2.6 100-HR-3-H Groundwater Interest Area

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This section describes groundwater flow and chemistry in the 100-HR-3-H groundwater interest area (including the 100-H Area located in the eastern portion of the 100-HR-3 Operable Unit). Figure 1.0-1 shows the 100-HR-3-H groundwater interest area location on the Hanford Site. Figure 2.6-1 shows facilities, wells, and shoreline monitoring sites in the 100-H Area. Hexavalent chromium is the principal contaminant of concern in 100-H Area groundwater.

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

Groundwater flows primarily toward the east-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. Since groundwater flows generally toward the northeast across the entire horn of the Hanford Site north of Gable Mountain, groundwater approaching the 100-H Area may contain contaminants that originated in the 100-D and 100-N Areas.

There is an upward hydraulic gradient between the confined and unconfined aquifers in the 100-H Area, based on data from well 199-H4-15B (unconfined aquifer) and piezometers 199-H4-15CQ (Ringold upper mud unit) and 199-H4-15CP (basalt-confined aquifer). In March 2008 the gradient between the Ringold upper mud unit and the unconfined aquifer was 0.012. The gradient between the basalt-confined and unconfined aquifers was 0.09. Well 199-H4-15CP is capped, or it would be flowing at the surface.

Some of the main concepts associated with the 100-HR-3-H groundwater interest area include the following.

- Principal sources of groundwater contamination included liquid waste sites (trenches, cribs, and basins). The waste sites have been remediated (shallow contaminated sediment has been excavated) and backfilled.
- Hexavalent chromium is the principal contaminant of concern in groundwater. The portion of the plume within the 100-H Area has shrunk and concentrations have declined.
- A pump-and-treat system removed ~2.3 kg of hexavalent chromium from the aquifer in fiscal year (FY) 2008, and ~51 kg since 1997. Concentrations in groundwater are mostly below the 22 µg/L remedial action goal.
- Strontium-90 and nitrate contamination also is present in groundwater.
- One *Resource Conservation and Recovery Act of 1976* (RCRA) unit is located in the 100-H Area. It is monitored under an alternative program in conjunction with the interim remedial action.
- Most of the wells in the 100-H Area are screened at the top of the unconfined aquifer, which is 2 to 6 m thick. Three wells completed in the Ringold upper mud unit have higher concentrations of chromium than shallow wells. The U.S. Department of Energy (DOE) will characterize this contamination in coming years.

The 100-H Area groundwater is monitored for the objectives of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), the *Atomic Energy Act of 1954* (AEA), and the 116-H-6 (183-H) Solar Evaporation Basins (a RCRA unit). Section 2.6.1 describes contaminant plumes and concentrations;

Section 2.6.2 summarizes operable unit activities; and Section 2.6.3 discusses groundwater monitoring of the 116-H-6 Solar Evaporation Basins.

2.6.1 Groundwater Contaminants

Wells in the 100-H Area are sampled for hexavalent chromium and co-contaminants identified under CERCLA: strontium-90, technetium-99, uranium, tritium, and nitrate (EPA/ROD/R10-96/134, p. 42). This section describes the distribution and trends of those groundwater contaminants beneath the 100-H Area.

Plume areas (square kilometers) in the 100-HR-3-H groundwater interest area:

Chromium,* 20 µg/L — 4.0

Nitrate, 45 mg/L — 0.03

Strontium-90, 8 pCi/L — 0.15

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

2.6.1.1 Chromium

Hexavalent chromium is the contaminant of concern for the 100-HR-3 Operable Unit interim action (EPA/ROD/R10-96/134), which includes the 100-H Area. The interim action record of decision requires remediation using a pump-and-treat system (Section 2.6.2).

The portion of the chromium plume in the 100-H Area where concentrations exceed the remedial action goal of 22 µg/L has shrunk substantially in recent years (Figure 2.5-4). Concentrations in shallow wells have been below the 100 µg/L drinking water standard since 2001. Well 199-H3-5 had the maximum concentration (72 µg/L in February 2008) in a shallow well for FY 2008. This is one of three former injection wells located in the southern 100-H Area where chromium concentrations have increased in recent years (Figure 2.6-3). Injection of treated water into these wells ceased in 2005. The source of chromium in this area is believed to be the 600 Area plume that originated in the 100-D Area.

Prior to FY 2008, the highest 100-H Area chromium concentrations were in well 199-H4-3, which is downgradient of the 116-H-6 Solar Evaporation Basins. In FY 2008, chromium concentrations in well 199-H4-3 ranged from less than 10 µg/L in November and December 2007 to 35 µg/L in August 2008 (Figure 2.6-4). Chromium peaks during the summers of 2006, 2007, and 2008 followed periods of elevated river stage. Co-contaminants nitrate, technetium-99, and uranium showed similar trends in 2006 and 2007. These constituents were not analyzed in samples from summer 2008. The concentration increases could be caused by movement of contamination from the lower vadose zone into groundwater, or possibly changing directions of groundwater flow because of seasonal variations or pump-and-treat effects.

Chromium concentrations were all below the drinking water standard in the upper aquifer of the 100-H Area, and most averaged less than the 22 µg/L remedial action goal in FY 2008.

Well 199-H4-3 has been an extraction well for the pump-and-treat system since August 2005. Chromium concentrations in November 2007 in the other five extraction wells are plotted in Figure 2.6-5. Most of the FY 2008 results were below the 22 µg/L remedial action goal.

