (299-W19-12, 299-W19-41, and 299-W19-44) within the contaminant plume emanating from beneath the site. All measured concentrations during the fiscal year were below the drinking water standard of 900 pCi/L.

It appears that a technetium-99 regional plume is encroaching into the area around Waste Management Area U. During fiscal year 2003, technetium-99 was either detected for the first time or concentrations began to increase in wells located outside and upgradient of the plume area. Concentrations of technetium-99 inside the local plume averaged between 240 to 450 pCi/L while concentrations in the wells outside the local plume were less than 100 pCi/L.

2.9.4.2 Waste Management Area S-SX

Technetium-99 and tritium have been detected in groundwater beneath Waste Management Area S-SX. The areal distributions of these two constituents in the vicinity of the waste management area are shown in Figures 2.9-19 and 2.9-20. These two figures suggest that the source for the tritium is the 216-S-25 crib located west (upgradient) of the waste management area; there are two sources of technetium-99 within the waste management area. The orientation of the tritium plume and the south technetium-99 plume is the same and consistent with the east-southeast direction of groundwater flow in the area. During fiscal year 2003, technetium-99 concentrations varied in the same manner as nitrate in all of the wells located in the two plumes emanating from the waste management area. Technetium-99 reached a maximum concentration of 188,000 pCi/L in well 299-W23-19 in January 2003, which is above the DOE derived concentration guide of 100,000 pCi/L. Concentrations subsequently declined to ~75,000 pCi/L by the end of the fiscal year. The farthest downgradient monitoring wells for both technetium-99 plumes had concentrations at ~3,500 to 4,000 pCi/L, where they may have begun to level off.

Technetium-99 capture and treatment at well 299-W23-19 during sampling, as agreed to by DOE and Ecology, was implemented beginning with the March 12, 2003, sampling event. Responsibility for pumping and treating of groundwater was transferred from CH2M HILL Hanford Group, Inc. to Fluor Hanford, Inc. after re-completion of the wellhead to allow sampling of the well without entering the tank farm. The practice of treating a day's worth of groundwater pumping each quarter (a goal of at least 3,785 liters) and disposing of it at the Effluent Treatment Facility was implemented.

Table 2.9-3 presents the date, amount of water collected, and a calculation of the mass and activity of technetium-99 removed from the aquifer. A total of ~0.001 curies (~0.067 grams) of technetium-99 has been recovered through fiscal year 2003. The sample of March 12, 2003, was below the target of 3,785 liters due to filter problems. The Effluent Treatment Facility requires that influent water not contain particles larger than 5 microns. A filter on the truck clogged with +5 micron material and slowed the pumping rate. A new filter design was adapted for the purgewater truck, and pumping rates have been able to meet the target volume in the last two quarters.

Table 2.9-1. Summary of Contaminant Mass Removed from the Aquifer during Pump-and-Treat Operations at the 200-UP-1 Operable Unit - Fiscal Year 2003 and Totals Since Startup of Operations

| <u>Contaminant</u> | <u>Fiscal Year 2003</u> | <u>Since Startup (March 1994)</u> |
|----------------------|-------------------------|-----------------------------------|
| Uranium | 21.2 kg | 179.5 kg |
| Technetium-99 | 11.8 g (0.2 Ci) | 102 g (1.73 Ci) |
| Carbon tetrachloride | 2.8 kg | 25.7 kg |
| Nitrate | 4,158 kg | 27,344 kg |

Table 2.9-2. Vertical Variation of Groundwater Composition Measured in the Wellbore of Well 299-W23-19 and Estimated for the Adjacent Aquifer During the End of a 4,013-Liter Purge on September 23, 2003

| <u>Measurement Point^(a)</u> | <u>Depth Below Water Table (m)</u> | <u>Interval Length^(b) (m)</u> | <u>Measured In-Well Specific Conductance ($\mu\text{S}/\text{cm}$)</u> | <u>Estimated Aquifer Specific Conductance Over the Interval^(c) ($\mu\text{S}/\text{cm}$)</u> |
|--|------------------------------------|--|---|--|
| Probe #1 | 1.2 | 1.2 | 2,100 | 2,100 |
| Probe #2 | 3.1 | 1.9 | 2,600 | 2,915 |
| Probe #3 | 4.9 | 1.8 | 1,900 | 694 |
| Pump Intake | 5.8 | 0.9 | 1,450 | 663 |
| Well Bottom | 7.7 | 1.9 | Not measured | |

(a) Data from probe #4 are considered unreliable and are not used in this estimate.

(b) The interval length is the distance between probes, between probe #3 and the pump intake, between probe #1 and the water table, or between the pump intake and the well bottom.

(c) It is assumed that the aquifer is homogenous and isotropic, i.e., water enters the well uniformly across the entire saturated portion of the screen during pumping. Therefore, the specific conductance in the aquifer for an interval was computed assuming that the quantity of water entering the well across that interval is only a function of the interval length.

Table 2.9-3. Quantity of Treated Groundwater and Technetium-99 Mass Removed from the Aquifer During Extended Purging at Well 299-W23-19

| <u>Sample Date</u> | <u>Volume of Water Treated Liters (gal)</u> | <u>Technetium-99 Concentration (pCi/L)</u> | <u>Activity of Technetium-99 Removed (Ci)</u> | <u>Mass of Technetium-99 Removed (g)</u> |
|--------------------|---|--|---|--|
| March 12, 2003 | 2,725 (720) | 133,000 | 0.00036 | 0.021 |
| June 18, 2003 | 4,028 (1,064) | 120,000 | 0.00048 | 0.028 |
| September 23, 2003 | 4,013 (1,060) | 74,300 | 0.00030 | 0.018 |
| Totals | 10,766 (2,844) | NA | 0.00114 | 0.067 |

NA = Not applicable.

