2.13 1100-EM-1 Operable Unit

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The scope of this section is the 1100-EM-1 groundwater interest area, which includes the 1100-EM-1 Operable Unit, a large portion of the south Hanford Site, and the offsite area to the south of the Hanford Site, including the former 1100 and 3000 Areas (Figure 2.1-1). Figure 2.12-1 shows facilities, wells, and shoreline monitoring sites in this region. The focus of this section will be the central and east portions of the 1100-EM-1 groundwater interest area near the Hanford Site south boundary. Trichloroethene is the contaminant of greatest significance in groundwater. Groundwater is monitored to assess the performance of natural attenuation of volatile organic compounds. In addition to the trichloroethene plume, contaminants of concern include breakdown products of trichloroethene (vinyl chloride and 1,1-dichloroethene) and nitrate.

Trichloroethene is the contaminant of greatest significance in groundwater at the 1100-EM-1 Operable Unit.

The 1100-EM-1 groundwater interest area is located in the south part of the Hanford Site and includes an area to the south of the Hanford Site (Figure 2.1-1). Well locations are shown in Figures 2.1-2 and 2.12-1).

Figure 2.12-3 shows the March 2003 water-table elevations and corresponding groundwater flow directions for the east portion of the 1100-EM-1 groundwater interest area. Groundwater in the 1100-EM-1 groundwater interest area generally flows eastward from the Yakima River (Figure 2.1-3) 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 entering 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 before discharging to the Columbia River. Additional information regarding groundwater flow in this area is provided in PNNL-14187.

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, fluoride, and chromium.

Groundwater in the 1100-EM-1 groundwater interest area includes CERCLA and AEA monitoring:

CERCLA Monitoring

- ***Fourteen compliance wells are sampled annually for trichloroethene, breakdown products, and nitrate.***
- ***One well is sampled annually for filtered chromium.***
- ***In fiscal year 2003, all 1100-EM-1 monitoring wells were sampled as scheduled (see Appendix A).***

AEA Monitoring

- ***Forty wells are sampled annually and semiannually for tritium, volatile organic compounds, nitrate, and general chemistry.***
- ***Five wells are sampled quarterly for tritium.***
- ***A few isolated wells are sampled annually for uranium, gross alpha, gross beta, technetium-99, and ammonia.***

2.13.1.1 Chlorinated Hydrocarbons

Trichloroethene contamination occurs 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 an industrial facility wells (Figure 2.12-11). The distribution of trichloroethene in the upper part of the unconfined aquifer shows that the plume has an elongated configuration. This configuration indicates a northeast flow direction around the city of Richland's North Well Field recharge ponds and toward the 300 Area.

Average trichloroethene concentrations continued to be <5 μg/L in all offsite facility wells during fiscal year 2003 (EMF-1865, Addenda 31 and 33). The maximum average trichloroethene concentration of quarterly samples was 4.7 μg/L immediately downgradient of the process lagoons. One quarterly sample that exceeded the drinking water standard showed a maximum trichloroethene concentration of 6.1 μg/L in March 2003. The past use of solvent to install and maintain process lagoon liners at the offsite industrial facility is the only potential source of trichloroethene identified in the east portion of the 1100-EM-1 groundwater interest area (DOE/RL-92-67).

Trichloroethene concentrations continued to decrease near DOE's Horn Rapids Landfill in fiscal year 2003.

Trichloroethene concentrations have decreased in essentially all the plume areas near DOE's Horn Rapids Landfill. Trichloroethene concentrations decreased by more than an order of magnitude in this area since monitoring began in 1990 (Figure 2.13-1). In fiscal year 2003, average trichloroethene concentrations were all <5 μg/L, ranging from less than detection to 3.1 μg/L downgradient of the landfill. The decreased concentrations in the majority of wells downgradient of DOE's Horn Rapids Landfill suggest that some elements of natural attenuation (e.g., volatilization, passive pumping) may have 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 show levels less than their respective minimum detection levels during fiscal year 2003.

