

## 2.6 100-HR-3-H Operable Unit

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The scope of this section is the 100-HR-3-H groundwater interest area, which is the east portion of the 100-HR-3 Operable Unit (see Figure 1.0-1 in Section 1.0). The “groundwater interest areas” are informally defined to facilitate scheduling, data review, and interpretation. Figure 2.6-1 shows facilities, wells, and shoreline monitoring sites in this region. Hexavalent chromium is the primary contaminant of concern in groundwater. Groundwater is monitored to assess the performance of a *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) interim action pump-and-treat system for chromium, to track other contaminant plumes, and for the 116-H-6 evaporation basins, a *Resource Conservation and Recovery Act* (RCRA) unit.

Groundwater flows primarily from the southwest to northeast beneath the 100-H Area, discharging to the Columbia River (Figure 2.6-2). Local flow directions are influenced by groundwater extraction and injection. Groundwater flows generally toward the northeast across the entire horn of the Columbia River north of Gable Mountain, so groundwater approaching the 100-H Area may contain contaminants that originated in the 100-D and 100-N Areas.

The remainder of this section describes contaminant plumes and concentration trends for the contaminants of interest (Section 2.6.1), summarizes operable unit activities (Section 2.6.2), and discusses groundwater monitoring of the 116-H-6 evaporation basins (Section 2.6.3).

*Hexavalent chromium is the primary contaminant of concern in the 100-H Area. A pump-and-treat system helps reduce the amount reaching the Columbia River.*

### 2.6.1 Groundwater Contaminants

This section describes monitoring results for chromium, strontium-90, technetium-99, uranium, nitrate, and tritium.

#### 2.6.1.1 Chromium

Hexavalent chromium is the contaminant of concern for the 100-HR-3 groundwater interim action (ROD 1996a), which includes the 100-H Area. The pump-and-treat system is discussed in Section 2.6.2. This section describes the distribution and trends of hexavalent chromium.

The portion of the chromium plume where concentrations exceed the remedial action goal of 22 µg/L has shrunk significantly in recent years (Figure 2.5-4 in

*Groundwater monitoring in the 100-HR-3-H groundwater interest area includes the following monitoring activities:*

*CERCLA and AEA Monitoring (Appendix A)*

- *Twenty-one wells are sampled monthly to semiannually to monitor the pump-and-treat system.*
- *Sixteen wells throughout the 100-H Area are sampled annually to biennially.*

*Facility Monitoring – 116-H-6 Evaporation Basins (Appendix B)*

- *Four downgradient wells are sampled annually for requirements of RCRA and AEA.*

Section 2.5). Concentrations in all shallow wells have been below the 100- $\mu\text{g/L}$  drinking water standard since 2001. The plume had various sources, but the highest concentrations in FY 2007 were in well 199-H4-3, located near the former 116-H-6 evaporation basins, ranging from 6  $\mu\text{g/L}$  in October 2006 to 55  $\mu\text{g/L}$  in June 2007 (Figure 2.6-3). Chromium concentrations in this well decreased more than an order of magnitude since the 1980s.

***Plume areas (square kilometers) at the 100-HR-3-H Operable Unit:***

***Chromium,\* 100  $\mu\text{g/L}$  — 0.17***

***Chromium, 20  $\mu\text{g/L}$  — 3.5***

***Nitrate, 45  $\text{mg/L}$  — 0.11***

***Strontium-90, 8  $\text{pCi/L}$  — 0.17***

***\*Includes chromium plume west to boundary with 100-HR-3-D interest area.***

***Chromium concentrations were all below the drinking water standard in the upper aquifer of 100-H Area, and most averaged less than the 22- $\mu\text{g/L}$  remedial action goal in FY 2007.***

Chromium concentrations in the current six extraction wells are plotted in Figure 2.6-4. Concentrations in well 199-H4-3 spiked in June 2007 to a maximum of 55  $\mu\text{g/L}$ . By August, concentrations were again below the remedial action goal. A similar increase occurred in summer 2006 in chromium and co-contaminants nitrate, technetium-99, and uranium. Concentrations of those contaminants rose only moderately in May 2007; they were not analyzed in the June 2007 sample that had the maximum chromium concentration. The cause of the variability is unknown, but may relate to movement of contamination from the vadose zone into groundwater.

Wells upgradient of the 100-H Area continued to have chromium concentrations near the drinking water standard (maximum 125  $\mu\text{g/L}$  in well 699-97-43), but concentrations show an overall decline since the early 1990s (Figure 2.6-5). The source of this contamination is probably old contamination that originated in the 100-D Area when a water-table mound was present there (WHC-SD-EN-TI-023). The highest chromium concentration in the new “horn” wells was 117  $\mu\text{g/L}$  in well 699-97-43B (October 2007). This well is screened at the top of the unconfined aquifer. This plume is the subject of an ongoing investigation (Section 2.5.2.4). An upcoming report will present results.

Chromium levels rose in former injection wells 199-H3-3, 199-H3-4, and 199-H3-5 in south 100-H Area in FY 2007 (Figure 2.6-6). Levels remained lower than those measured in 1996, before injection began. The highest concentration in FY 2007 was 58  $\mu\text{g/L}$  in February in well 199-H3-5. The chromium may have historical sources in the 100-H or 100-D Areas.

Chromium concentrations in aquifer tubes are highest upstream and downstream of the main 100-H Area (Figure 2.6-7). Tubes AT-43 and AT-44, north of the 100-H Area, intercept part of the plume that has moved across the horn, and concentrations have been as high as 50  $\mu\text{g/L}$  in recent years. In FY 2007, the highest was 37  $\mu\text{g/L}$  in tube AT-43-M. South of the main 100-H Area at tube sites 50 and 51, the maximum concentration in FY 2007 was 35  $\mu\text{g/L}$  (Figure 2.6-8). This contamination south of the main 100-H Area could have moved south along the shoreline from 100-H Area sources. Chromium was lower (~10  $\mu\text{g/L}$ ) in tubes monitoring the shoreline downgradient of the 100-H Area pump-and-treat system.

Three wells that monitor a deeper portion of the Ringold Formation continued to have elevated chromium concentrations (Figure 2.6-9). These wells are screened at elevations ranging from 94 to 104 meters. Adjacent water-table wells are screened from 112 to 117 meters. Well 199-H3-2C is located on the west side of 100-H Area, upgradient of waste sites. Chromium concentrations in this well have increased over the last several years, reaching ~50  $\mu\text{g/L}$  in FY 2007. An adjacent well completed at the water table has much lower chromium concentrations (11  $\mu\text{g/L}$ ). Well 199-H4-12C is located near the river, downgradient of the 116-H-6 basins and adjacent to extraction well 199-H4-12A. The deep well has declining chromium concentrations

at levels just below the drinking water standard (90 µg/L). Piezometer 199-H4-15CS is also adjacent to an extraction well. Chromium concentrations in the piezometer are steady at levels just above the drinking water standard. Three deeper piezometers in well 199-H4-15C showed much lower chromium levels when they were sampled in 1996 through 2004 (undetected to 32 µg/L). Concentrations of other contaminants that would indicate the influence of the 116-H-6 basins (nitrate, technetium-99, and uranium) are low in the deeper wells. The source of this deeper chromium is unknown.

