19.0 1100-EM-1 Groundwater Interest Area

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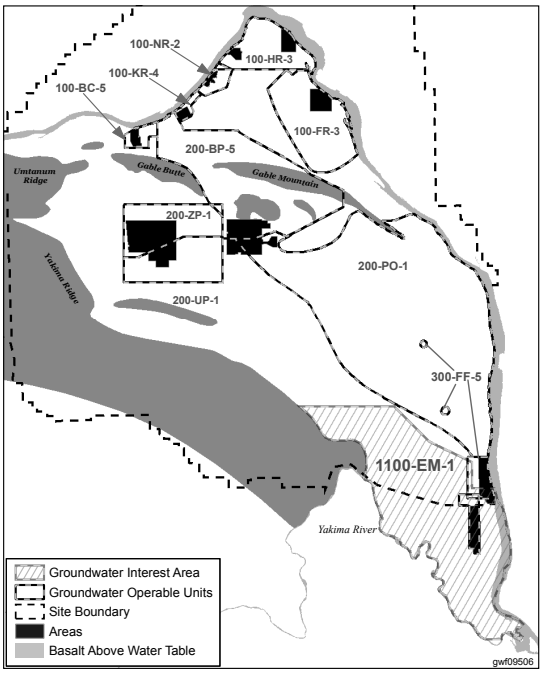
This chapter describes groundwater flow and contaminant distributions in the 1100-EM-1 groundwater interest area, which includes the former 1100-EM-1 Operable Unit (OU) and an area south of the Hanford Site designated as the Richland North Area that includes the areas formerly designated as the 1100 and 3000 Areas. Figure 19-1 shows the facilities and monitoring wells in this region.



This chapter outlines a conceptual site model (Section 19.1), describes contaminant plumes and concentration trends for the contaminants of concern (Section 19.2), and discusses the activities for the 1100-EM-1 groundwater interest area (Section 19.3). Trichloroethene and nitrate are the contaminants of greatest concern in the groundwater. Groundwater beneath the 1100-EM-1 OU portion of the 1100-EM-1 groundwater interest area is monitored to assess the performance of natural attenuation of volatile organic compounds. Groundwater is also evaluated for trichloroethene and its breakdown products (e.g., vinyl chloride and 1,1-dichloroethene), as well as nitrate. Groundwater monitoring for the *Atomic Energy Act of 1954* (AEA) is integrated fully with *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) monitoring. There are no active waste disposal facilities or *Resource Conservation and Recovery Act of 1976* (RCRA) sites in this area.

The report covers the period from October 1, 2008, through December 31, 2009. The reason that this report covers a 15-month period is the result of moving from a fiscal year (FY) reporting period (October 1 to September 31) to a calendar year (CY) reporting period (January 1 to December 31). This change is being made so all groundwater information (i.e., pump-and-treat, RCRA, CERCLA, and AEA) can be presented in a single report. As a result of this change, the following date conventions are used throughout this report.

- FY 2009: Refers to the fiscal year named (i.e., October 1, 2008, to September 30, 2009).
- CY 2009: Refers to the calendar year named (i.e., January 1, 2009, to December 31, 2009).
- Reporting period: Refers to the entire 15-month reporting period covered in this report (i.e., October 1, 2008, to December 31, 2009).

19.1 Conceptual Model

The primary site of concern in the 1100-EM-1 groundwater interest area is the former Horn Rapids Landfill (Figure 19-1). Located north of Horn Rapids Road (near its intersection with Stevens Drive, along the southern boundary of the Hanford Site), the Horn Rapids Landfill operated from the late 1940s to the 1970s as an uncontrolled landfill. The landfill extends over ~20 hectares of generally flat terrain. Originally a borrow pit for sand and gravel, the Horn Rapids Landfill was used primarily for disposal of office and construction waste, asbestos, sewage sludge, fly ash, and reportedly numerous drums of unidentified organic liquids (DOE/RL-90-18, *Phase I Remedial Investigation Report for the Hanford Site 1100-EM-1 Operable Unit*).

Five disposal trenches were identified during a study that researched historical aerial photographs, onsite investigations, and geophysical surveys. Surface debris (consisting of auto and truck tires, wood, metal shavings, soft drink cans and bottles, and other small pieces of refuse) was scattered across the site. A single trench, the westernmost of the identified waste disposal trenches, was posted with signs warning that the trench contained asbestos (DOE/RL-92-67, *Final Remedial Investigation/ Feasibility Study for the 1100-EM-1 Operable Unit Hanford*).

Groundwater in the region flows primarily west to east from the Yakima River and discharges to the Columbia River (Figure 19-2). In the northeastern portion of the 1100-EM-1 groundwater interest area, groundwater flows northeast and converges with groundwater beneath the 300 Area before discharging to the Columbia River. In the east-central portion of the 1100-EM-1 groundwater interest area (Richland North Area), groundwater flow from the west is diverted to the northeast and southeast around a recharge mound created by the city of Richland's recharge ponds (near the North Richland Well Field) before discharging to the Columbia River. Recharge to the unconfined aquifer in the 1100-EM-1 groundwater interest area is primarily from agricultural irrigation between the Yakima and Columbia Rivers, as well as precipitation. Irrigation water is mainly extracted from the Columbia River.