Several wells upgradient of the 100-H Area continued to have chromium concentrations near or above the drinking water standard. The highest concentration for FY 2008 was 117 µg/L (hexavalent chromium) in well 699-97-43B in October 2007. This contamination probably originated in the 100-D Area when a water-table mound was present (WHC-SD-EN-TI-023, *Hydrogeologic Information Summary for the Northern Hanford Site*). This plume is the subject of an ongoing investigation of the horn (Section 2.5.2.4). An upcoming report will include a hydrogeological summary of the area.

Figure 2.6-6 shows chromium concentrations in November 2007 in aquifer tubes and near-river wells in two cross sections parallel to the Columbia River. The top panel includes recently installed aquifer tubes on the east side of the horn. The highest concentrations (~60 µg/L) were observed in two shallow tubes near the south end of the cross section. Some of these tubes were sampled quarterly in FY 2008. The highest concentration in May 2008 was 73.4 µg/L in a deep tube, C5674 (45.9 µg/L in the shallow tube). The bottom panel of Figure 2.6-6 shows chromium concentrations along the 100-H Area and downstream. The highest concentration was 41 µg/L in tube AT-51-D, downstream of 100-H Area.

Three wells monitoring a water-bearing layer within the Ringold upper mud unit continued to have elevated chromium concentrations (Figure 2.6-7). These wells (199-H3-2C, 199-H4-12C, and 199-H4-15CS) are screened at elevations ranging from 94 to 104 m. Adjacent water-table wells are screened from 112 to 117 m. Well 199-H3-2C is located on the western side of 100-H Area, upgradient of waste sites. Chromium concentrations in this well have increased over the last several years, reaching ~50 µg/L in FY 2007 and FY 2008. Adjacent well 199-H3-2A, completed at the water table, has much lower chromium concentrations (less than 10 µg/L). Well 199-H4-12C is located near the river, downgradient of the 116-H-6 Solar Evaporation Basins and adjacent to extraction well 199-H4-12A. Well 199-H4-12C has declining chromium concentrations. Piezometer 199-H4-15CS also is 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 lower chromium levels, with a maximum concentration of 50 µg/L in piezometer 199-H4-15CR. Concentrations of other contaminants that would indicate the influence of the 116-H-6 Solar Evaporation Basins (e.g., nitrate, technetium-99, and uranium) are low in the deeper wells. The source of this deeper chromium is unknown. The deep chromium contamination is being investigated in response to a five-year review action item (Section 2.6.2.1).

The Ringold upper mud unit does not appear to be contaminated across the horn.

The Ringold upper mud unit does not appear to be contaminated across the horn. In FY 2007 and FY 2008, the DOE installed three wells in the horn to monitor the Ringold upper mud unit: 699-97-43C, 699-97-45B, and 699-97-48C. Routine samples from the wells had concentrations less than 20 µg/L. During development (extended pumping) of well 699-97-48C, chromium concentrations rose to ~40 µg/L. Routine samples in the subsequent months had levels less than 20 µg/L. The chromium in the upper mud unit at this well may have been introduced during drilling, or may be a remnant of local contamination introduced by a nearby well that was formerly screened across a long interval.

2.6.1.2 Strontium-90

Strontium-90 concentrations continued to exceed the drinking water standard (8 pCi/L) in two wells. Both of these wells are located in southeastern 100-H Area near the former retention basin and disposal trenches. The highest concentration in FY 2008 was 24.8 pCi/L in well 199-H4-63, confirming a declining trend. The strontium-90 contamination causes gross beta concentrations to exceed the 50 pCi/L drinking water standard in the region of the plume. The highest gross beta concentration in FY 2008 was 57.2 pCi/L in well 199-H4-13, equivalent to ~28 pCi/L strontium-90 (samples from well 199-H4-13 were not analyzed for strontium-90).

Six aquifer tubes were sampled for strontium-90 in FY 2008: AT-47-D and -M, AT-H-3-D and –S, and new tubes C6296 and C6297. The highest concentration was 11.6 pCi/L in AT-47-M, which is near well 199-H4-63.

2.6.1.3 Technetium-99 and Uranium

Although detected during FY 2008 in groundwater downgradient of the former 116-H-6 Solar Evaporation Basins, technetium-99 and uranium concentrations did not exceed the drinking water standards (900 pCi/L and 30 µg/L respectively). The highest technetium-99 and uranium concentrations were in well 199-H4-3, at 31 pCi/L and 8.4 µg/L, respectively. Concentrations increased in this well during summer 2006 and 2007, along with chromium. Technetium-99 and uranium were not analyzed during summer 2008.

2.6.1.4 Tritium

Tritium concentrations do not exceed 2,000 pCi/L in most 100-H Area wells. The highest concentration in the 100-H Area for FY 2008 was 4,400 pCi/L in well 199-H4-49 (in the southern 100-H Area). Wells in the 600 Area upgradient of the 100-H Area have tritium concentrations greater than 2,000 pCi/L, with a maximum of 5,500 pCi/L in well 699-97-43B.

