2.6 100 H Area

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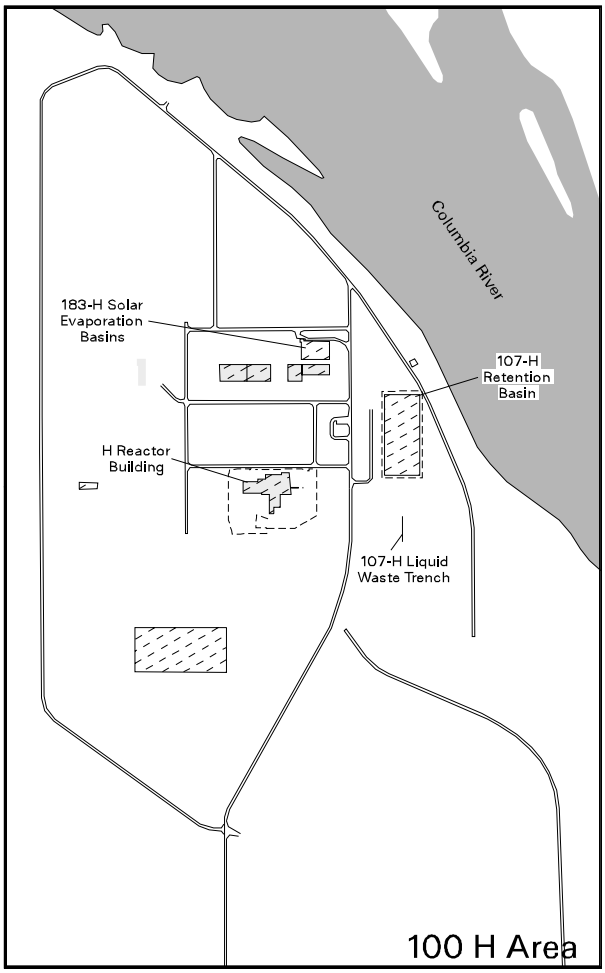
The H Reactor operated between 1949 and 1965 using a single-pass cooling system. This configuration resulted in large volumes of used coolant being released to the soil column, which had significant implications with regard to vadose zone contamination and groundwater movement. An additional source for groundwater contamination was leakage of fuel fabrication effluent stored in solar evaporation basins during the period 1973 to 1985 (Section 2.6.3). Groundwater approaching the 100 H Area from the west is contaminated by chromium and tritium, originating from past disposal in the 100 D Area and possibly the 100 N Area.

A comprehensive description of 100 H Area operations and waste sites is presented in the technical baseline report for the 100-HR-3 Operable Unit (BHI-00127). Facilities and monitoring wells referred to in the text are included on Plate 1.

The presence of chromium in groundwater at the 100 H Area is an environmental restoration issue. In particular, there is concern over chromium in groundwater from 100 H Area that upwells through the adjacent riverbed gravel used by salmon for spawning habitat. Pore water samples collected from gravelly areas used for redds (groups of egg pockets) (BHI-00345, Rev. 1) revealed chromium at concentrations well above the 11 µg/L standard for protecting aquatic organisms. A pump-and-treat system is operating currently to reduce the rate at which chromium enters the Columbia River and also the amount of chromium in near-river groundwater (Section 2.6.4).

Additional remedial actions are underway in the 100 H Area to address vadose zone contamination beneath the 107-H retention basins and adjacent liquid waste disposal trench. These facilities and their underlying soil may contain contaminants that pose a threat to groundwater. The contaminated concrete and soil are being transported to the Environmental Restoration Disposal Facility in the 200 Areas plateau. The H reactor building is scheduled for remediation beginning in fiscal year 2000.



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The contaminants of potential concern in groundwater beneath the 100 H Area include chemical constituents chromium and nitrate, and radiological constituents strontium-90, technetium-99, tritium, and uranium. Organic constituents are not present at levels of concern. The following sections describe contaminants in their order of relative significance to environmental restoration issues.

Monitoring Objectives in 100 H Area

Groundwater monitoring is conducted in the 100 H Area:

- annually to describe the nature and extent of contamination in support of environmental restoration decisions
- annually to monitor conditions beneath the former 183-H Basins, a RCRA site
- semiannually to monitor trends in variable constituents/wells
- various time intervals to evaluate the performance of a pump-and-treat system for chromium.

2.6.1 Groundwater Flow

Groundwater flow beneath the 100 H Area is generally southwest to northeast, toward the Columbia River (see Plate 2). Flow through the sandy/gravelly sediment near the water table is relatively rapid and estimated to be in the range 0.3 to 2.0 meters per day (DOE/RL-93-43, Rev. 0). Because groundwater flows toward the northeast across the entire northern tip of the Hanford Site, groundwater approaching the shoreline upstream of 100 H and along 100 H may contain contaminants whose origin was liquid effluent disposal at the 100 D and 100 N areas.

During periods of high river discharge, significant bank storage of river water takes place along the 100 H shoreline. When combined with a possible preferential pathway created by a former river channel in the sediment of the unconfined aquifer, this promotes groundwater flow that is parallel to the Columbia River. This condition is observed in water-table contour maps drawn for the seasonal high water period during May and June (PNNL-11573) and affects groundwater movement up to a distance of ~300 meters inland. Daily and seasonal river stage fluctuations create corresponding changes in the elevation of the water table, which may cause changes in water quality monitoring results.

The extraction and injection of groundwater associated with the interim remedial action to address chromium contamination also influence the movement of groundwater in the vicinity of the associated wells. This influence is described in Section 2.6.7.

2.6.2 Chromium

Chromium contamination currently observed in 100 H Area groundwater (see Figure 2.5-1) includes a significant component of chromium-bearing groundwater from upgradient sources, such as waste sites in the 100 D Area in addition to 100 H sources. Evidence for this is (1) the groundwater flow direction inferred from water-table elevation maps and (2) chromium concentration trends in wells located along the flow path between 100 D Area and 100 H Area (Figure 2.6-1). Several 100 H Area wells show recent changes in chromium that may be associated with the arrival of chromium- and tritium-bearing groundwater from west of the 100 H Area. These include wells near the H reactor building (Figure 2.6-2). Injection of treated effluent from the chromium pump-and-treat system (Section 2.6.7) may also influence the groundwater flow pattern in that area, thus contributing to the observed changes.

Chromium concentrations in 100 H groundwater are generally 100 µg/L or less, with several exceptions, indicating that the groundwater is typically below the 100 µg/L drinking water standard. However, the more stringent standard for protection of freshwater aquatic organisms (11 µg/L) is exceeded along a portion of the groundwater/river interface adjacent to gravelly riverbed areas that are heavily used by salmon for spawning (Dauble and Watson 1997). During previous field studies, samples of pore water were obtained from the spawning gravels in this area and found to contain chromium concentrations as high as 130 µg/L (BHI-00345, Rev. 1).

Chromium concentrations near the approximate center of mass for the plume are illustrated by trend charts for wells 199-H4-14, 199-H4-18, and 199-H4-16 (Figure 2.6-3) and the map shown in Figure 2.6-16.

Chromium concentrations in well 199-H4-14 have historically been higher than in surrounding wells, presumably because of chromium releases at the former water treatment facility located near the well. Figure 2.6-3 shows the concentration trend for well 199-H4-14 and for two wells located downgradient-199-H4-16 and 199-H4-18. Concentration changes observed in 199-H4-18 may be the result of southward displacement of the contaminant plume associated with the former 183-H solar evaporation basins because of high water-table conditions during 1996 and 1997.

Chromium is elevated in groundwater beneath the 100 H Area. Sources include waste sites in the area and upgradient in the 100 D Area.

Several anomalous occurrences of chromium are being tracked. The first involves well cluster 199-H3-2A, -2B, and -2C (trend plots for these wells are shown in Figure 2.6-4). Well 199-H3-2C is completed in a confined aquifer beneath the overlying unconfined aquifer, which is monitored by wells 199-H3-2A and -2B. In late summer 1996, the water quality observed in 199-H3-2C became very similar to that of water from the shallower wells, as illustrated by the change in chromium concentrations. The change occurred at about the same time as pumping began in well 199-H3-2A, as part of the interim remedial action for chromium. An explanation for this change is not yet available.

A second anomaly is found in well 199-H4-12C, which is also completed in a confined unit beneath the unconfined aquifer. This well has shown relatively high chromium concentrations (~300 μg/L) since it was constructed in 1986 (Figure 2.6-5) though no other contamination indicators are present. One current explanation for these results involves corrosion of the stainless steel well screen (Hewitt 1994; Oakley and Korte 1996). There is no other evidence suggesting that waste effluents have contaminated this deep aquifer.

2.6.3 Strontium-90

The primary source for strontium-90 contamination observed currently in groundwater is past disposal of highly contaminated reactor coolant to the 107-H retention basin and 107-H liquid waste disposal trench, which is located nearby. Also, highly contaminated sludge from the retention basin was placed in an adjacent trench (107-H sludge burial trench), which is located between the basin and the Columbia River. The vadose zone beneath the basin and trenches is potentially contaminated with strontium-90, some of which has dispersed downward and entered groundwater. The upper portion of the vadose zone beneath these facilities is being excavated during 1999, with the contaminated soil being trucked to the Environmental Restoration Disposal Facility in the 200 Areas plateau.

Typical groundwater concentrations for strontium-90 are illustrated by the trend chart for well 199-H4-11 (Figure 2.6-6), which is located between the retention basin and the Columbia River. The concentration trend for gross beta has also been included in the figure. Where strontium-90 is the principal beta emitter present, the concentration of strontium-90 is approximately one-half that of gross beta.

Strontium-90 is present in groundwater near the Columbia River in the 100 H Area but was not detected in pore water from the river bottom.

Independent researchers have recently inferred that strontium-90 is present in mulberry bushes along the 100 H shoreline and also speculated that strontium-90 is present in riverbed gravel used by salmon for spawning (GAP 1999b). Pore water samples that were still available from an earlier investigation of these gravels (BHI-00345, Rev. 1) were subsequently analyzed for strontium-90, and none was detected (see Section 2.6.9.3). More complete descriptions of the results are presented in PNNL-13177, along with a discussion of strontium-90 in the 100 Areas and its ecological implication.

2.6.4 Tritium

Tritium concentrations in the 100 H Area are below the 20,000 pCi/L drinking water standard (see Plate 3). The maximum value observed during fiscal year 1999 was ~8,400 pCi/L. During the last several years, tritium has increased in concentration at some 100 H Area wells in an area northeast of the H reactor building (Figure 2.6-7). While concentrations are typically in the range 4,000 to 5,000 pCi/L, the increasing trend may be indicative of contaminant plume movement across the northern tip of the Hanford Site. Upgradient of the wells shown in Figure 2.6-7, tritium concentrations are decreasing in two wells that monitor groundwater from 100 D and 100 N area sources (Figure 2.6-8). This suggests that the higher concentration core of the plume has passed these wells. A second possibility is that injection of treated effluent from the chromium pump-and-treat system at wells 199-H3-3, 199-H3-4, and 199-H3-5 may influence the direction of groundwater flow near the H reactor building, causing a redistribution of the plume.

An increase in tritium concentrations occurred in well 199-H3-2C beginning in mid-1996, from very low concentrations to a peak of ~3,200 pCi/L (Figure 2.6-9). The change is significant because this well monitors a confined aquifer that is separate from the overlying unconfined aquifer; the confined unit is not known to have received any contamination. Other water quality indicators changed in well 199-H3-2C at the same time (e.g., chromium; see Section 2.6.2), with the characteristics of water from 199-H3-2C looking very similar to those for water from the shallower wells. An explanation for this condition has not yet been established.