In FY 2007 and early FY 2008, DOE installed new wells and aquifer tubes to help define chromium contamination between 100-D and 100-H Areas. This region is known as the “horn” of the Hanford Site, and is discussed in Section 2.5. Three of the new wells are completed in the Ringold upper mud, paired with adjacent wells completed at the water table. At the time of this writing, chromium data were available from two of these well pairs. Well 699-97-48B and C (shallow and deep, respectively), both had 42 µg/L hexavalent chromium. Closer to the 100-H Area, well 699-97-43B (shallow) had 117 µg/L chromium while its deep counterpart 699-97-43C had only 8 µg/L. Well locations are shown in Figure 2.1-1 of Section 2.1.

### 2.6.1.2 Strontium-90

Strontium-90 concentrations continued to exceed the drinking water standard (8 pCi/L) beneath a portion of the southeast 100-H Area near the former retention basin and disposal trenches. The plume distribution has not changed appreciably in over 10 years (see Figure 2.6-8 in PNNL-15670 for a FY 2005 map). Few wells were sampled for strontium-90 in FY 2007. The highest concentration was 30.7 pCi/L in well 199-H4-63, a decline from recent years.

Three aquifer tubes were sampled for strontium-90 in FY 2007: AT-47-D, AT-48-M, and AT-H-3-S. All results were below the drinking water standard. The highest was 5.4 pCi/L in AT-H-3-S.

### 2.6.1.3 Technetium-99 and Uranium

Technetium-99 and uranium concentrations are detected in groundwater downgradient of the former 116-H-6 evaporation basins, but levels did not exceed the drinking water standards in FY 2007. The highest technetium-99 concentration was 99 pCi/L in well 199-H4-3 (the drinking water standard is 900 pCi/L). Uranium showed a similar trend, with a maximum concentration of 22 µg/L in May 2007 (the drinking water standard is 30 µg/L). Figure 2.6-10 shows technetium-99 and uranium trends in this well.

Technetium-99 and uranium levels were very low in aquifer tubes in FY 2007. The highest concentrations were in tube AT-H-3-S, where technetium-99 and uranium were reported at 5.4 pCi/L and 1.34 µg/L, respectively.

### 2.6.1.4 Tritium

Tritium concentrations continued to decline in most wells. The highest concentration in the 100-H Area was 2,800 pCi/L in well 199-H4-15A. Well 699-97-43, located west (upgradient) of the 100-H Area, continued to have a higher tritium concentration than wells within the 100-H Area (5,150 pCi/L).

### 2.6.1.5 Nitrate

Nitrate concentrations continued to exceed the drinking water standard (45 mg/L) in a few wells near the former 116-H-6 evaporation basins. The highest concentration was 66 mg/L in well 199-H4-3 in May 2007.

*Nitrate  
concentrations  
exceed drinking  
water standards near  
the former 116-H-6  
evaporation basins.*

A second nitrate plume in southeast 100-H Area is shrinking, and in FY 2007, the only results that exceeded the drinking water standard were in well 199-H4-46 (46.9 mg/L) and aquifer tube 50-M (45.2 mg/L). Nitrate concentrations have been stable at these sites in recent years.

*The remedial action objectives for the 100-HR-3 Operable Unit (ROD 1996a) are:*

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

*The contaminant of concern is hexavalent chromium. The record of decision specifies the cleanup goal at compliance wells as 22 µg/L.*

*During FY 2007, the pump-and-treat system extracted ~146.6 million liters of groundwater from the 100-H Area, removing ~2.4 kilograms of hexavalent chromium.*

## 2.6.2 Operable Unit Activities

This section summarizes activities associated with groundwater in the 100-H Area portion of the 100-HR-3 Operable Unit. These include a pump-and-treat system and investigation of chromium deeper in the Ringold Formation.

### 2.6.2.1 Status of Five-Year Review Action Item

The second CERCLA five-year review was published in November 2006 (DOE/RL-2006-20). The review identified one action<sup>(a)</sup> pertaining to the 100-H Area:

- **Action 12-1.** Perform additional characterization of the aquifer below the initial aquitard (September 2009).

DOE installed three wells in the 600 Area screened in this unit, and continued to monitor three wells in the 100-H Area. Section 2.6.1.1 presents monitoring results. DOE plans to conduct additional characterization of this aquifer in the 100-H Area.

### 2.6.2.2 Pump-and-Treat System

A pump-and-treat system operates in the 100-H Area as part of a CERCLA interim action for the 100-HR-3 Operable Unit (ROD 1996a). Interim remedial action monitoring is described in DOE/RL-96-90. Long-term monitoring requirements in the 100-H Area were derived from Change Control Form 107. Figure 2.6-1 displays locations of extraction and injection wells and Appendix A lists sampling frequencies and constituents.

The 100-H pump-and-treat system is reducing overall contamination in the operable unit by removing contaminant mass. During FY 2007, the pump-and-treat system extracted ~146.6 million liters of groundwater from the 100-H Area, removing ~2.4 kilograms of hexavalent chromium.

The pump-and-treat system has removed ~49 kilograms of hexavalent chromium from the 100-H Area groundwater since startup in July 1997. This represents more than the ~42 kilograms estimated in the plume in 1992 (WHC-SA-1674-VA). That estimate did not include chromium from upgradient sources (100-D Area) nor in the vadose zone.

Chromium concentrations in 100-H Area groundwater have declined, and the plume in the uppermost aquifer has shrunk. Those changes are likely due to a combination of the effects of the pump-and-treat system and dispersion (i.e., natural processes). There were no changes made to the pump and treat network in the 100-H Area during FY 2007.

(a) Another issue pertained to chromium in the “horn” between 100-D and 100-H Areas. It is discussed in Section 2.5.

Hexavalent chromium concentrations stabilized in a range between 5 µg/L and 15 µg/L in compliance well 199-H4-5 during FY 2007. In September 2007, concentrations in former compliance wells 199-H4-4, 199-H4-63 and 199-H4-64 (now extraction wells) ranged from 10 to 25 µg/L (Figure 2.6-4). During FY 2007, concentrations ranged from 2 µg/L to 28 µg/L in these wells. The maximum chromium concentration in an extraction well during FY 2007 was 55 µg/L in well 199-H4-3.

