

## 2.4 100-NR-2 Operable Unit

### **M. J. Hartman**

The scope of this section is the 100-NR-2 groundwater interest area, which includes the 100-NR-2 Groundwater 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 2.4-1 shows facilities and wells in this region and Figure 2.4-2 shows shoreline monitoring sites and wells in an area of particular interest for monitoring. Strontium-90 is the contaminant of greatest significance in groundwater, and is the subject of a *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) interim action (ROD 1999b). From 1995 until 2006, DOE operated a pump-and-treat system with a goal of reducing the amount of strontium-90 entering the Columbia River. In 2006 and 2007, DOE began to implement an in-aquifer method of remediation (Section 2.4.2). DOE also monitors groundwater at four *Resource Conservation and Recovery Act* (RCRA) units, and to track other contaminant plumes for the *Atomic Energy Act* (AEA).

Groundwater flows primarily to the north and northwest, toward the Columbia River (Figure 2.4-3). The water table is influenced by river stage, and until March 2006, was influenced by groundwater extraction near the 116-N-1 facility and injection near the 116-N-3 facility. As the effects of extraction and injection dissipated, the gradient evened out. In 2007, the 119-meter contour moved farther south and the 118-meter contour moved closer to the river.

The remainder of this section describes contaminant plumes and concentration trends for the contaminants of concern under AEA, CERCLA, or RCRA monitoring.

***Strontium-90 is the most significant groundwater contaminant beneath the 100-NR-2 Operable Unit. The general shape of the plume has not changed in many years.***

***Groundwater monitoring in the 100-NR-2 groundwater interest area includes the following monitoring activities:***

#### ***CERCLA and AEA Monitoring (Appendix A)***

- ***Twenty-six wells are sampled monthly to annually; several monthly samples could not be collected.***
- ***Twenty wells, twenty-three aquifer tubes, and three seep wells are sampled monthly to annually under a rebound/shoreline groundwater monitoring plan; some monthly samples and quarterly samples were not collected.***

#### ***Facility Monitoring (Appendix B)***

- ***Five wells are sampled semiannually for the 116-N-1 liquid waste disposal facility for requirements of RCRA and AEA.***
- ***Five wells are sampled semiannually for the 120-N-1 percolation pond and 120-N-2 surface impoundment for requirements of RCRA and AEA; one well was sampled only once because of low water levels.***
- ***Five wells are sampled semiannually for the 116-N-3 liquid waste disposal facility for requirements of RCRA.***

## 2.4.1 Groundwater Contaminants

This section describes distributions and trends for groundwater contaminants in the 100-NR-2 Operable Unit (ROD 1999b): strontium-90, tritium, nitrate, sulfate, petroleum hydrocarbons, manganese, iron, and chromium.

### 2.4.1.1 Strontium-90

Strontium-90 was present in the liquid effluent discharged to the 116-N-1 facility (1963 to 1985) and the 116-N-3 facility (1983 to 1991). Both facilities were excavated to remove highly-contaminated soil, and backfilled with clean soil. The vadose zone and aquifer beneath the facilities remain contaminated with strontium-90, which binds to sediment grains and is moderately mobile in groundwater.

A record of decision stipulates interim remedial action for strontium-90 in the 100-N Area (ROD 1999b). From 1995 to March 2006, a pump-and-treat system operated between the 116-N-1 facility and the Columbia River to reduce the amount of contamination entering the river. Because strontium-90 binds to sediment, the pump-and-treat system was not effective in cleaning up the aquifer. DOE began to implement an in situ remedial action, apatite sequestration, in 2006 and 2007 (Section 2.4.2.3). The cessation of groundwater extraction and the apatite injections have affected strontium-90 concentrations in some areas, as discussed below.

The size and shape of the strontium-90 plume change very little from year to year. The plume extends from beneath the 116-N-1 and 116-N-3 facilities to the Columbia River at levels above the drinking water standard (8 pCi/L) (Figure 2.4-4). Concentrations >100 pCi/L are limited to the top ~3 meters of the aquifer (PNNL-16346).

Aquifer tubes on the 100-N Area shore have allowed a detailed depiction of the strontium-90 plume where it discharges to the Columbia River. Figure 2.4-5 shows strontium-90 concentrations in this region in August/September 2007. Maximum concentrations (>1,000 pCi/L) consistently are detected in tubes at the previously identified center of the plume.