2.6.5 Nitrate

During fiscal year 1999, 14 wells in the 100 H Area exceeded the 45 mg/L maximum contaminant level. Concentrations were measured to a high of 217 mg/L in well 199-H4-4, which is located within the 183-H plume. The average value for nitrate in 100 H Area wells is 49 mg/L.

A general increase in nitrate concentrations is apparent in the historical trends for numerous 100 H Area wells, and also for wells located in other reactor areas. This trend is illustrated in Figure 2.6-10. The cause for the gradual increase is not known.

2.6.6 183-H Solar Evaporation Basins RCRA Monitoring

Groundwater near the former 183-H solar evaporation basins is monitored to meet RCRA final status monitoring requirements. Wastes were removed from the treatment facility during the late 1980's, followed by decontamination and demolition, which was completed in 1995 (DOE/RL-97-48). Contaminated soil was then removed, although nitrate and fluoride remained elevated in the remaining soil, thus requiring postclosure groundwater monitoring.

The 183-H basins are a RCRA site that has contaminated groundwater with chromium, nitrate, technetium-99, and uranium. Groundwater is monitored in conjunction with an interim remedial measure at the 100-HR-3 Operable Unit.

Groundwater movement in the vicinity of the basins has been modified by the interim remedial action to address chromium. While pumping operations are in progress, RCRA monitoring is conducted to track the trends of five contaminants associated with leakage from the basins: chromium, fluoride, nitrate, technetium-99, and uranium (PNNL-11573).

Groundwater chemistry near these former basins is characterized by elevated levels of chromium, nitrate, sodium, sulfate, technetium-99, and uranium. All of these constituents were present in waste discharged to the basins when they were in use. Concentrations in fiscal year 1999 were lower than in recent years. See Appendix A for supporting information about this RCRA site.

2.6.6.1 Groundwater Flow

As indicated on the March 1999 water-table map (see Plate 2), groundwater beneath the former basins flows generally to the east-northeast, toward the Columbia River. Technetium-99 and uranium plumes originating at the basins have migrated primarily toward the east (see Section 5.7 of PNNL-12086). The rate of flow in March 1999 is estimated to be between 0.12 to 3.2 meters per day (see Table A.2).

Groundwater levels fluctuate with the stage of the Columbia River (Figure 2.6-11). Water levels were measured monthly in well 199-H4-4 and ranged in elevation from 114.51 meters in October 1998 to 116.77 meters in July 1999. Periods of high river stage influence flow velocity in the area temporarily, creating a potential for flow toward the south. Groundwater flow around the 183-H solar evaporation basins is also influenced by the pump-and-treat system, as discussed in Section 2.6.7.

2.6.6.2 Technetium-99 and Uranium

Concentrations of technetium-99 and uranium were lower in fiscal year 1999 than in recent years as illustrated by concentrations in wells 199-H4-3 and 199-H4-4 (Figure 2.6-12) These basin contaminants are very mobile in groundwater, and concentrations fluctuate in response to changes in the stage of the Columbia River. Usually concentrations are highest when river stage is low. However, in November 1998, river stage was low, and concentrations were also low, especially in well 199-H4-3. These changes may represent a shift in the contaminant plume caused by the influence of the pump-and-treat system.

Only three wells exceeded the 20-μg/L maximum contaminant level for uranium in fiscal year 1999: 199-H4-3, 199-H4-4, and 199-H4-12A. The highest annual average was ~31 μg/L in well 199-H4-4. Well 199-H4-4 also had the highest concentration of technetium-99, with an annual average of ~550 pCi/L. This was below the 900 pCi/L drinking water standard.

Well 199-H4-5 had peaks in concentrations of chromium, nitrate, technetium-99, and uranium in fiscal year 1998. Levels declined again in fiscal year 1999 (Figure 2.6-13). Changing directions of groundwater flow caused by the pump-and-treat system may have caused the spikes.

Well 199-H4-18 is located near the southern boundary of the contaminant plume attributable to the 183-H solar evaporation basins. During periods of high water-table conditions, the plume appears to be displaced slightly to the south, as indicated by a change in the direction of water-level gradients. This is reflected in well 199-H4-18 by increased concentrations of technetium-99 and nitrate, which are 183-H plume indicators, during the summer of each year (Figure 2.6-14). This was especially apparent during 1996, a year of an usually high water table.

2.6.6.3 Nitrate

Leakage from the basins contributed to a more widespread plume of nitrate (see Section 2.6.5). The highest concentrations in 100 H Area in fiscal year 1999 were observed in downgradient well 199-H4-4 at 217 mg/L. Like technetium-99 and uranium, concentrations in wells downgradient of the basins were generally lower in fiscal year 1999 than in the previous several years.

2.6.6.4 Chromium

Leakage from the 183-H solar evaporation basins also contributed to the widespread plume of chromium (see Figure 2.5-1 and Section 2.6.2). Unlike co-contaminants, chromium appears to have increased in recent years in well 199-H4-3 (Figure 2.6-15). Seasonal fluctuations are evident in well 199-H4-4, where chromium is analyzed monthly. High river stage in the spring and early summer was accompanied by low concentrations of chromium. Specific conductance of those samples was also low, indicating possible dilution by river water.

Chromium declined in well 199-H4-5 after a 1998 peak (see Figure 2.6-14). The changes in concentration may be related to changes in groundwater flow caused by the pump-and-treat system (Section 2.6.7).

Chromium remains elevated, but is gradually declining, in well 199-H4-12C (see Figure 2.6-5). This well is completed in a deeper part of the aquifer than the other wells nearby. The well is monitored as part of the *Resource Conservation and Recovery Act of 1976* (RCRA) network to ascertain whether pumping the shallow aquifer (i.e., well 199-H4-12A) affects the chromium concentrations observed in the deeper aquifer (PNNL-11573). The average concentration for well 199-H4-12C in fiscal year 1999 was ~200 μg/L. Other contaminants that are characteristic of 183-H waste are not elevated, and the cause for this elevated chromium is currently not understood.

2.6.6.5 Fluoride

This constituent was detected in the vadose zone beneath the basins during remediation activities in 1996, making it a constituent of interest for RCRA postclosure care (DOE/RL-97-48, Rev. 0; PNNL-11573). Recent and historical values for fluoride are an order of magnitude lower than the 4 mg/L maximum contaminant level. Fluoride concentrations in downgradient wells were lower than in upgradient wells during fiscal year 1999, suggesting no addition of fluoride to groundwater as it passes beneath the footprint of the former basins.

2.6.7 Groundwater Remediation

A pump-and-treat system, located in the 100 H Area, began operating in 1997 as an interim action for the 100-HR-3 Operable Unit. Three of the extraction wells are located within ~50 meters of the river shore, two others are located farther inland near the 183-H solar evaporation basins. Four compliance wells are located within ~100 meters of the river shore.

2.6.7.1 Interim Remedial Action Objectives

The record of decision (ROD 1996b) contains the following specific remedial action objectives that pertain to operation of the pump-and-treat system:

- protect aquatic receptors in the river bottom from contaminants in groundwater entering the Columbia River
- protect human health by preventing exposure to contaminants in the groundwater
- provide information that will lead to the final remedy.

The record of decision stipulates that the interim action pump-and-treat system continues operating until the selection of the final remedy or when the U.S. Environmental Protection Agency and Washington State Department of Ecology are satisfied that termination (or intermittent operation) is appropriate. The pump-and-treat system may be shut down when

- sampling results indicate that the concentration of hexavalent chromium is below 22 μg/L in the compliance wells
- data indicate that the concentration will remain below the compliance value
- effectiveness of the treatment technology does not justify further operation
- an alternative and superior treatment technique becomes available and feasible (ROD 1996b).

2.6.7.2 Remediation Progress During Fiscal Year 1999

The pump-and-treat system made progress toward achieving the remedial action objectives during fiscal year 1999. Figure 2.6-16 shows the flow lines and hydraulic capture estimated to occur during a low flow period in the Columbia River (November 1998), when groundwater flow to the river is greatest. This simulation estimates that much of the contaminated groundwater is prevented from discharging to the Columbia River (DOE/RL-99-13).

Although designed primarily to prevent or reduce the amount of contaminated groundwater discharging into the Columbia River, the pump-and-treat system also reduces overall contamination in the operable unit by removing contaminant mass. The pump-and-treat program collects hydraulic monitoring data, contaminant monitoring data, and operating data to

assess the performance of the system and to provide the basis to select the final remedy as part of the record of decision.

The goal of a pump-and-treat system in the 100 H Area is to prevent chromium from reaching the Columbia River, where it could harm young salmon. Since 1997, 15 kilograms of chromium have been removed from groundwater.

During fiscal year 1999, the pump-and-treat system extracted over 131.0 million liters of groundwater and removed over 6.1 kilograms of hexavalent chromium in the 100 H Area (Table 2.6-1). The average concentration of hexavalent chromium from 100 H Area wells was 50.6 µg/L. After treatment, the average effluent concentration was 2 µg/L, with hexavalent chromium being undetected during 45 of the 52 sampling events. A total of 15.0 kilograms of hexavalent chromium has been removed since startup of the pump-and-treat system in July 1997. Published estimates for the total amount of hexavalent chromium in the plume targeted for remedial action range between 42 and 250 kilograms (Peterson and Connelly 1992; DOE/RL-94-95, Rev. 1). A principal reason for uncertainty in these estimates is the lack of data on the vertical distribution of contamination in the aquifer. An order-of-magnitude estimate for the rate at which chromium is discharging to the Columbia River via groundwater flow is 0.05 kilogram per day (BHI-00469). This equates to a total mass flux of ~41 kilograms that would have entered the Columbia River since July 1997. The actual flux is believed to be less because of the pump-and-treat system.

2.6.7.3 Influence on Aquifer Conditions

The concentration of chromium declined below the 22-µg/L action level in some of the extraction and compliance wells during all three summers that the pump-and-treat system operated. Each time, the concentration rebounded over the action level by the following September. In September 1999, chromium was measured at 77, 48, and 37 µg/L in compliance wells 199-H4-4, 199-H4-63, and 199-H4-64, respectively (Figure 2.6-17).

Because of the recurring elevated concentration of hexavalent chromium in the compliance wells, the annual summary report (DOE/RL-99-13) recommended continued operation of the pump-and-treat system. The cyclical pattern in the hexavalent chromium trend plots makes it difficult to quantify the effectiveness of the pump-and-treat system in lowering the concentration of hexavalent chromium in the aquifer. The concentration in the compliance wells falls close to or below the 22 µg/L remedial action objective level during the summer, but rebounds greatly over it in the fall and winter. The decrease in concentration in certain extraction wells (Figure 2.6-18) and compliance wells indicates that the concentration throughout the aquifer is decreasing in some areas, but the rate of decline is inconsistent throughout the targeted plume area. The pump-and-treat system reduces the total amount of chromium in the environment, but a review of the contaminant data indicates that many years of pumping may be required before the remedial action objectives have been entirely satisfied.

2.6.8 Waste Site Remediation

Remedial action excavation of waste sites in the 100 H Area continued in fiscal year 1999. Activities consisted of removing and stockpiling clean overburden soil and removing contaminated soil/debris for disposal at the Environmental Restoration Disposal Facility. Water from the Columbia River was used for dust control; it was applied as necessary during remediation activities. Application of water was held to a minimum to reduce the potential for mobilizing contaminants from the vadose zone to the groundwater. Groundwater in the 100 H Area is 15 to 18 meters below the ground surface. Waste sites excavated in fiscal year 1999 included

- 107-H retention basin (waste site 116-H-7) — Excavation began in March 1999 and continued

throughout fiscal year 1999. Excavation is scheduled to be completed during the first quarter of fiscal year 2000. The depth of the excavation will be ~10 meters below ground surface.