Local stratigraphy mirrors that of most of the Hanford Site with the lowermost unit being the Saddle Mountains Basalt. In the vicinity of the Horn Rapids Landfill, all of the upper fines (Unit 4) and most of the upper coarse (Unit 5) sequence have been removed by Ice Age flooding. The lowermost, coarse sequence (Unit 9) is also missing in this area. This puts the Ringold lower mud unit (Unit 8) in direct contact with the basalt. The remainder of the Ringold Formation consists of the fine-grained unit sediments and the mixed coarse and fine layers of Units 6 and 7, and the lowermost material of Unit 5 (see Chapter 3.0). The gravel- and sand-dominated facies of the Hanford formation unconformably overlie the Ringold Formation units.

None of the wells in the 1100-EM-1 OU penetrate the full thickness of the aquifer; however, wells in the nearby 300 Area suggest that the sediments above the basalt are up to 53 meters thick. The silt and clay-dominated facies of Unit 6 form a local, laterally extensive upper aquitard that is up to 10 meters thick. The thickness of the unconfined aquifer in this area is ~5.6 to 9 meters, with all but the upper few meters residing in the Ringold Formation. Because of the significant difference in hydraulic properties between the open-matrixed Hanford formation and the more indurated Ringold sediments, most of the wells used to monitor trichloroethene have screen intervals that penetrate the upper ~4.5 to 7.5 meters of the unconfined aquifer.

Trichloroethene-contaminated groundwater was found both upgradient and downgradient of the Horn Rapids Landfill. A review of all available information indicated that trichloroethene contamination moved into the Hanford Site's 1100 Area via groundwater. AREVA, a facility adjacent to Horn Rapids Landfill, has investigated soil and groundwater contamination as an independent action in accordance with *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act – Cleanup," which is discussed in the *2006 Annual RCRA Report – Groundwater Quality Assessment Program* (E06-02-2006). The past use of solvents at the AREVA lagoon area was the only documented record of trichloroethene occurrence or use near the contaminant plume identified during the 1100-EM-1 OU remedial investigation/ feasibility study. Trichloroethene was used during the installation, repair, and cleaning of lagoon liners at various times from 1978 through 1988 (i.e., for bonding overlapping liner sections together). While the Horn Rapids Landfill was alleged

to have received drummed waste solvents (DOE/RL-90-18), soil vapor surveys, geophysical investigations, and trenching activities during the remedial investigation/feasibility study did not reveal evidence of a trichloroethene source at the Horn Rapids Landfill (DOE/RL-92-67).

The *Declaration of the Record of Decision for the 1100 Area* (EPA/ROD/R10-93/063) established the natural attenuation alternative as the remedial action for the trichloroethene plume. Site characterization was conducted to validate using natural attenuation as a remedial action at the Horn Rapids Landfill site during the remedial investigation/feasibility study in the late 1980s and early 1990s (DOE/RL-90-18; DOE/RL-92-67). The biological breakdown of trichloroethene commonly results in the formation of organic compounds such as vinyl chloride and cis-1,2- dichloroethene. These compounds can also pose a risk to human health and the environment and are monitored in groundwater at the site.

Since implementation of the selected remedy, concentrations of trichloroethene have declined dramatically and have been below the detection limit for the last 2 years (Figure 19-3). To date, no degradation products have been detected.

19.2 Groundwater Contaminants

Wells in the 1100-EM-1 groundwater interest area are sampled for chlorinated hydrocarbons (primarily trichloroethene) and identified co-contaminants (i.e., nitrate, tritium, gross alpha, uranium, ammonia, and gross beta) under CERCLA and the AEA.

Plume areas (square kilometers) above the drinking water standard at the 1100-EM-1 Operable Unit:

Nitrate, 45 mg/L — 4.549
Primarily from offsite sources.

19.2.1 Trichloroethene

Trichloroethene contamination occurs at levels below the 5 µg/L drinking water standard (DWS) in the 1100-EM-1 groundwater interest area beneath the inactive Horn Rapids Landfill and offsite in wells monitored by AREVA. The distribution of trichloroethene in the upper portion of the unconfined aquifer follows the northeast flow direction, toward the 300 Area.

The past use of solvent to install and maintain process lagoon liners at AREVA is the only potential source of trichloroethene identified in the eastern portion of the 1100-EM-1 groundwater interest area (DOE/RL-92-67). AREVA successfully closed the surface impoundment in CY 2008 and is no longer required to publish quarterly RCRA groundwater monitoring data. AREVA will continue to produce an annual report on results of the groundwater monitoring program for their facility. Information reported for the AREVA facility was obtained from AREVA's CY 2009 report (E06-09-002).