***Plume areas (square kilometers)  
at the 100-NR-2 Operable Unit:***

***Nitrate, 45 mg/L — 0.46***

***Strontium-90, 8 pCi/L — 0.58***

***Tritium, 20,000 pCi/L — 0.09***

Strontium-90 trends in monitoring wells near the former waste sites show no obvious, long-term decline in concentrations, but significant variability related to water levels (Figure 2.4-6). When the water table rises beneath the former waste facilities, strontium-90 from the vadose zone is mobilized and concentrations in groundwater increase. Water levels and strontium-90 concentrations in wells near the 116-N-1 facility were high in the late 1980s, when liquid effluent was being discharged elsewhere in the 100-N Area, and declined after effluent discharges ceased in 1991. Concentrations rose again in the mid 1990s, which correlated with several years of relatively high river stage. Concentration peaks in 2006 and 2007 were correlated with periods of high water table.

Strontium-90 concentrations rebounded in three of the four former extraction wells after pump-and-treat operations ceased in March 2006 (Figure 2.4-7). The rebound was most evident in wells 199-N-75 and 199-N-103A, where concentrations increased from several hundred pCi/L in 2005 and 2006 to over 1,000 pCi/L after pumping ceased. Strontium-90 levels in 2006 and 2007 were also higher in well 199-N-105A than the previous few years, but the change was less distinct. Strontium-90 levels in well 199-N-106A, which has the highest concentrations of the four former extraction wells, continued a generally declining trend in 2006 and 2007.

Along the Columbia River shore, strontium-90 and gross beta<sup>(a)</sup> concentrations increased to new maxima in several aquifer tubes in August 2007. These tubes are all located in the core of the plume between Array-4A and Array-6A. Tube NVP2-116.0 detected the highest strontium-90 concentration: 15,000 pCi/L (Figure 2.4-8). As discussed in Section 2.4.2.3, the new remedial action (i.e., apatite injections) may temporarily increase strontium-90 concentrations. Concentrations also increased in monitoring wells downgradient of the apatite barrier, but changes were not as dramatic as in the aquifer tubes, and levels were much lower. The reason for this disparity may be the difference in the screened depths. The aquifer tubes showing strontium-90 peaks in August are screened between 115.4 and 116.7 meters elevation in the Ringold Formation (Figure 2.4-9). Aquifer tubes completed at shallower depths had lower concentrations. The screened intervals of the monitoring wells are larger, from ~115 to ~120 meters (i.e., above the water table).

#### 2.4.1.2 Tritium

The tritium plume has diminished since 1991 when effluent discharge to the 116-N-3 facility ceased. In FY 2007, only two wells had concentrations exceeding the drinking water standard (20,000 pCi/L). The maximum concentration was 23,000 pCi/L in well 199-N-32, near the 116-N-3 facility.

Unlike strontium-90, tritium is present through the entire thickness of the unconfined aquifer. Concentrations in wells 199-N-69 and 199-N-70, completed at the base of the unconfined aquifer, are about the same as in nearby shallow wells. Tritium concentration in well 199-N-80, which monitors a confined aquifer in the Ringold Formation was 18,000 pCi/L in FY 2007, about the same as the previous year.

The shoreline aquifer tubes had very low or undetectable concentrations of tritium.

#### 2.4.1.3 Nitrate

Nitrate concentrations exceed the drinking water standard (45 mg/L) beneath a portion of the 100-N Area (see Figure 2.4-14 in PNNL-16346 for FY 2006 map). The highest nitrate concentrations in FY 2007 were again in well 199-N-67 near the 116-N-1 facility, with a maximum concentration of 294 mg/L. Concentrations in other wells within the plume were much lower (<80 mg/L).

Figure 2.4-10 shows nitrate trend plots for two wells near the 116-N-1 facility for their entire period of record. The 116-N-1 facility was in use through 1985. Figure 2.4-11 shows the nitrate trend in a well near the 116-N-3 facility, which was in use from 1983 to 1991. At both sites, nitrate concentrations were high in the mid-1980s, declined sharply by 1990, and then began to increase again. Levels peaked in FY 2006 and remained high in FY 2007. The reason for the increase is not known.

Near the 120-N-1 percolation pond in south 100-N Area, nitrate concentrations also increased in the 1990s (Figure 2.4-12). During the pond's period of use (1977 to 1990), only low levels of nitrate (~1 mg/L) were detected in effluent to the facility (see Appendix B of DOE/RL-96-39). Monitoring began in 1987 and nitrate concentrations

***Injection of apatite-forming chemical in shoreline wells caused variations in strontium-90 concentrations. One aquifer tube had a concentration up to 15,000 pCi/L.***

***Nitrate concentrations continued to exceed the drinking water standard in FY 2007.***

(a) Gross beta values are equal to twice the strontium-90 concentration (PNNL-16894).

in groundwater were also low (1 to 4 mg/L). Nitrate levels exceeded the drinking water standard in well 199-N-59 since 1998. Nitrate levels have been increasing in nearby well 199-N-72, exceeding the standard since 2005.