- 100-H-5 sludge burial site — This site is located just east of the retention basin. Excavation began in September 1999 and is scheduled to be completed during the second quarter of fiscal year 2000. The depth of the excavation will be ~5 meters below ground surface.

- 107-H Liquid Waste Disposal Trench (waste site 116-H-1) — Excavation began in July 1999 and is scheduled to be completed during the first quarter of fiscal year 2000. The depth of the excavation will be ~5 meters below ground surface.

- Reactor process piping — Overburden removal began in August 1999 and is scheduled to be completed during the second quarter of fiscal year 2000. The depth of excavation ranges from 2 to 10 meters below ground surface.

2.6.9 Water Quality at Shoreline Monitoring Locations

Groundwater near the Columbia River is sampled annually in the late fall via aquifer sampling tubes and riverbank seeps. The sampling tubes are polyethylene tubes that were installed in the aquifer near the low-water shoreline. Riverbank seepage appears at numerous locations when the river level is low. In fiscal year 1999, special studies of shoreline vegetation and pore water samples were conducted in 100 H Area.

2.6.9.1 Aquifer Sampling Tubes

Samples collected during the fall 1998 sampling round were screened for hexavalent chromium, gross beta, nitrate, technetium-99, and tritium. Hexavalent chromium concentrations ranged from 11 µg/L downstream of the 100 H Area to a maximum of 73 µg/L near the 107-H retention basin. This concentration is consistent with hexavalent chromium concentrations in samples from nearby well 199-H4-11.

Tritium concentrations ranged from 1,000 to 3,800 pCi/L. Gross beta concentrations in the same locations ranged from undetected downstream of the 100 H Area to 97 pCi/L near the 107-H retention basin. These concentrations are consistent with gross beta and tritium concentrations in samples from groundwater monitoring wells near the 100 H shoreline. Technetium-99 was detected in samples from three tubes near the 107-H retention basin, with a maximum concentration of 56 pCi/L.

Nitrate concentrations ranged from 13 mg/L downstream of the 100 H Area to 50 mg/L near the retention basin. These concentrations are consistent with nitrate detected in groundwater samples from monitoring wells near the Columbia River shoreline.

2.6.9.2 Riverbank Seepage

Five riverbank seeps were sampled in the fall 1998 for the 100-HR-3 Operable Unit. These seeps were sampled during low-river discharge, when seepage is least influenced by bank storage of river water and is most representative of groundwater that discharges into the Columbia River. The specific conductance of the collected seep samples ranged from 154 to 280 µS/cm, indicating a mix of groundwater and river water drains back to the river from bank storage.

Chromium concentrations ranged from 6.7 to 57.6 µg/L. The highest chromium concentration was detected in a sample from a seep near the 107-H retention basin and is consistent with aquifer sampling tube and groundwater well sample analytical results.

Gross beta ranged from 3.1 pCi/L upstream of the 100 H Area to a maximum of 38.8 pCi/L near the 107-H retention basin. Gross beta observed at this location is most likely the result of strontium-90 in the groundwater. The maximum tritium concentration was detected in a sample from a seep upstream of the 100 H Area.

2.6.9.3 Special Shoreline Studies

Analysis of radioactivity in shoreline vegetation at the 100 H Area led to speculation that strontium-90

might be present in riverbed pore water where chromium had been observed previously (GAP 1999b). In an attempt to test this hypothesis, archived samples of pore water from the original study (BHI-00345, Rev. 1) were reanalyzed for strontium-90. Strontium-90 was not detected in any of the samples (Table 2.6-2). The pore water sampling locations are in the nearshore area adjacent to the former 107-H retention basin.

Analysis of shoreline vegetation reveals the presence of radionuclides of Hanford Site origin at very low concentrations (WDOH/320-023). The roots of mulberry bushes are bathed in a mixture of groundwater and river water in the zone of bank storage and, thus, provide insight on possible contaminants in groundwater near the Columbia River.

Table 2.6-1. Performance Statistics for the 100 H Pump-and-Treat System for Chromium, Fiscal Year 1999

Well or Sample Location	Annual Average Flow Rate (L/min)	Maximum Sustained Flow Rate (L/min)	Total Volume Pumped (x 10^6 L)	Average Chromium Concentration (µg/L)	Chromium Mass Removed (kg)
199-H3-2A	69.2	78.1	32.8	16.2	0.5
199-H4-7	46.2	52.2	19.7	63.6	1.3
199-H4-11	83.3	91.6	37.1	61.0	2.3
199-H4-12A	49.4	52.5	22.0	62.6	1.4
199-H4-15A	47.6	51.4	19.3	51.8	1.0
H-Influent	279.6	317.3	131.0	50.6	6.6
H-Effluent	548.8	601.5	258.6	2.1	--

Data Source: Project Specific Database for the 100-HR-3 Operable Unit.

Table 2.6-2. Chromium and Strontium-90 Results for River Substrate Pore Water Samples

Riverbed Sampling Site	Distance Offshore (m)	Sample Specific Conductance (µS/cm)	Hexavalent Chromium (µg/L)	Strontium-90 (pCi/L)	Minimum Detection Level (pCi/L)
TH-1A	21	207	100	-0.436	3.2
TH-1A (dupl)	21	198	130	0.931	7.72
TH-1B	30	155	52	-1.02	3.14
TH-1B (dupl)	30	183	103	-4.2	9.01
TH-2A	30	149	<1	-0.751	4.62
TH-2B	43	137	<1	-0.034	3.83
TH-3A	12	175	1.2	0.523	4.77
TH-3B	24	147	9	3.27	3.83
TH-13A	7	177	2.6	0.23	3.85
TH-14A	7	190	73	-0.551	3.1

Note: The specific conductance of river water measured just above the pore water sampling sites ranged between 149 and 155 µS/cm. The pore water sample specific conductance indicates the sample was primarily river water, with only a minor added component of groundwater. Strontium-90 analyses were performed on archived pore water samples during August 1999. All results for strontium-90 indicate non-detection.

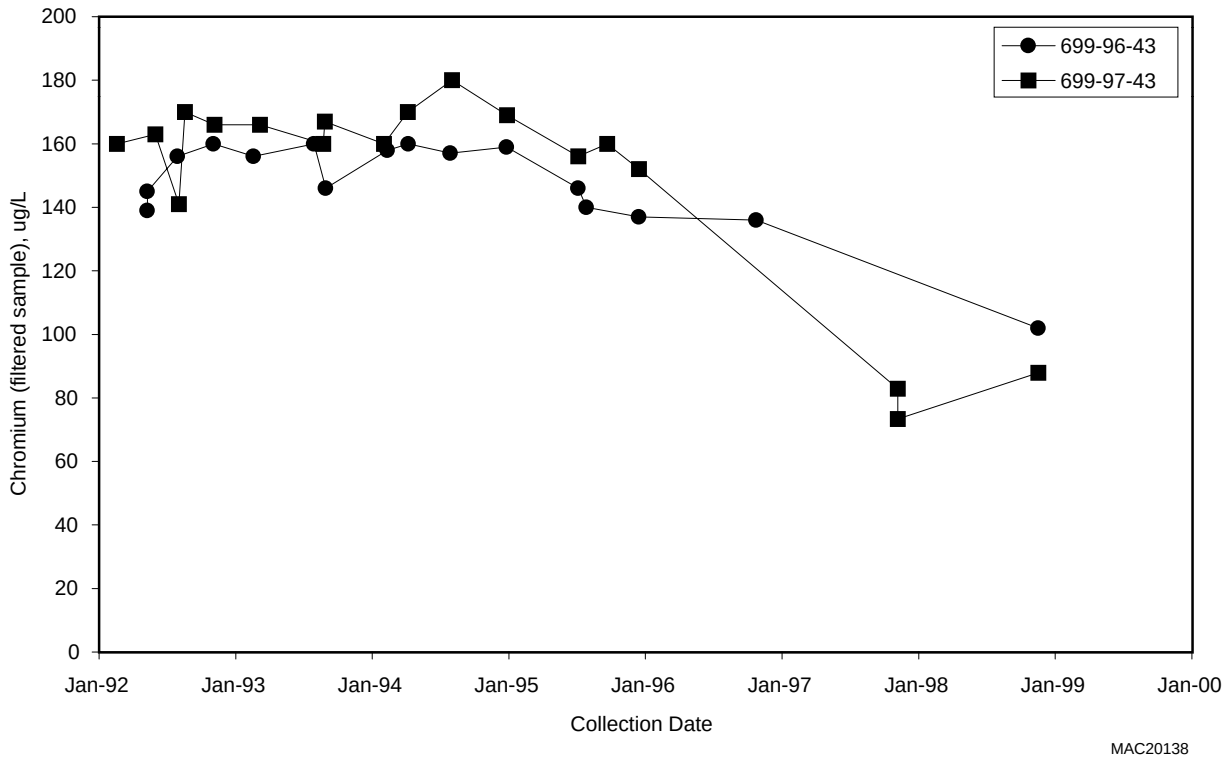


Figure 2.6-1. Chromium in Wells 699-96-43 and 699-97-43 Between 100 H and 100 D Areas

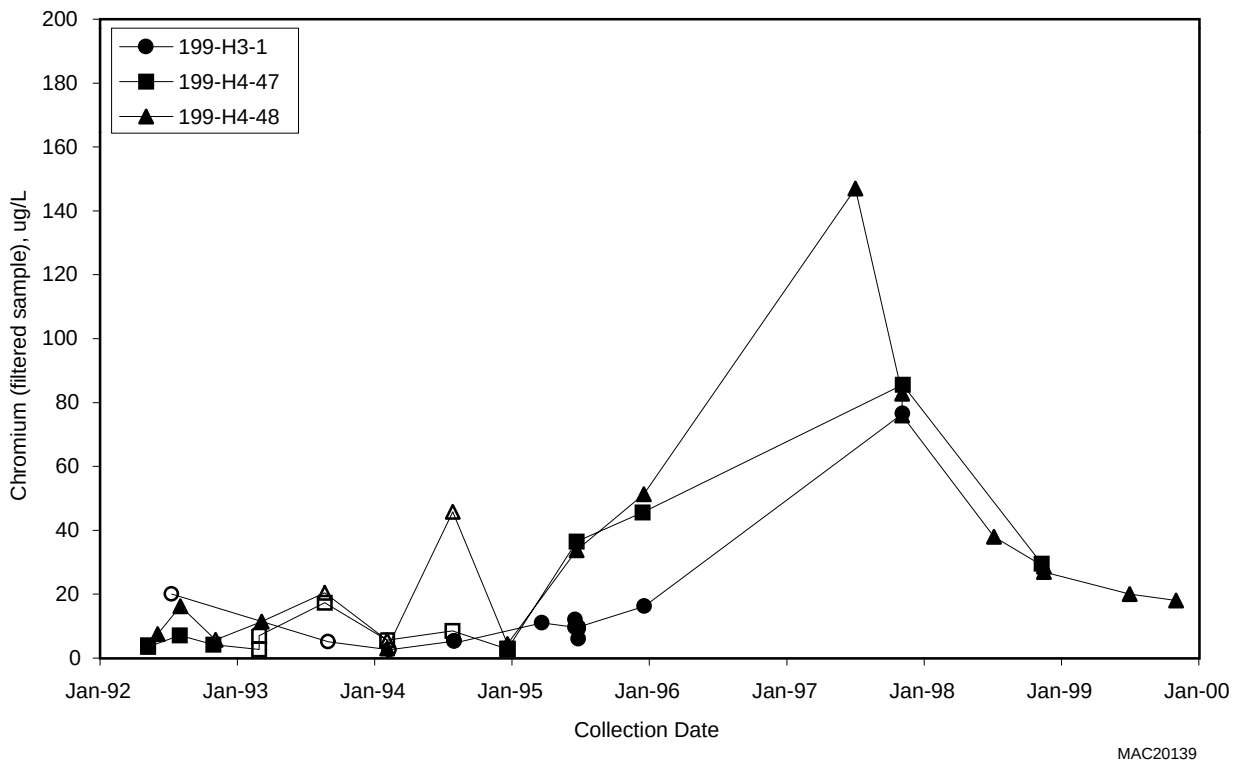


Figure 2.6-2. Chromium in Wells 199-H3-1, 199-H4-47, and 199-H4-48 Near H Reactor

