

2.13 1100-EM-1 Operable Unit

S. P. Luttrell and W. D. Webber

The scope of this section is the 1100-EM-1 groundwater interest area, which includes the 1100-EM-1 Operable Unit, a large region in the south portion of the Hanford Site, and the offsite area south of the Hanford Site, including the areas formerly designated as the 1100 and 3000 Areas of the Hanford Site (see Figure 1.0-1 in Section 1.0). The groundwater interest areas are informal designations to aid planning, scheduling, and data interpretation. Figure 2.13-1 shows facilities, wells, and shoreline monitoring sites in this region. The focus of this section is the central and east portions of the 1100-EM-1 groundwater interest area near the south boundary of the Hanford Site. Trichloroethene and nitrate are the contaminants of greatest significance in groundwater. Groundwater is monitored for the 1100-EM-1 Operable Unit to assess the performance of natural attenuation of volatile organic compounds. Groundwater is also evaluated for trichloroethene breakdown products (vinyl chloride and 1,1-dichloroethene) and nitrate.

Figure 2.13-2 shows the March 2007 water-table elevations and corresponding groundwater flow directions for the east portion of the 1100-EM-1 groundwater interest area. Water-table elevation contours in the west portion of Figure 2.13-2, which are consistent with the site-wide water-table map in Figure 2.1-2, are constructed with water-level measurements in wells and by Yakima River stage west of the map area. Groundwater in the 1100-EM-1 groundwater interest area generally flows eastward from the Yakima River (see Figure 2.1-2 in Section 2.1) and discharges to the Columbia River. In the northeast part 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 part of the 1100-EM-1 groundwater interest 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, located near the North Richland Well Field before discharging to the Columbia River. Agricultural irrigation supplied primarily by the Columbia River, as well as precipitation, recharges the unconfined aquifer between the Yakima and Columbia Rivers.

Nitrate and trichloroethene are the contaminants of greatest significance in groundwater at the 1100-EM-1 Operable Unit.

Groundwater monitoring in the 1100-EM-1 groundwater interest area includes the following monitoring activities:

CERCLA Monitoring (Appendix A)

- ***Fifteen wells are monitored annually; one well was not sampled as scheduled in FY 2007.***
- ***In FY 2007, a change request was approved that reduces monitoring to annual sampling of three wells.***

AEA Monitoring

- ***Wells are sampled annually and semiannually.***

2.13.1 Groundwater Contaminants

This section describes the distribution of groundwater contaminants in the 1100-EM-1 groundwater interest area. Groundwater contaminants discussed are chlorinated hydrocarbons (primarily trichloroethene), tritium, nitrate, uranium, ammonia, gross alpha, gross beta, and technetium-99.

2.13.1.1 Chlorinated Hydrocarbons

Trichloroethene contamination occurs at levels below the 5 µg/L drinking water standard in the 1100-EM-1 groundwater interest area beneath the U.S. Department of Energy's (DOE's) inactive Horn Rapids Landfill and offsite in AREVA wells (Figure 2.13-3). The distribution of trichloroethene in the upper part of the unconfined aquifer shows that the plume has an elongated configuration that reflects the northeast flow direction toward the 300 Area. The thickness of the unconfined aquifer in this area is ~5.6 to 9 meters. 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 sample concentrations continued to be <5 µg/L in all AREVA wells during the first three quarters of fiscal year (FY) 2007 (E06-01-20064Q; E06-01-20071Q; E06-01-20072Q [AREVA 2007]). AREVA data for the fourth quarter of FY 2007 were not published by the time this report was published. The maximum trichloroethene concentration during these first two quarters was 2.9 µg/L immediately downgradient of the process lagoons. 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 also publishes an annual report on the Groundwater Quality Assessment Program for their facility (E06-02-2006).

Trichloroethene concentrations have decreased in all the plume areas near DOE's Horn Rapids Landfill. Trichloroethene concentrations decreased by an order of magnitude in this area since monitoring began in 1990 (Figure 2.13-4). In FY 2007, trichloroethene concentrations were all <5 µg/L, ranging from less than detection to 2.0 µg/L downgradient of the landfill. The decreased concentrations in the majority of wells downgradient of DOE's Horn Rapids Landfill suggest that natural attenuation (e.g., volatilization, passive pumping) has reduced the plume mass. For a discussion of trichloroethene in the 300 Area, see Section 2.12.1.2.

Potential breakdown products of trichloroethene, including vinyl chloride and 1,1-dichloroethene, continued to be undetected at their respective minimum detection limits during FY 2007.