2.6.1.5 Nitrate

Nitrate concentrations exceeded the drinking water standard (45 mg/L) in some 100-H Area monitoring wells; however, concentrations were below the standard in FY 2008. The highest concentration in a monitoring well was 44.3 mg/L (well 199-H6-1 in the southern 100-H Area). A sample from one aquifer tube downstream from the 100-H Area, AT-51-M, had a concentration of 45.6 mg/L.

Well 199-H4-3 has had nitrate concentrations above the drinking water standard in the past. In FY 2008, the highest concentration was 35.5 µg/L in February. Nitrate peaks during the summers of 2006 and 2008 coincided with peaks in chromium, technetium-99, and uranium (Sections 2.6.1.1 and 2.6.1.3). The well was not sampled during summer 2008.

2.6.2 Operable Unit Activities

The remedial action objectives for the 100-HR-3 Operable Unit (EPA/ROD/R10-96/134) are as follows.

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

This section summarizes activities associated with groundwater in the eastern portion of the 100-HR-3 Operable Unit. Eleven new monitoring wells were installed in this region in FY 2008 as part of the horn chromium investigation (Section 2.5.2.4).

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[1] pertaining to the

1 Another issue pertained to chromium in the "horn" between 100-D and 100-H Areas. It is discussed in Section 2.5.

100-H Area: Action 12-1, perform additional characterization of the aquifer below the initial aquitard (September 2009).

Section 2.6.1.1 presents monitoring results. Additional work will be performed under the systematic planning process and remedial process optimization for the 100-HR-3 Operable Unit.

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 (EPA/ROD/R10-96/134). DOE/RL-96-90,describes interim remedial action monitoring. 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. For interim action monitoring, one monthly sample was missed in two wells (199-H4-5 and 199-H4-63) because of conflicts scheduling field staff. For long-term monitoring, all wells were sampled as planned.

During FY 2008, the pump-and-treat system extracted ~142.9 million liters of groundwater from the 100-H Area, removing ~2.3 kg of hexavalent chromium.

The 100-H Pump-And-Treat System is reducing overall contamination in the operable unit by removing contaminant mass. During FY 2008, the pump-and-treat system extracted ~142.9 million liters of groundwater from the 100-H Area, removing ~2.3 kg of hexavalent chromium.

The pump-and-treat system has removed ~51 kg of hexavalent chromium from the 100-H Area groundwater since July 1997. This represents more than the ~42 kg of chromium that was estimated to be in the plume in 1992 (WHC-SA-1674-VA, *Characterization of a Chromium Plume in Groundwater along the Columbia River Shoreline, Hanford Site, Washington*). The estimate did not include chromium from upgradient sources (100-D Area) nor the vadose zone.

Chromium concentrations in 100-H Area groundwater have declined, and the plume in the uppermost aquifer has shrunk. There were no changes made to the pump-and-treat network in the 100-H Area during FY 2008.

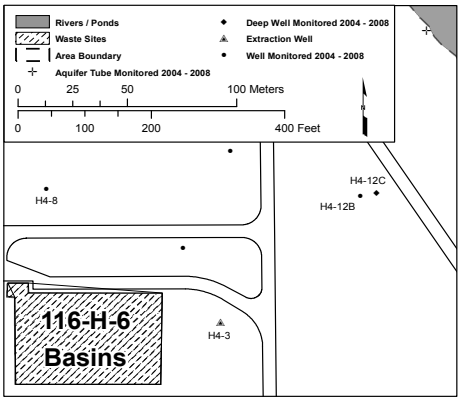
Hexavalent chromium concentrations stabilized at levels below the remedial action goal in compliance well[2] 199-H4-5. Concentrations[3] ranged from 2 to 16 µg/L in FY 2008. Most of the FY 2008 chromium concentrations[3] for former compliance wells 199-H4-4, 199-H4-63, and 199-H4-64 (now extraction wells) were below the remedial action goal (Figure 2.6-5).

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 2007 can be found in DOE/RL-2008-05. Results for FY 2008 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 Certain monitoring wells are designated as “compliance wells” in the interim action record of decision. Chromium concentrations in samples from these wells are compared to the remediation goal (22 µg/L) to determine if the remedial action is effective.

3 Hexavalent chromium and filtered, total chromium

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



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The 116-H-6 Solar Evaporation Basins are the only RCRA site in the 100-H Area. The unit was incorporated into the Hanford Facility RCRA Permit (WA7890008967) as the 183-H Solar Evaporation Basins. The site is monitored during the postclosure period under corrective action monitoring requirements of WAC 173-303-645(11)(g). The monitoring network consists of 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 2008 for the constituents of interest listed in the groundwater-monitoring plan (PNNL-11573, *Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*). The constituents of interest (except fluoride) were discussed in Section 2.6.1. Fluoride concentrations remained low (less than 300 µg/L) in groundwater downgradient of the 116-H-6 Solar Evaporation Basins. Two reports present groundwater monitoring results for July to December 2007 and January to June 2008 (SGW-37294 and SGW-39299, respectively).

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. Although not regulated under RCRA, technetium-99 and uranium were included in the monitoring plan for completeness and were incorporated by reference in the Hanford Facility RCRA Permit.