The city of Richland monitors upper unconfined groundwater quarterly for chemical constituents at their Horn Rapids Sanitary Landfill (formerly Richland Landfill). The landfill is located in the central portion of the 1100-EM-1 groundwater interest area adjacent to the southern boundary of the Hanford Site (see Figure 2.1-2 for location). Chlorinated hydrocarbons were detected in city landfill monitoring wells between ~1 and 1.5 kilometers south of the Hanford Site boundary at levels above their respective drinking water standards during fiscal year 2003 (City of Richland 2003a, 2003b, 2003c, 2003d). The highest average concentrations, which decreased for all but trichloroethene during fiscal year 2003, were 30 μg/L 1,1-dichloroethene, 48 μg/L cis-1,2-dichloroethene, 60 μg/L tetrachloroethene, and 27 μg/L trichloroethene. During fiscal year 2003, these constituents were found to be below their respective minimum detection limits at an onsite well (699-S31-1) just northeast of the city's sanitary landfill.

2.13.1.2 Tritium

The 200 Area tritium plume extends southward toward the 1100-EM-1 groundwater interest area at levels below 2,000 pCi/L. Tritium continues to be closely monitored because of its potential impact to the city of Richland's North Well Field (Figure 2.13-2). South of the 300 Area, tritium levels were slightly elevated above background in wells near the city of Richland's North Well Field and in wells north of the well field during fiscal year 2003 (Figure 2.12-14). 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). The average tritium concentration from monthly Columbia River samples collected at the Richland Pumphouse was 72.1 pCi/L during fiscal year 2003. However, these levels are far below the drinking water standard (20,000 pCi/L). Trends in these tritium concentrations have consistently shown fluctuating levels in the last few years, as shown in Figure 2.13-2. Columbia River

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

****Nitrate — 3.94***

****Also includes portion of plume beneath 300-FF-5 Operable Unit.***

water, which shows slightly elevated tritium levels near the shoreline, is piped to the recharge pond system. Thus, a likely source of the elevated tritium levels is recharge of Columbia River water discharged to the ponds.

Tritium is not migrating in groundwater from the 200 Areas tritium plume to the well field. Several 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 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 flow.
- Groundwater flow is directed outward from the elevated groundwater levels at the city of Richland's North Well Field Recharge Ponds.

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

These factors produce converging flow lines in the 300 Area and discharge to the Columbia River (Figure 2.12-3). Figure 2.12-14 shows a region of low tritium concentrations between the 200 Areas tritium plume and the slightly elevated tritium concentrations near the North Richland Well Field and Recharge Ponds. Thus, there is no indication that the tritium plume is migrating southward and affecting the well field. Tritium in the 300 Area is discussed in Section 2.12.

2.13.1.3 Nitrate

The nitrate distribution in the east portion of 1100-EM-1 groundwater interest area is shown in Figure 2.12-13. 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 2.12-1).

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 fiscal year 2003 (Figure 2.13-3). Some of the highest nitrate levels occur near an offsite industrial facility and DOE's inactive Horn Rapids Landfill. Elevated nitrate near these areas is likely the result of agricultural activities to the west and southwest. An example of elevated nitrate concentrations showing an increasing trend continues to occur along the west edge of DOE's Horn Rapids Landfill immediately north of the industrial facility (well 699-S31-E8A in Figure 2.13-3). The highest nitrate concentration in this area was 261 mg/L immediately downgradient of the offsite facility. Nitrate data for the offsite wells are reported in EMF-1865, Addenda 31 and 33. Nitrate concentrations continued to be elevated in wells downgradient of DOE's inactive Horn Rapids Landfill in fiscal year 2003. The highest average nitrate concentration in this area was 224 mg/L. The shape of the plume (as defined by the 100-mg/L contour) near the offsite industrial 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. Figure 2.12-13 indicates that groundwater with nitrate levels above the drinking water standard discharges to the Columbia River immediately south of the 300 Area.

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

The nitrate plume map indicates that the eastward migration of nitrate is being diverted around the groundwater mound that is in the vicinity of the recharge ponds (Figure 2.12-3). Nitrate levels in wells at the well field continued to be lower than ambient groundwater, a result of recharge from infiltration of river water at the recharge ponds.