The city of Richland monitors groundwater in the upper part of the unconfined aquifer quarterly for chemical constituents at their Horn Rapids Sanitary Landfill (formerly Richland Landfill), located approximately one kilometer south of the Hanford Site boundary (see Figure 2.1-1). Chlorinated hydrocarbons (e.g., tetrachloroethene, trichloroethene, and vinyl chloride) continue to exceed drinking water standards in several monitoring wells. During FY 2007, chlorinated hydrocarbons were below their respective minimum detection limits at onsite well 699-S31-1 (see Figure 2.1-1) just northeast of the city's sanitary landfill.

Trichloroethene concentrations continue to decrease in all plume areas near DOE's Horn Rapids Landfill.

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

** Nitrate — 4.54*

** Primarily from offsite sources.*

A confined aquifer found in the Ringold Formation is monitored for trichloroethene downgradient of the inactive DOE Horn Rapids Landfill. Two wells, one upgradient and one downgradient of the landfill, monitor this confined aquifer. This confined aquifer lies below a clay-silt aquitard, but above 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, which suggests that the trichloroethene plume in the unconfined aquifer did not migrate downward into the underlying confined aquifer.

2.13.1.2 Tritium

The 200 Area tritium plume extends south into the 300 Area, but values less than 300 pCi/L continue to be reported in the 1100-EM-1 groundwater interest area (Figure 2.13-5). Tritium 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 part of the unconfined aquifer was determined to be 63.9 pCi/L (DOE/RL-96-61). Tritium levels were above this background in several wells near the city of Richland's North Well Field during FY 2007. These levels are far below the drinking water standard (20,000 pCi/L). Trends in tritium concentrations in wells west and north of the city of Richland's North Well Field have fluctuated in the last few years, as shown in Figure 2.13-6.

Tritium is not migrating in groundwater from the Hanford Site 200 Areas tritium plume to the city of Richland well field. Factors that limit the migration of the tritium plume into the east portion of the 1100-EM-1 groundwater interest area are:

- 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 contributes to the eastward and northeastward flow.
- Groundwater flow is directed outward from the elevated groundwater levels at the city of Richland's North Well Field because of ponds used to recharge the well field.

These factors produce converging groundwater flow lines in the 300 Area and discharge to the Columbia River (Figure 2.13-2). Figure 2.13-5 shows a region of low tritium concentrations between the 200 Areas tritium plume and the elevated tritium concentrations near the North Richland Well Field and recharge ponds. Thus, no indication exists that the tritium plume is migrating southward to and affecting the city of Richland well field. Tritium in groundwater in the 300 Area is discussed in Section 2.12.

2.13.1.3 Nitrate

The nitrate distribution in the east portion of the 1100-EM-1 groundwater interest area is shown in Figure 2.13-7. Nitrate contamination in this area is likely the result of industrial and agricultural uses off the Hanford Site. Agricultural uses include application of fertilizers onto irrigation circles in the central portion of the 1100-EM-1 groundwater interest area (Figure 2.13-1).

Monitoring data show that the Richland North Well Field is not contaminated by the Hanford Site tritium plume through the groundwater flow system.

Nitrate contamination in groundwater is the result of industrial and agricultural uses off the Hanford Site.

Uranium contamination is present near DOE's inactive Horn Rapids Landfill, but the source is located offsite.

Nitrate concentrations above the drinking water standard (45 mg/L) are found over much of the east portion of the 1100-EM-1 groundwater interest area and continued to increase in a number of wells in FY 2007 (Figure 2.13-8). Some of the highest nitrate levels occur near an offsite facility (AREVA) and DOE's inactive Horn Rapids Landfill. The highest nitrate concentration in this area was 370 mg/L immediately downgradient of the AREVA facility. Nitrate data for the offsite AREVA wells are reported in E06-01-20064Q, E06-01-20071Q, and E06-01-20072Q.

Nitrate concentrations continued to be elevated in wells downgradient of DOE's inactive Horn Rapids Landfill in FY 2007. The highest nitrate concentration was 274 mg/L. An example of elevated nitrate concentrations immediately downgradient of the landfill are shown for well 699-S31-E10D (Figure 2.13-8). The distribution of nitrate and shape of the nitrate plume (as defined by the 250 mg/L contour) near the AREVA facility and DOE's inactive Horn Rapids Landfill indicates that nitrate in these areas continues to migrate in a northeast direction toward the 300 Area. Groundwater and aquifer tube sample data, shown in Figure 2.13-7, indicates that groundwater with nitrate levels above the drinking water standard has discharged to the Columbia River immediately south of the 300 Area. Nitrate concentration was 49.6 mg/L in the shallow tube at location AT-3-8 in January 2006 (not sampled in FY 2007); the mid-depth tube at this location had a nitrate concentration of 30.1 mg/L in FY 2007.