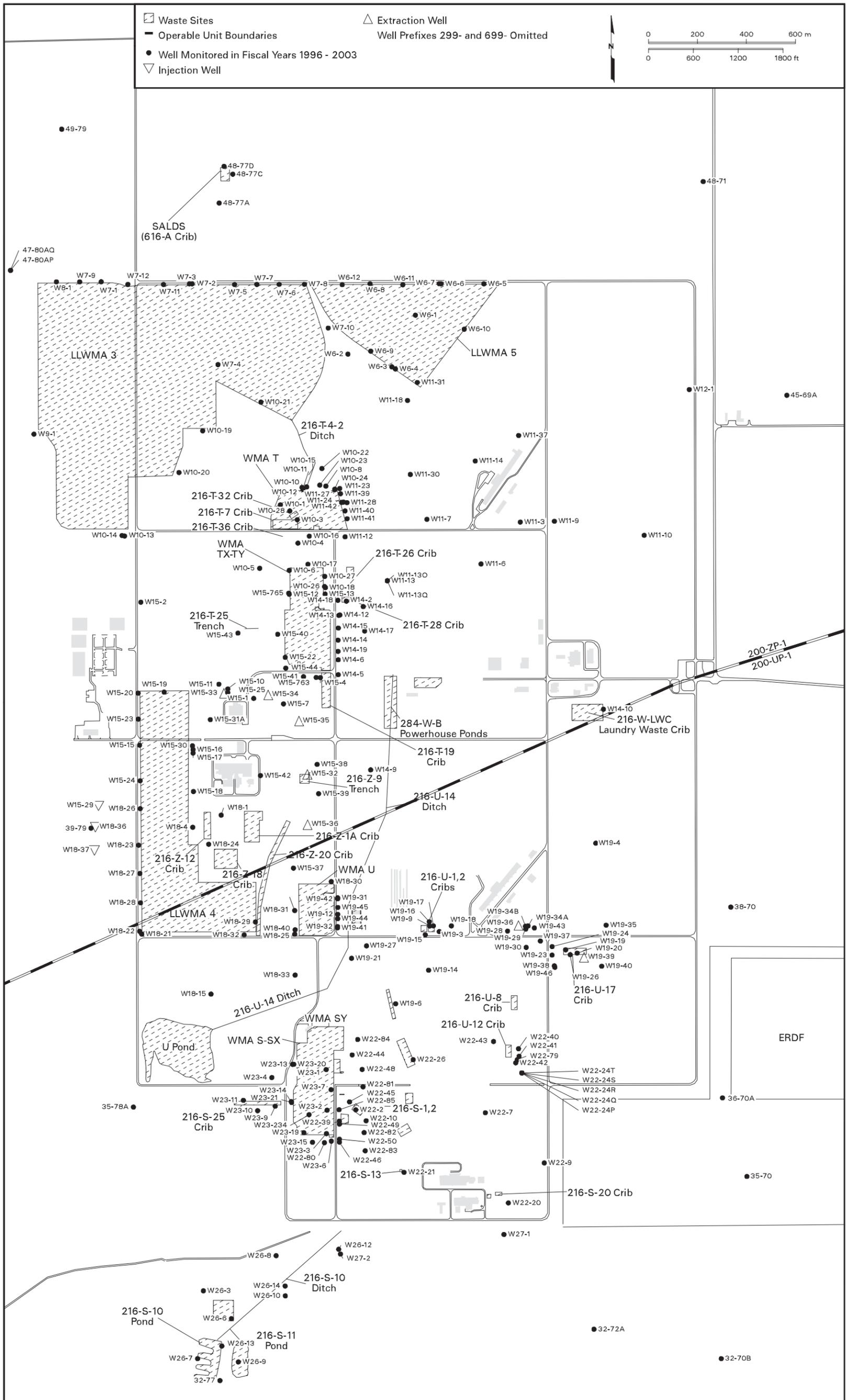
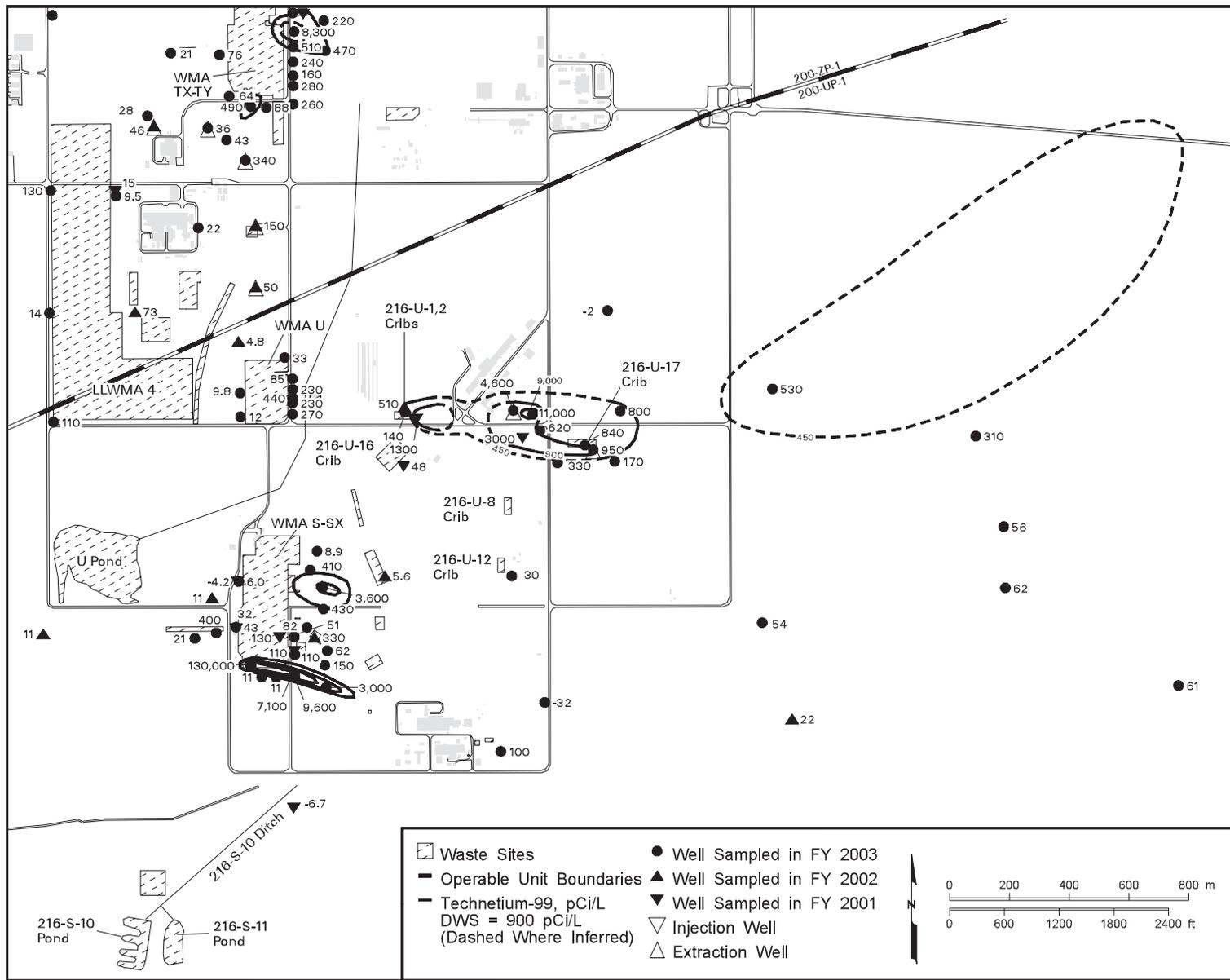


Figure 2.9-1. Facilities and Groundwater Monitoring Wells in the 200 West Area



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Figure 2.9-2. Average Technetium-99 Concentrations in the 200-UP-1 Groundwater Interest Area, Top of Unconfined Aquifer