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

CERCLA and AEA Monitoring (Appendix A)

- ***Twenty-seven wells are scheduled for monthly to semiannual sampling to monitor the pump-and-treat system. Two monthly samples were not collected.***
- ***Thirteen wells throughout the 100-H Area are scheduled for annual or biennial sampling. All wells were sampled as scheduled.***
- ***Thirty-two wells in the 600 Area between 100-D and 100-H Areas are scheduled for quarterly to biennial sampling. All were sampled as scheduled.***

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

- ***Four downgradient wells are scheduled for annual sampling to meet RCRA and AEA requirements. All wells were sampled as scheduled.***

Figure 2.6-1. Facilities and Groundwater Monitoring Wells in the 100-H Area.

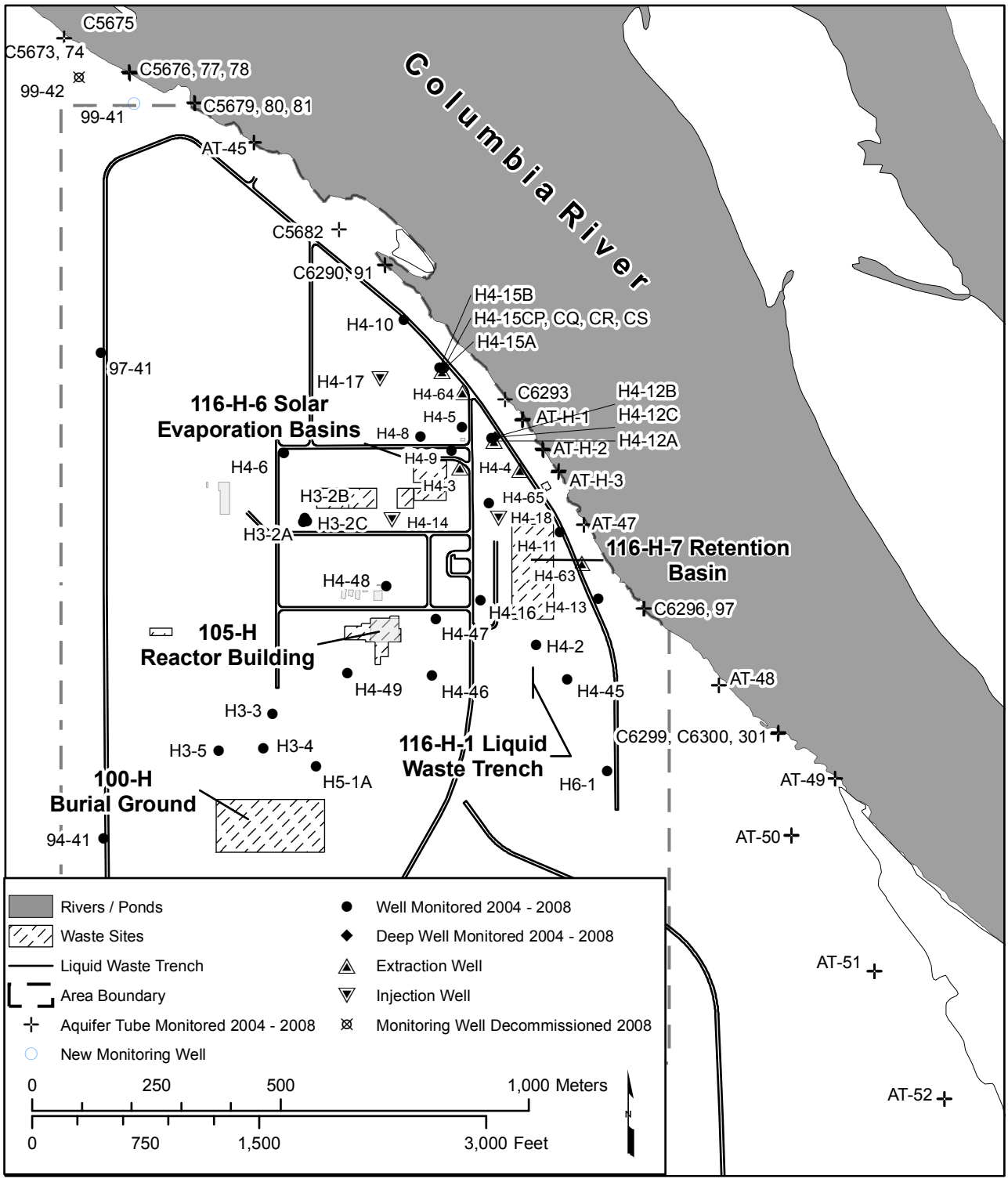

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Figure 2.6-2. 100-H Area Water-Table Map, March 2008.