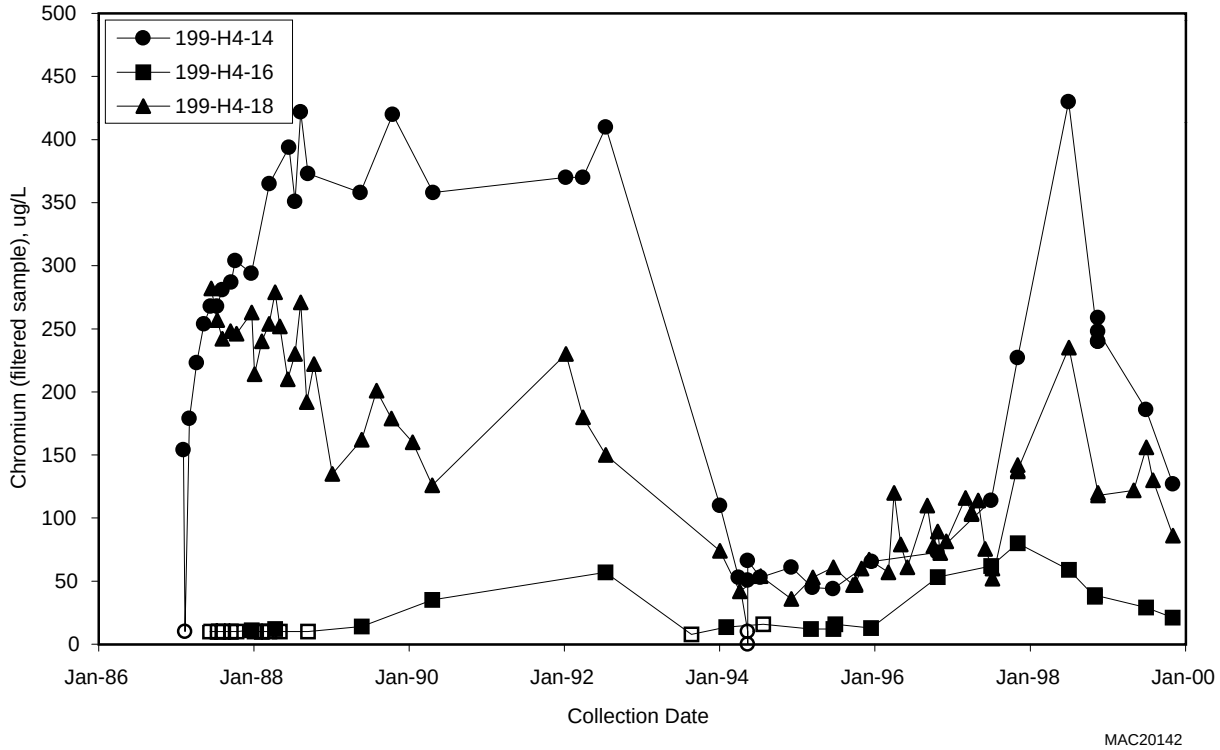


Figure 2.6-3. Chromium in Wells 199-H4-14, 199-H4-16, and 199-H4-18 at 100 H Area

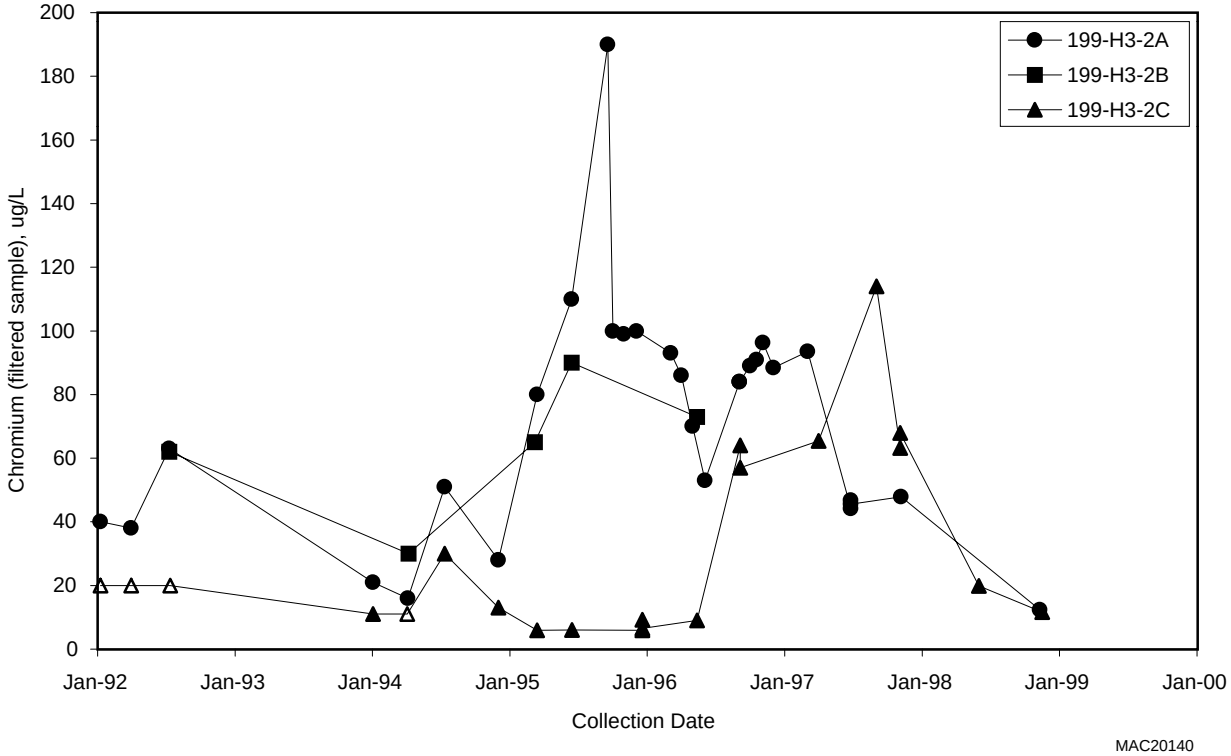


Figure 2.6-4. Chromium in Wells 199-H3-2A, 199-H3-2B, and 199-H3-2C at 100 H Area

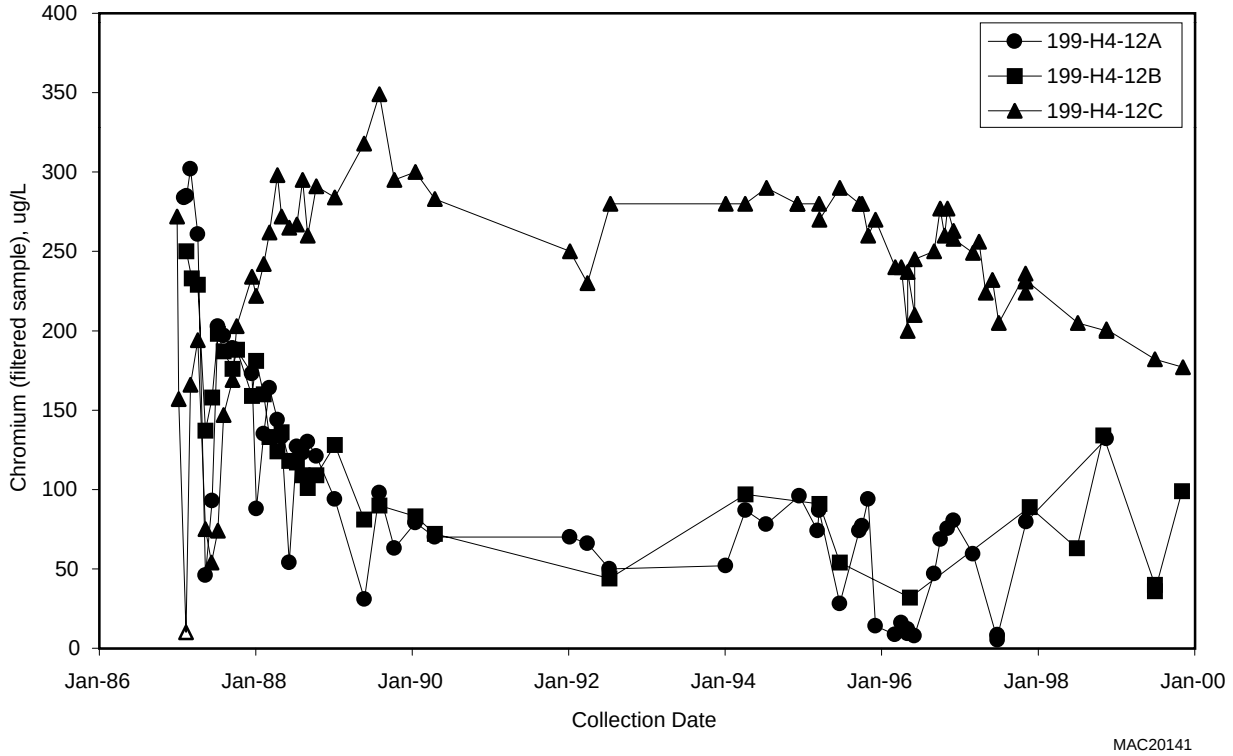


Figure 2.6-5. Chromium in Wells 199-H4-12A, 199-H4-12B, and 199-H4-12C at 100 H Area