Anomalously low nitrate concentrations (undetected) continued to be observed in well 199-N-18. The low concentrations are believed to be caused by chemical reduction of the nitrate caused by biodegradation of hydrocarbons (Section 2.4.1.5). Other chemical constituents and parameters also support the interpretation of chemical reduction around well 199-N-18: low dissolved oxygen, low pH, detectable nitrite, and high concentrations of metals (especially iron and manganese).

#### 2.4.1.4 Sulfate

The former 120-N-1 percolation pond introduced sulfate and sodium to 100-N Area groundwater. In FY 2007 no wells exceeded the 250 mg/L secondary drinking water standard for sulfate. Sulfate concentrations remain elevated in groundwater north and northwest of the 120-N-1 site. A second area of elevated sulfate concentrations underlies the 116-N-3 trench. This contamination is residual from previous flow conditions that carried sulfate from the 120-N-1 percolation pond inland and then toward the north.

The highest sulfate concentration in FY 2007 was 239 mg/L in well 199-N-59, adjacent to the 120-N-1 site (Figure 2.4-13). This was the first time since 1996 the concentration in this well was below the secondary drinking water standard.

#### 2.4.1.5 Petroleum Hydrocarbons

Petroleum hydrocarbons from a 1960s diesel fuel leak (DOE/RL-95-111) continued to be detected in 100-N Area groundwater. Of the affected wells, 199-N-18 is closest to the former leak site and had the highest levels of groundwater contamination. In September 2007, this well had 190 mg/L total petroleum hydrocarbons in the diesel range. April data from this well were inconsistent and flagged in the database as potentially erroneous.<sup>(b)</sup> Peak concentrations of thousands of milligrams per liter were observed in 2001 to 2003.

DOE continued a remedial action to remove free product from well 199-N-18 in FY 2007. The passive remediation method employs a polymer that selectively absorbs petroleum products from the surface of the water like a sponge. Four cylinders of this material are lowered into the well, where the material absorbs the contamination. The cylinders are changed every two months when they are saturated with oil.

Evidence of low levels of hydrocarbon contamination have been observed in wells 199-N-3, 199-N-19, and 199-N-96A in the past (PNNL-14187, Section 2.4), but not in FY 2007. These wells are located near well 199-N-18 and may be influenced by contamination from the same source.

Total organic carbon concentrations were slightly elevated in shoreline wells 199-N-96A and 199-N-123. Concentrations ranged from undetected to 5,300 µg/L in FY 2007.

Petroleum hydrocarbons have been detected in some of the 100-N Area aquifer tubes. Appendix D of PNNL-16894 discusses evidence for this contamination. Low levels (<1 mg/L) of total petroleum hydrocarbons in the diesel range were reported in

*Petroleum hydrocarbons continued to be detected in 100-N Area groundwater, but concentrations declined.*

(b) Samplers attempt to collect water samples from well 199-N-18 from the water column below the floating product. However, the well is sampled by lowering a bottle into the well, which disturbs the floating product. Thus, it is not surprising that concentrations of hydrocarbons vary among samples.

several tubes around Array-0A. Workers observed a small oil sheen during installation of these tubes in January 2007.

Near the N Reactor building, well 199-N-16 also has evidence of petroleum contamination, believed to be from a separate past source. Total petroleum hydrocarbons (diesel) were measured at up to 7.2 mg/L in FY 2007, slightly lower than the previous year.

#### **2.4.1.6 Manganese and Iron**

Manganese continued to exceed its secondary drinking water standard (50 µg/L) in two wells affected by petroleum contamination: 199-N-16 (654 µg/L) and 199-N-18 (4,570 µg/L). Iron also exceeded its secondary drinking water standard (300 µg/L) in well 199-N-18 (16,400 µg/L). Natural biodegradation of the hydrocarbons creates reducing conditions, which increases the solubility of metals such as manganese and iron from the well casing or aquifer sediment.

Manganese exceeded the secondary drinking water standard in several wells near the apatite barrier, e.g. 199-N-122 and 199-N-147. The elevated metals are caused by reducing conditions associated with the treatment system. This is expected to be a transient effect.

#### **2.4.1.7 Chromium**

Only one well in the 100-N Area has chromium concentrations above the drinking water standard (100 µg/L). Well 199-N-80, which is completed in a thin, confined aquifer in the Ringold Formation, had a chromium concentration in FY 2007 of 172 µg/L in a field-filtered sample, a typical level for this well. Chromium was present in the effluent discharged to the 116-N-1 facility, but levels in wells monitoring the unconfined aquifer were low while the facility was in use, and remained low through FY 2007. Thus, it is unlikely that the chromium seen in deep well 199-N-80 originated at the 116-N-1 facility. A down-hole video survey of this well in 2001 observed corrosion of the screen, which could affect chromium levels.