2.13.1.4 Gross Alpha and Uranium

Elevated levels of gross alpha and uranium occur downgradient of an offsite industrial facility (AREVA) near DOE's inactive Horn Rapids Landfill. Gross alpha data for the offsite AREVA wells are reported in E06-01-20064Q, E06-01-20071Q, and E06-01-20072Q. Several wells downgradient of the AREVA facility showed elevated gross alpha levels, with the highest value of 119 pCi/L during FY 2007 immediately downgradient of the AREVA facility. The gross alpha is likely largely attributed to uranium from industrial uses. If gross alpha is attributed to uranium, then 119 pCi/L gross alpha is equivalent to 172 µg/L uranium, which is above the drinking water standard (30 µg/L) for uranium.

The distribution of uranium near DOE's inactive Horn Rapids Landfill was shown in PNNL-16346. Uranium concentrations in a well downgradient of the Horn Rapids Landfill increased to a maximum of 23.0 µg/L then decreased slightly to 22.6 µg/L (Figure 2.13-9) in FY 2007.

2.13.1.5 Other Constituents

Ammonia – Ammonia was detected in several wells downgradient of the AREVA facility in FY 2007. Concentrations of ammonia in AREVA wells generally remained steady in FY 2007 (E06-01-20064Q, E06-01-20071Q, and E06-01-20072Q). The highest average concentration detected was 12.6 mg/L (as NH₃). Ammonia is typically converted to nitrate by nitrification processes.

Gross Beta – Gross beta continued to be detected in wells (E06-01-20064Q, E06-01-20071Q, and E06-01-20072Q) downgradient of AREVA during FY 2007. The highest average gross beta measurement in FY 2007 was 72.2 pCi/L. The elevated gross beta may be a result of technetium-99 in groundwater.

Technetium-99 – Low levels of technetium-99 are detected near DOE's inactive Horn Rapids Landfill. Results of FY 2007 technetium-99 analyses from well 699-S31-E10B were 36.3 pCi/L in November 2006 and 58.3 pCi/L in August 2007.

2.13.2 Operable Unit Activities

The 1100-EM-1 Operable Unit, which contains DOE's inactive Horn Rapids Landfill, was placed on the National Priorities List in 1989 and de-listed from the National Priorities List in 1996. Results of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) investigation for this operable unit are presented in the final remedial investigation study (DOE/RL-92-67) and the record of decision (ROD 1993). 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 analysis of trichloroethene, its breakdown products (e.g., vinyl chloride and 1,1-dichloroethene), and nitrate in wells downgradient of DOE's inactive Horn Rapids Landfill, as recommended in the sampling plan (PNNL-12220). A list of wells and constituents are provided in Appendix A. Fourteen of 15 wells were sampled in FY 2007 (Appendix A).

The second CERCLA five-year review was published in November 2006 (DOE/RL-2006-20) and stated, "The plume mass and concentration have been adequately reduced to be protective of human health and the environment. Groundwater monitoring for the 1100-EM-1 Operable Unit is no longer necessary but continues following an extended period of monitoring that shows contaminant levels are below the maximum contaminant level and continue to show a downward trend." Figure 2.13-10 provides the trend for trichloroethene in the compliance wells.

The review identified the following action, "Submit a change request to modify groundwater monitoring for the 1100-EM-1 Operable Unit." This action was completed with TPA Change Notice 163, approved in June 2007. Through this approval, groundwater monitoring has been reduced to annual monitoring of three of the original network of wells.

The remedial action objectives for the 1100-EM-1 Operable Unit (ROD 1993) are:

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

The CERCLA five-year review action to reduce monitoring requirements was completed and documented in a TPA Change Notice.