2.13.1.4 Gross Alpha and Uranium

Elevated levels of gross alpha and uranium occur downgradient of an offsite industrial facility near DOE's inactive Horn Rapids Landfill. The highest gross alpha level was an average of 77 pCi/L immediately downgradient of this facility during fiscal year 2003

(EMF-1865, Addenda 31 and 33). Most of the wells downgradient of the offsite facility showed average gross alpha levels that were above the drinking water standard (15 pCi/L), which excludes uranium. However, it is probable that the gross alpha levels are largely attributed to uranium because of industrial uses offsite. If gross alpha is attributed to uranium with natural isotopic abundances, then 77 pCi/L gross alpha is equivalent to ~112 μg/L uranium, which is above the drinking water standard (30 μg/L) for uranium. The offsite facility is not required to analyze samples collected from their wells for uranium.

The distribution of uranium near DOE's inactive Horn Rapids Landfill is shown in Figure 2.12-5. The map shows a small plume of uranium with levels less than the drinking water standard (30 μg/L) near the landfill. Uranium concentrations in wells downgradient of the landfill increased slightly between fiscal year 2002 and fiscal year 2003. Uranium concentrations ranged up to 18 μg/L, with the highest concentration immediately downgradient of DOE's Horn Rapids Landfill (Figure 2.13-4). At this time, the landfill is not considered a source of the uranium contamination in groundwater because no known uranium sources exist in the landfill. The shape of the uranium contours suggests a uranium source off the Hanford Site.

2.13.1.5 Other Constituents

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

Ammonia, fluoride, and gross beta are found at low levels in wells near an offsite industrial facility. Chromium continued to be monitored in one well downgradient of the 1171 Building in the former 1100 Area.

Ammonia – Concentrations of ammonia in the offsite facility wells generally remained steady in fiscal year 2003 (EMF-1865, Addenda 31 and 33). The highest average concentration detected was 13.6 mg/L (as NH_3) in well SPC-GM-10. Ammonia is typically absorbed by plants and soil microorganisms or is taken up as an exchangeable ion on soil particles (Hausenbuiller 1972). However, ammonia is usually less stable than nitrate in a biological system like the soil medium and is rapidly converted to nitrate. Ammonia was detected in seven wells downgradient of the offsite facility in fiscal year 2003. The fact that ammonia is found in the groundwater suggests that relatively high concentrations reached the soil column.

Fluoride – One well downgradient of the offsite industrial facility showed fluoride concentrations above the drinking water standard (4 mg/L) in fiscal year 2003 (EMF-1865, Addenda 31 and 33). The highest average concentration was 4.3 mg/L in well SPC-GM-4. Fluoride contamination is most likely the result of past processing at the offsite facility. Average fluoride concentrations in onsite wells for this area continued to be <1 mg/L.

Gross Beta – Gross beta continued to be detected in wells downgradient of the offsite facility during fiscal year 2003 (EMF-1865, Addenda 31 and 33). The highest average gross beta measurement in fiscal year 2003 was 34.7 pCi/L in well SPC-GM-8. Low levels of technetium-99, detected near DOE's inactive Horn Rapids Landfill, may be related to the gross beta measurements.

Chromium – Filtered chromium, which had been detected above the drinking water standard in the past, was not detected during fiscal year 2003 in one well downgradient of the 1171 Building.

2.13.2 CERCLA Groundwater Monitoring

The selected remedy for 1100-EM-1 Operable Unit groundwater is monitored natural attenuation of volatile organic compounds, with institutional controls on drilling of new water supply wells (ROD 1993). The U.S. Environmental Protection Agency

conducted a 5-year review in 2001, and no groundwater monitoring changes were required at the DOE's Horn Rapids Landfill (EPA 2001).

The monitoring objective was to continue groundwater monitoring of wells downgradient of the DOE's Horn Rapids Landfill during a period of 5 years (DOE/RL-95-50; PNNL-12220). The monitoring was to include annual sampling for trichloroethene, its breakdown products (vinyl chloride, 1,1-dichloroethene), and nitrate (Sections 2.13.1.1 and 2.13.1.3). A secondary objective was to sample chromium in one well downgradient of the 1171 Building. Additional information is provided in Appendix A.