The highest chromium concentration in the unconfined aquifer in FY 2007 was 33 µg/L in a filtered sample from well 199-N-64, in central 100-N Area. The well is not located near any of the three major liquid waste sites. Chromium concentrations were even higher in this well in the 1990s, exceeding the drinking water standard once. A down-hole video survey of this well in September 2000 showed screen corrosion, which is the probable cause of the elevated chromium.

### **2.4.2 Operable Unit Activities**

---

This section summarizes activities related to groundwater in the 100-NR-2 Operable Unit. The primary contaminant of concern is strontium-90. Operable unit activities in FY 2007 included rebound monitoring of a former pump-and-treat system and emplacement of a permeable reactive barrier.

#### **2.4.2.1 Status of Five-Year Review Action Items**

The second CERCLA five-year review was published in November 2006 (DOE/RL-2006-20). The review identified two issues pertaining to the 100-N Area and two follow-up actions. In FY 2007 DOE made progress on both actions, which are due September 2008:

- **Action 6-1.** Implement the treatability test plan for permeable reactive barrier using apatite sequestration (DOE/RL-2005-96). Workers injected apatite-forming chemicals into shoreline wells to create a 90-meter barrier in FY 2007. Section 2.4.2.3 discusses the apatite barrier.
- **Action 7-1.** Perform additional data collection to support risk assessment, provide previously collected data, and collect additional pore water data from new and existing aquifer tubes. Samplers continued to collect water from aquifer tubes in FY 2007. Section 2.4.1 discusses significant results. Data are included in electronic files accompanying this report. DOE is installing additional tubes in FY 2008 and is conducting additional studies of petroleum hydrocarbons along the Columbia River shore. Results will be reported to Ecology.

#### 2.4.2.2 Rebound Monitoring

A pump-and-treat system operated from 1995 until March 2006 in the 100-N Area as part of a CERCLA interim action (ROD 1999b). The system removed ~1.8 curies of strontium-90 from the aquifer. Because strontium-90 binds to sediment grains, the pump-and-treat system was not effective in cleaning the aquifer. One of the requirements of the record of decision was to evaluate technologies to clean up the groundwater. Therefore, the Washington State Department of Ecology (Ecology),

U.S. Environmental Protection Agency (EPA), and U.S. Department of Energy (DOE) approved a Tri-Party Agreement change control form<sup>(c)</sup> in 2006 requiring the pump-and-treat system be put on cold standby and a permeable reactive barrier be constructed. The interim action record of decision allowed the pump-and-treat system to be shut down with Ecology approval; therefore, no explanation of significant difference to the 1999 record of decision was needed to place the system on cold standby.

The monitoring requirements for the 100-NR-2 interim action are specified by Tri-Party Agreement Change Control Form M-15-96-08. Wells, constituents, and sampling frequencies for interim action monitoring are shown in Appendix A. During FY 2007, all wells were sampled as scheduled except two wells scheduled for monthly sampling that were sampled less often.

DOE performed supplemental monitoring of the shoreline area (PNNL-15798). Some of the monthly samples were not collected in FY 2007 (see Appendix A). Section 2.4.1 presented results of shoreline groundwater monitoring.

***The remedial action objectives in the 100-NR-2 Operable Unit (ROD 1999b) are:***

- ***Protect the Columbia River from the adverse impact of groundwater contamination by limiting exposure pathways, reducing or removing sources, controlling groundwater movement, or reducing the concentration of contaminants.***
- ***Protect the unconfined aquifer by implementing remedial actions that reduce the concentration of contaminants.***
- ***Obtain information to evaluate technologies to remove strontium-90 and evaluate the impact to ecological receptors.***
- ***Prevent destruction of sensitive wildlife habitat and minimize the disruption of cultural resources.***
- ***In 2006, Ecology added a requirement for the pump-and-treat system to be put on standby, and an alternative, in situ treatment technology to be tested.***

(c) Federal Facility Agreement and Consent Order Change Control Form M-16-06-01, "Establish Interim Milestone M-016-14, Complete Construction of a Permeable reactive Barrier at 100-N." February 15, 2006.

Additional details on the pump-and-treat system and operational data for calendar year 2006 are available in DOE/RL-2006-76. An upcoming report will present results for calendar year 2007.