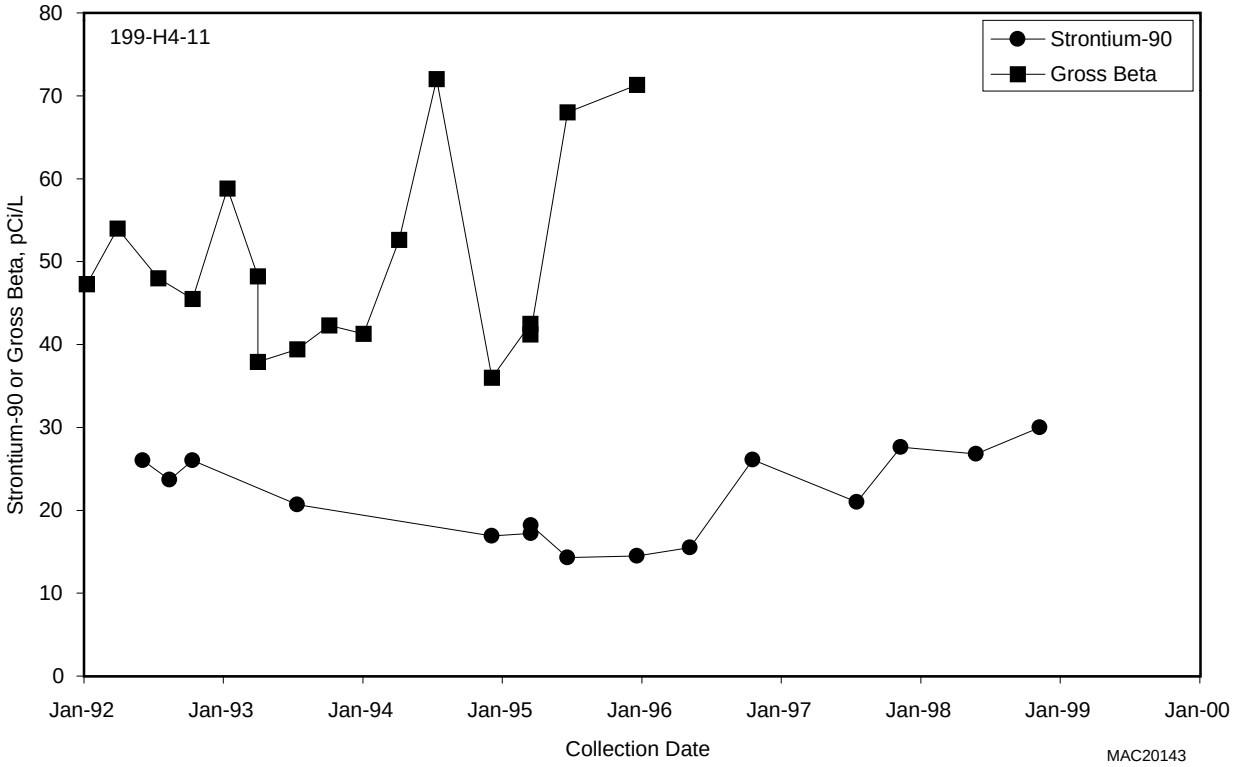


Figure 2.6-6. Strontium-90 and Gross Beta in Well 199-H4-11

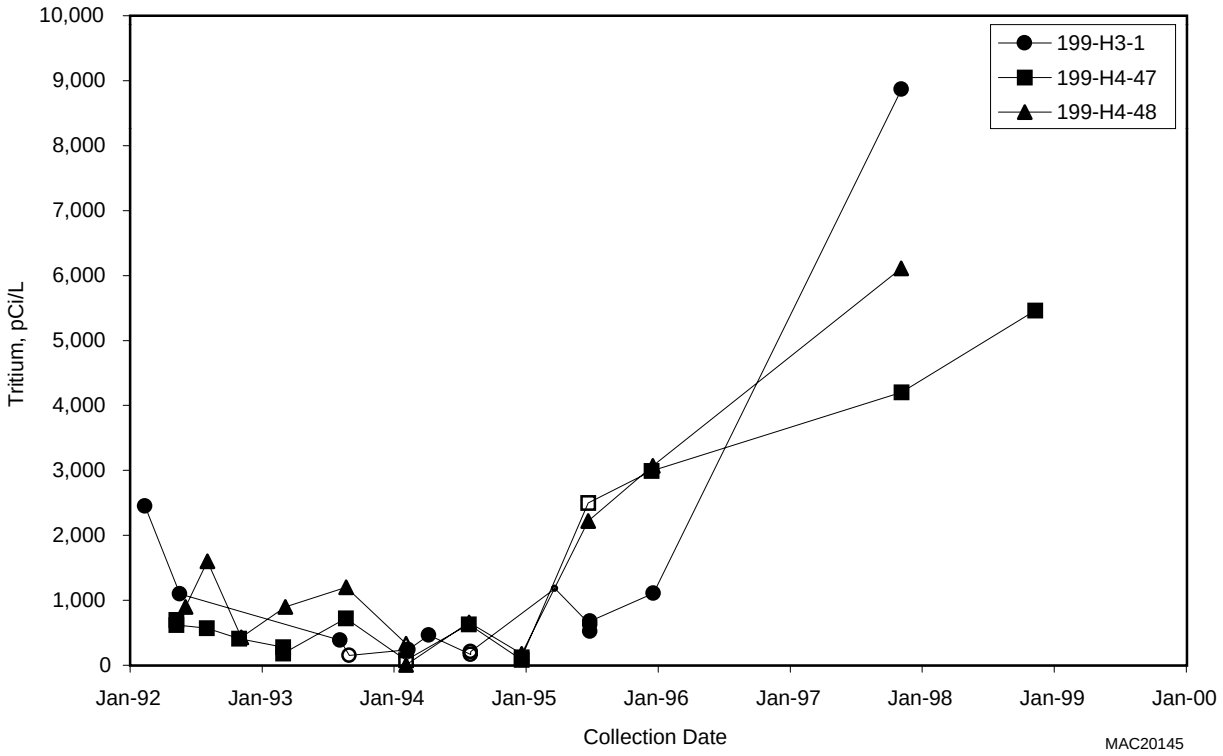


Figure 2.6-7. Tritium in Wells 199-H3-1, 199-H4-47, and 199-H4-48, Northeast of H Reactor

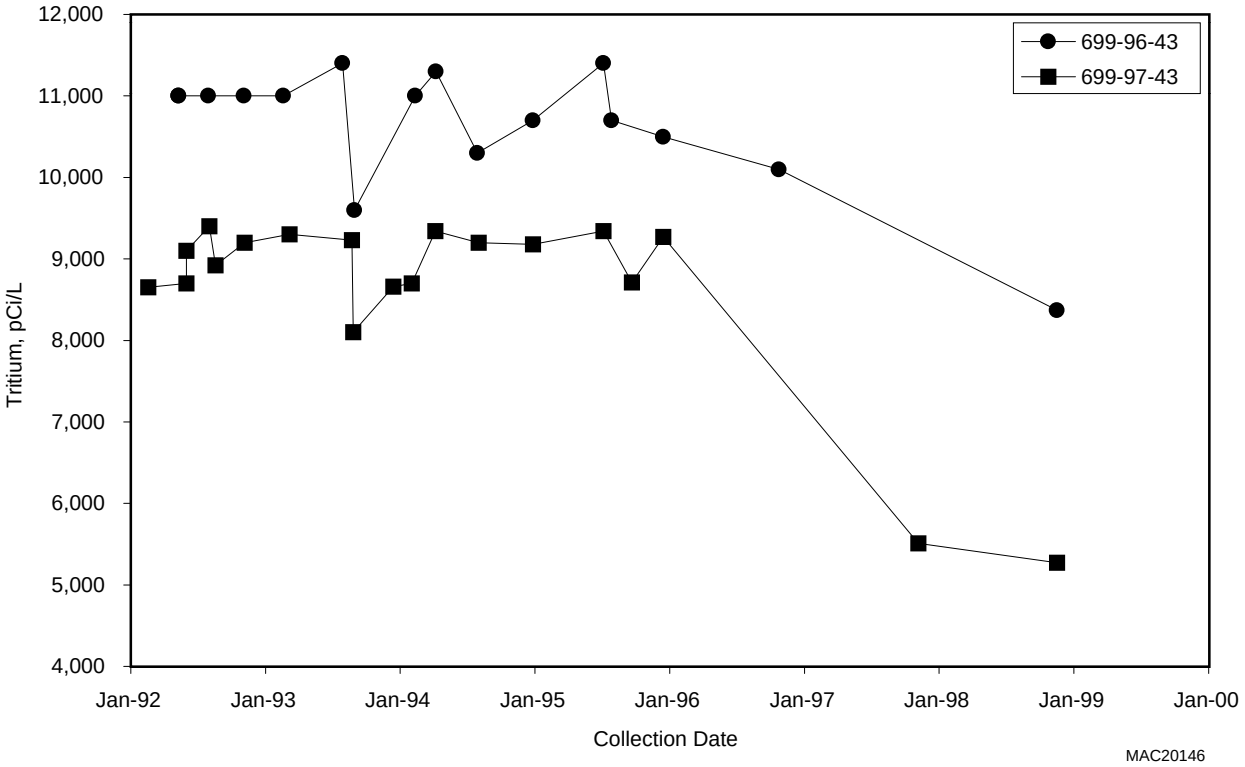


Figure 2.6-8. Tritium in Wells 699-96-43 and 699-97-43 Between 100 D and 100 H Areas

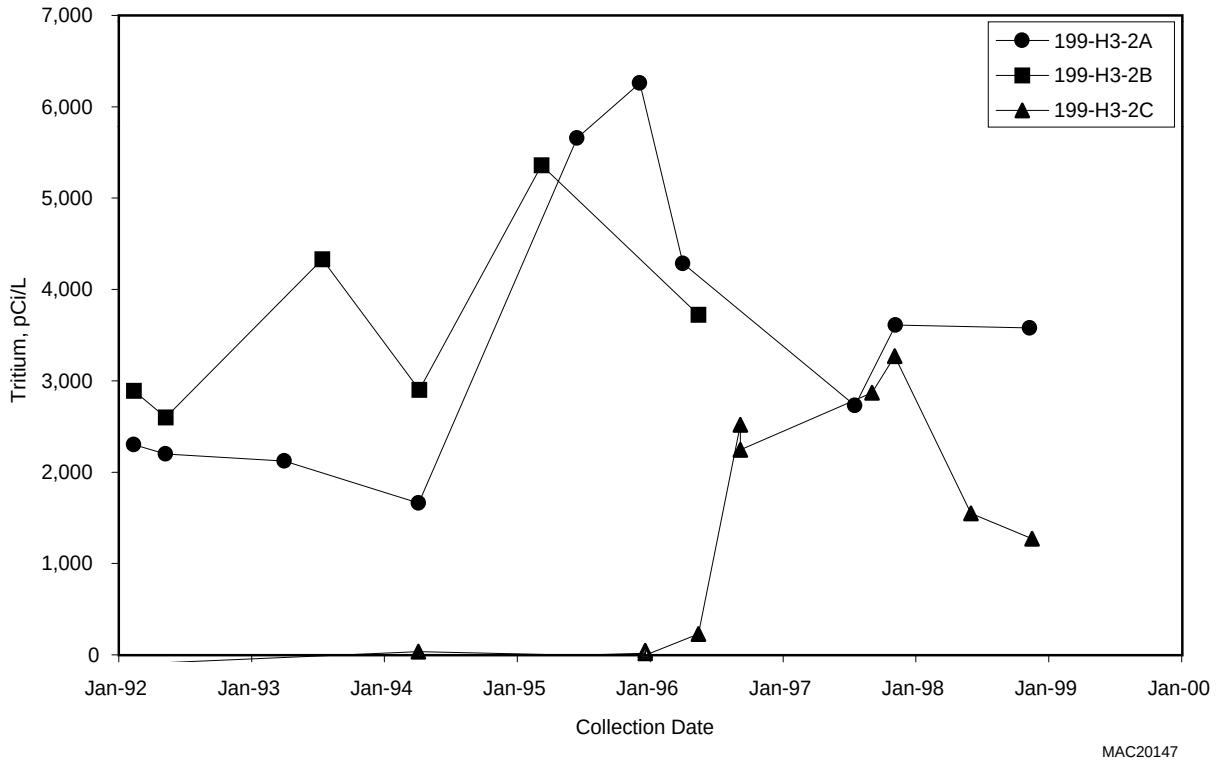


Figure 2.6-9. Tritium in Wells 199-H3-2A, 199-H3-2B, and 199-H3-2C, Western 100 H Area