Most chromium concentrations in the extraction wells were below the 22-µg/L remedial action goal.

- 199-H4-3: 6 of 28 hexavalent chromium results >22 µg/L (maximum 55 µg/L)
- 199-H4-4: 2 of 28 hexavalent chromium results >22 µg/L (maximum 26 µg/L)
- 199-H4-12A: 3 of 28 hexavalent chromium results >22 µg/L (maximum 27 µg/L)<sup>(b)</sup>
- 199-H5-15A: 7 of 28 hexavalent chromium results >22 µg/L (maximum 30 µg/L)<sup>(b)</sup>
- 199-H4-63: 1 of 31 hexavalent chromium results >22 µg/L (maximum 28 µg/L)
- 199-H4-64: 2 of 28 hexavalent chromium results >22 µg/L (maximum 25 µg/L)

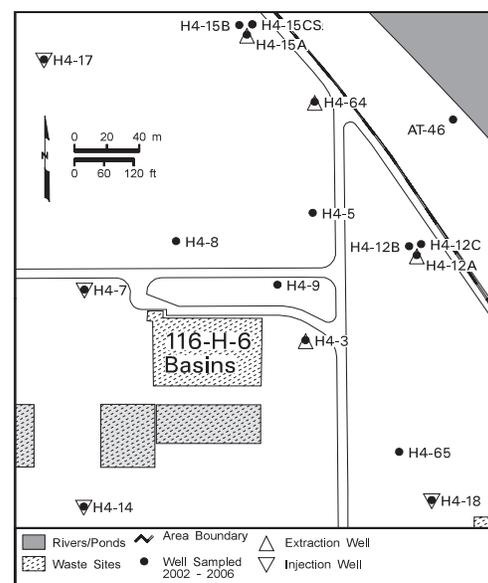
Results of performance monitoring are incorporated with the discussion of general contamination in Section 2.6.1. Results of operational monitoring and additional details about the pump-and-treat system for calendar year 2006 can be found in DOE/RL-2006-76. Results for 2007 will be published in an upcoming annual report on the 100-HR-3, 100-KR-4, and 100-NR-2 pump-and-treat systems.

### 2.6.3 Facility Monitoring — 116-H-6 (183-H) Evaporation Basins

The 116-H-6 (183-H) evaporation basins are the only RCRA site in the 100-H Area. The unit was incorporated into the Hanford Facility RCRA Permit (Ecology 1994a). The site is monitored during the post-closure period under corrective action monitoring requirements of WAC 173-303-645(11)(g). The monitoring network comprises wells 199-H4-3, 199-H4-8, 199-H4-12A, and 199-H4-12C. Lists of wells and constituents monitored and a well location map are included in Appendix B.

The four wells in the RCRA network were sampled as scheduled in FY 2007 for the constituents of interest listed in the groundwater monitoring plan (PNNL-11573). Trends in the constituents of interest (except fluoride) were discussed in Section 2.6.1. Fluoride concentrations remained low (<300 µg/L) in groundwater downgradient of the 116-H-6 evaporation basins.

While the 100-HR-3 pump-and-treat system is operating, RCRA monitoring consists of annual sampling of four wells for chromium, fluoride, nitrate, technetium-99, and uranium. The latter two constituents are not regulated under RCRA but were included in the monitoring plan for completeness and were incorporated by reference in the Hanford Facility RCRA Permit (Ecology 1994a).



(b) Excluding erroneous high value in November 2006, which was traced to a defective analytical ampule.