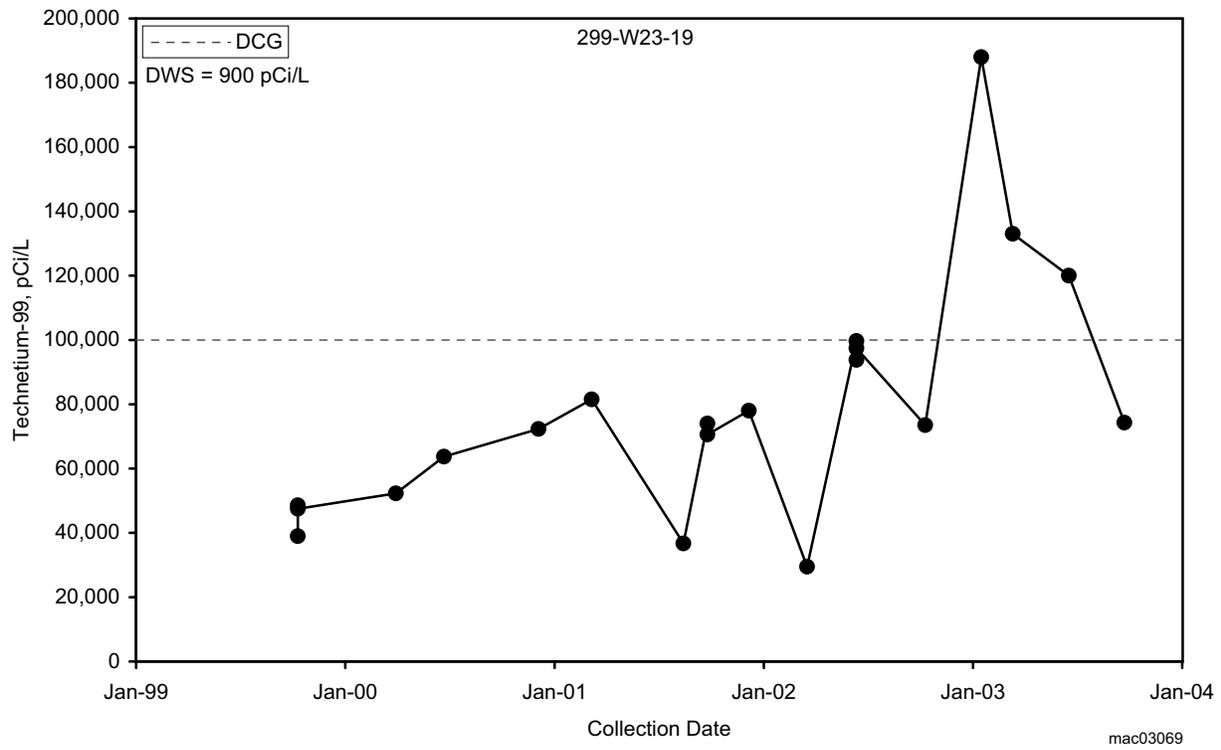
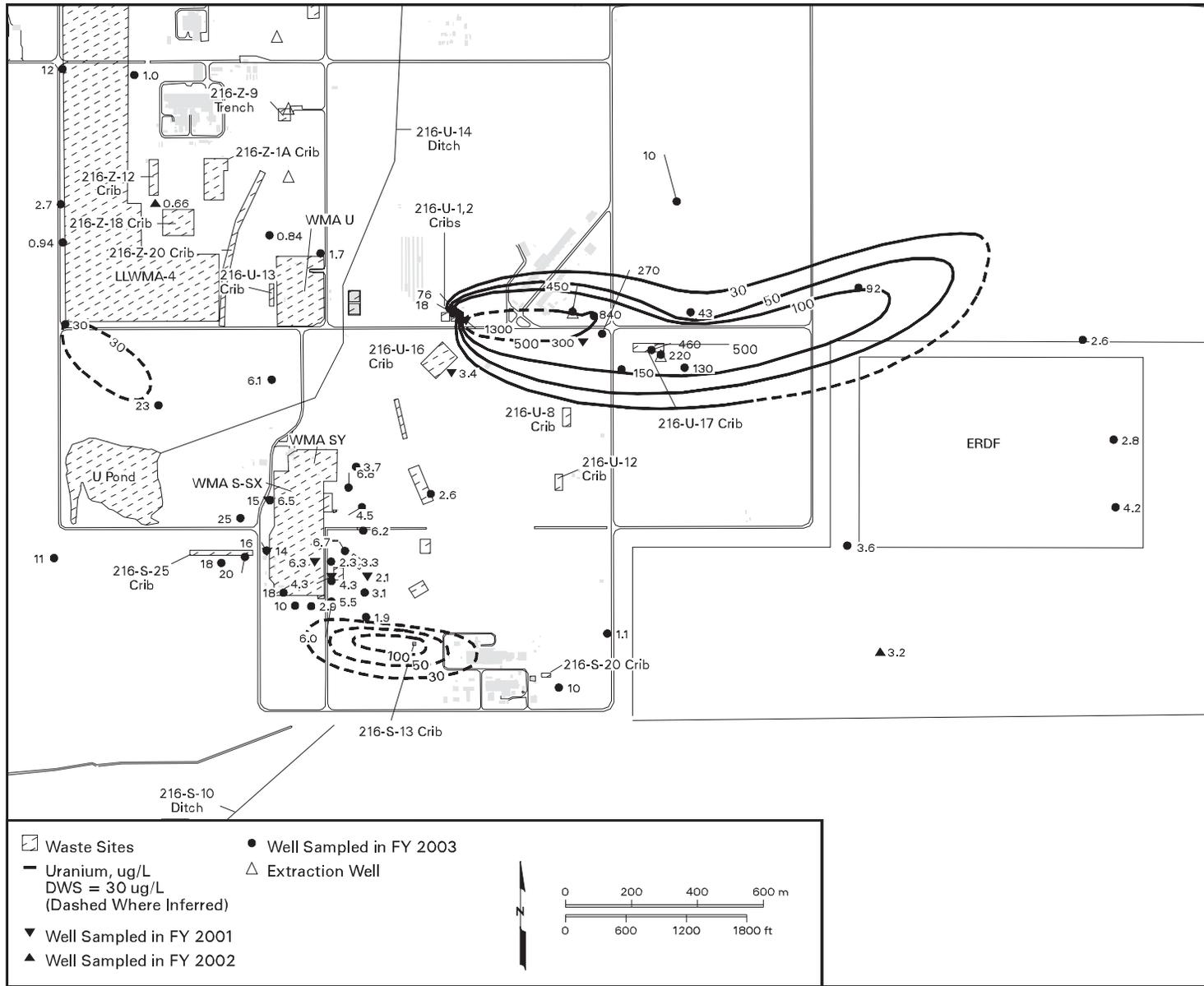
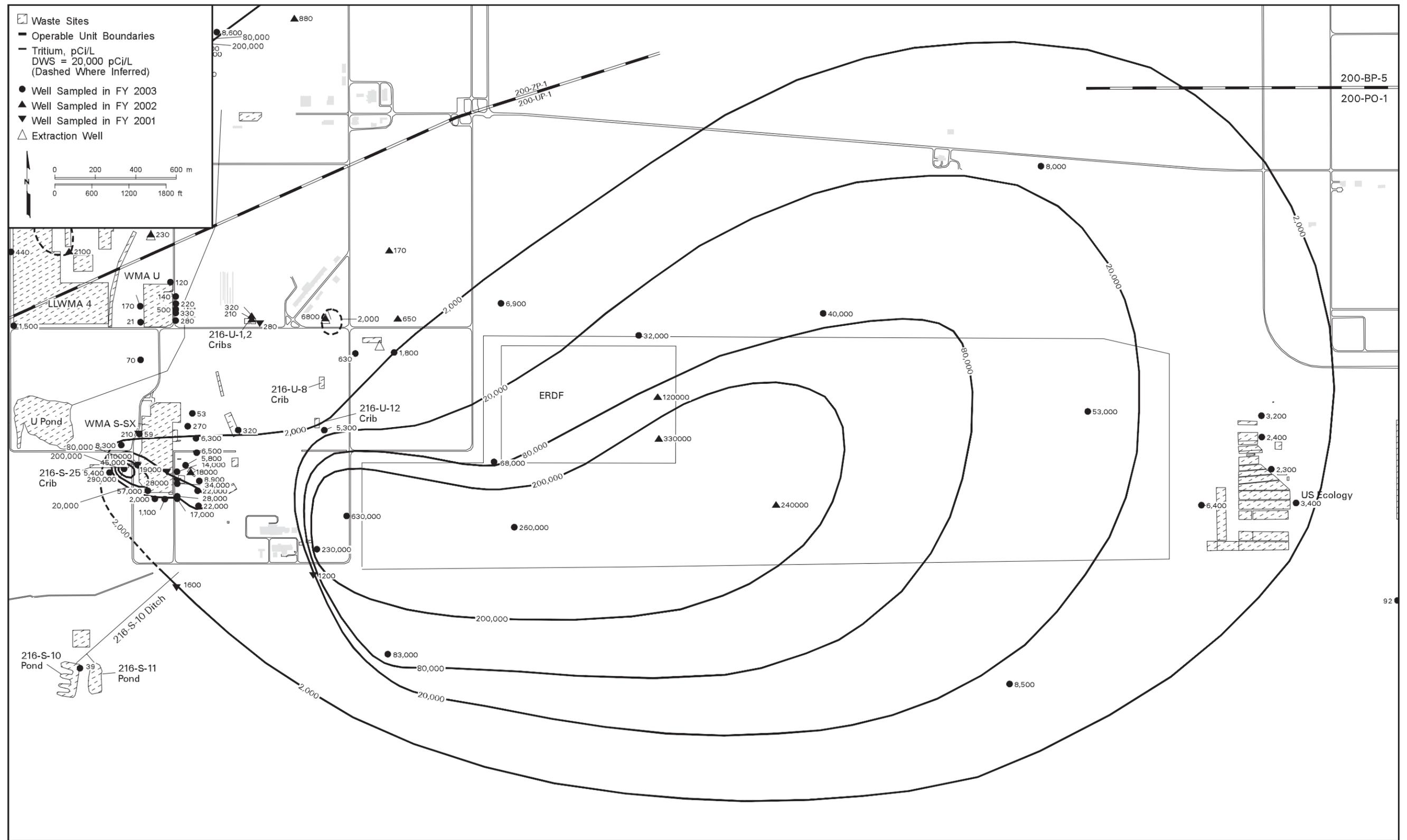


Figure 2.9-3. Technetium-99 Concentrations at Waste Management Area S-SX



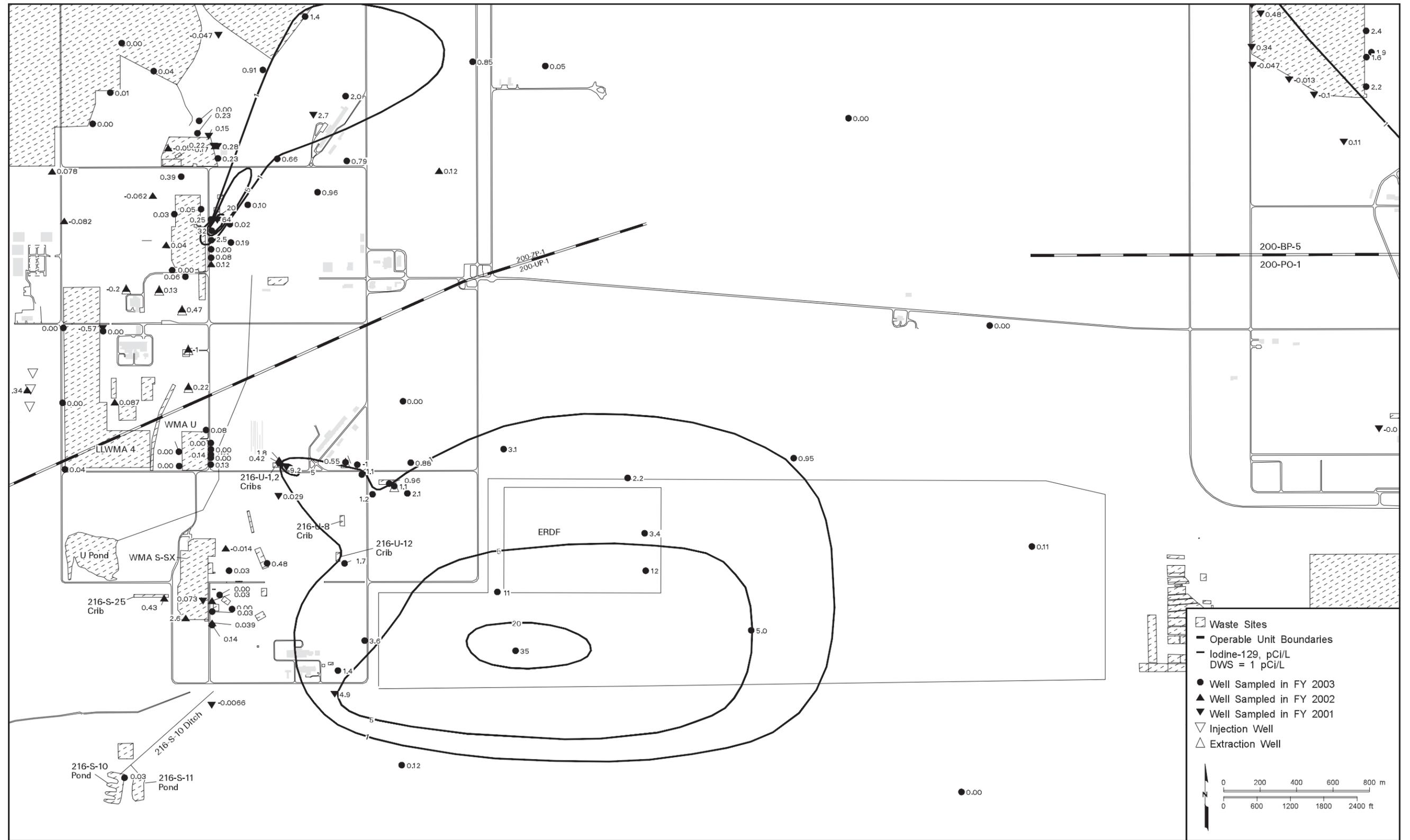
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Figure 2.9-4. Average Uranium Concentrations in the 200-UP-1 Groundwater Interest Area, Top of Unconfined Aquifer