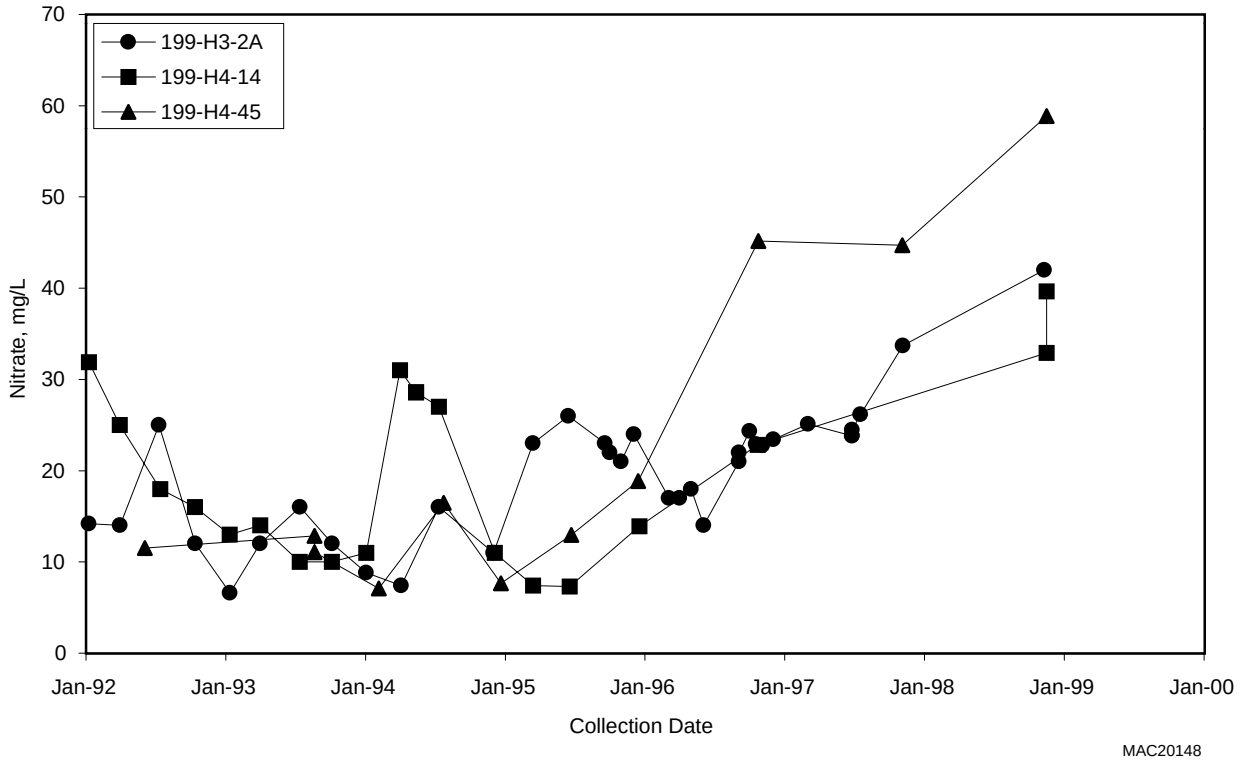


Figure 2.6-10. Example of Increasing Nitrate in Wells at 100 H Area

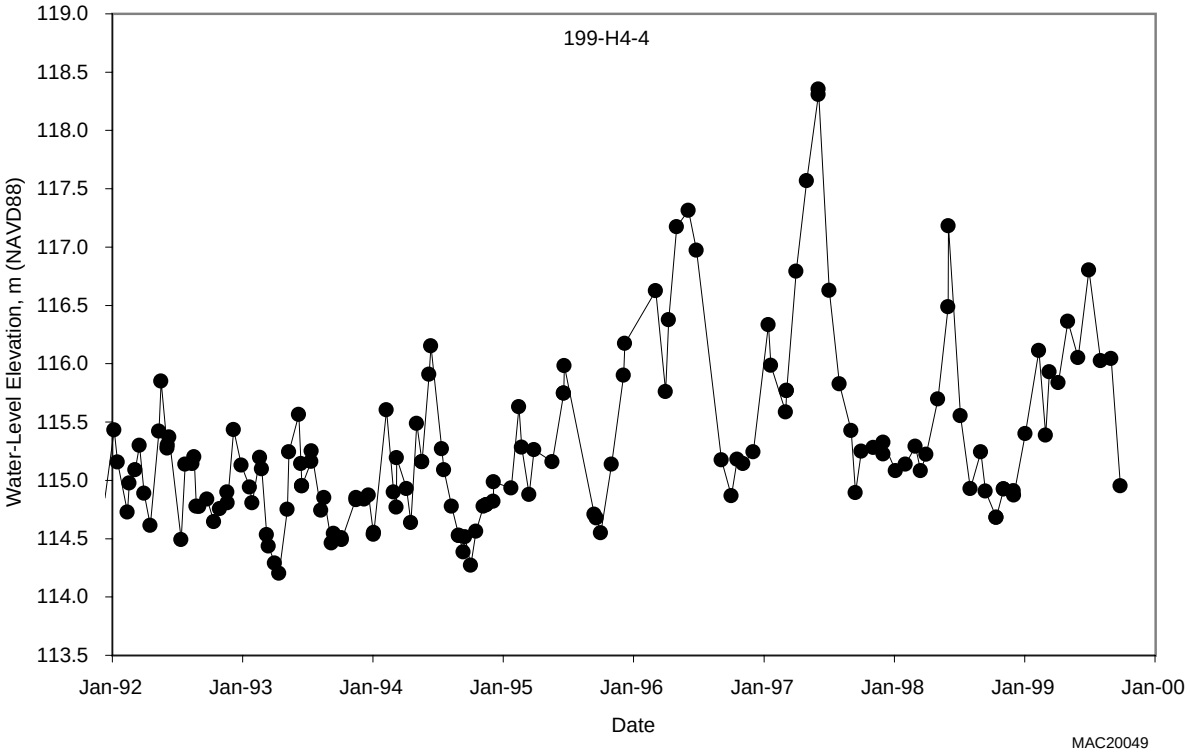
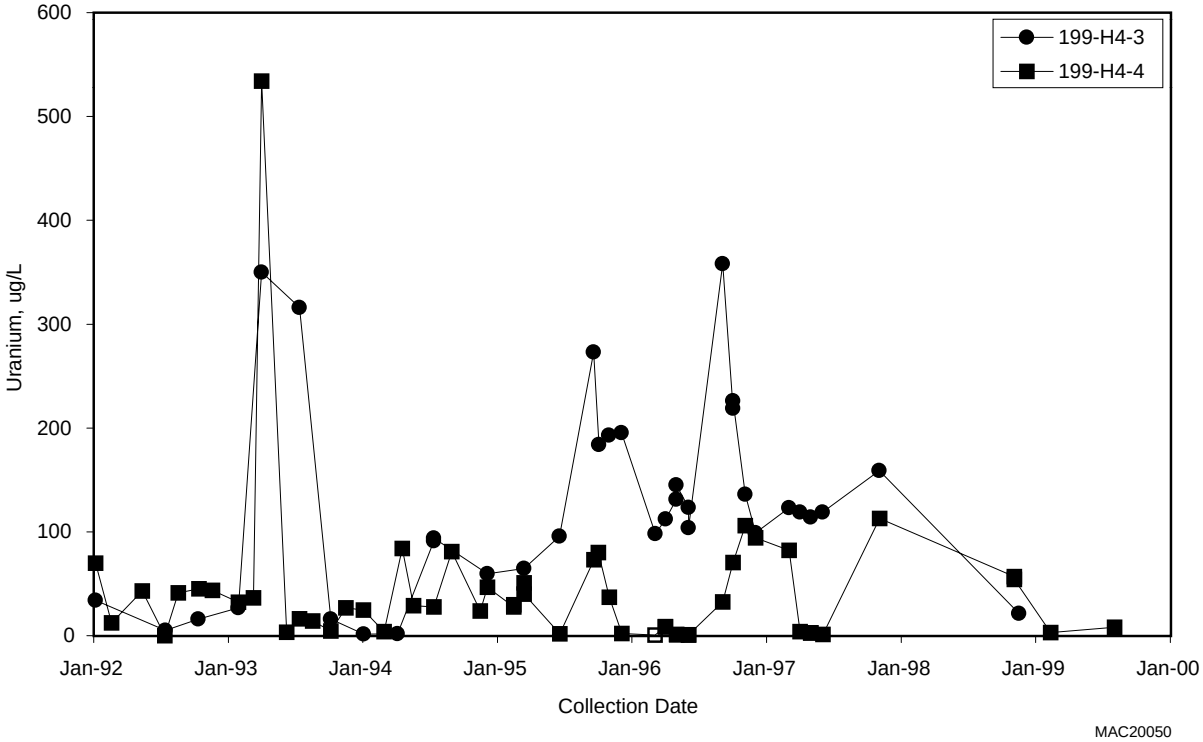


Figure 2.6-11. Water Levels in Well 199-H4-4 Monitoring 183-H Solar Evaporation Basins



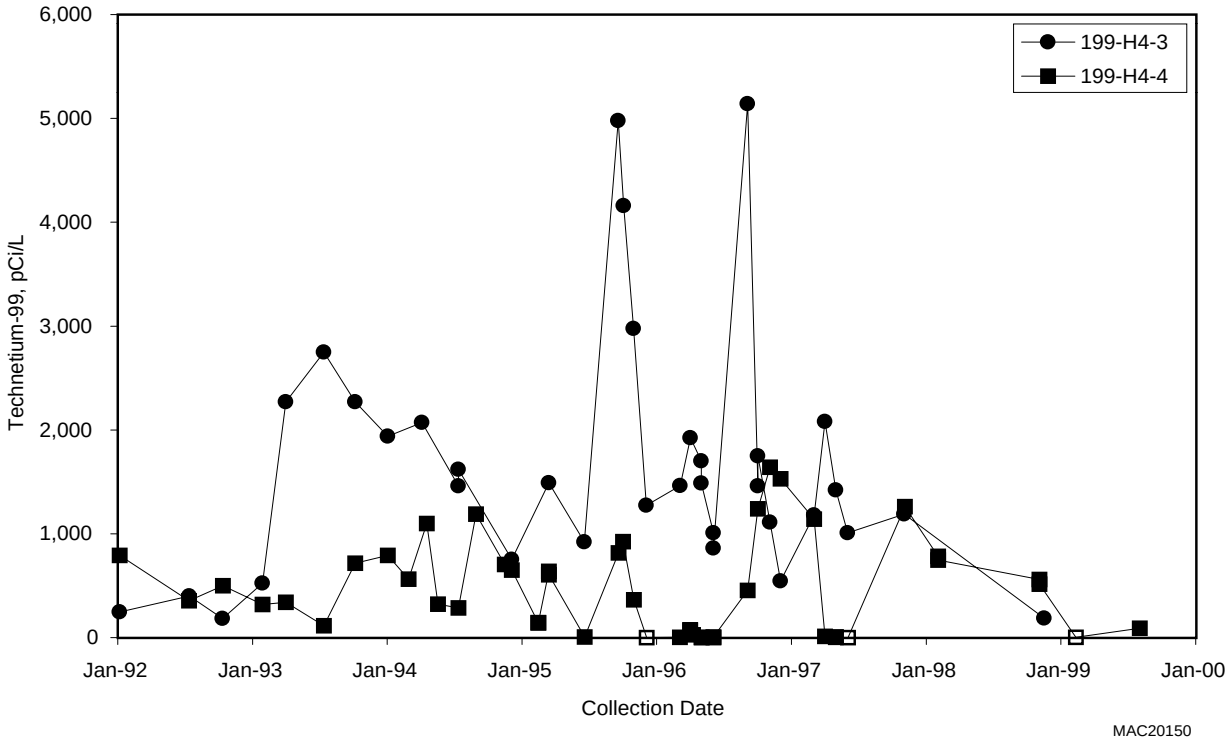


Figure 2.6-12. Technetium-99 and Uranium in Wells 199-H4-3 and 199-H4-4 Monitoring 183-H Solar Evaporation Basins