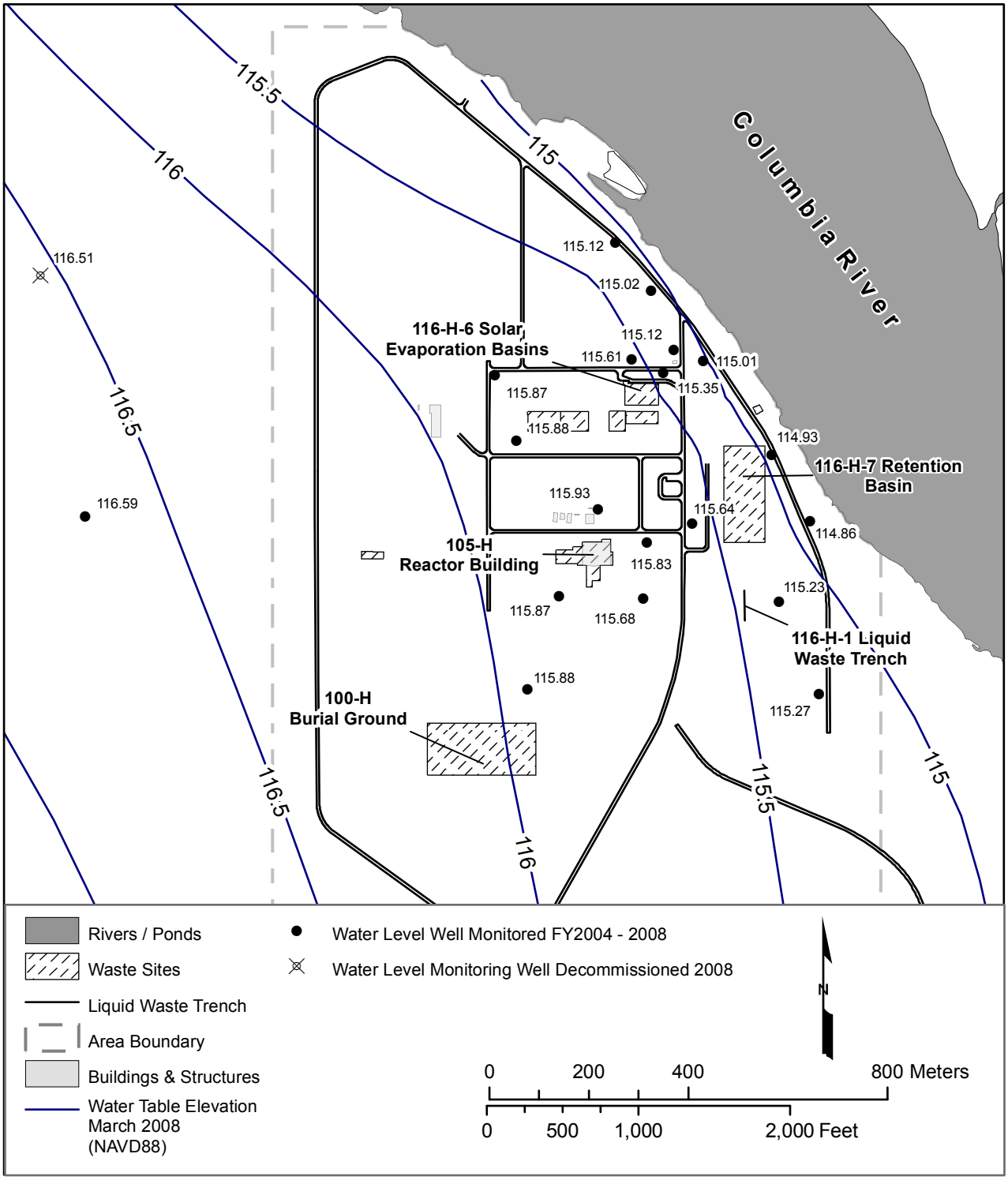

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Figure 2.6-3. Hexavalent Chromium Concentrations in 100-H Area Former Injection Wells.