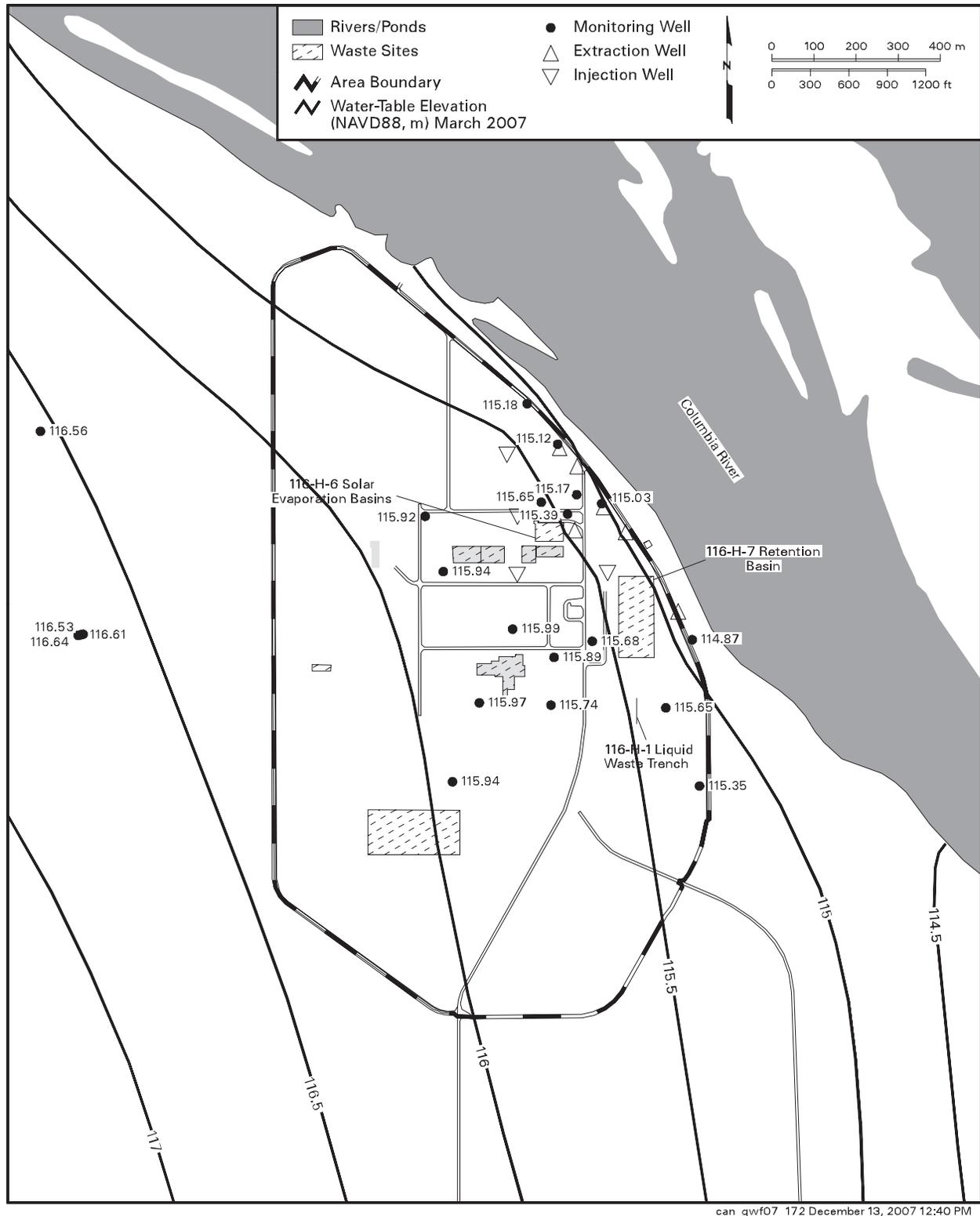


Figure 2.6-2. 100-H Area Water-Table Map, March 2007