### 2.4.2.3 Permeable Reactive Barrier

DOE has agreed to construct and evaluate the effectiveness of a permeable reactive barrier, using apatite sequestration technology, as part of the CERCLA remedial investigation/feasibility study process and consistent with the 1999 interim remedial action record of decision for the 100-NR-1 and 199-NR-2 Operable Units (ROD 1999b).

DOE installed a 90-meter apatite permeable reactive barrier near the Columbia River shoreline in FY 2006 and 2007. Strontium-90 sequestration by this technology occurs through the injection of a calcium citrate phosphate solution. In situ biodegradation of the citrate results in apatite precipitation, adsorption of strontium-90 to the apatite, then apatite recrystallization with strontium substituting for calcium. Strontium-90 is held in place in the apatite mineral crystal structure where it decays naturally. A treatability test plan (DOE/RL-2005-96) describes the process.

Two pilot injection tests were conducted in June and September 2006. DOE used the results of these tests and subsequent bench-scale testing to modify the chemistry of the injected solution. DOE conducted two injection campaigns in FY 2007. The first campaign targeted the Ringold Formation when the water table was relatively low (February 28 through March 22). The second campaign targeted the Hanford formation when the water table was high (June 6 through July 10).

Researchers predicted a “salt effect” that could temporarily increase strontium-90 concentrations downgradient of the treatment zone. The injected solution has high total dissolved solids. As this water migrates from the treatment zone into an area where strontium-90 has not been sequestered by apatite, cations exchange with strontium adsorbed on aquifer sediments. The researchers modified the protocols to minimize this effect.

Figure 2.4-14 illustrates strontium-90 concentrations in wells 199-N-137 and 199-N-138. These wells were used for test injections in FY 2006 and in the full injection campaigns in FY 2007. A pronounced salt effect was evident following the 199-N-137 test injection in 2006. Smaller effects are evident following the FY 2007 injections in these and nearby wells. Strontium-90 concentrations at the end of FY 2007 were much lower than baseline levels.

Figure 2.4-15 illustrates strontium-90 concentrations in wells 199-N-122 and 199-N-123, located immediately downgradient of the treatment zone. As expected, there was a brief spike in strontium-90 levels after each injection. With each subsequent injection the desorbed strontium-90 was less and concentrations dropped in a shorter amount of time.

As discussed in Section 2.4.1, strontium-90 concentrations increased dramatically in aquifer tubes downgradient of the treatment zone (see Figure 2.4-8). Levels were much higher in the aquifer tubes than in the injection wells or downgradient monitoring wells. DOE will continue to monitor these tubes to determine if concentrations subside.

All low-concentration injections were completed in FY 2007. Injection well sampling continues monthly. An addendum to the treatability test plan will be

*In FY 2007, DOE injected chemicals into shoreline wells to create a permeable barrier designed to trap strontium-90 in the aquifer. The barrier is ~90 meters long across the most contaminated section of the shore.*

prepared which will allow high-concentration injections to be conducted in FY 2008 to enhance the performance of the barrier. An upcoming report will evaluate the effectiveness of the FY 2007 injections and make recommendations for future work.

Apatite injections treat the strontium-90 contamination in the aquifer, but much of the contamination is in the vadose zone. Pacific Northwest National Laboratory is conducting a study of apatite infiltration, under an Environmental Management Technology (EM-22) project (<http://www.hanford.gov/cp/gpp/science/em21.cfm>). Primary objectives of this project are to develop an infiltration strategy that defines apatite solution precipitation rate and strontium sequestration processes under variably saturated conditions, and with variable apatite concentrations. Results will be used to design an efficient and effective infiltration strategy that will be tested at a field scale.

#### **2.4.2.4 Phytoremediation**

***K.M. Thompson, R.B. Rowley, S.W. Petersen, and J.S. Fruchter***

Phytoremediation has been identified as a potential technology for the removal of strontium-90 from the soil as a filter for groundwater along the Columbia River at the 100-N Area. Phytoremediation is a managed remediation technology in which plants are used to extract or sequester soil contaminants. Greenhouse studies have demonstrated the viability of phytoremediation to remove strontium-90 from soil and water in the 100-N Area. The technology would be used in conjunction with the apatite barrier.

Pacific Northwest National Laboratory is conducting a study of phytoremediation, under a DOE EM-22 project (<http://www.hanford.gov/cp/gpp/science/em21.cfm>). A demonstration plot of coyote willow plants was constructed in March 2007 along the banks of the Columbia River at the 100-K Area. The area chosen for the test was not contaminated by strontium-90 or any other radionuclide. At this site, the willows were at least partially submerged for at least 12 hours a day from planting in March through the month of June. At times, they were totally submerged. The plants were harvested (all leaves and branches removed) in three stages during July, September, and October 2007. During actual remediation, harvesting would prevent leaf drop from spreading contamination. The willow shrubs recovered quickly after harvesting, with new shoots and leaves visible after a few weeks. The field study will continue in FY 2008 to determine growth during the second year.