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.***

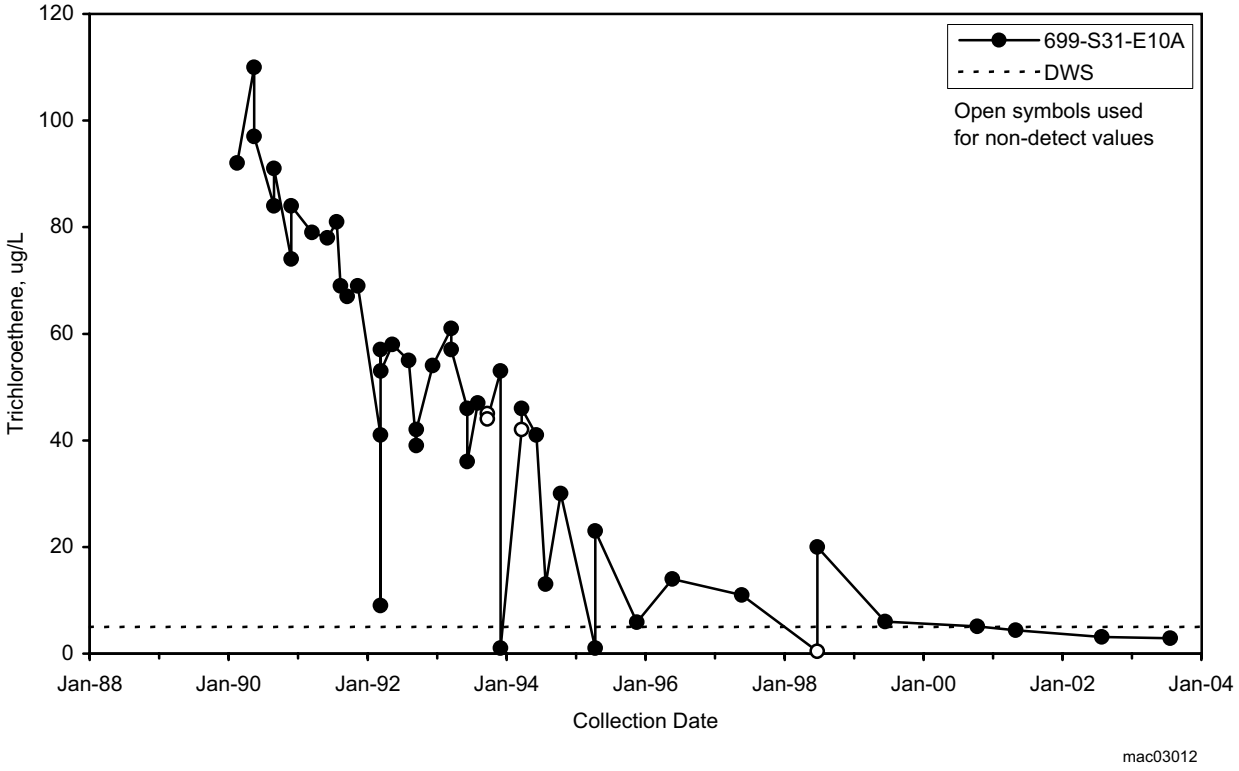

Figure 2.13-1. Trichloroethene Concentrations Near the U.S. Department of Energy's Inactive Horn Rapids Landfill