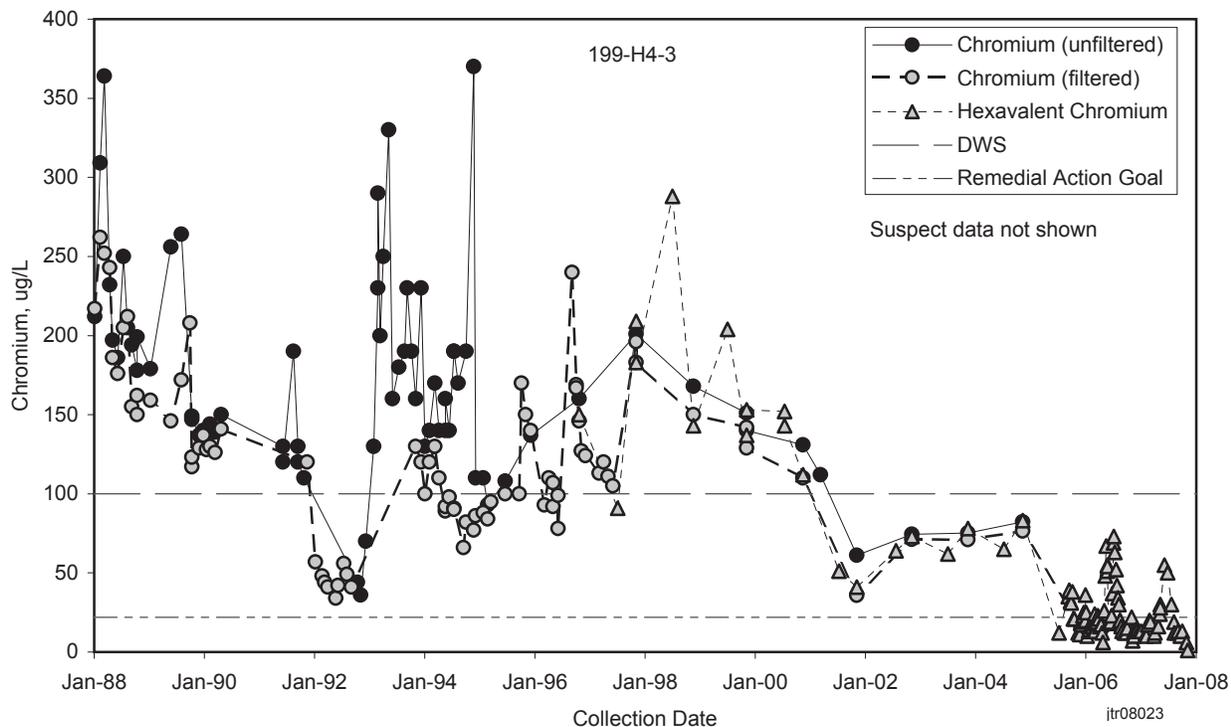
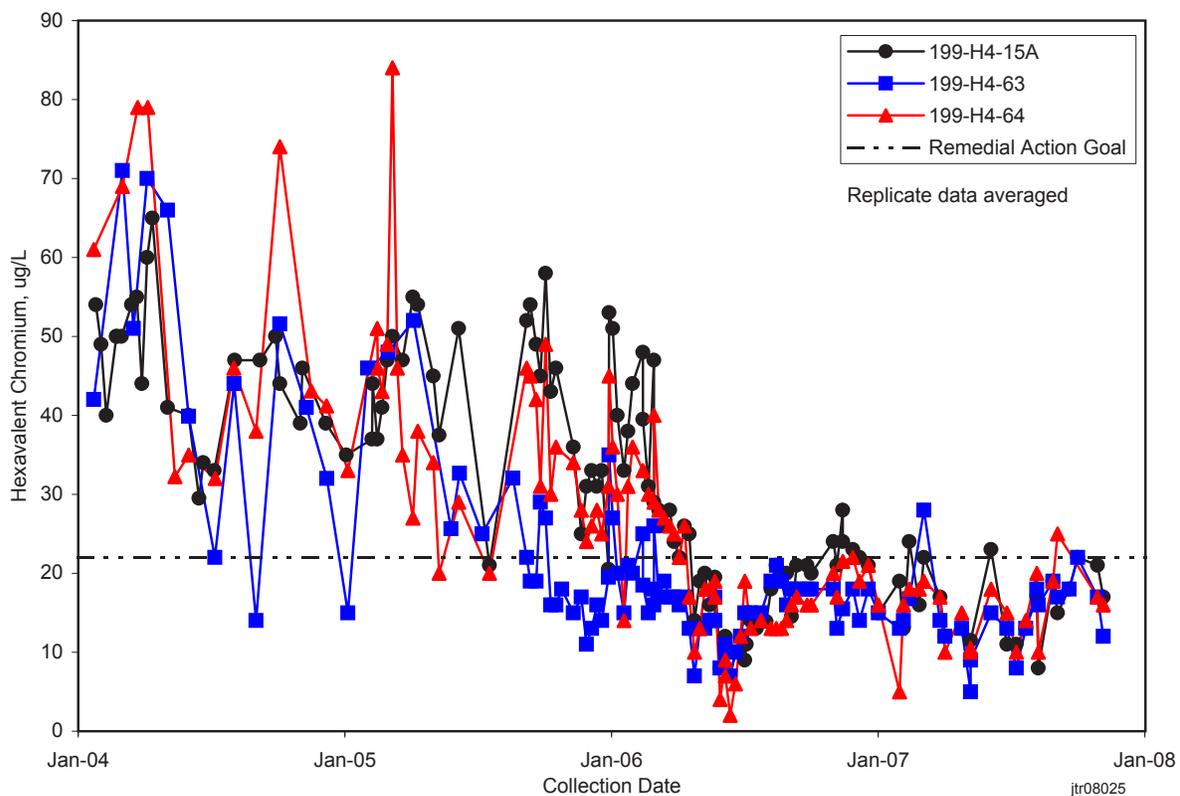
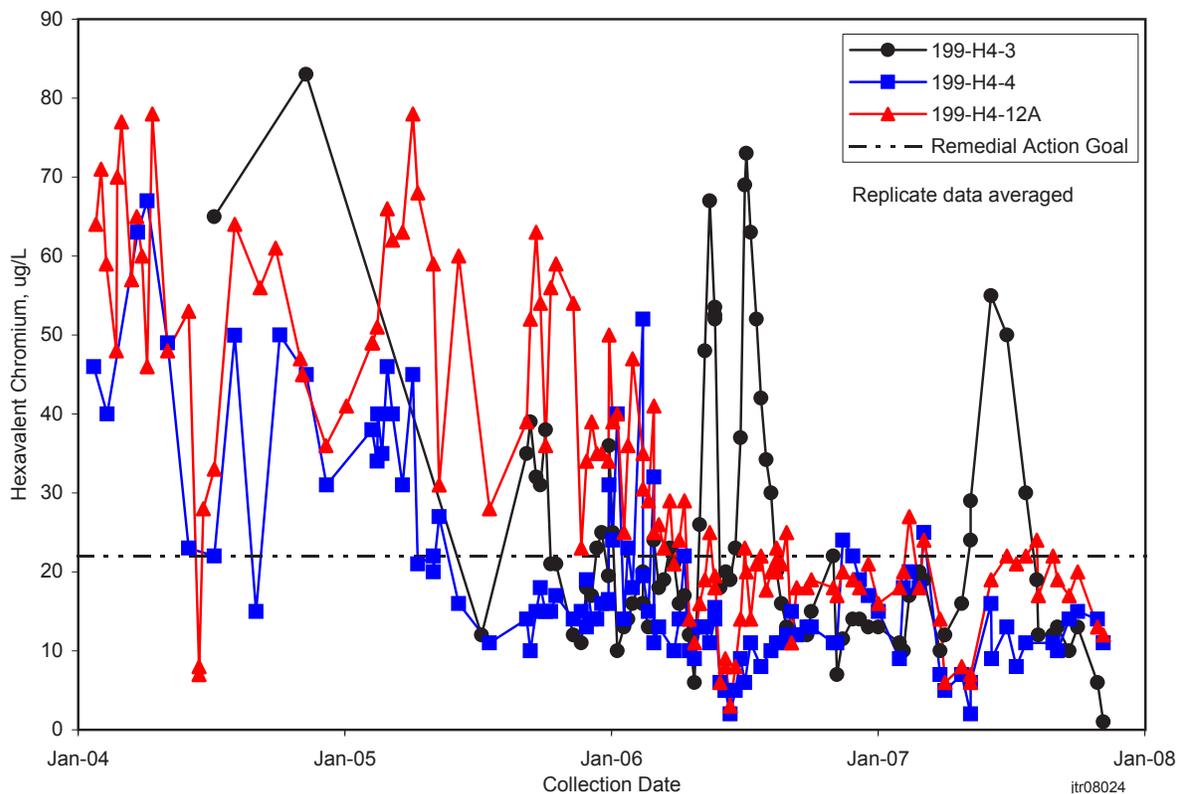