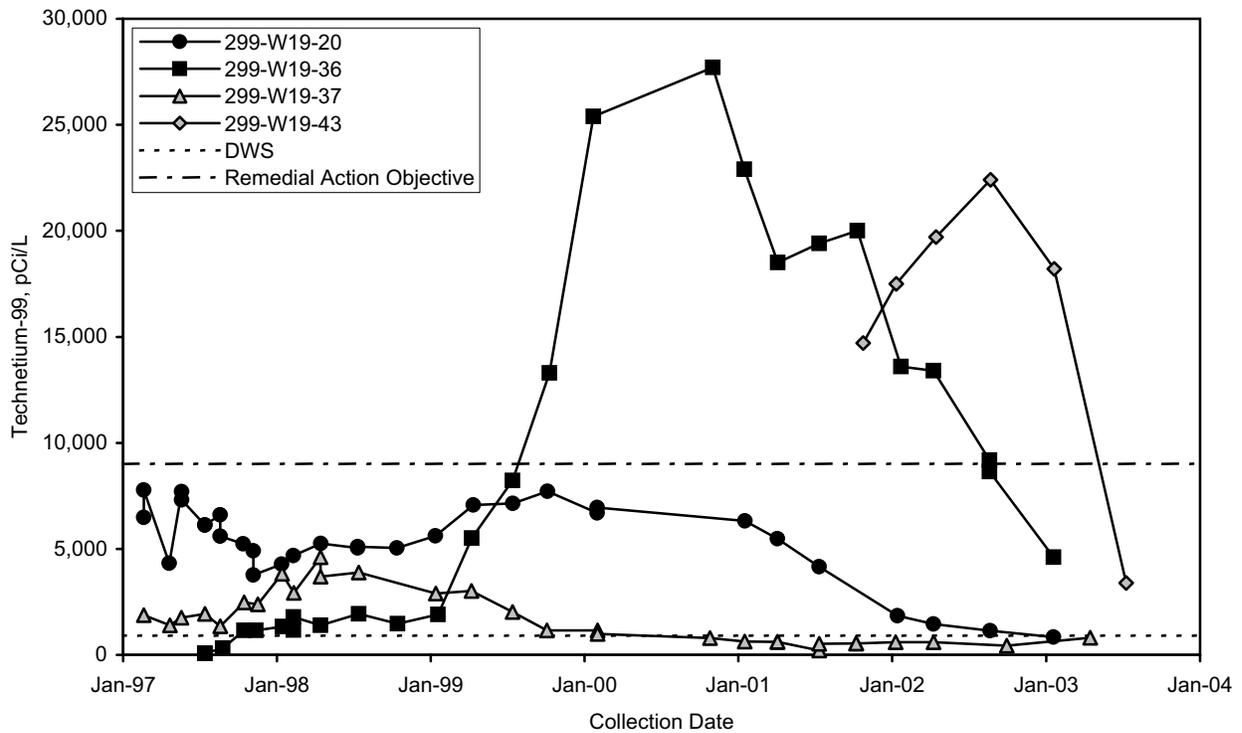
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Figure 2.9-5. Average Tritium Concentrations in the 200-UP-1 Groundwater Interest Area, Top of Unconfined Aquifer



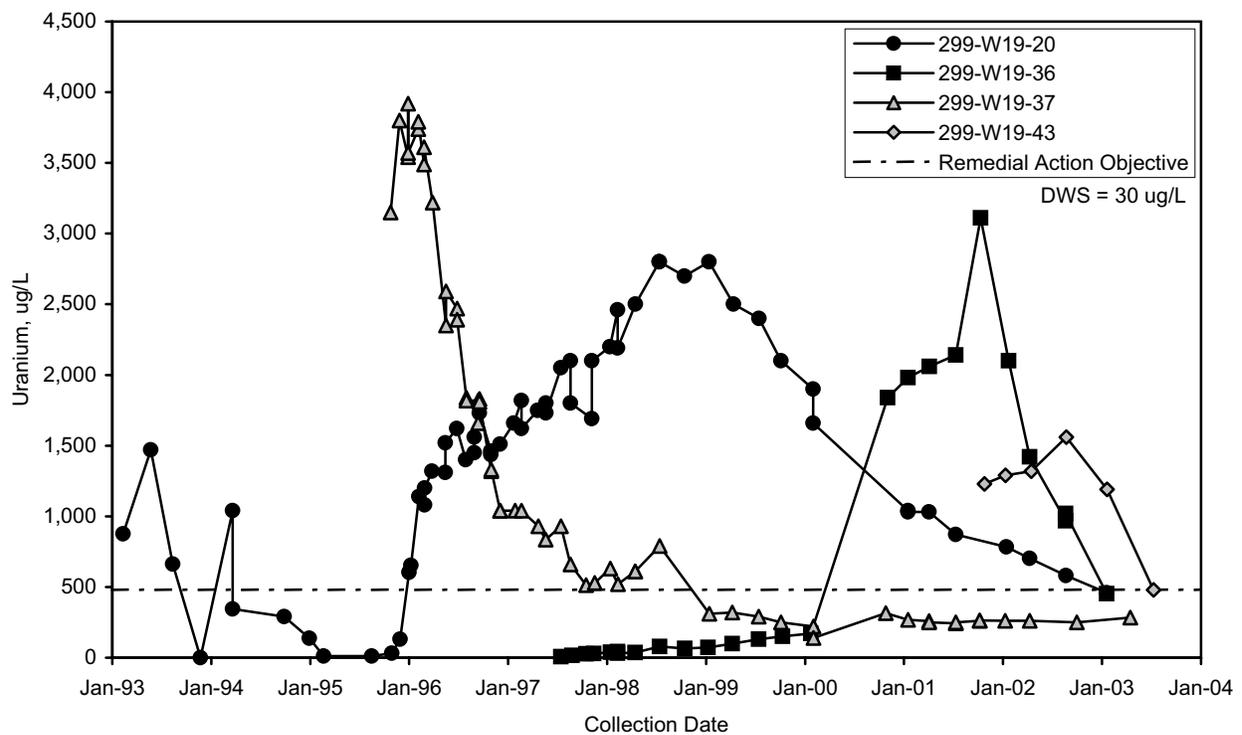
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Figure 2.9-6. Average Iodine-129 Concentrations in the 200-UP-1 Groundwater Interest Area, Top of Unconfined Aquifer



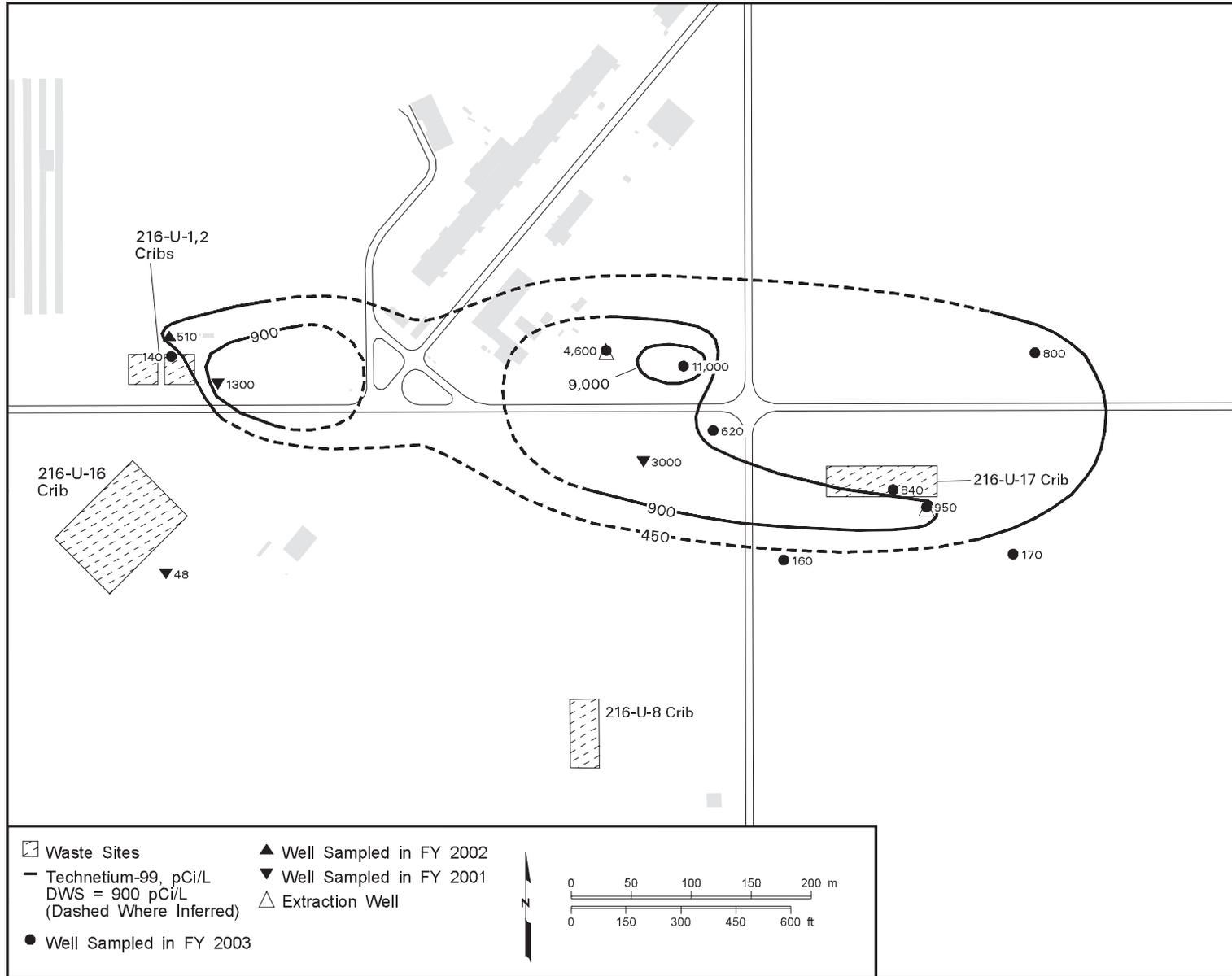
mac03068

Figure 2.9-8. Technetium-99 Concentrations in Extraction and Monitoring Wells at the 200-UP-1 Pump-and-Treat Area (Well 299-W19-43 replaced well 299-W19-36 as an extraction well in May 2003.)