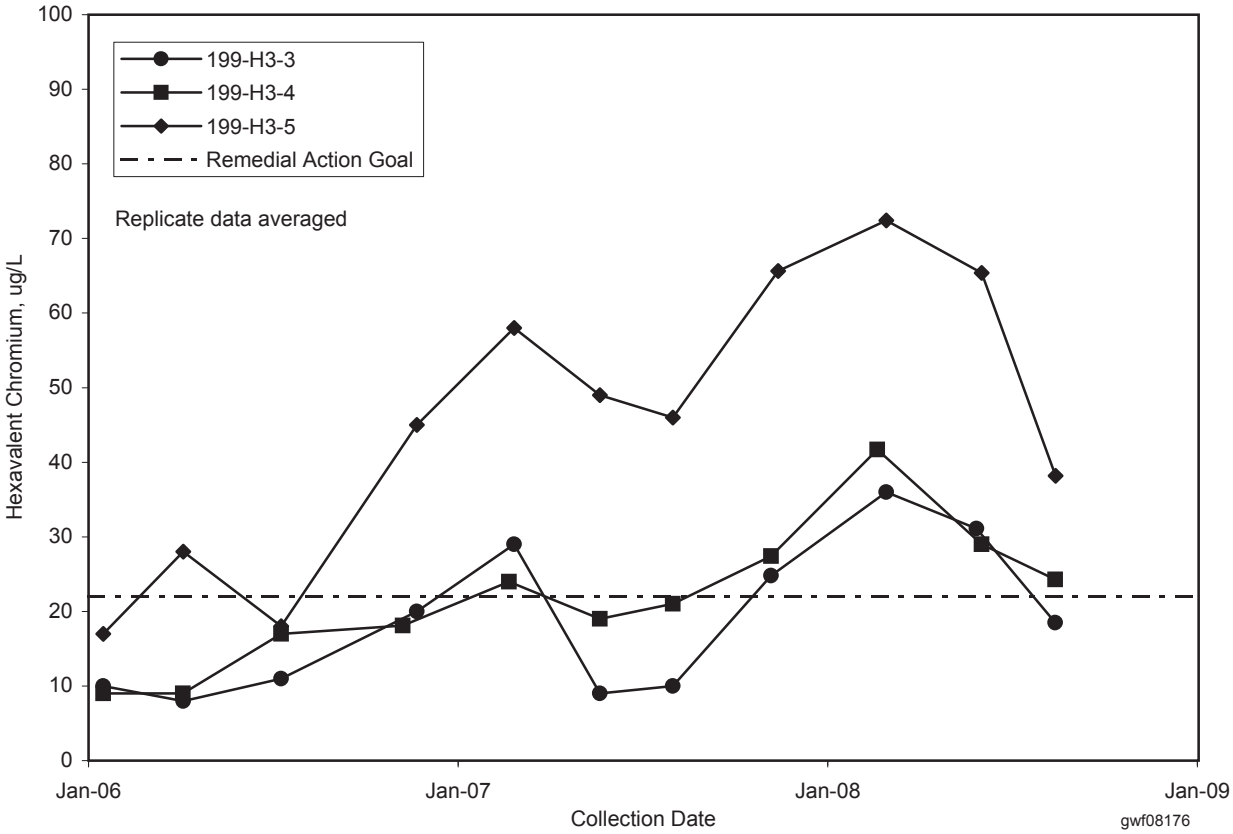

Figure 2.6-4. Hexavalent Chromium Concentrations in Extraction Well 199-H4-3 and 100-H Area River Stage.

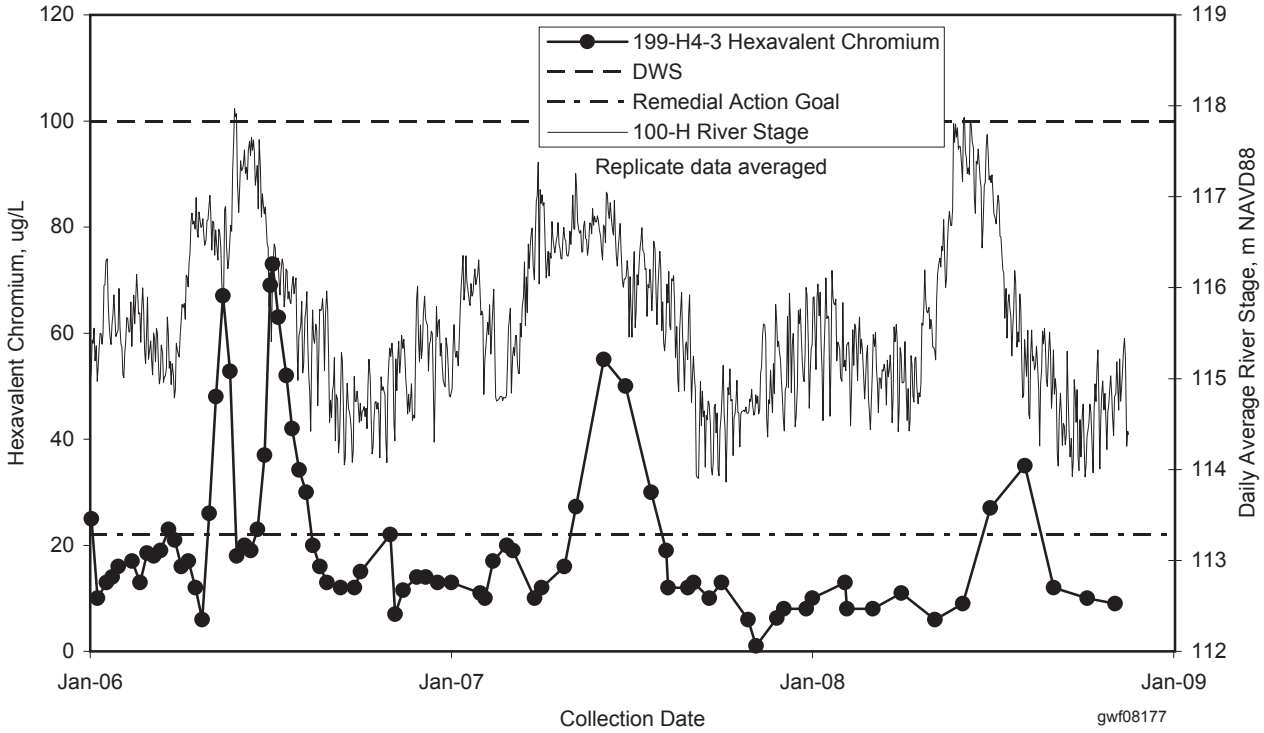

Figure 2.6-5. Chromium Concentrations in Extraction Wells for the 100-HR-3 Pump-and-Treat System.