Figure 2.6-3. Chromium Concentrations East of 116-H-6 Evaporation Basins



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Figure 2.6-4. Chromium Concentrations in Extraction Wells for 100-HR-3 Pump-and-Treat System at 100-H Area

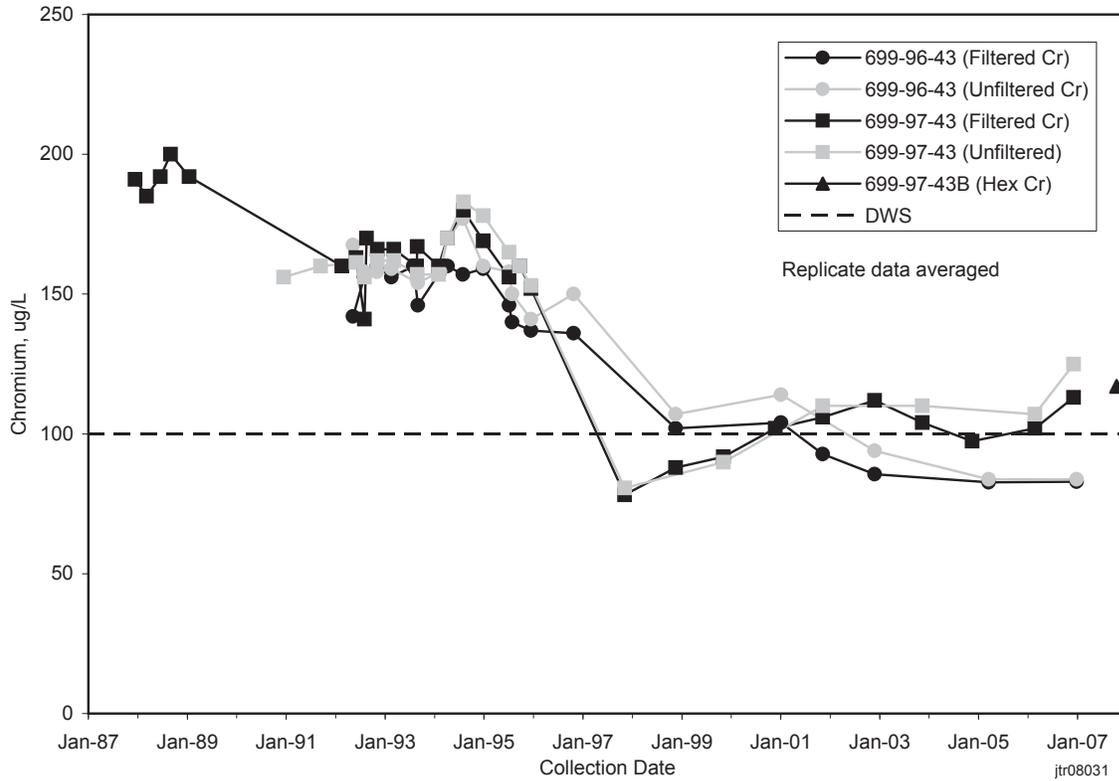


Figure 2.6-5. Chromium Concentrations Upgradient of 100-H Area

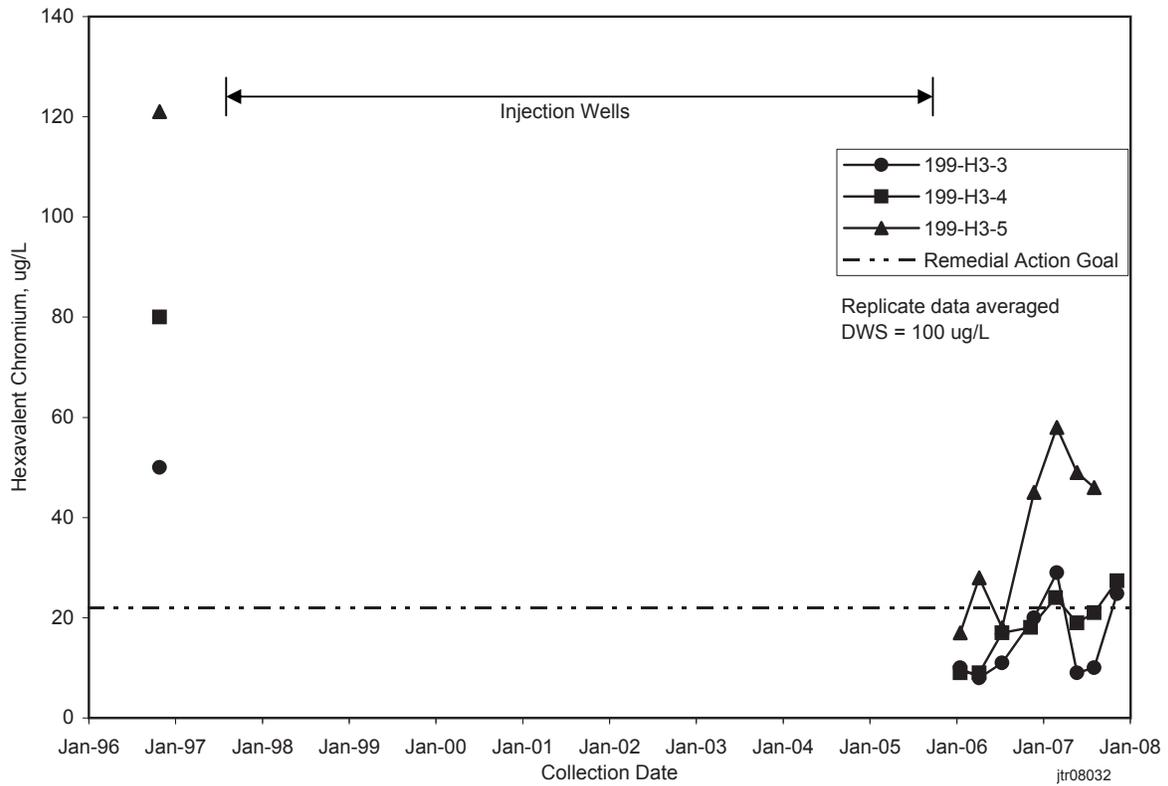
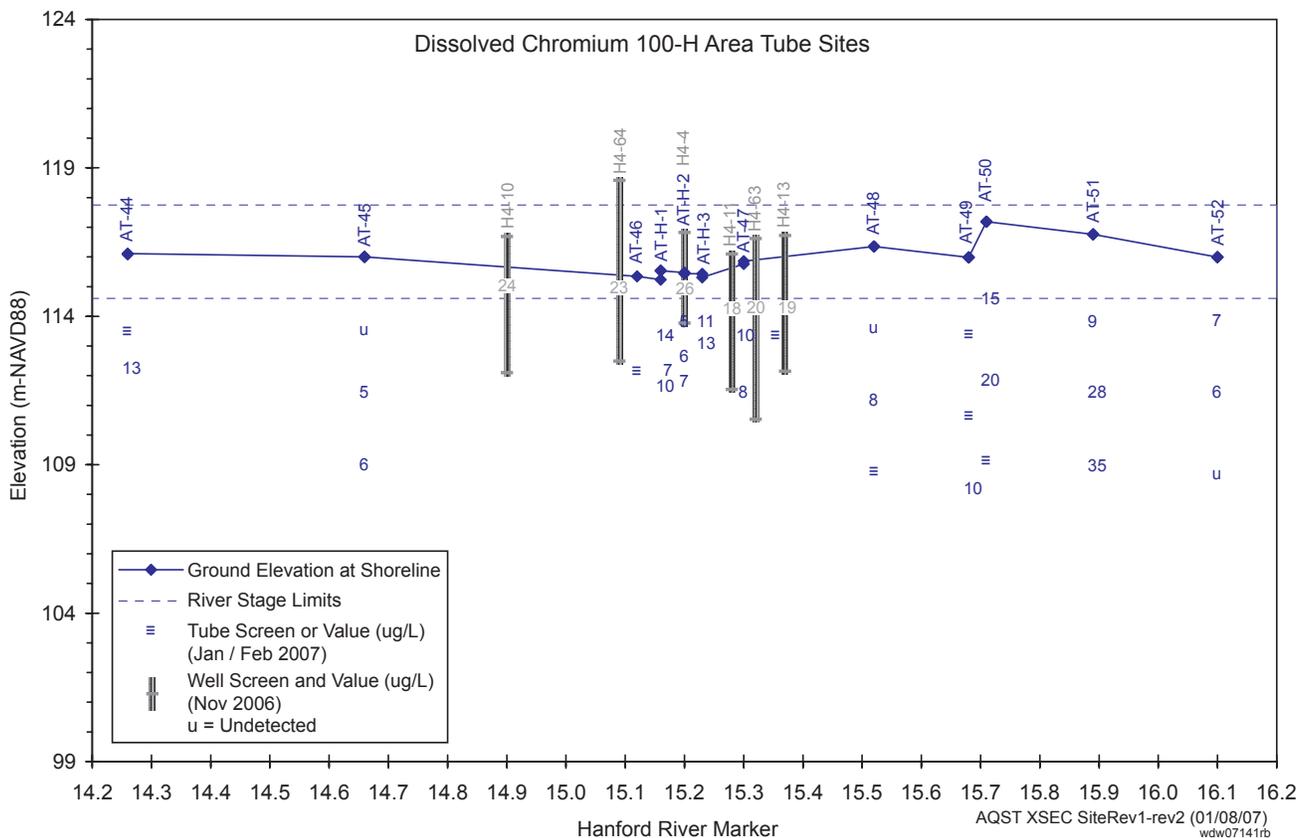
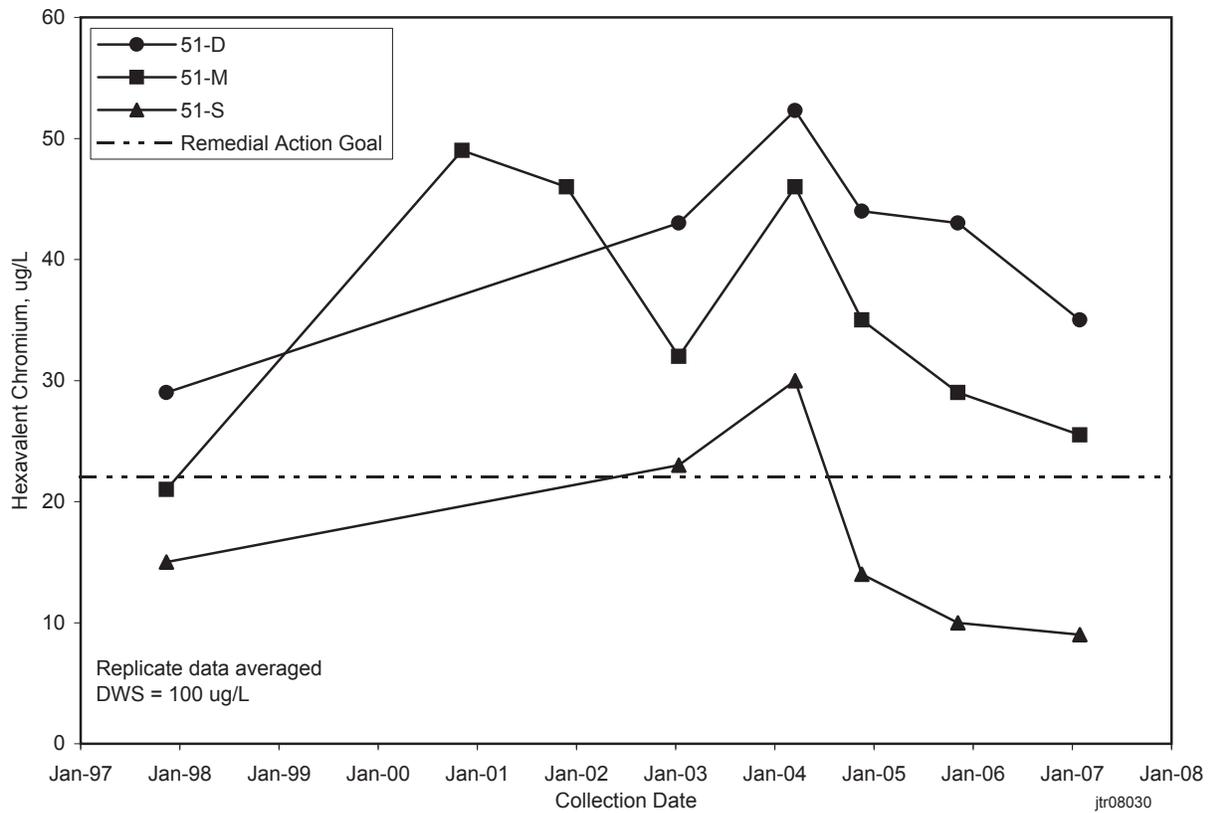
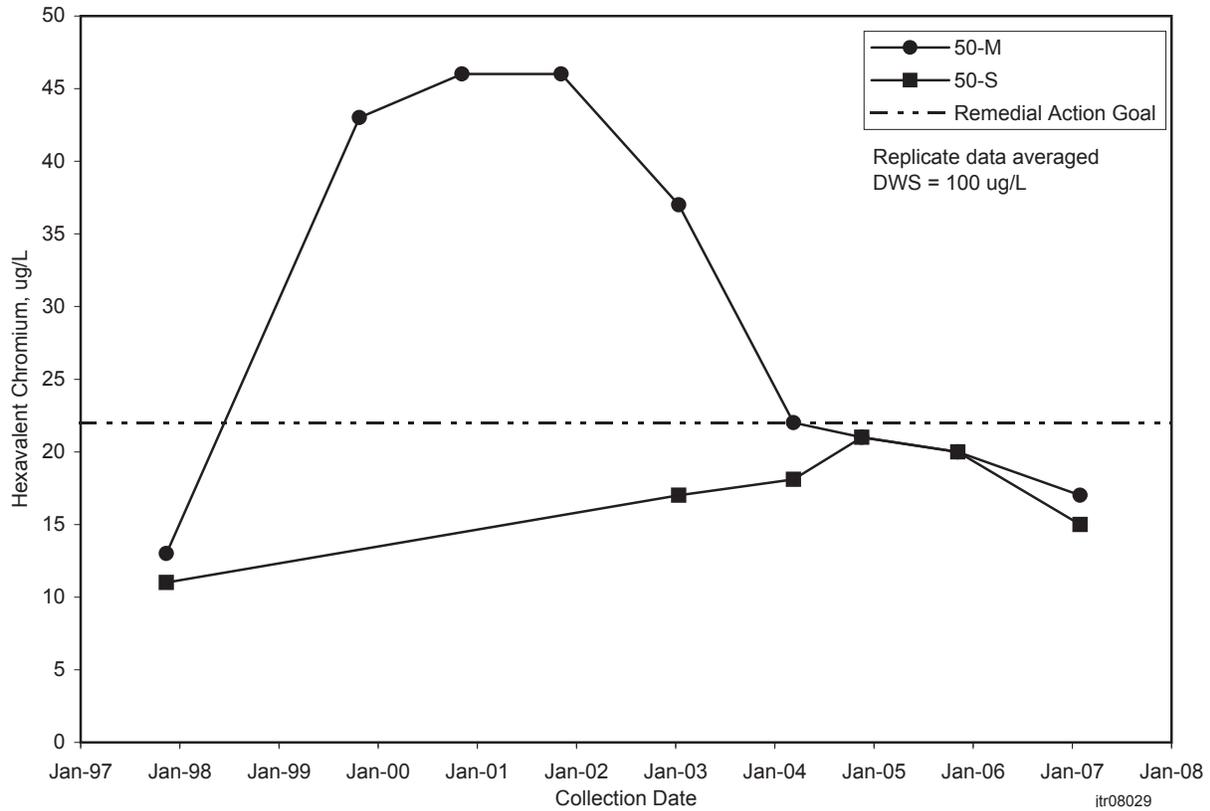