mac03070

Figure 2.9-9. Uranium Concentrations in Extraction and Monitoring Wells at the 200-UP-1 Pump-and-Treat Area (Well 299-W19-43 replaced well 299-W19-36 as an extraction well in May 2003.)



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Figure 2.9-10. Average Technetium-99 Concentrations in the 200-UP-1 Pump-and-Treat Area, Top of Unconfined Aquifer

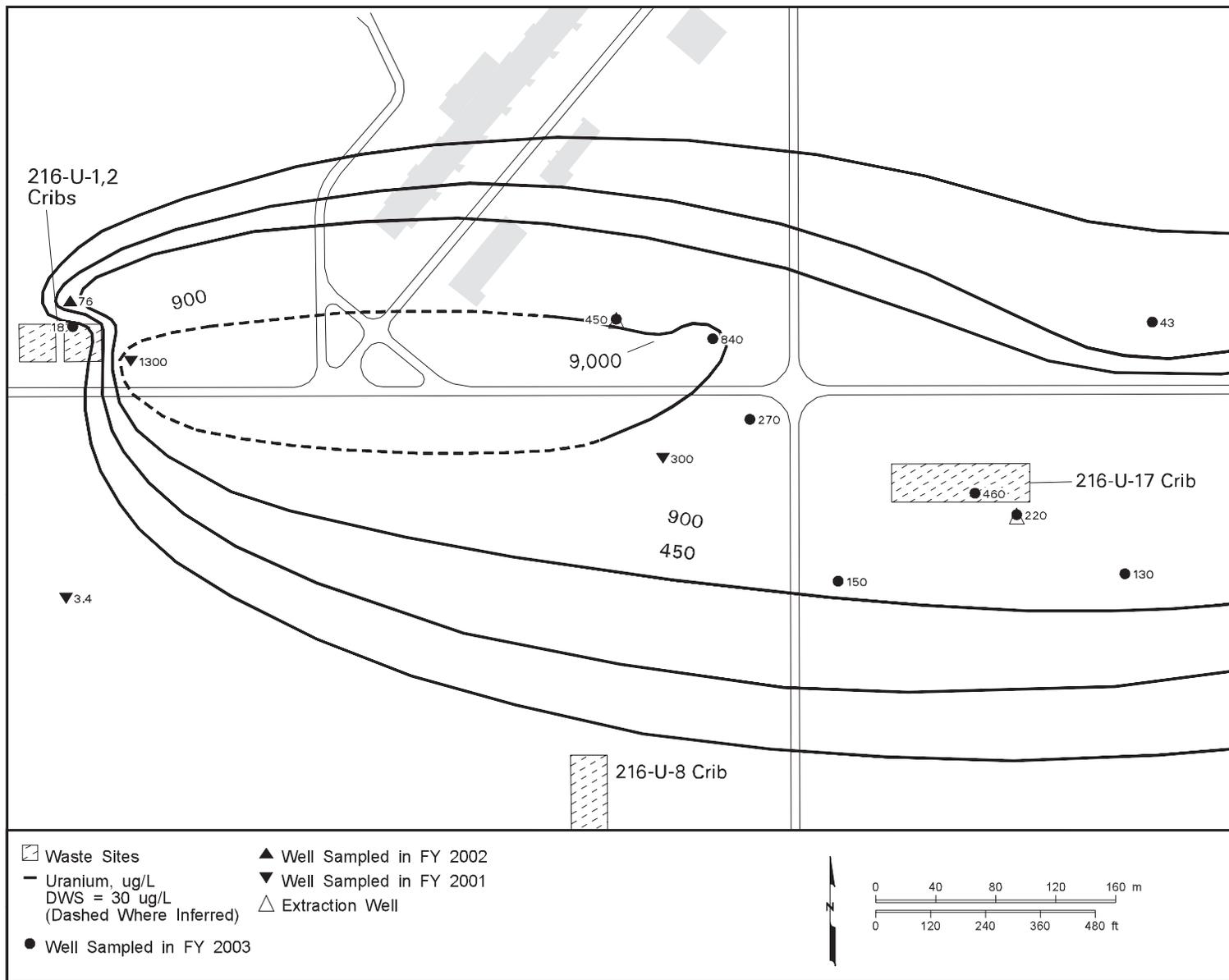
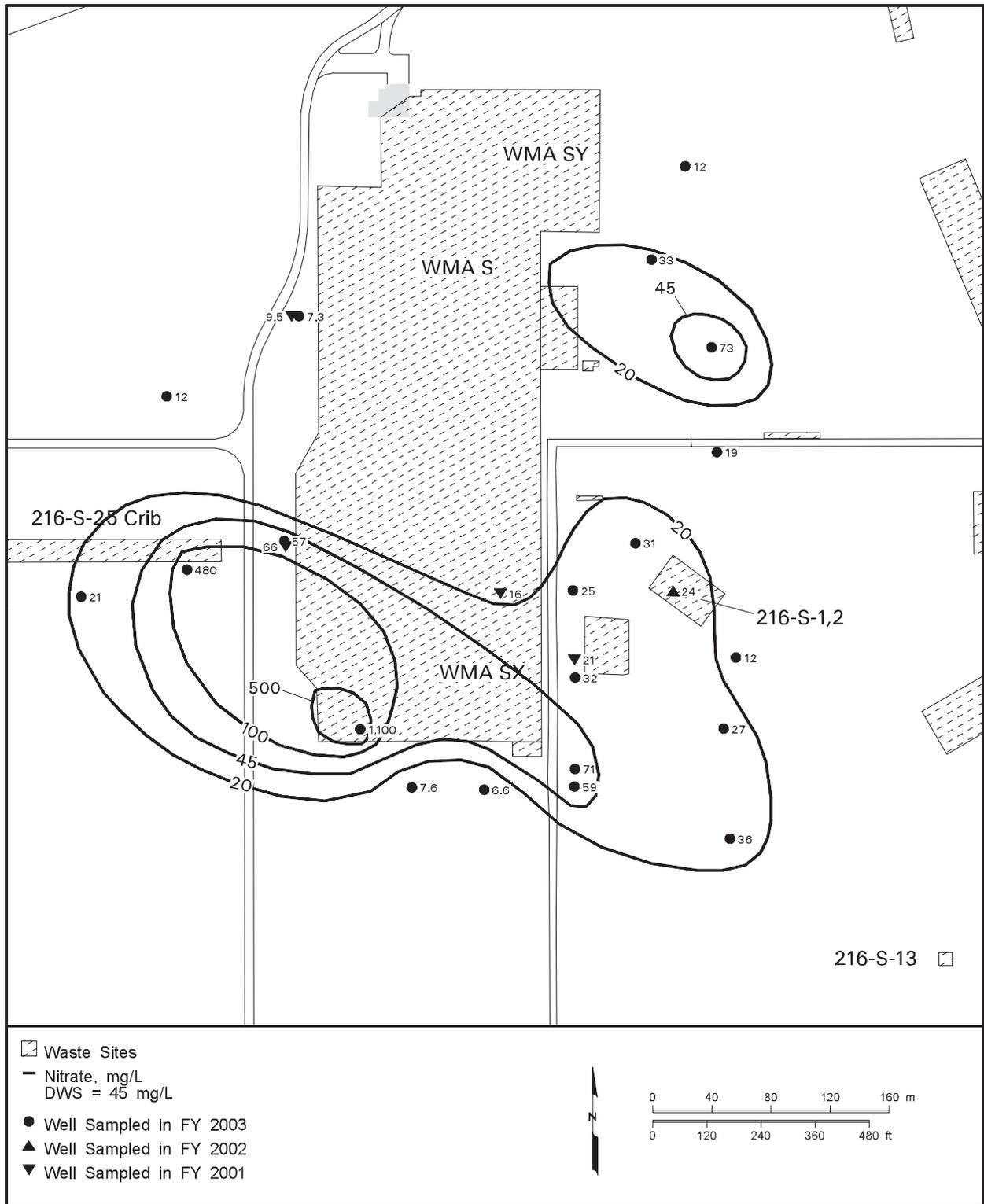