### **2.4.3 Facility Monitoring**

This section describes results of monitoring individual facilities: the 116-N-1 and 116-N-3 facilities, 120-N-1 percolation pond, and 120-N-2 surface impoundment. Groundwater is monitored at these facilities to meet the requirements of RCRA for hazardous waste constituents and AEA for source, special nuclear, and by-product materials. Data from facility-specific monitoring are also integrated into the CERCLA groundwater investigations. Hazardous constituents and radionuclides are discussed jointly in this section to provide comprehensive interpretations for each facility. Groundwater data for these facilities are available in the Hanford Environmental Information System (HEIS 1994) and in the data files accompanying this report.

***Strontium-90  
and tritium  
concentrations  
exceed drinking  
water standards at  
the 116-N-1 liquid  
waste disposal  
facility.***

Additional information including well and constituent lists, maps, flow rates, and statistical tables are included in Appendix B.

### 2.4.3.1 116-N-1 (1301-N) Liquid Waste Disposal Facility

This facility contaminated groundwater with radionuclides during its period of use in the 1960s through 1985. Strontium-90 and tritium concentrations in groundwater exceed drinking water standards. Results of monitoring were discussed in Section 2.4.1. The facility was excavated to remove shallow vadose zone sediment, where most of the radionuclide contamination resided, and was backfilled in FY 2006. Wells downgradient of the 116-N-1 facility are sampled quarterly to annually for strontium-90 and gamma activity. No gamma-emitters were detected in FY 2007. Strontium-90 concentrations rebounded in several downgradient wells formerly used for groundwater extraction (see Section 2.4.1.1).

This facility is included in the Hanford Facility RCRA Permit (Ecology 1994a). The permit states that RCRA monitoring during closure activities will follow the requirements of BHI-00725. That plan and a supplemental plan (PNNL-13914) are similar to an interim status indicator evaluation program (40 CFR 265.93(b), as referenced by WAC 173-303-400).

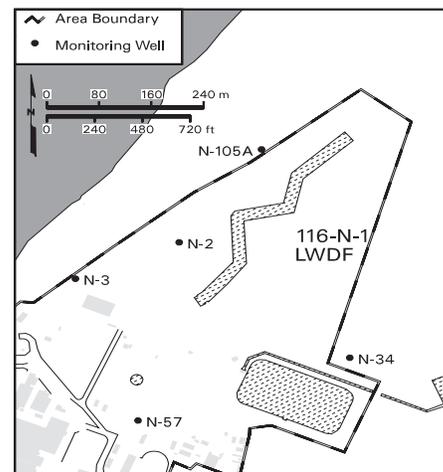
Groundwater flows to the northwest beneath the 116-N-1 facility, discharging to the Columbia River. The hydraulic gradient in March 2007 was 0.0016, and flow rate was estimated to be between 0.03 to 0.58 meter/day (Appendix B).

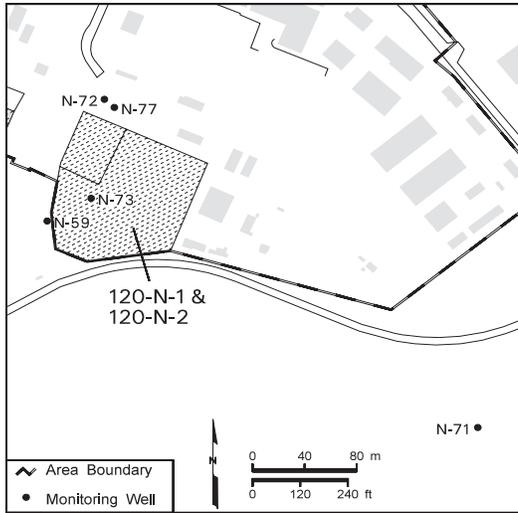
Upgradient and downgradient wells are scheduled for sampling twice each year for contamination indicator parameters (pH, specific conductance, total organic carbon, and total organic halides) and once for groundwater quality and site-specific parameters. The wells were sampled as scheduled in FY 2007.

Average specific conductance in downgradient well 199-N-3 continued to exceed the critical mean value (1,165  $\mu\text{S}/\text{cm}$ ) in FY 2007. This was a continuation of previous exceedances, and prior assessment results (WHC-SD-EN-EV-003) indicated the elevated specific conductance is related to constituents from the 120-N-1 percolation pond. Recent data indicate this conclusion remains valid (see Appendix B).