Trichloroethene concentrations continued to be below detection limits during the reporting period.

Trichloroethene concentrations have decreased in all areas near the Horn Rapids Landfill. Trichloroethene concentrations decreased by an order of magnitude in this area since monitoring began in 1990. During the reporting period, trichloroethene concentrations downgradient of the landfill were all less than the 5 µg/L DWS and also less than the detection limit of 1.0 µg/L. The decreased concentrations in the majority of wells downgradient of the Horn Rapids Landfill suggest that natural attenuation (e.g., biodegradation and passive pumping) continues to reduce the plume mass. Monitoring results from wells screened at the base of the unconfined aquifer have been below the DWS since monitoring started. These wells remain below the detection limit. Chapter 18.0 discusses trichloroethene in the 300 Area.

Potential breakdown products of trichloroethene (including vinyl chloride and cis-1,2-dichloroethene) also remained undetected at the minimum detection limit of 1.0 µg/L during CY 2009.

The city of Richland monitors groundwater in the upper portion of the unconfined aquifer quarterly for chemical constituents at their Horn Rapids Sanitary Landfill (formerly the Richland Landfill), located ~1 kilometer south of the Hanford Site boundary on Highway 240. Various chlorinated hydrocarbons (e.g., tetrachloroethene, trichloroethene, and vinyl chloride) continue to exceed DWSs in several monitoring wells. During CY 2009, chlorinated hydrocarbons were below their respective minimum detection limits at onsite well 699-S31-1, northeast of the city's sanitary landfill.

A confined aquifer found near the base of the Ringold Formation is also monitored for trichloroethene downgradient of the Horn Rapids Landfill. Two wells (one upgradient and one downgradient of the landfill) monitor this confined aquifer, which lies between a clay-silt aquitard and the basalt surface, at a depth of ~18 to 21 meters below the water table. Trichloroethene has not been detected in this confined aquifer since monitoring began in 1991, suggesting that the trichloroethene plume in the unconfined aquifer did not migrate downward into the underlying confined aquifer.

19.2.2 Nitrate

Elevated nitrate concentrations continued to be measured but are related to offsite industrial and agricultural activities.

Nitrate concentrations above the DWS of 45 mg/L are found over much of the 1100-EM-1 groundwater interest area (Figure 19-4) and continued to increase in a number of wells in CY 2009. Some of the highest nitrate levels occur near an offsite facility (AREVA) and the inactive Horn Rapids Landfill. The highest nitrate concentration in this area was 370 mg/L, downgradient of the AREVA facility. Nitrate data for the AREVA wells are reported in E06-09-002. Nitrate contamination in this area is likely the result of industrial and agricultural uses off the Hanford Site. Agricultural uses include application of fertilizers to irrigated fields west of the 1100-EM-1 groundwater interest area (Figure 19-4).

Nitrate concentrations continued to be elevated in wells downgradient of the Horn Rapids Landfill in CY 2009, with the highest nitrate concentration at 330 mg/L. The distribution of nitrate and the shape of the nitrate plume near the AREVA facility and the Horn Rapids Landfill indicate that nitrate in these areas continues to migrate in a northeast direction, toward the 300 Area (Figure 19-4). Groundwater and aquifer tube sampling data indicate that groundwater with nitrate levels above the DWS has reached the Columbia River immediately south of the 300 Area. Aquifer tube AT-3-8-S (immediately south of the 300 Area) had a maximum nitrate concentration of 84.1 mg/L. A water sample collected from spring DR42-2 at the 300 Area had a nitrate concentration of 15.5 mg/L, while the Columbia River had nitrate concentrations of ~4 mg/L (PNNL-17603, *Hanford Site Environmental Report for Calendar Year 2007*).

19.2.3 Tritium

The tritium plume in the 200 Areas extends south into the 300 Area, and tritium detections with concentrations below the DWS of 20,000 pCi/L continue to be reported in the 1100-EM-1 groundwater interest area (Figure 19-5). The tritium plume continues to be closely monitored because of its proximity to the city of Richland's North Well Field. The background geometric mean tritium concentration in the upper portion of the unconfined aquifer was 63.9 pCi/L (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). Although tritium

levels were above background in several wells near the city of Richland's North Well Field during CY 2009 (maximum concentration of 371 pCi/L), these levels are far below the DWS. Tritium concentration trends in wells west and north of the city of Richland's North Well Field have fluctuated in the last few years.

Tritium is not migrating in groundwater from the tritium plume in the 200 Areas to the city of Richland North Well Field. The following factors limit the migration of the tritium plume into the east portion of the 1100-EM-1 groundwater interest area:

- Groundwater generally flows from west to east between the Yakima River, a recharge source, and the Columbia River.
- Artificial recharge from agricultural irrigation in the west and central portions of the 1100-EM-1 groundwater interest area south of the Hanford Site contribute to the eastward and northeastward flow.
- Groundwater flow is directed radially outward from the elevated groundwater levels at the city of Richland's North Well Field because of the ponds used to recharge the well field.