Figure 2.6-6. Chromium Concentrations in Former Injection Wells in South 100-H Area

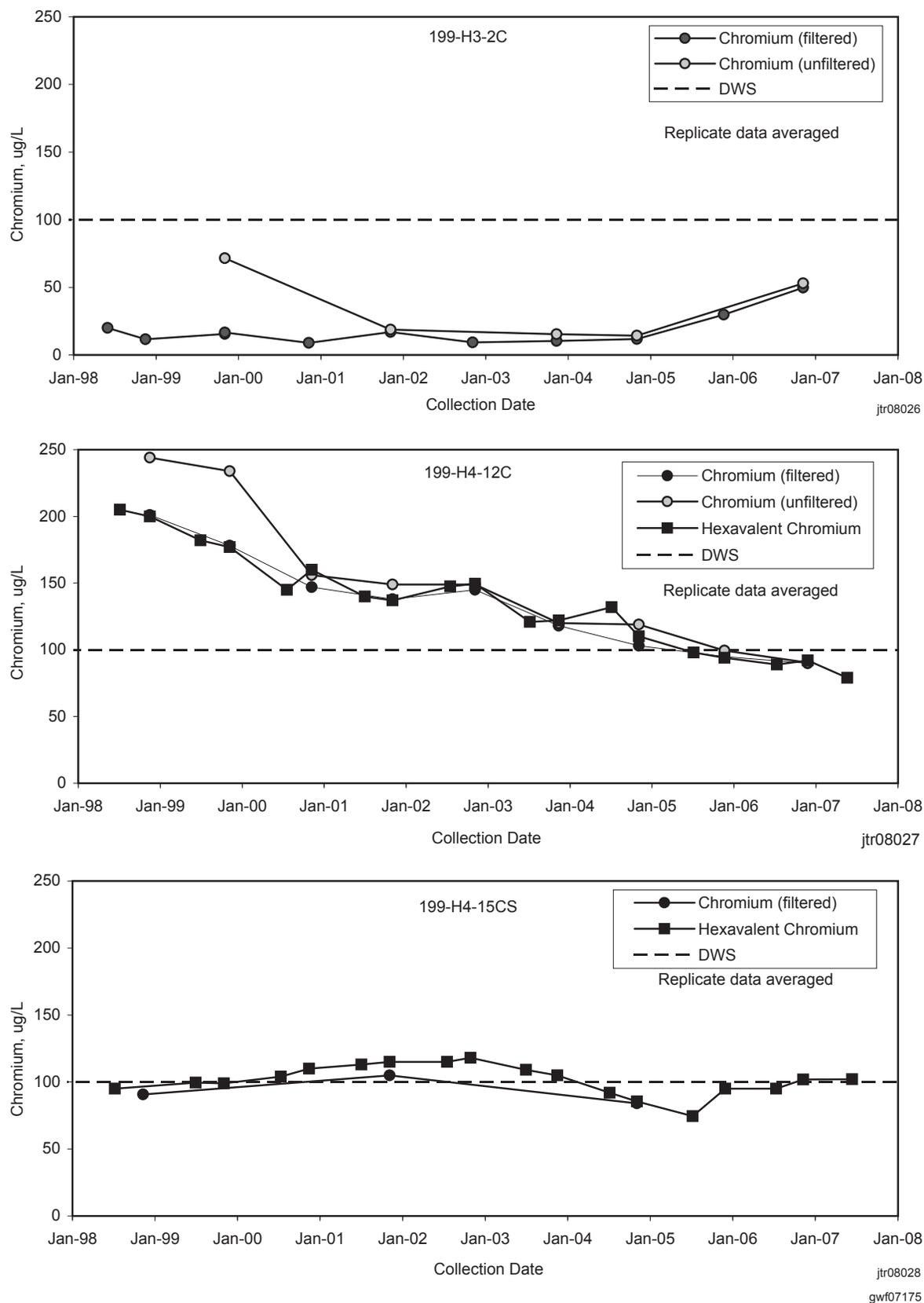


**Figure 2.6-7. Sample Elevations and Chromium Concentrations in Wells and Aquifer Tubes in 100-H Area (from SGW-35028)**

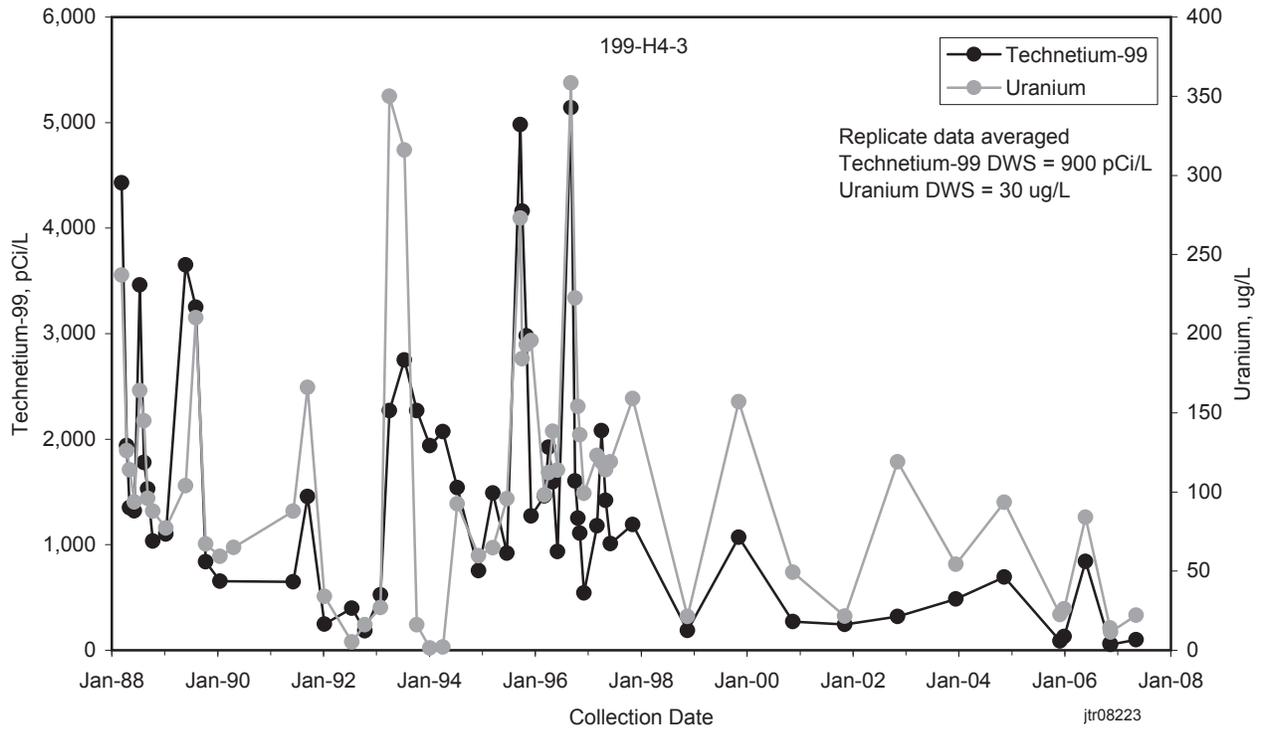


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Figure 2.6-8. Chromium Concentrations in Aquifer Tubes South of 100-H Area



**Figure 2.6-9. Chromium Concentrations in Wells Screened in the Ringold Upper Mud Unit**



**Figure 2.6-10. Technetium-99 and Uranium Concentrations East of 116-H-6 Evaporation Basins**