Figure 2.9-11. Average Uranium Concentrations in the 200-UP-1 Pump-and-Treat Area, Top of Unconfined Aquifer



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Figure 2.9-12. Average Nitrate Concentrations at Waste Management Area S-SX, Top of Unconfined Aquifer

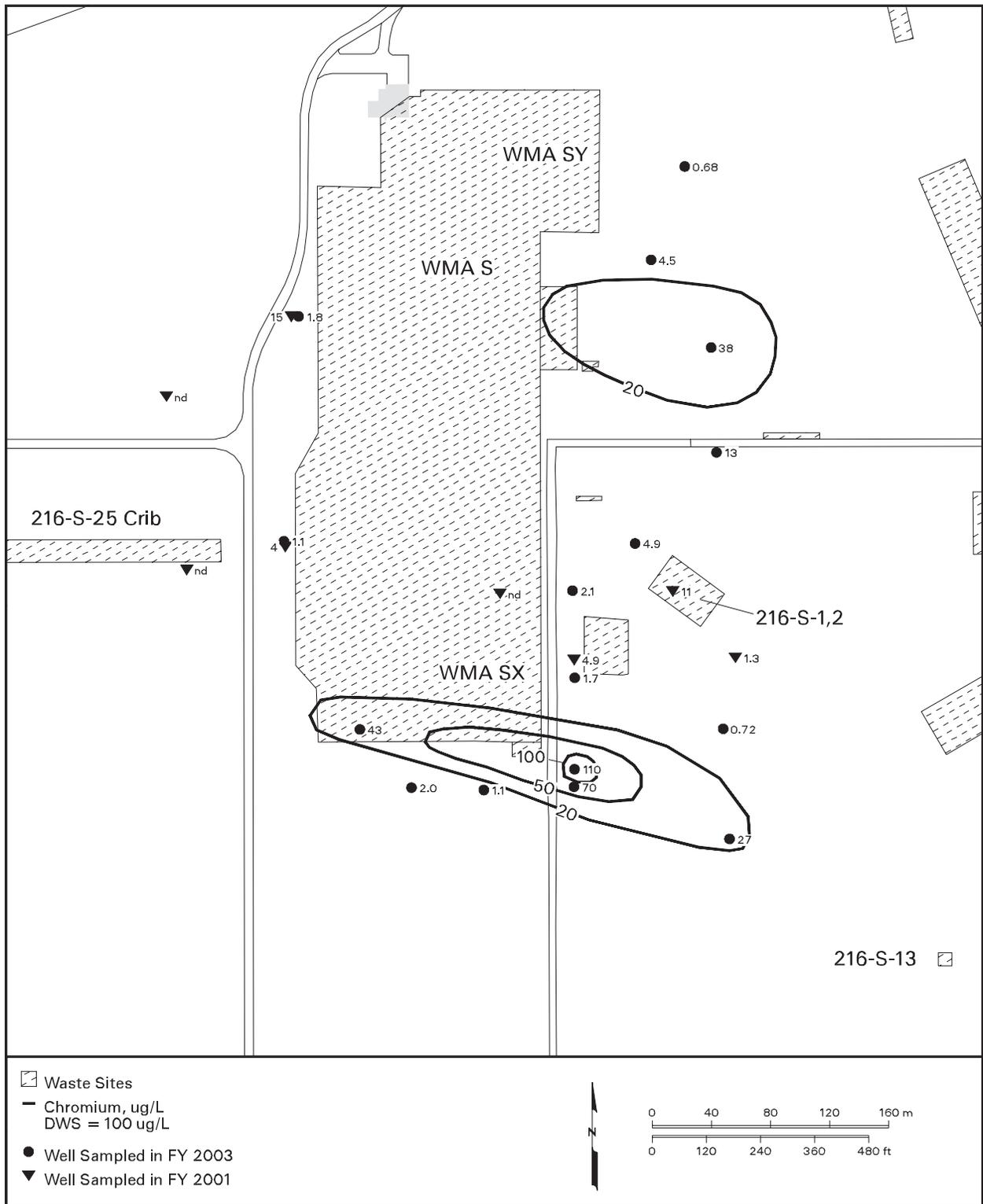
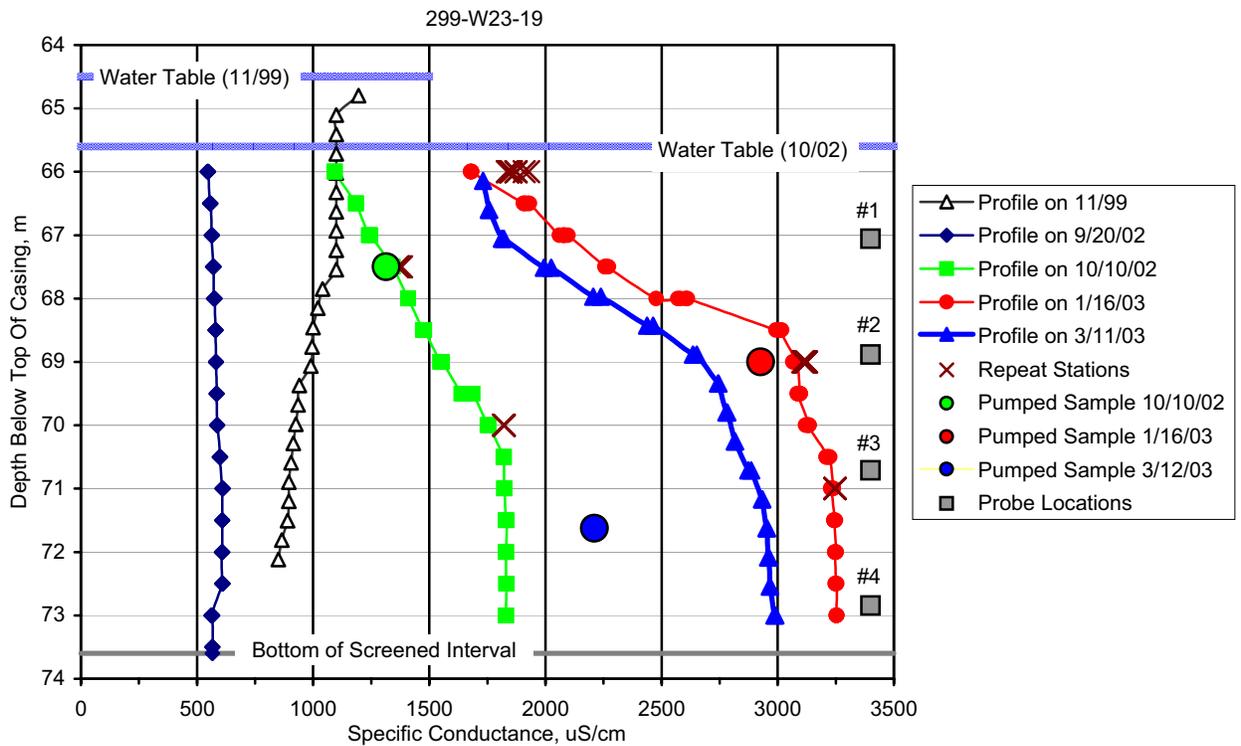
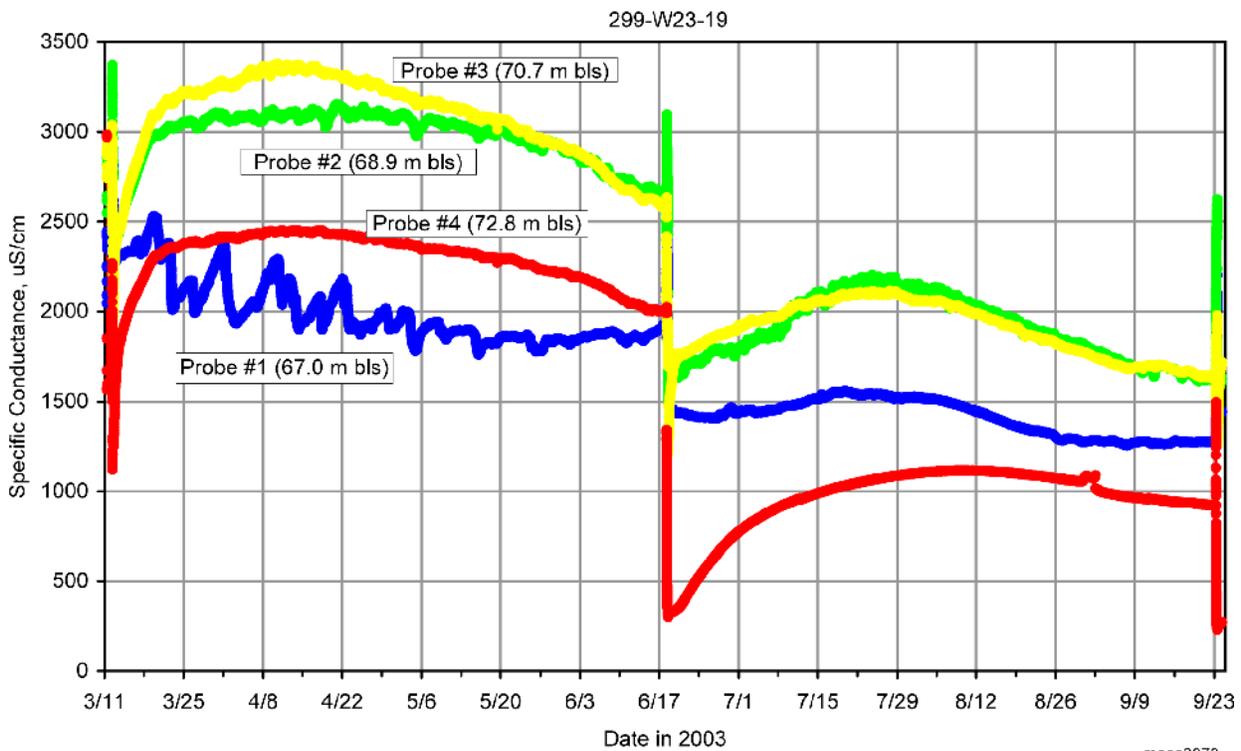


Figure 2.9-13. Average Chromium Concentrations at Waste Management Area S-SX, Top of Unconfined Aquifer



maco3072

Figure 2.9-14. Wellbore-Fluid Specific Conductance Logs Collected in Well 299-W23-19 at Waste Management Area S-SX



maco3073

Figure 2.9-15. Wellbore-Fluid Specific Conductance Measurements Collected in Well 299-W23-19 at Waste Management Area S-SX (Data from probe #4 are shown for information purposes but are considered unreliable.)