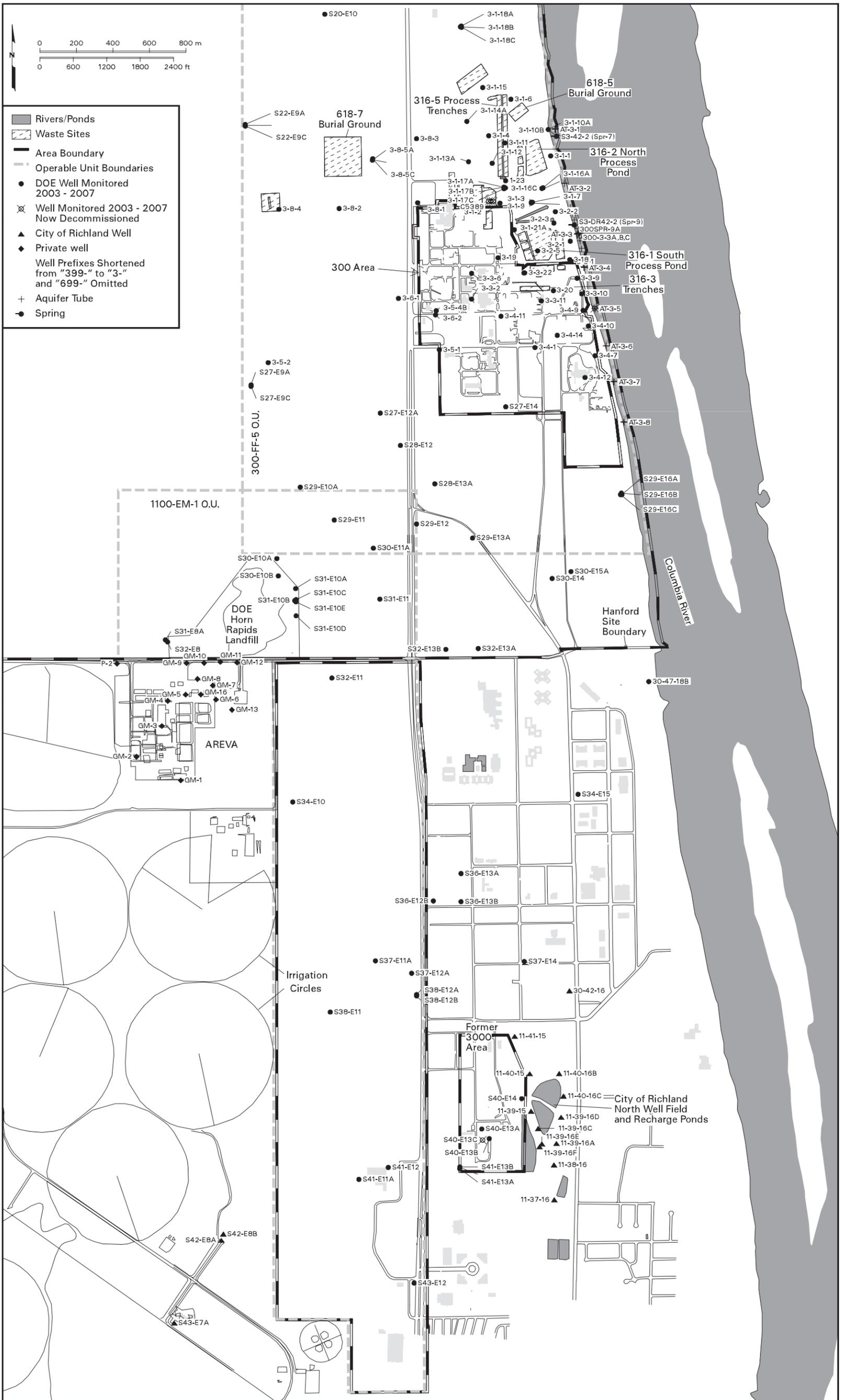


Figure 2.13-1. Groundwater Monitoring Wells and Facilities in 1100-EM-1 and 300 Areas