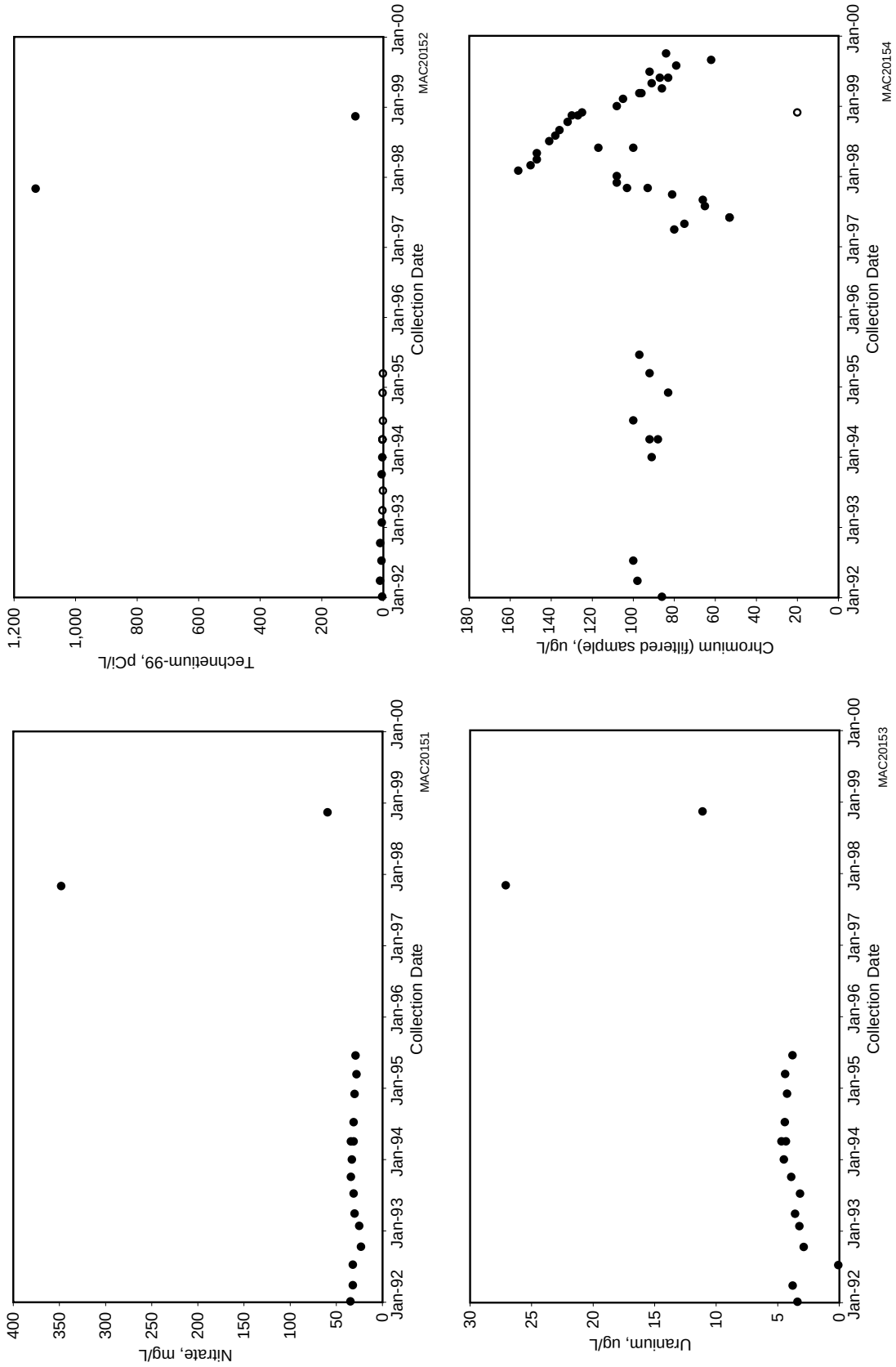


Figure 2.6-13. Contaminants in Well 199-H4-5 Near 183-H Solar Evaporation Basins

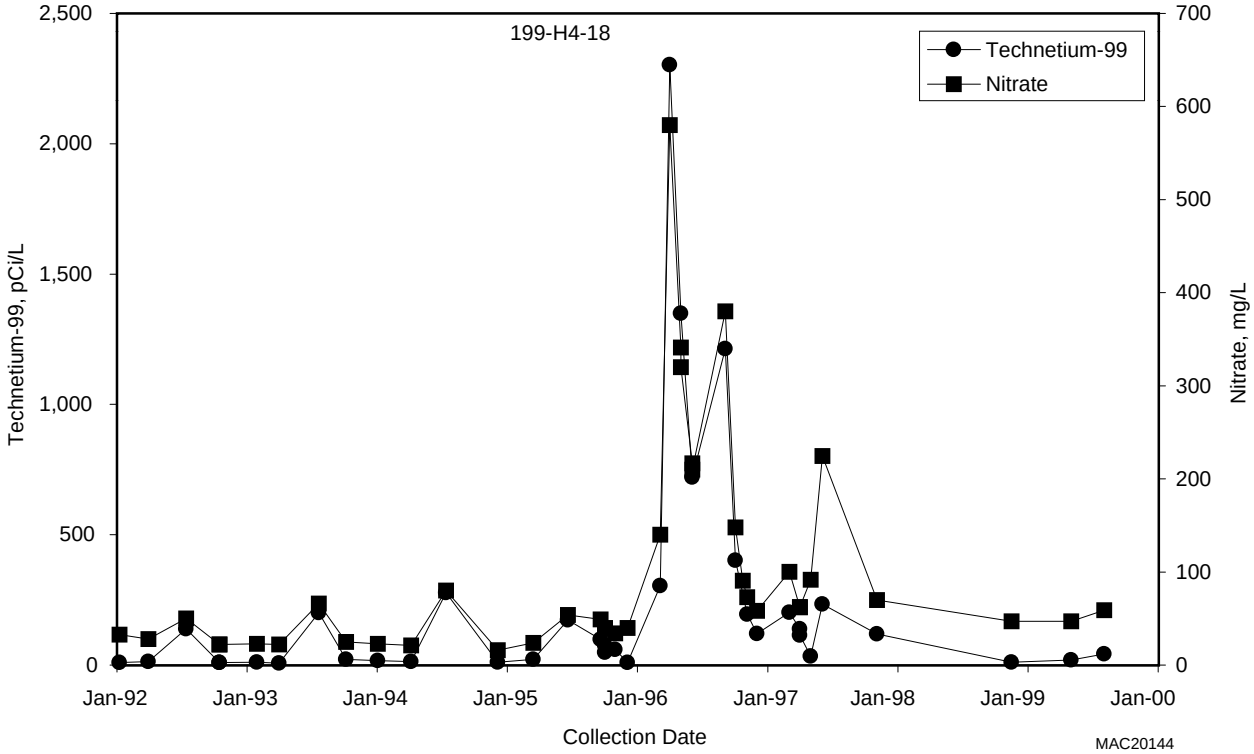
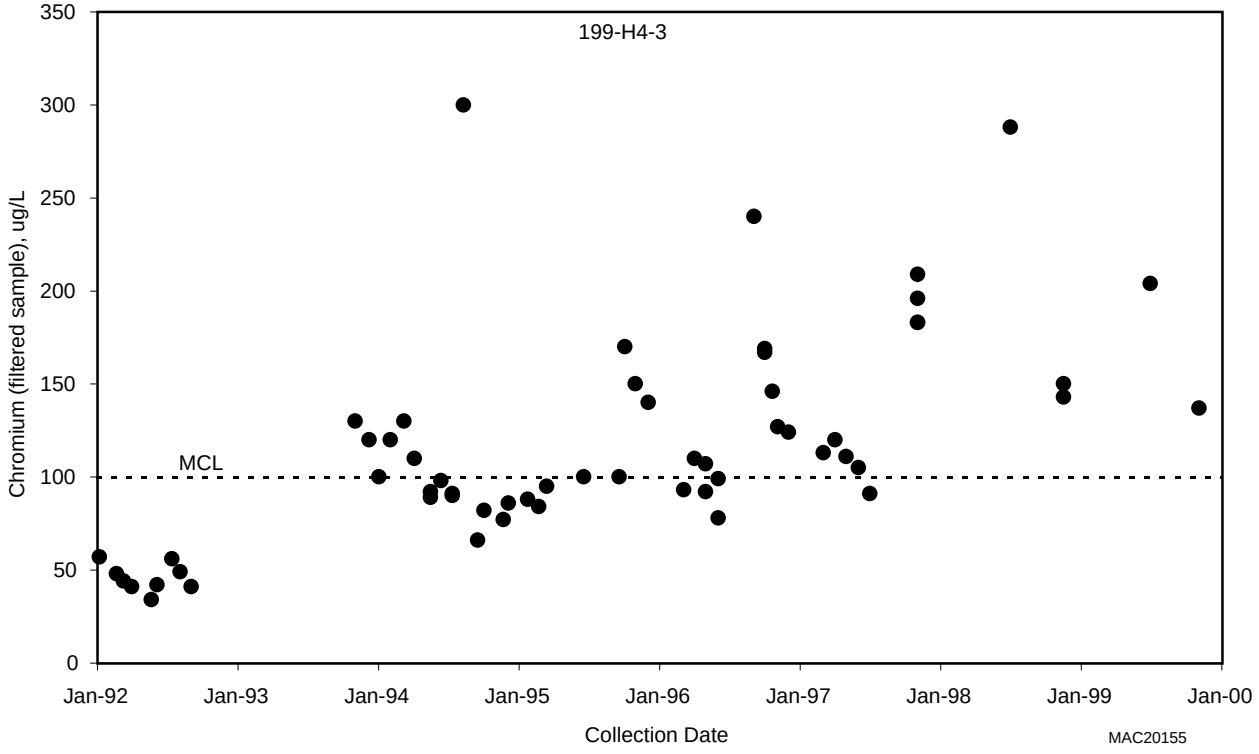


Figure 2.6-14. Technetium-99 and Nitrate in Well 199-H4-18



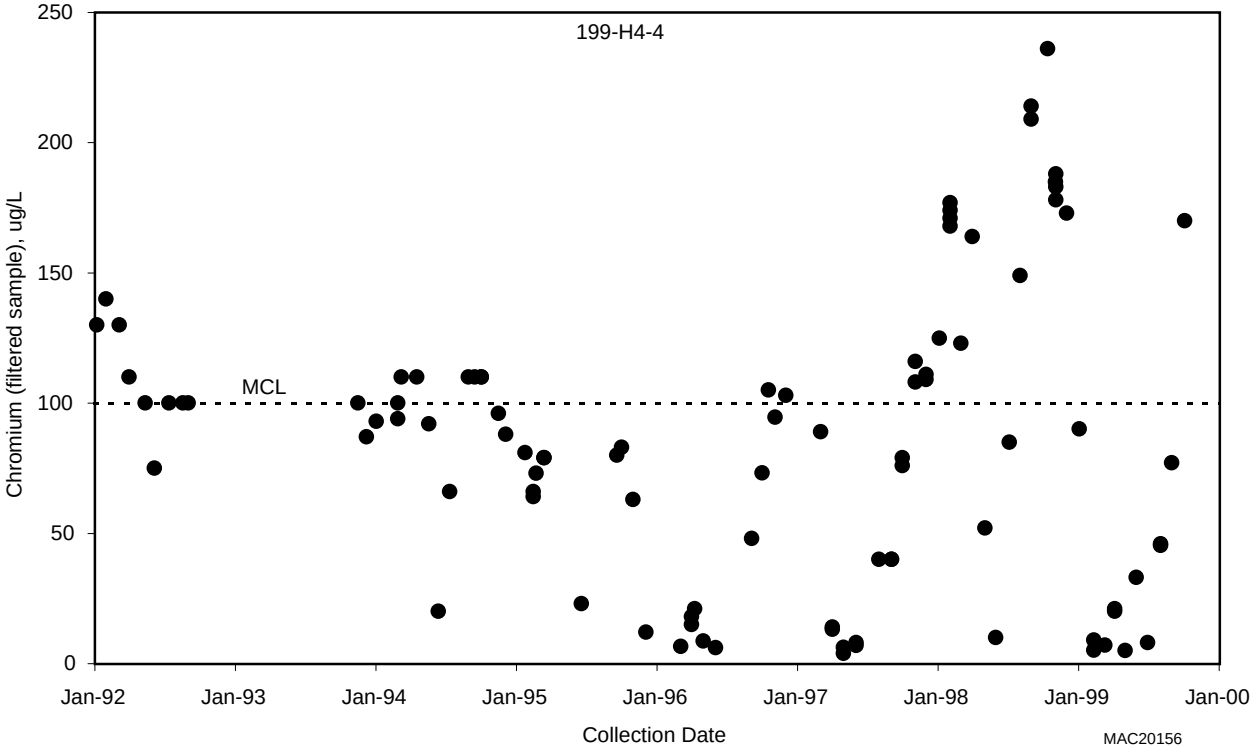


Figure 2.6-15. Chromium in Wells 199-H4-3 and 199-H4-4 Monitoring 183-H Solar Evaporation Basins