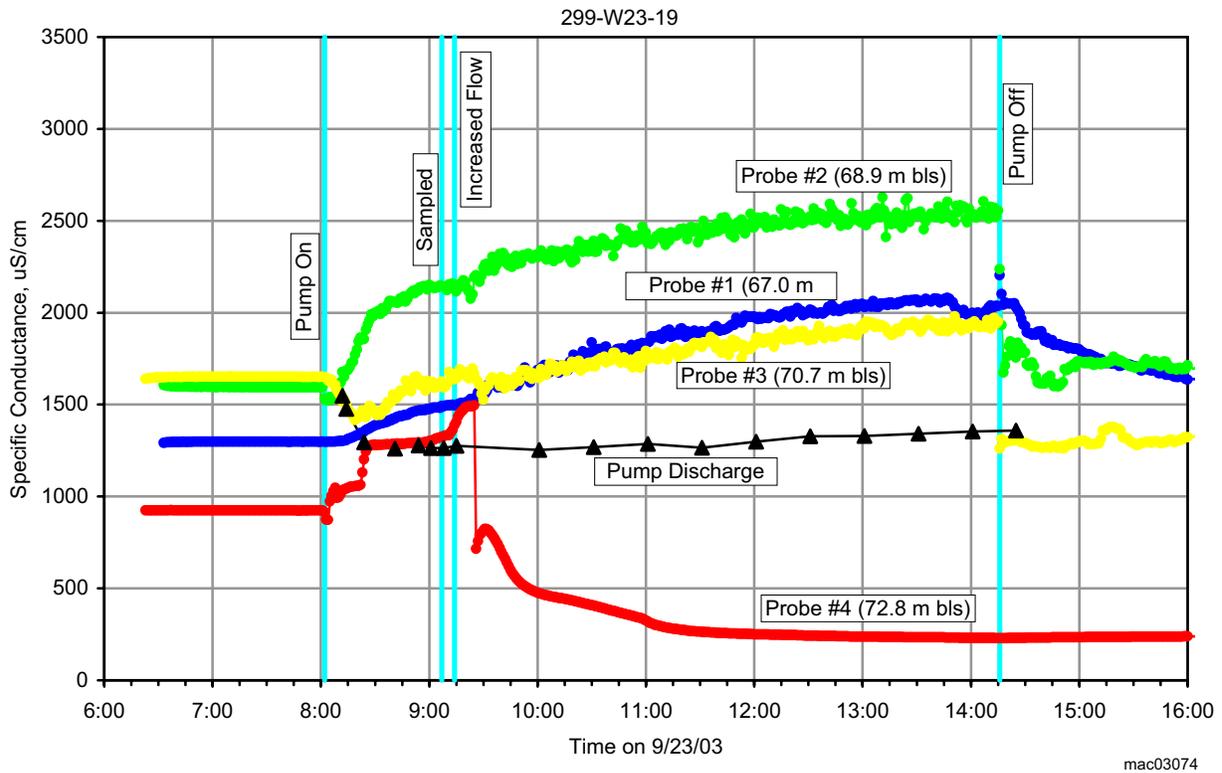


Figure 2.9-16. Wellbore-Fluid Specific Conductance Measurements Collected during Sampling on September 23, 2003 in Well 299-W23-19 (Data from probe #4 are shown for information purposes but are considered unreliable.)