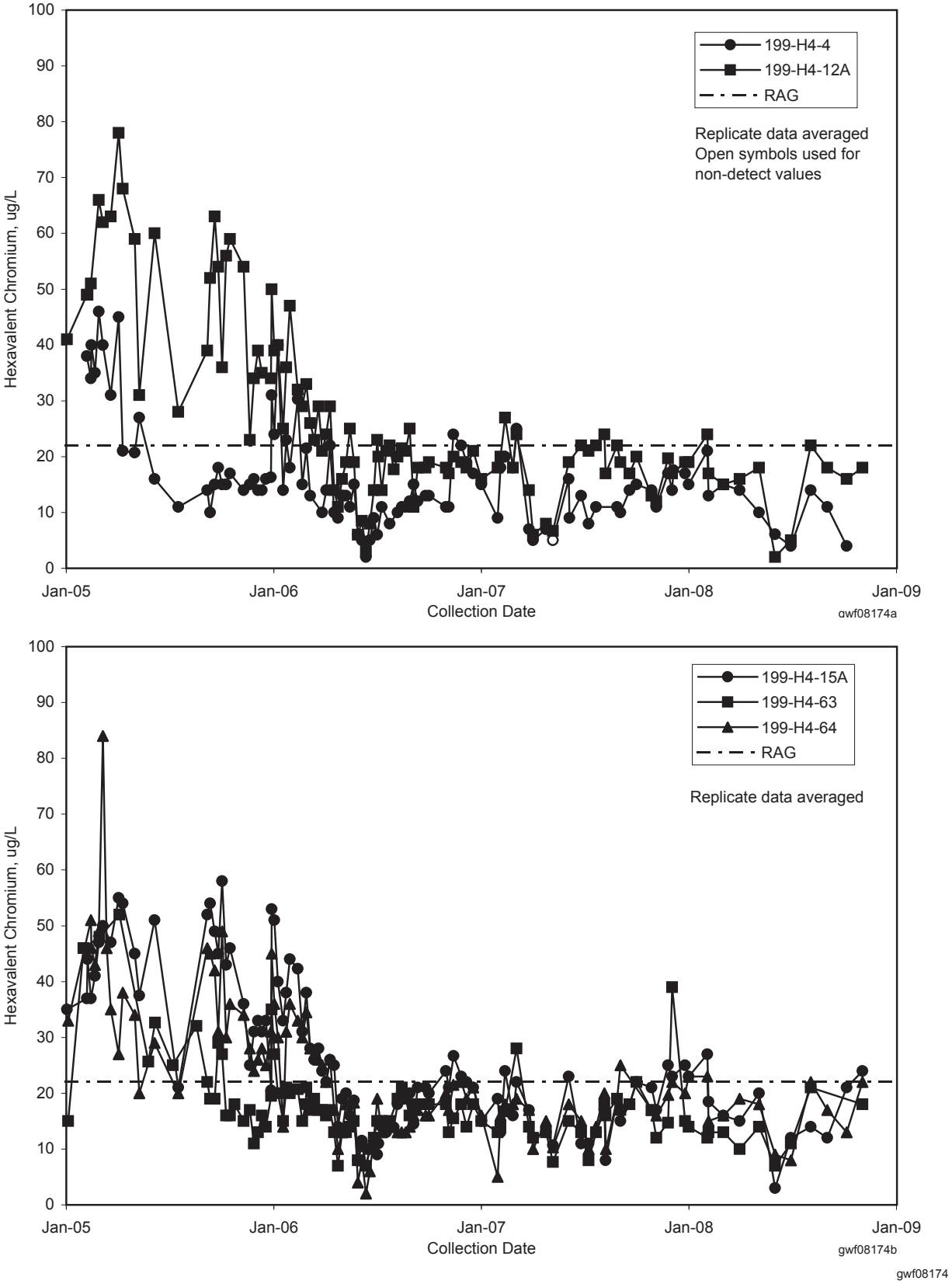

Figure 2.6-6. Cross Section of Chromium Concentrations and Screen Elevations in Wells and Aquifer Tubes in the 100-H Area.