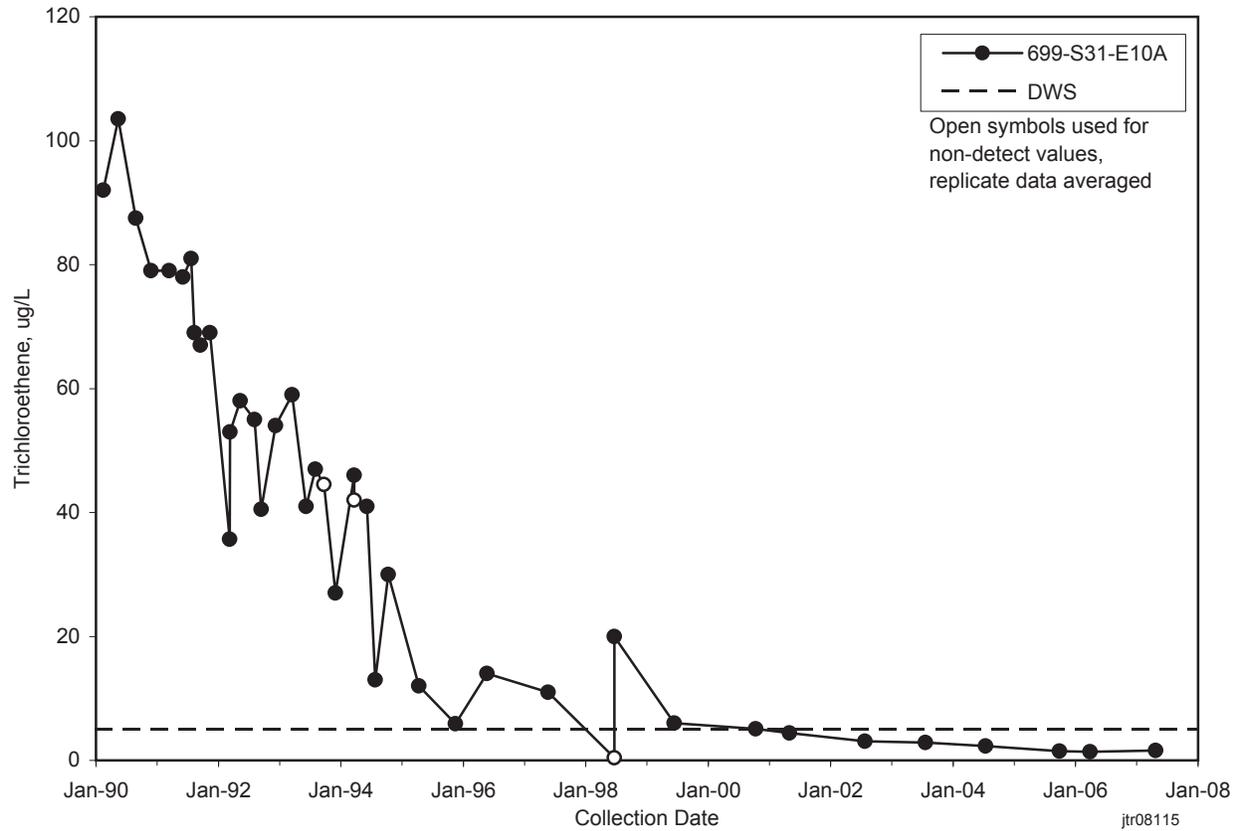


Figure 2.13-4. Trichloroethene Concentrations near the DOE Inactive Horn Rapids Landfill