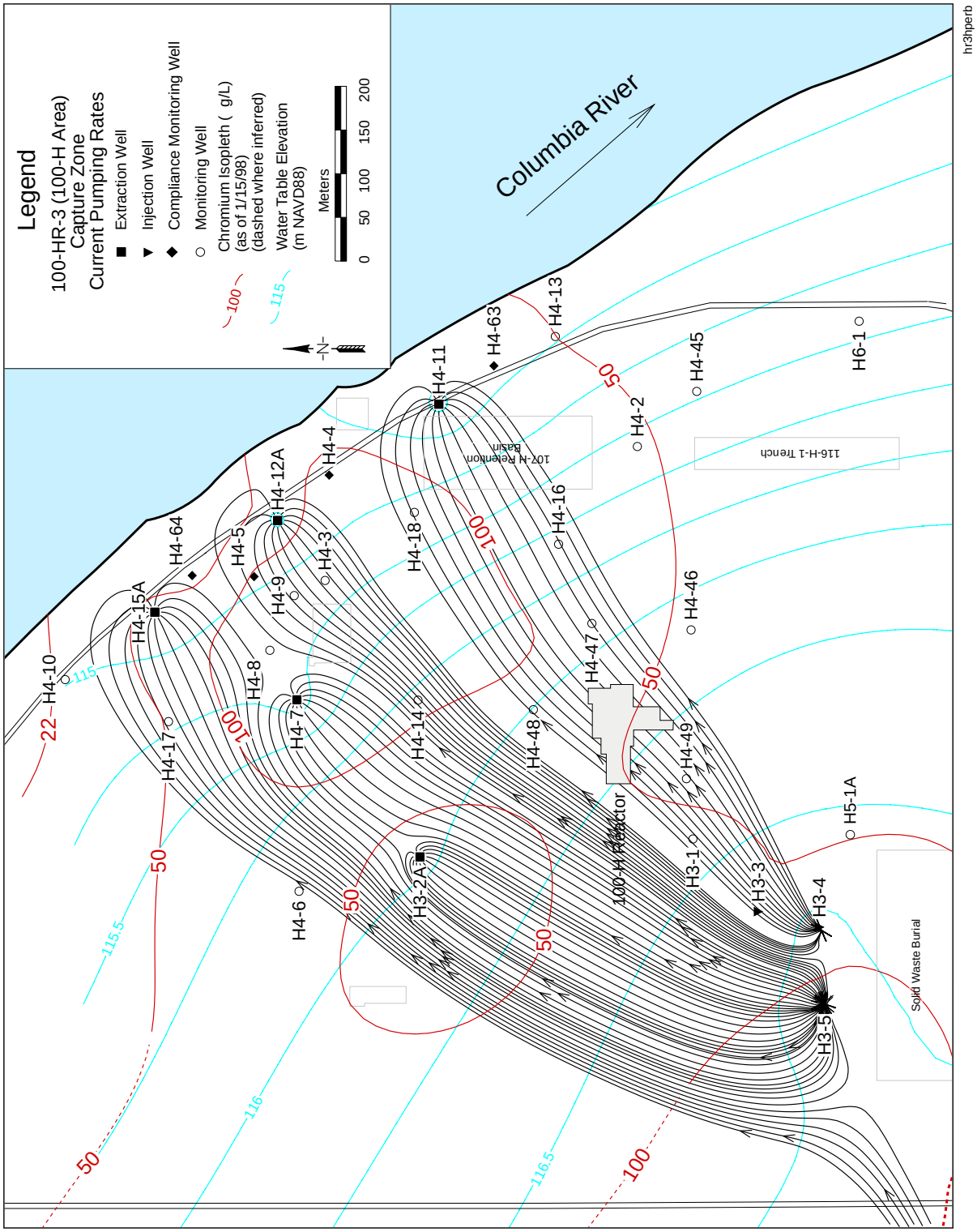


Figure 2.6-16. Capture Zone from 100-HR-3 Pump-and-Treat System (DOE/RL-99-13)

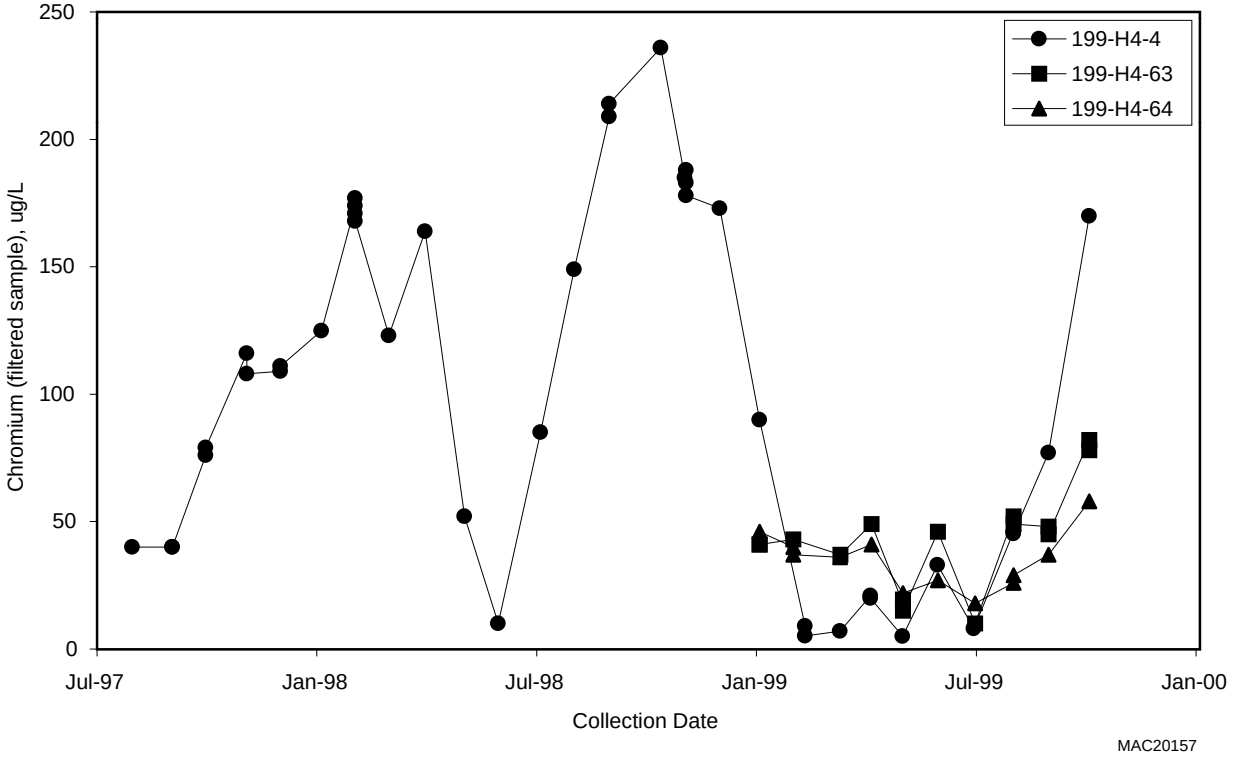


Figure 2.6-17. Chromium in Pump-and-Treat Compliance Wells

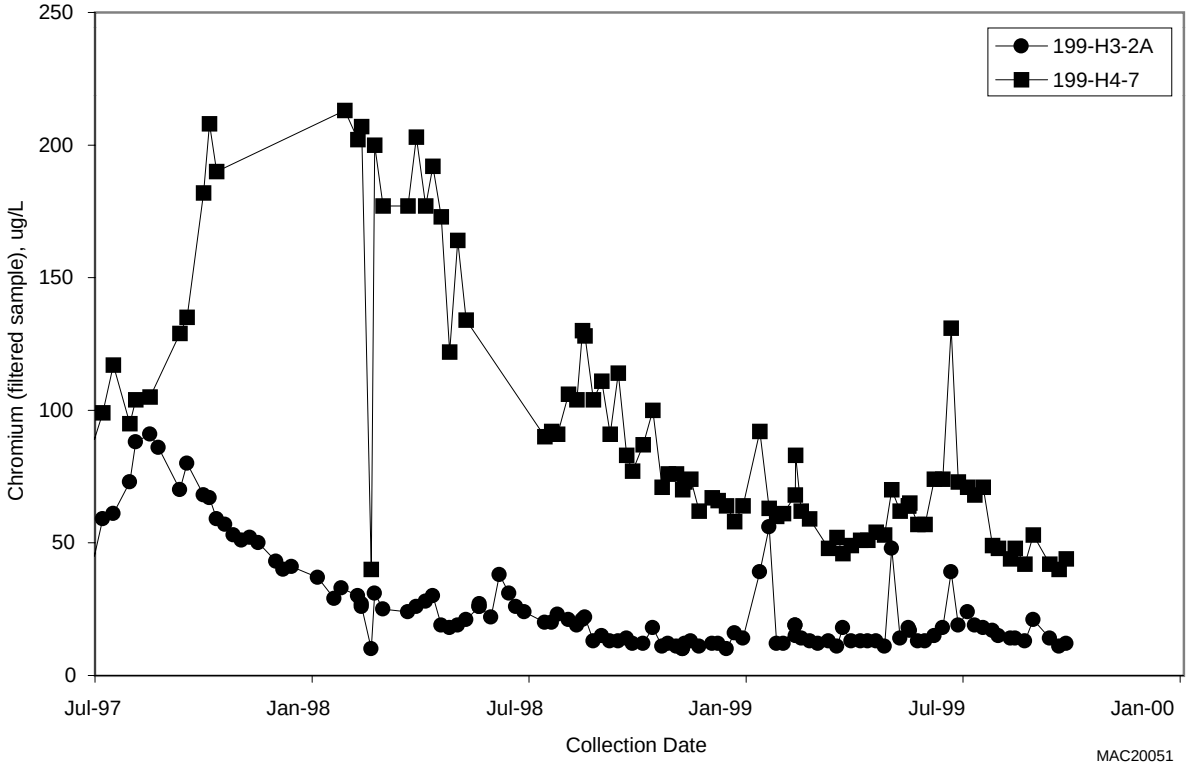


Figure 2.6-18. Chromium in Pump-and-Treat Extraction Wells