These factors produce converging groundwater flow lines in the 300 Area where groundwater discharges to the Columbia River (Figure 19-2). Chapter 18.0 discusses tritium in groundwater in the 300 Area.

19.2.4 Gross Alpha and Uranium

Elevated levels of gross alpha and uranium occur downgradient of the AREVA facility, near the Horn Rapids Landfill. Gross-alpha data for the AREVA wells are reported in E06-09-002. During CY 2009, several wells downgradient of the AREVA facility showed elevated gross-alpha levels, with the highest maximum concentration of 123 pCi/L immediately downgradient of the AREVA facility (south of Horn Rapids Road). Gross alpha is largely attributed to uranium from industrial use at the facility. The maximum uranium concentration from the facility was 93.5 µg/L in June 2009 (E06-09-002).

The FY 2006 annual groundwater report (PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*) discussed the distribution of uranium near the Horn Rapids Landfill. The CY 2009 uranium concentrations in wells downgradient of the Horn Rapids Landfill decreased slightly (maximum of 23.5 µg/L) compared to FY 2008 (maximum of 24.6 µg/L). The presence of uranium at these locations likely is associated with the plume moving northeast from the AREVA facility.

19.3 Groundwater Interest Area Activities

The 1100-EM-1 OU, including the inactive Horn Rapids Landfill, was placed on the National Priorities List in 1989 and was de-listed from the National Priorities List in 1996. The results of the CERCLA investigation for the 1100-EM-1 OU are presented in the final remedial investigation study (DOE/RL-92-67) and the Record of Decision (EPA/ROD/R10-93/063). The selected remedy for groundwater is monitored natural attenuation of volatile organic compounds, with institutional controls on drilling of new water supply wells. Monitoring includes the analysis of trichloroethene, its breakdown products (e.g., vinyl chloride and 1,1-dichloroethene), and nitrate in wells downgradient of the Horn

The remedial action objectives for the 1100-EM-1 Operable Unit (EPA/ROD/R10-93/063) are as follows.

- ***Attain concentration of less than 5 µg/L trichloroethene at designated point of compliance.***
- ***Protect environmental receptors in surface waters by reducing groundwater contaminant concentrations in the plume.***

Rapids Landfill, as recommended in the sampling plan (PNNL-12220, *Sampling and Analysis Plan Update for Groundwater Monitoring – 1100-EM-1 Operable Unit*).

The second CERCLA 5-year review, published in November 2006 (DOE/RL-2006-20, *The Second CERCLA Five-Year Review Report for the Hanford Site*), stated that the plume mass and concentration have been adequately reduced to be protective of human health and the environment. The review also stated that groundwater monitoring for the 1100-EM-1 OU is no longer necessary but continues following an extended period of monitoring, indicating that contaminant levels are below the DWS and continue to show a downward trend.

In June 2007, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) change notice TPA-CN-163 was approved, which reduced the groundwater monitoring requirements to annual monitoring of three of the original network wells (699-S28-12, 699-S31-E10A, and 699-S31-E10C). All three of the wells were sampled for volatile organic compounds in CY 2009 (Appendix A, Table A-20).

19.4 Conclusions and Recommendations

The use of monitored natural attenuation for the treatment of chlorinated organic compounds is successfully continuing. During CY 2009, trichloroethene concentrations downgradient of the Horn Rapids Landfill were less than the 5 µg/L DWS and less than the detection limit of 1.0 µg/L. The potential breakdown products of trichloroethene (including vinyl chloride and 1,1-dichloroethene) remained undetected (minimum detection limit of 1.0 µg/L) during CY 2009.

Various chlorinated hydrocarbons continue to exceed DWSs in several monitoring wells at the city of Richland's sanitary landfill. During CY 2009, chlorinated hydrocarbons were below their respective minimum detection limits at onsite well 699-S31-1, northeast of the city's sanitary landfill.

Concentrations of nitrate and uranium also show elevated levels. The source of both these contaminants can be traced to offsite non-Hanford Site sources.

Sampling status for the upcoming sampling year will continue monitoring the three wells downgradient of the DOE's Horn Rapids Landfill. These wells will be sampled annually in accordance with the approved sampling and analysis plan. Wells in the area between the site boundary and the city of Richland's North Well Field will be sampled semiannually to verify that contaminants from the Hanford Site are not migrating toward the well field.

Figure 19-1. Facilities and Groundwater Monitoring Wells in the 1100-EM-1 Operable Unit.