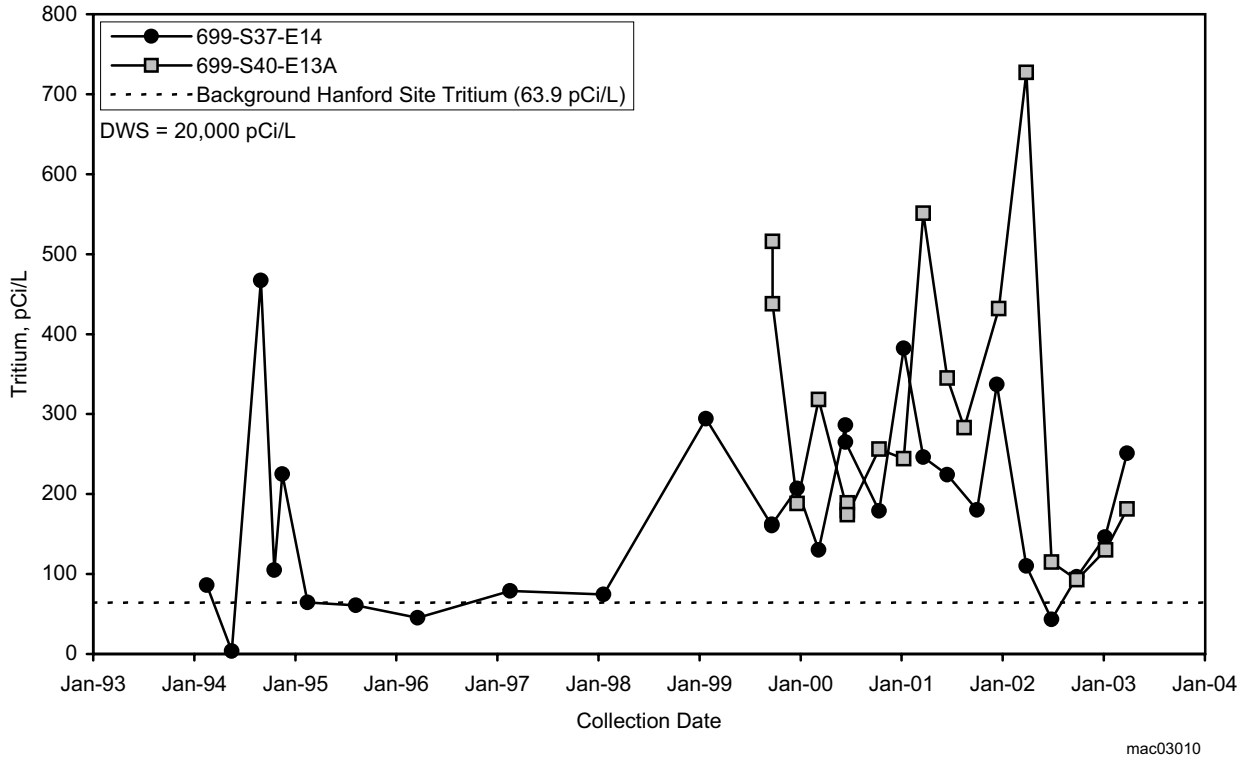

Figure 2.13-2. Tritium Concentrations in Wells Monitoring the 1100-EM-1 Groundwater Interest Area