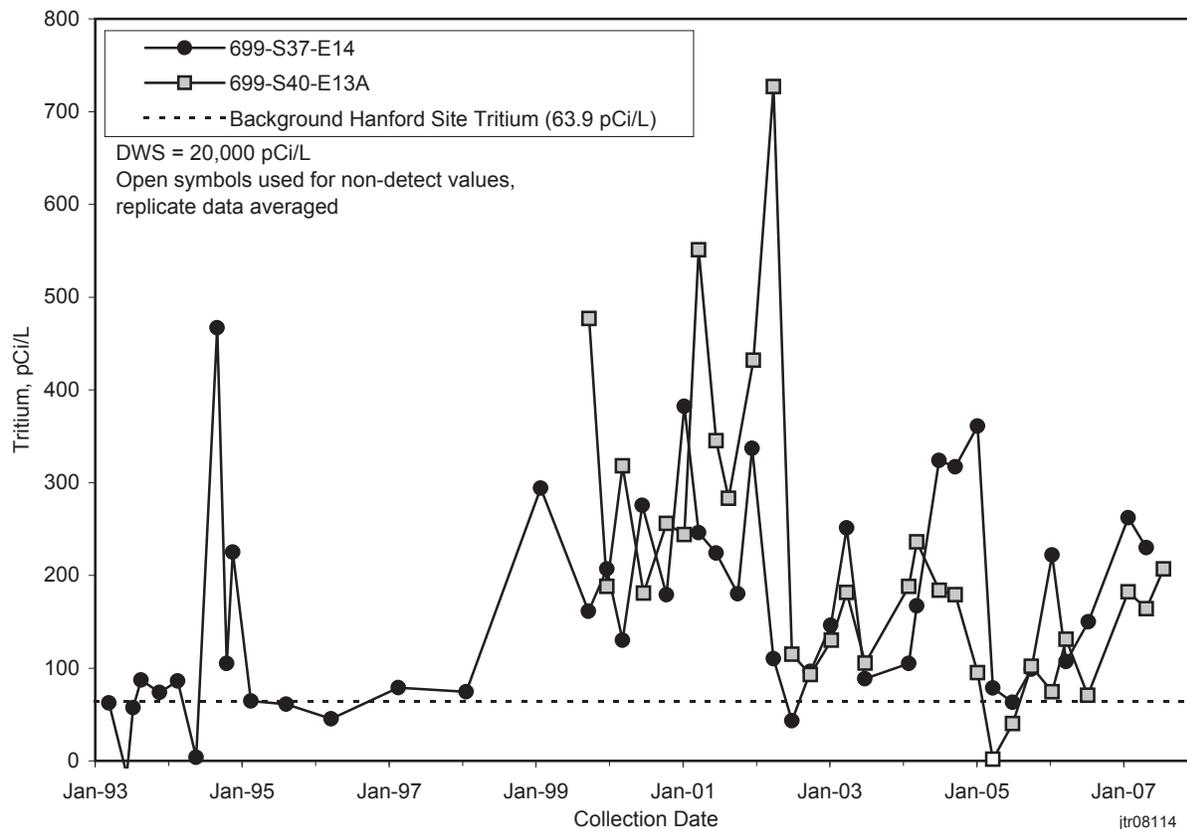
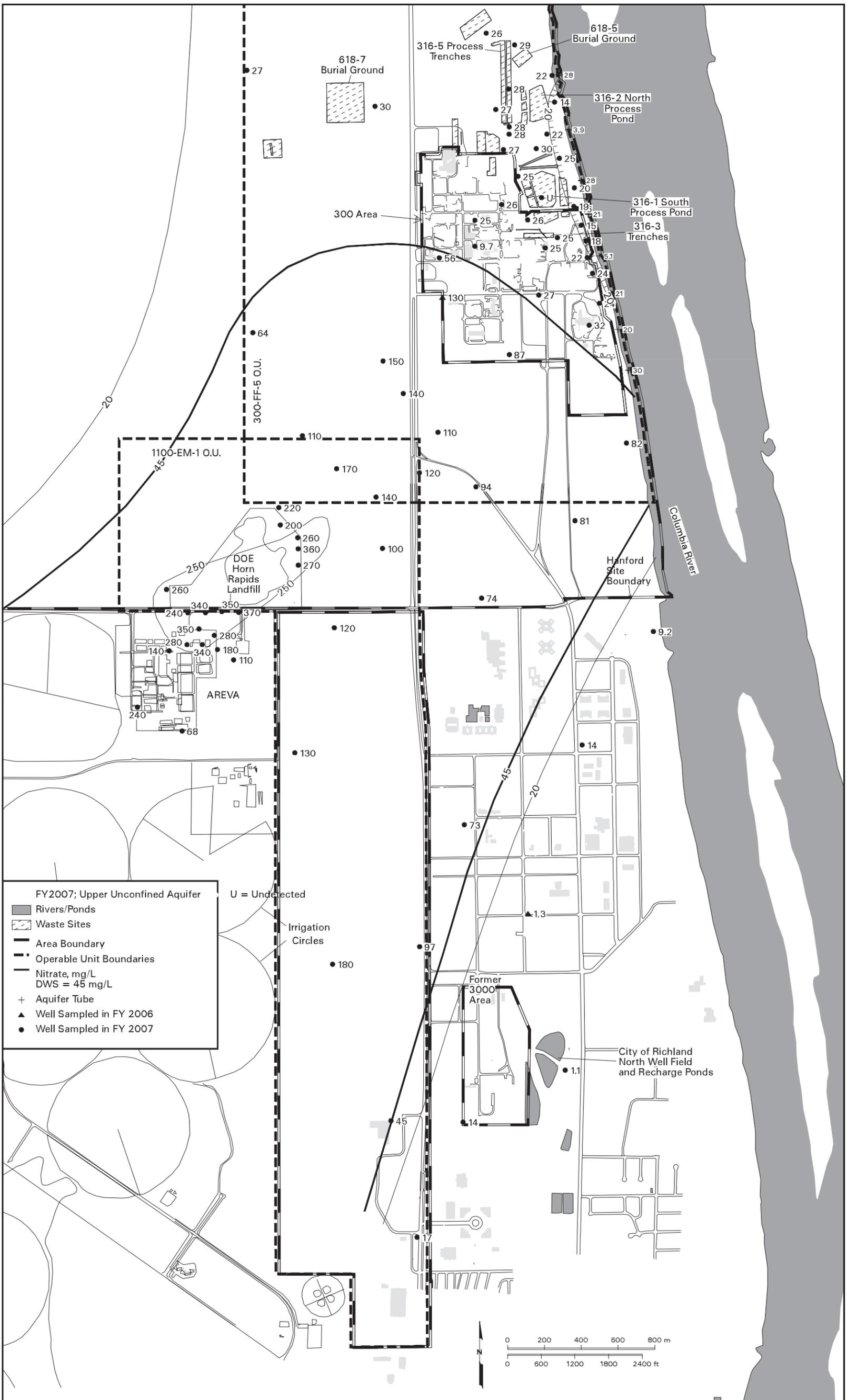


Figure 2.13-6. Tritium Concentrations in Selected Wells in 1100-EM-1 Groundwater Interest Area



can_gwf07_427 February 20, 2008 9:36 AM

Figure 2.13-7. Average Nitrate Concentrations in 1100-EM-1 Groundwater Interest Area, Upper Part of Unconfined Aquifer