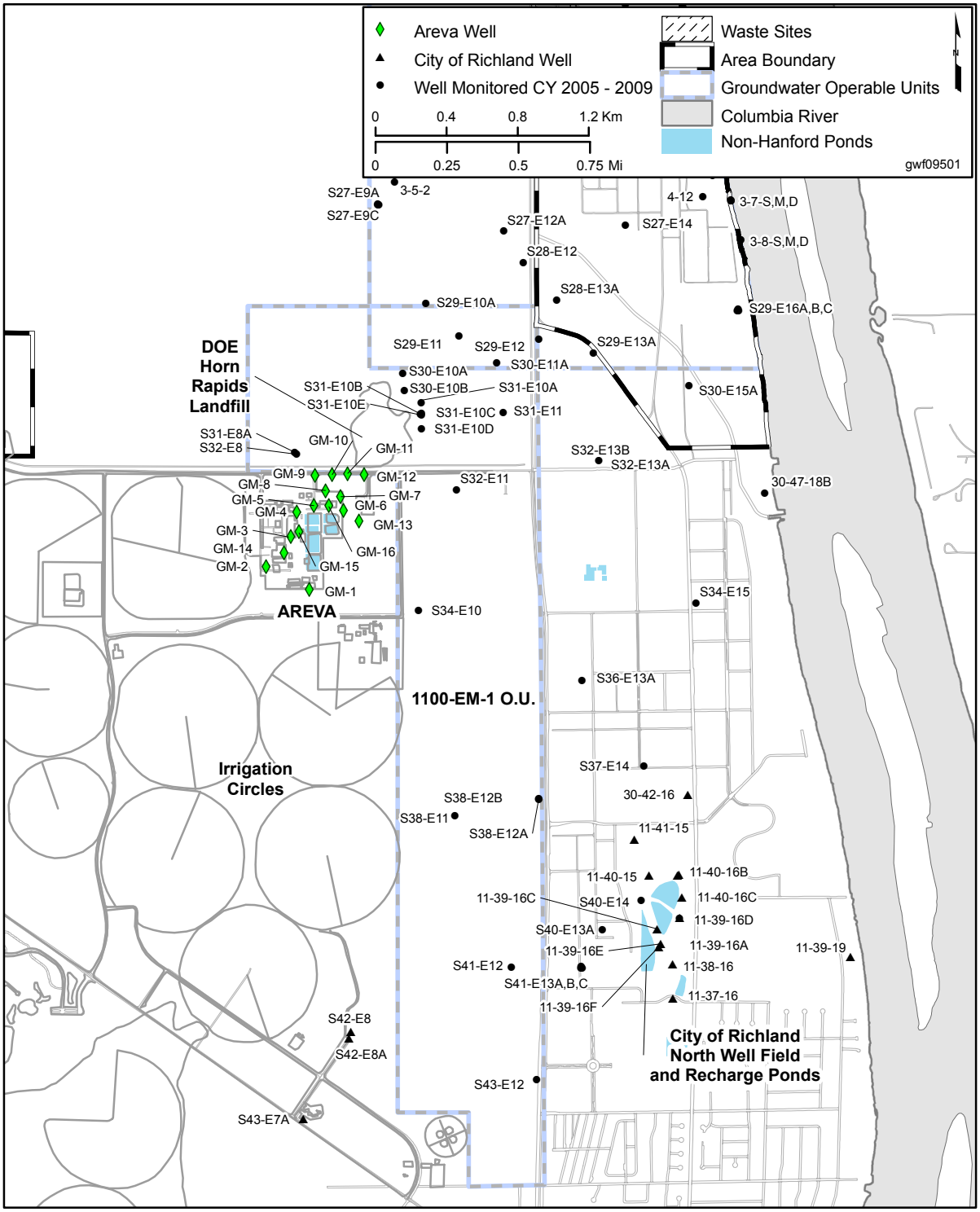


Figure 19-2. 1100-EM-1 Operable Unit and Adjacent 300 Area Water Table Map, March 2008.