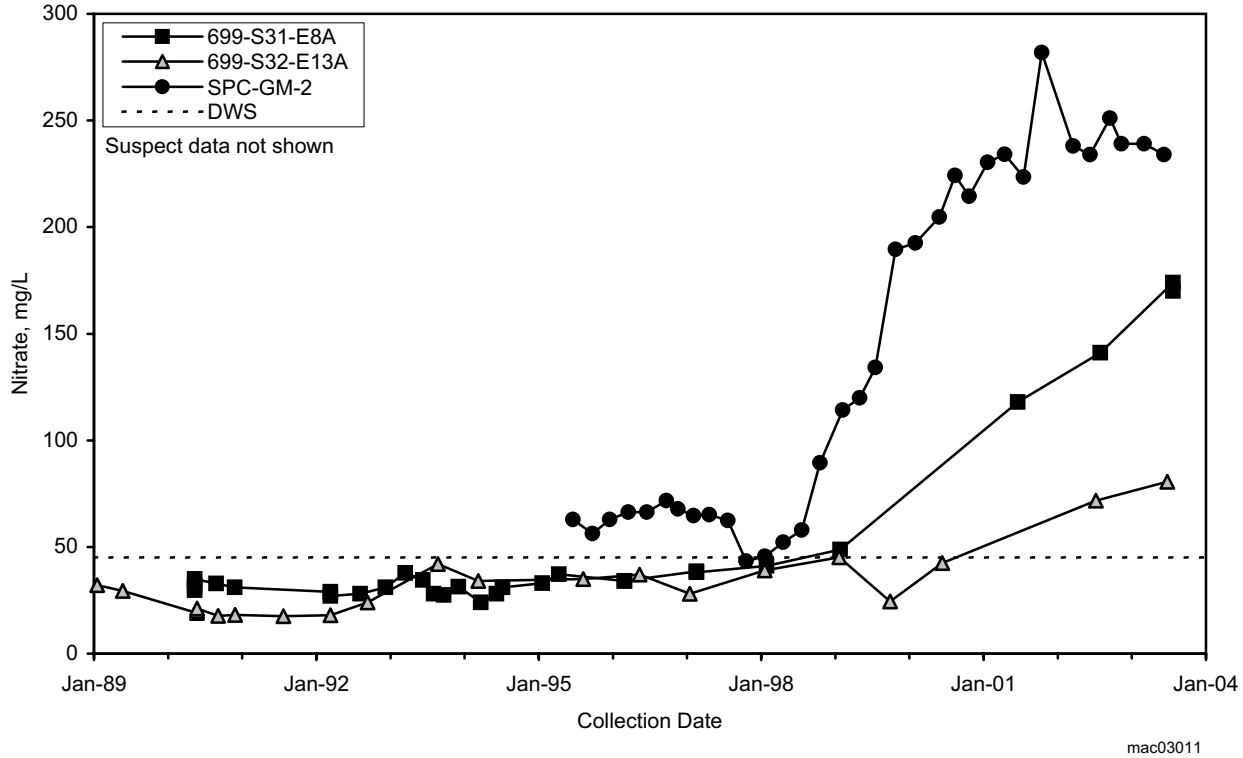

Figure 2.13-3. Nitrate Concentrations in Wells Monitoring the 1100-EM-1 Groundwater Interest Area (data for well SPC-GM2 taken from EMF-1865)

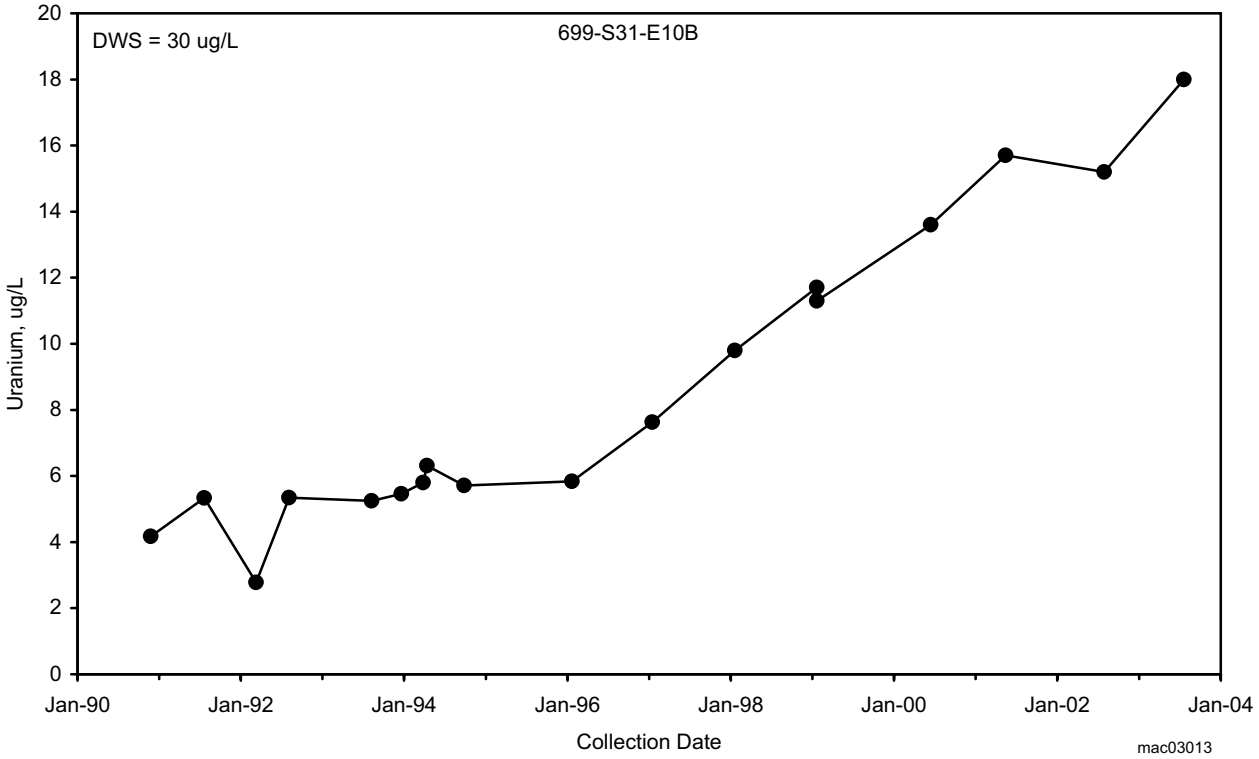

Figure 2.13-4. Uranium Concentrations Near the U.S. Department of Energy's Inactive Horn Rapids Landfill