In October 2006, well 199-N-3 exceeded the critical mean value for total organic carbon. This sampling event was delayed from FY 2006. Split sample sets were sent to two laboratories. The average result from one laboratory were below the critical mean value. The results from the other laboratory were rejected because of problems with the analysis (see Appendix C) (SGW-33492).

In September 2007, well 199-N-3 again exceeded the critical mean value (2,075  $\mu\text{g}/\text{L}$ ) for total organic carbon (Figure 2.4-16). This well is believed to be affected by the diesel plume that is detected in nearby well 199-N-18. However, total petroleum hydrocarbons contamination has remained below detection limits. Verification sampling for total organic carbon will be performed and results will be discussed in an upcoming RCRA quarterly report.





Upgradient/downgradient comparison values for indicator parameters have been revised based on recent data for use in FY 2008 comparisons (see Appendix B).

#### 2.4.3.2 120-N-1 (1324-NA) Percolation Pond and 120-N-2 (1324-N) Surface Impoundment

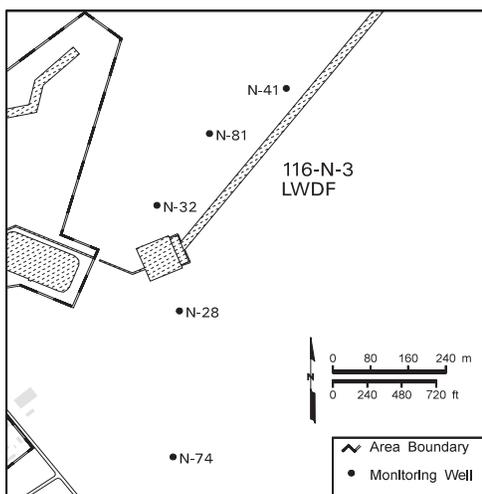
These facilities were used to treat and dispose of corrosive, non-radioactive waste from 1977 to 1990. They have been remediated and backfilled.

These facilities are included in the Hanford Facility RCRA Permit (Ecology 1994a). The permit states that RCRA monitoring during closure activities will follow the requirements of BHI-00725. That plan, and a supplemental plan (PNNL-13914), are similar to an interim status indicator evaluation program (40 CFR 265.93(b), as referenced by WAC-173-303-400). The two units are monitored as a single site (waste management area) because of their proximity and similar waste type.

Groundwater flows to the northwest beneath the 120-N-1 and 120-N-2 facilities, discharging to the Columbia River. The hydraulic gradient in March 2007 was 0.0026, and flow rate was estimated to be between 0.05 to 0.95 meter/day (Appendix B).

During FY 2007, four of the five monitoring wells for this site were sampled twice for contamination indicator parameters and groundwater quality and once for site-specific parameters, as planned (see Appendix B). Downgradient well 199-N-59 contained too little water to sample in December 2006, but was successfully sampled in June 2007. DOE plans to replace this well in FY 2008.

Average specific conductance values in wells downgradient of the facilities continued to exceed the critical mean value (490  $\mu\text{S}/\text{cm}$ ) in FY 2007. A previous groundwater quality assessment indicated that the high specific conductance is caused by sulfate and sodium (WHC-SD-EN-EV-003), which are not listed hazardous waste constituents. Recent data indicate this conclusion remains valid (see Appendix B). Other indicators remained below critical mean values in FY 2007.



Upgradient/downgradient comparison values for indicator parameters were revised based on recent data for use in FY 2008 comparisons (see Appendix B).

#### 2.4.3.3 116-N-3 (1325-N) Liquid Waste Disposal Facility

This facility contaminated groundwater with radionuclides during its period of use from 1983 to 1991. Strontium-90 and tritium concentrations in groundwater downgradient of the facility exceed drinking water standards. Results of monitoring were discussed in Section 2.4.1. The facility was excavated to remove the shallow vadose zone material, which contained the highest concentrations of radionuclides, and backfilled.

This facility is included in the Hanford Facility RCRA Permit (Ecology 1994a). The permit states that RCRA monitoring during

closure activities will follow the requirements of BHI-00725. That plan, and a supplemental plan (PNNL-13914), are similar to an interim status indicator evaluation program (40 CFR 265.93(b), as referenced by WAC 173-303-400).

Groundwater flows to the north beneath the 116-N-3 facility, then turns to the northwest and discharges to the Columbia River. The hydraulic gradient in March 2007 was 0.0010, and the groundwater flow rate was estimated to be between 0.02 to 0.37 meter/day (Appendix B).