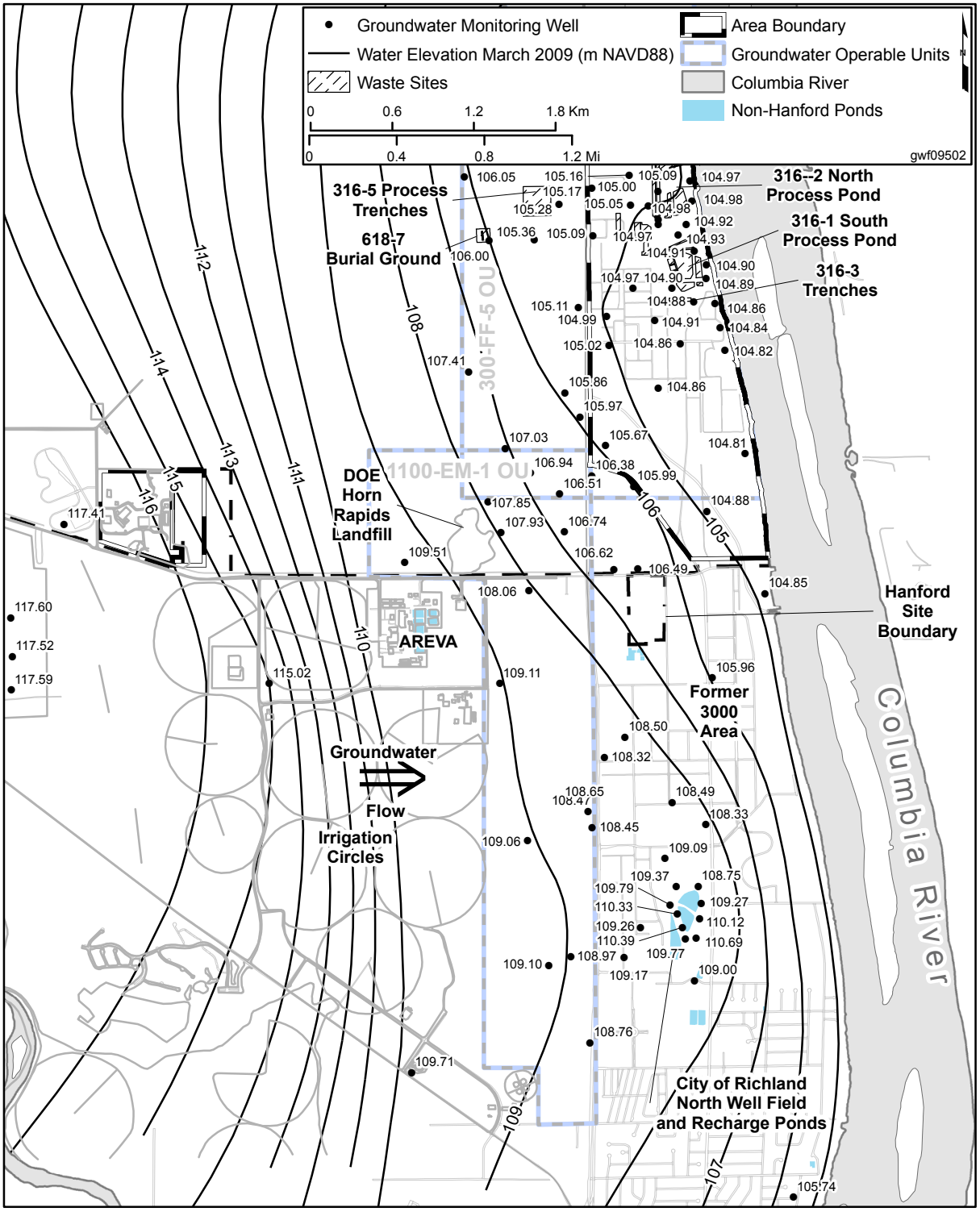


Figure 19-3. Trichloroethene Concentrations in 1100-EM-1 Operable Unit.