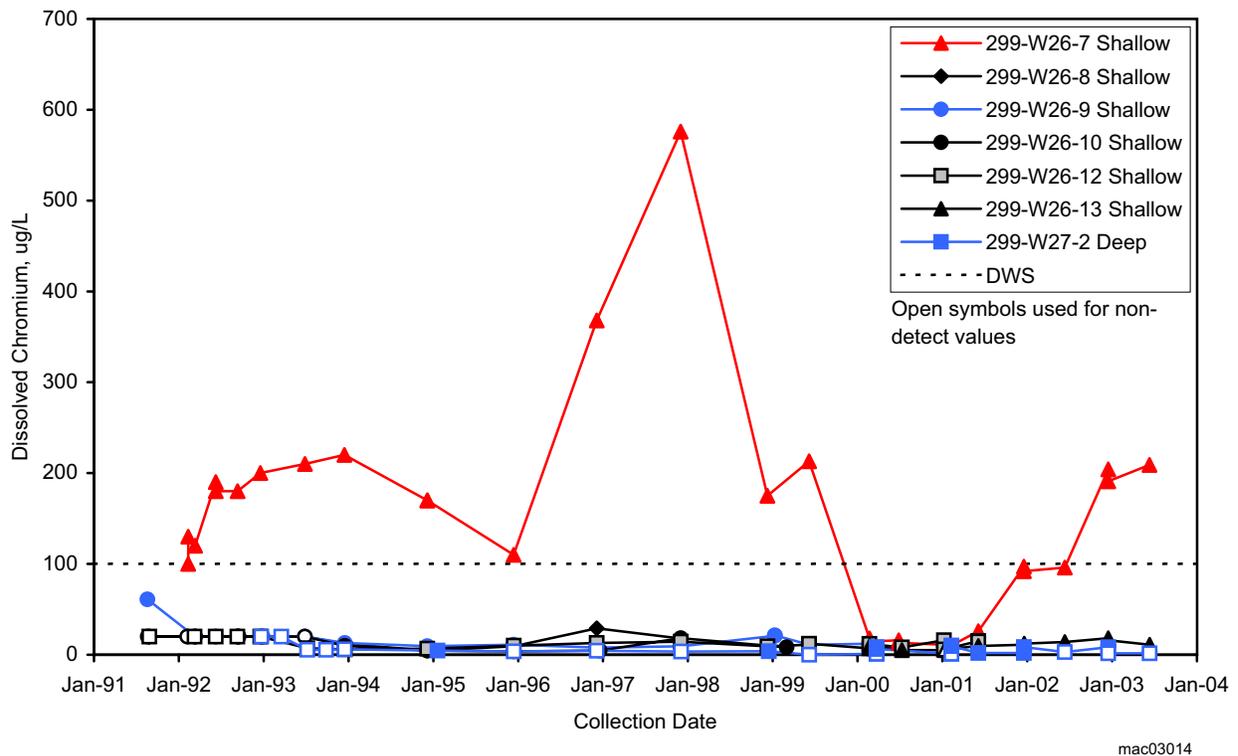


Figure 2.9-17. Chromium Concentrations Near the 216-S-10 Pond and Ditch

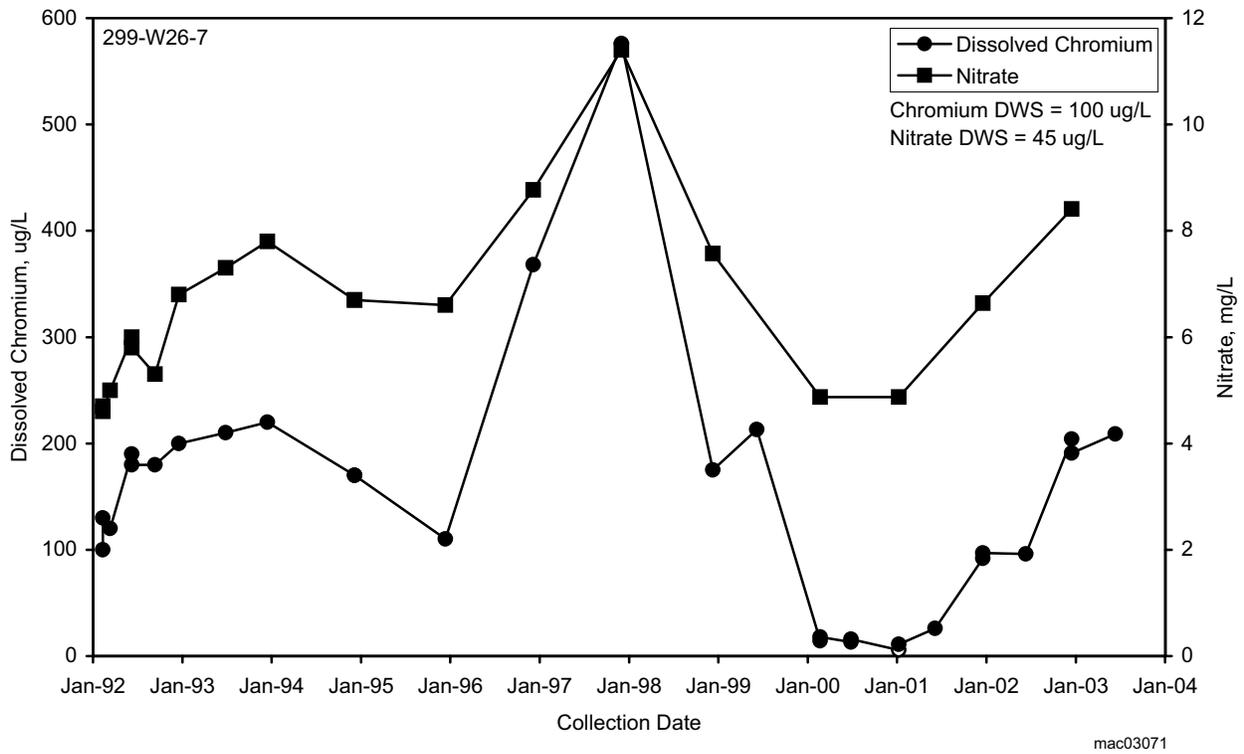
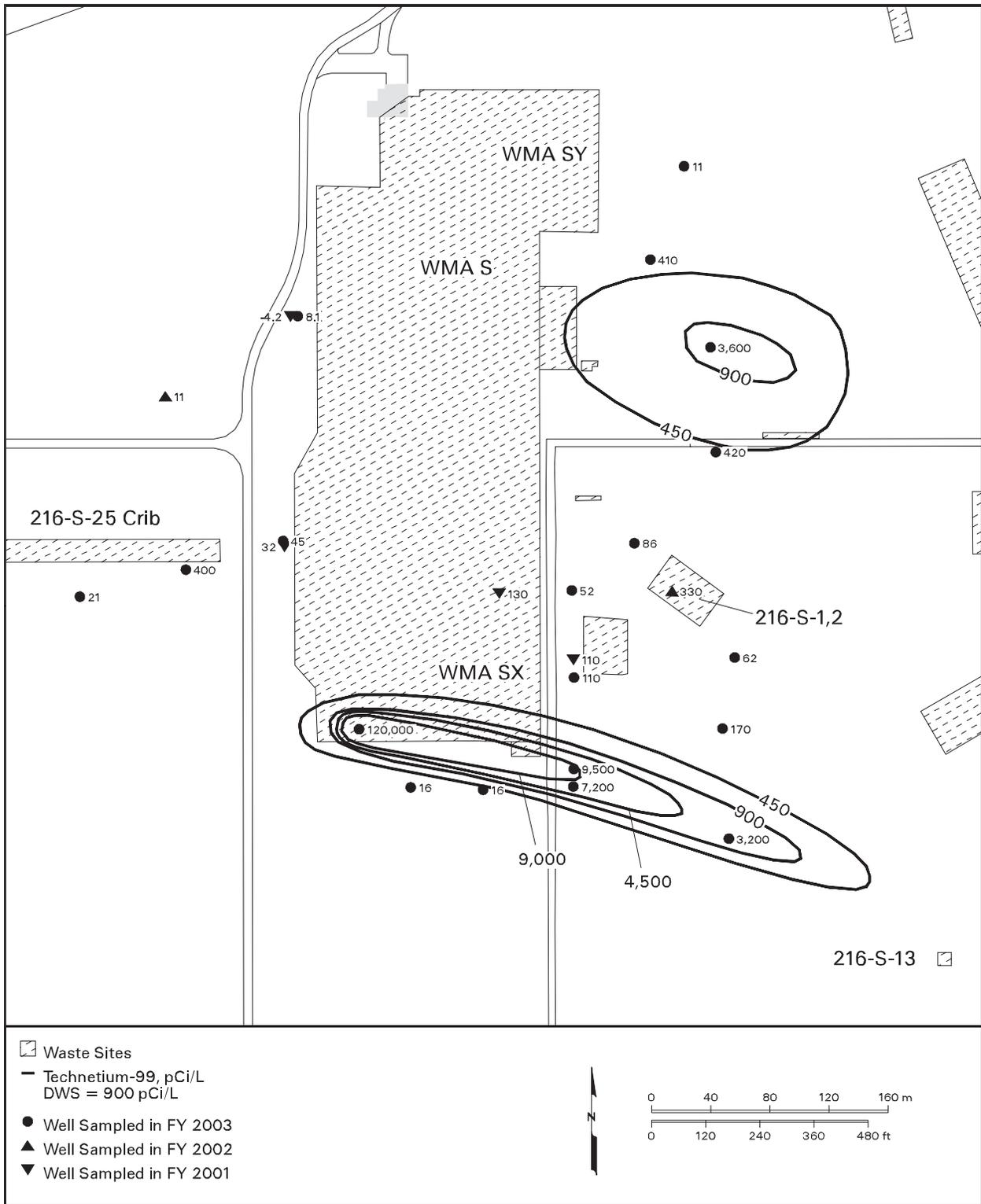


Figure 2.9-18. Chromium and Nitrate Concentrations in Well 299-W26-7 Near the 216-S-10 Pond and Ditch



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

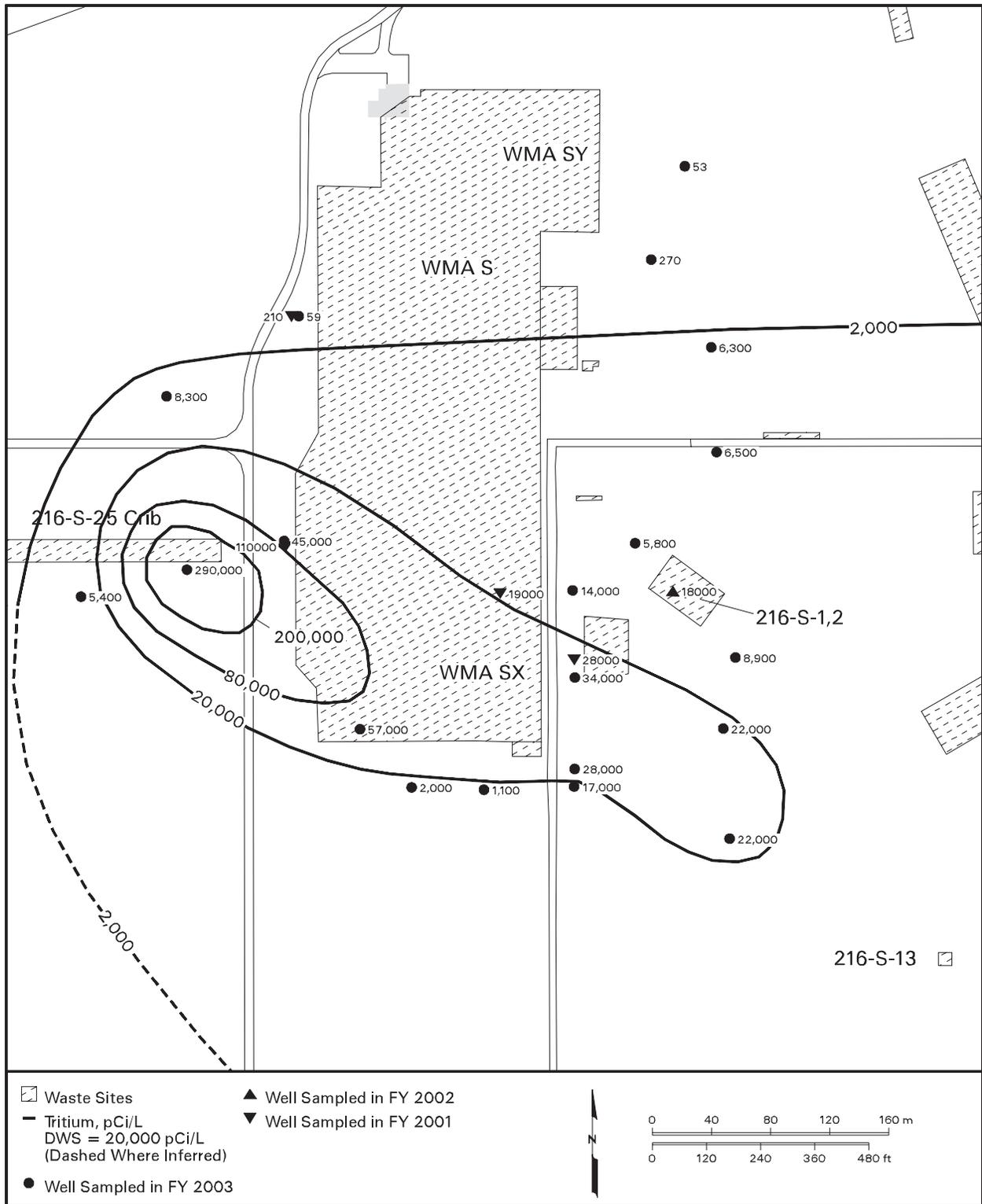


Figure 2.9-20. Average Tritium Concentrations at Waste Management Area S-SX, Top of Unconfined Aquifer