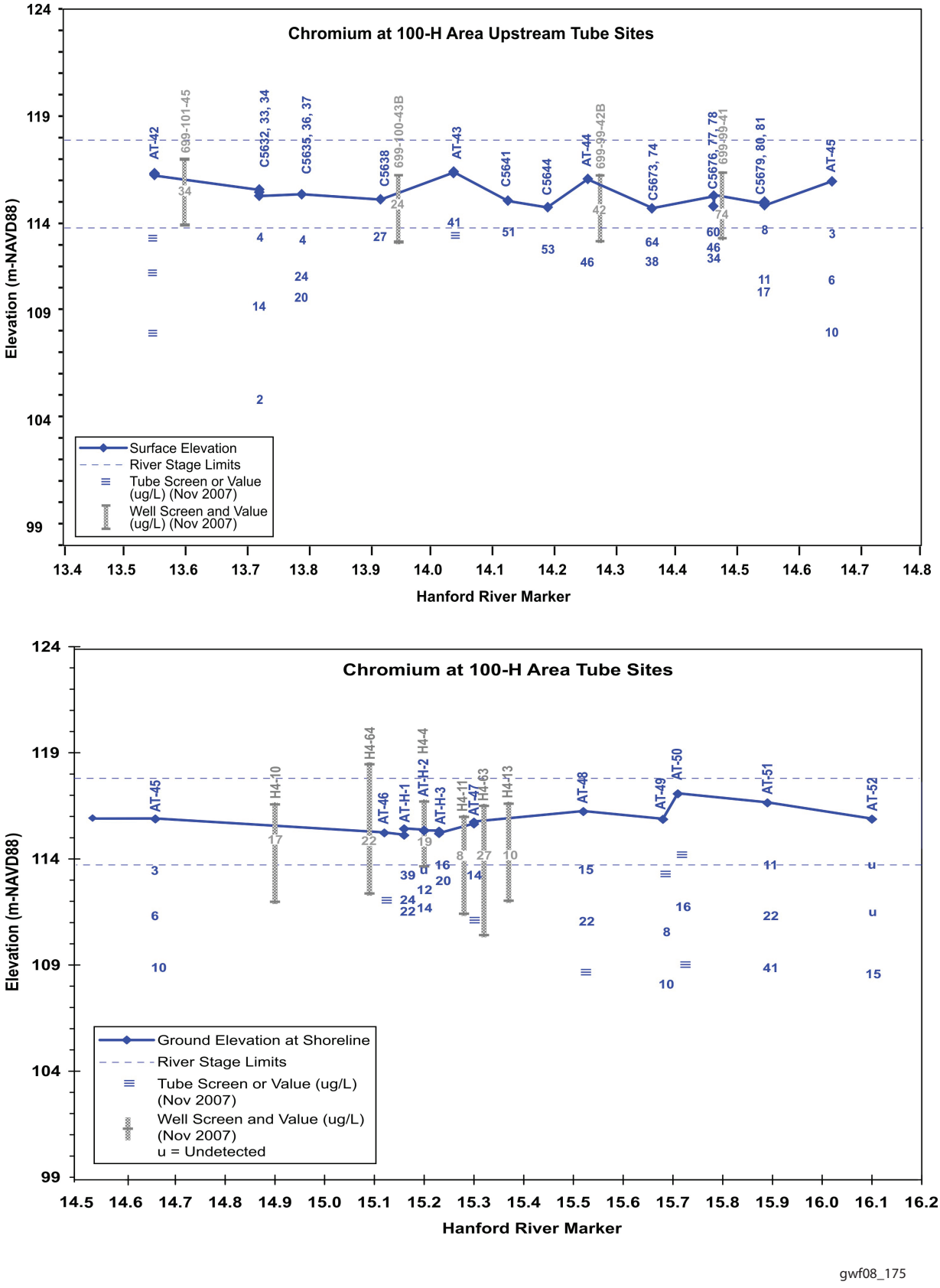
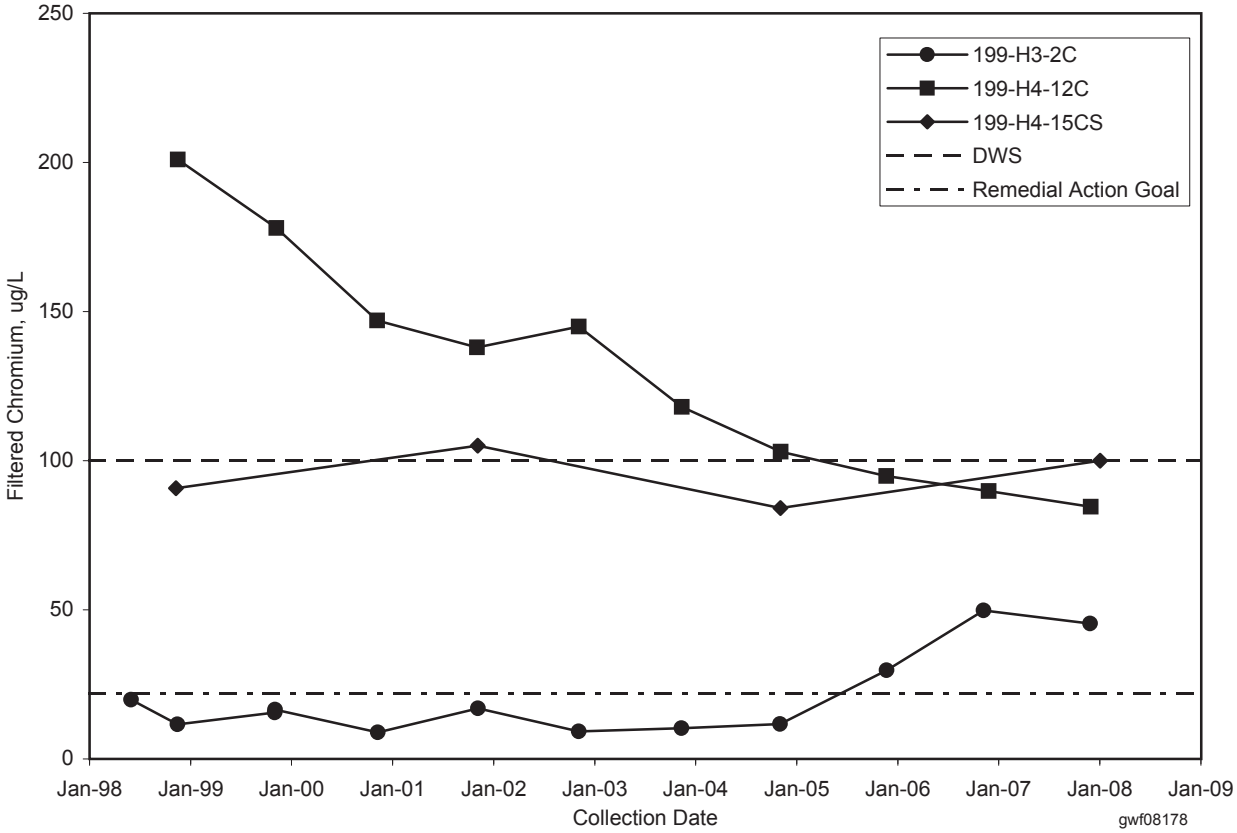
Figure 2.6-7. Chromium Concentrations in Wells Monitoring the Confined Aquifer in the Ringold Upper Mud Unit.