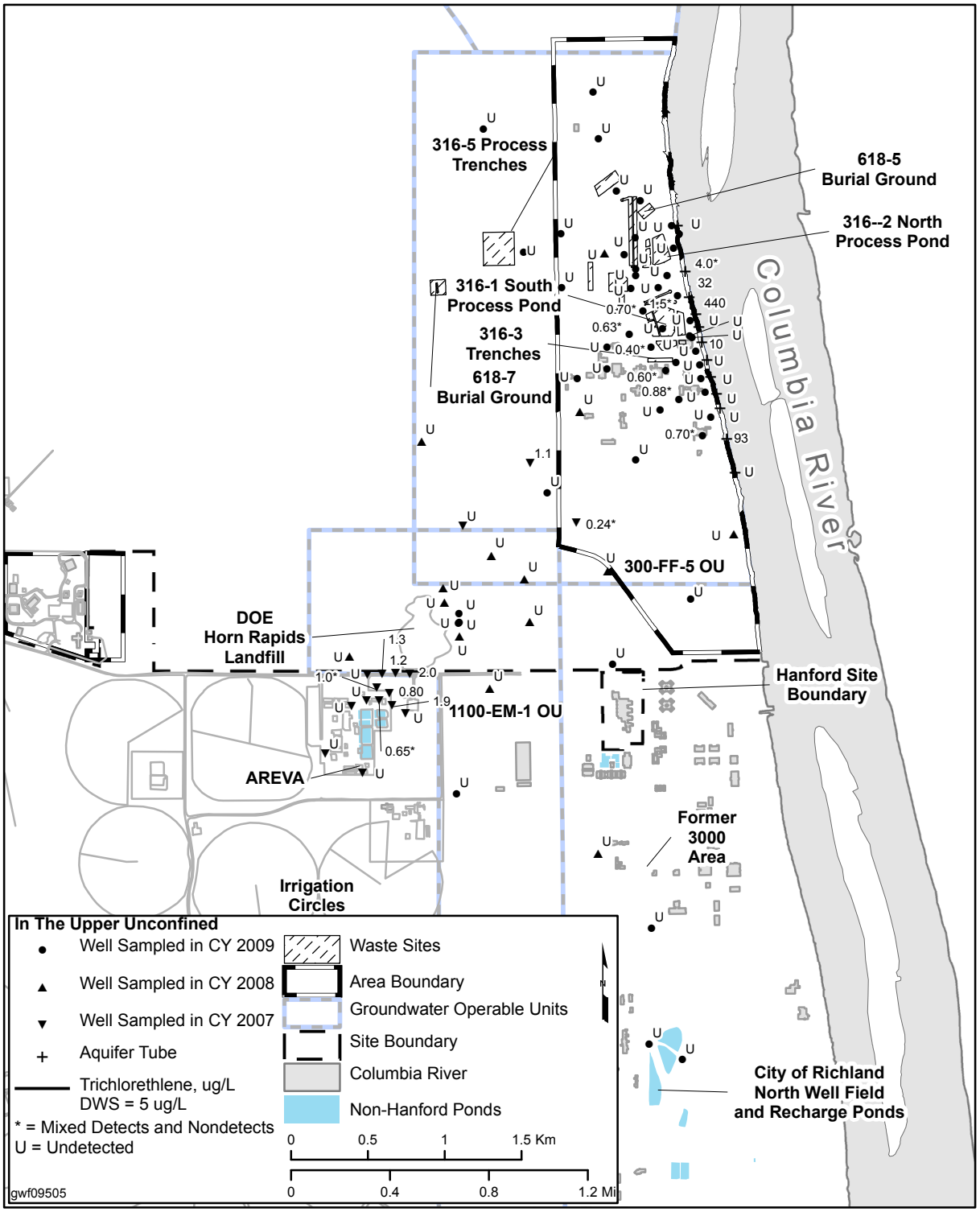


Figure 19-4. Average Nitrate Concentrations in the 1100-EM-1 Operable Unit and Adjacent 300 Area, Upper Portion of Unconfined Aquifer.