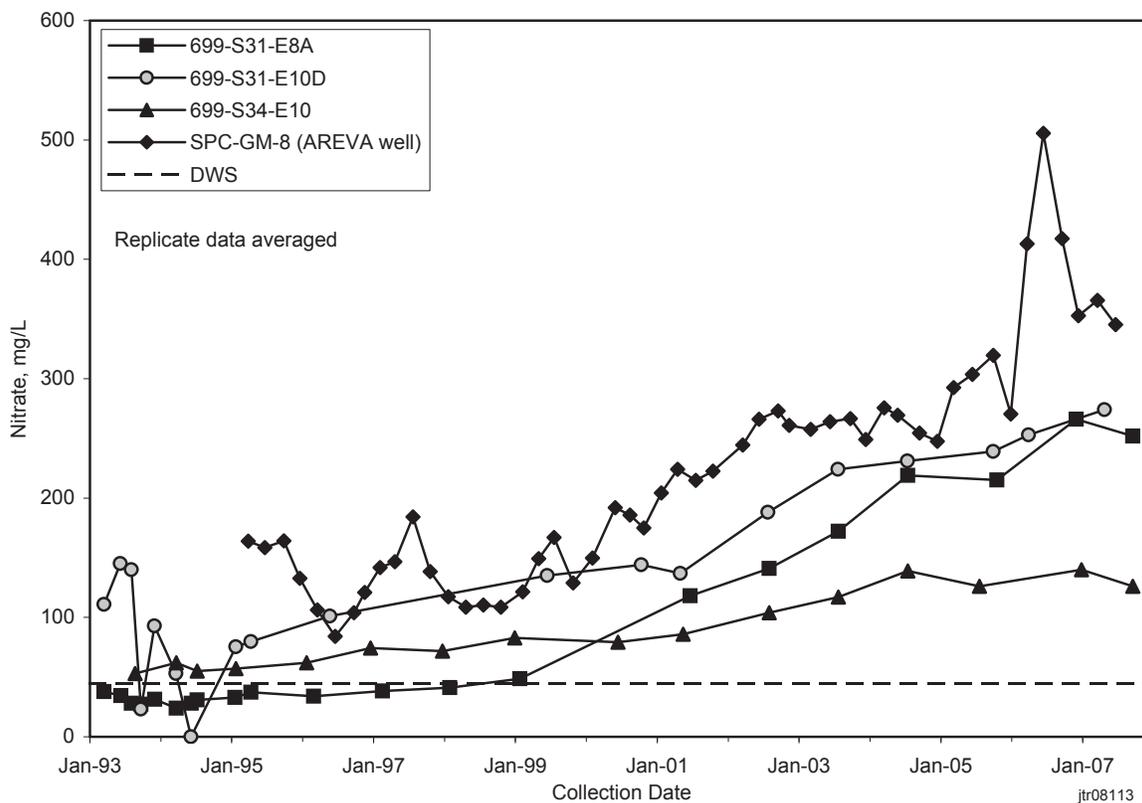


Figure 2.13-8. Nitrate Concentrations in Selected Wells in 1100-EM-1 Groundwater Interest Area