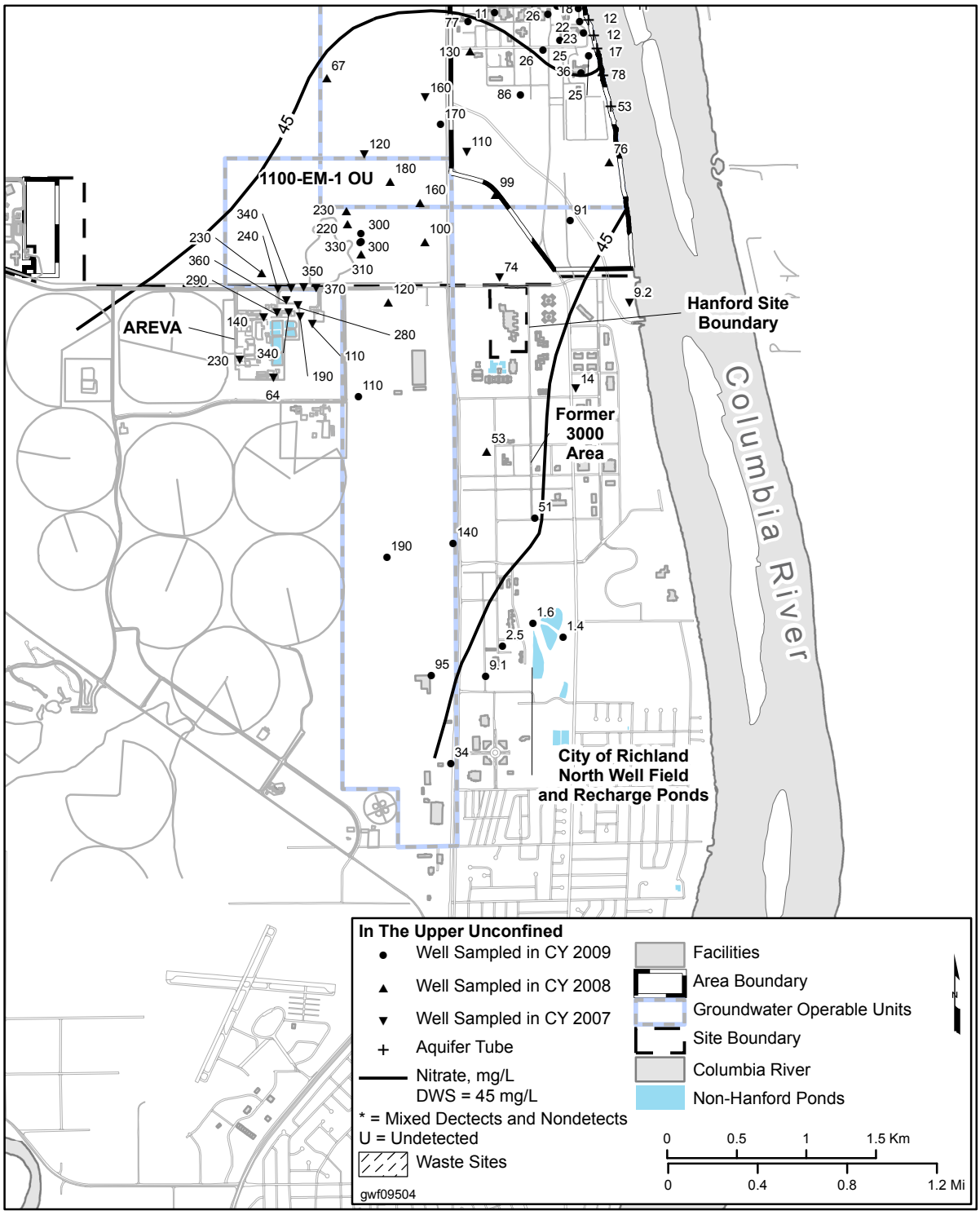
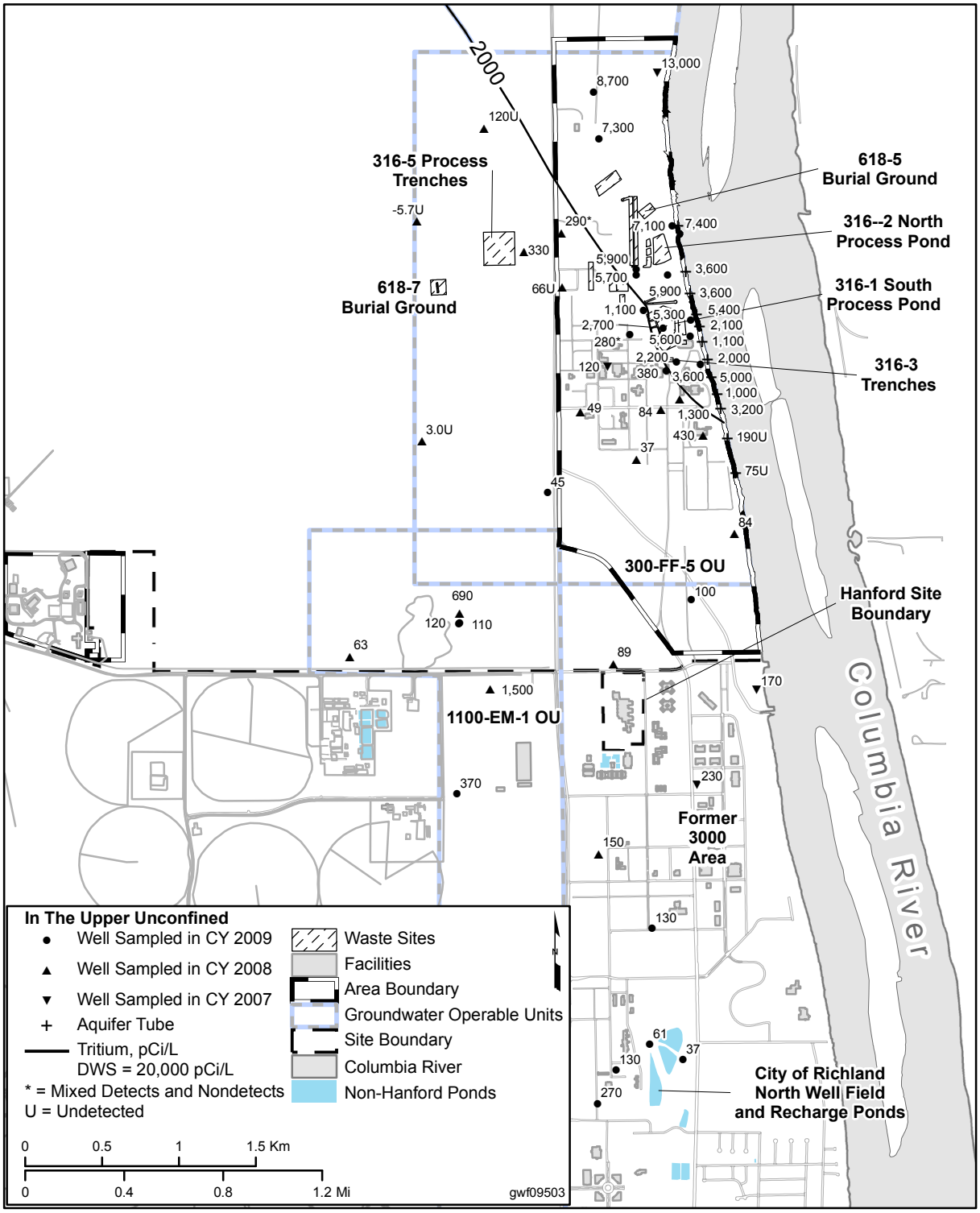


Figure 19-5. Average Tritium Concentrations in the 1100-EM-1 Operable Unit and Adjacent 300 Area, Upper Portion of Unconfined Aquifer.



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