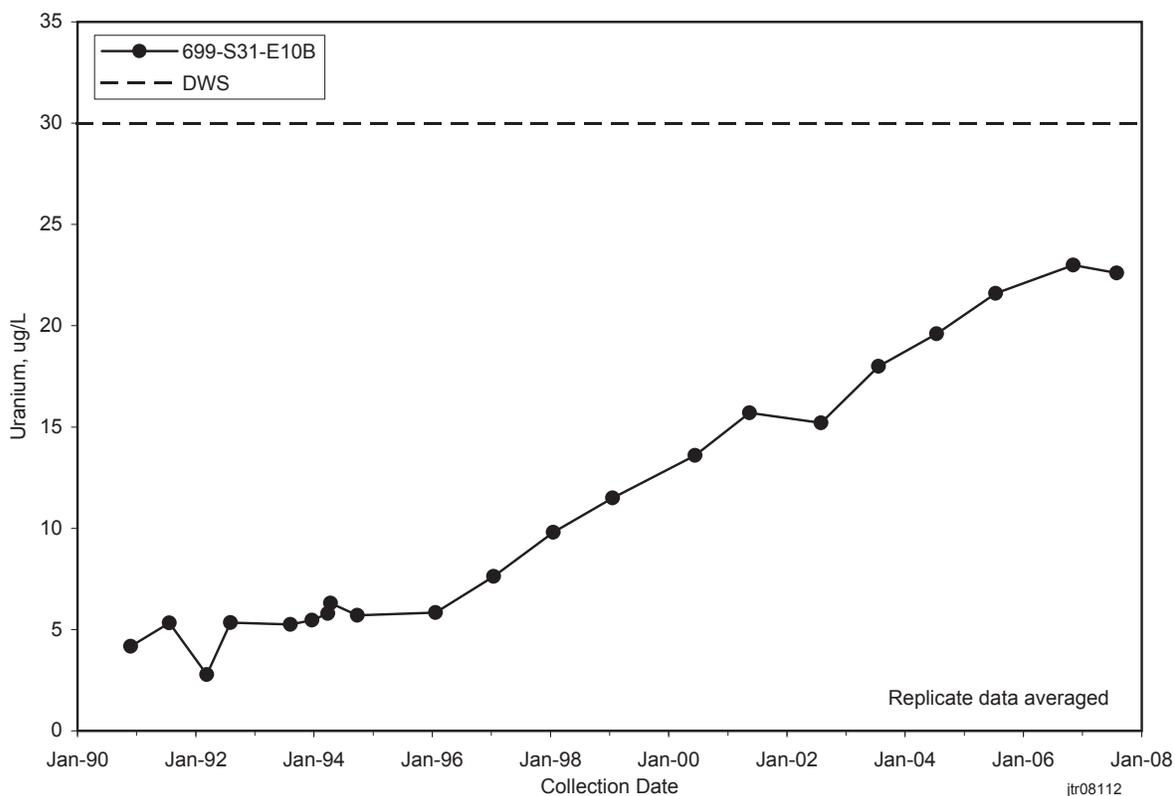


Figure 2.13-9. Uranium Concentrations near DOE Inactive Horn Rapids Landfill

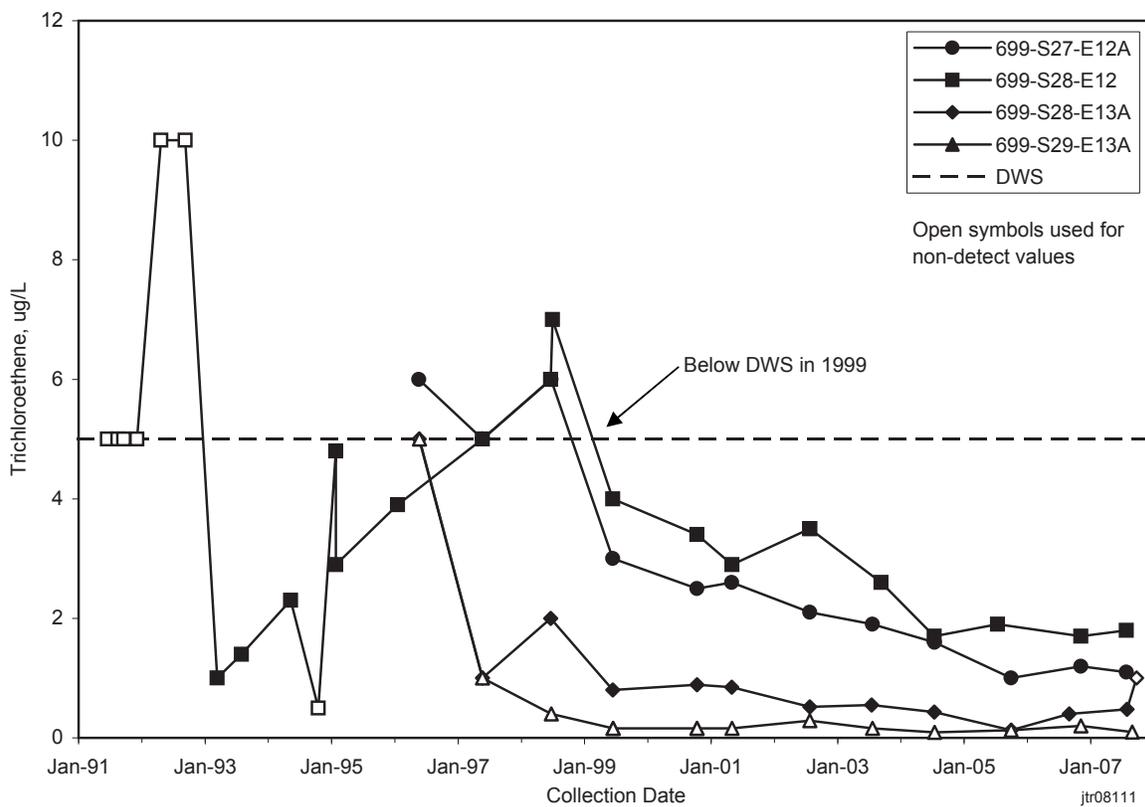


Figure 2.13-10. Trichloroethene Concentrations in 1100-EM-1 Operable Unit Compliance Wells