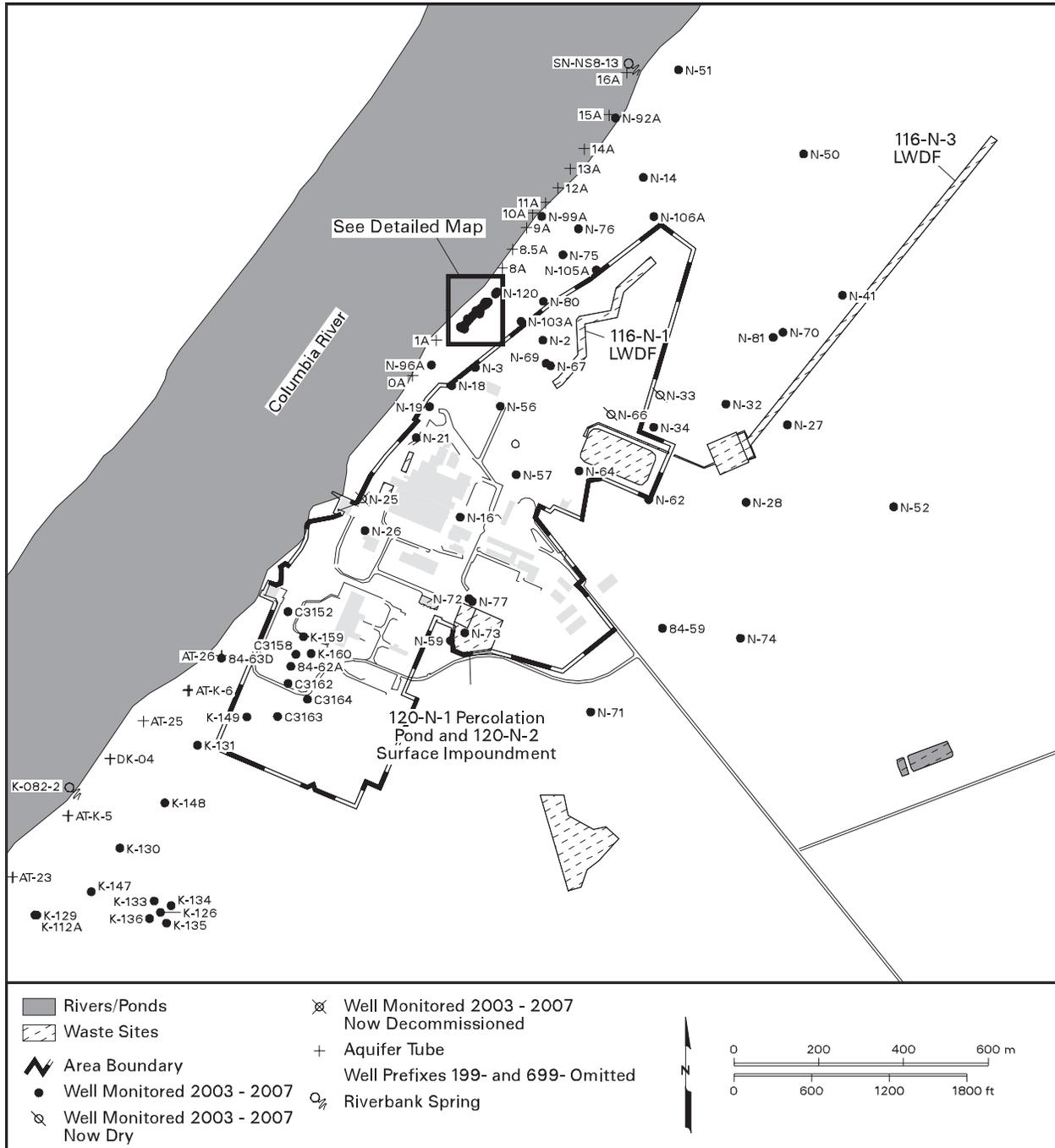
All five wells were sampled twice for contamination indicator parameters (pH, specific conductance, total organic carbon, and total organic halides) and once for groundwater quality and site-specific parameters, as planned. However, samplers neglected to take quadruplicate field readings in one well in March (Appendix B).

Average specific conductance values in downgradient wells 199-N-32, 199-N-41, and 199-N-81 continued to exceed the critical mean value in FY 2007. This was a continuation of previous exceedances noted in 1999 through 2006. DOE notified Ecology of the original exceedance and submitted an assessment report<sup>(c)</sup> that concluded the exceedance was caused by past discharges to the 120-N-1 percolation pond. Recent data indicate this conclusion remains valid (see Appendix B).

Detection monitoring will continue in FY 2008. Upgradient/downgradient comparison values for indicator parameters were revised based on recent data for use in FY 2008 (see Appendix B).

---

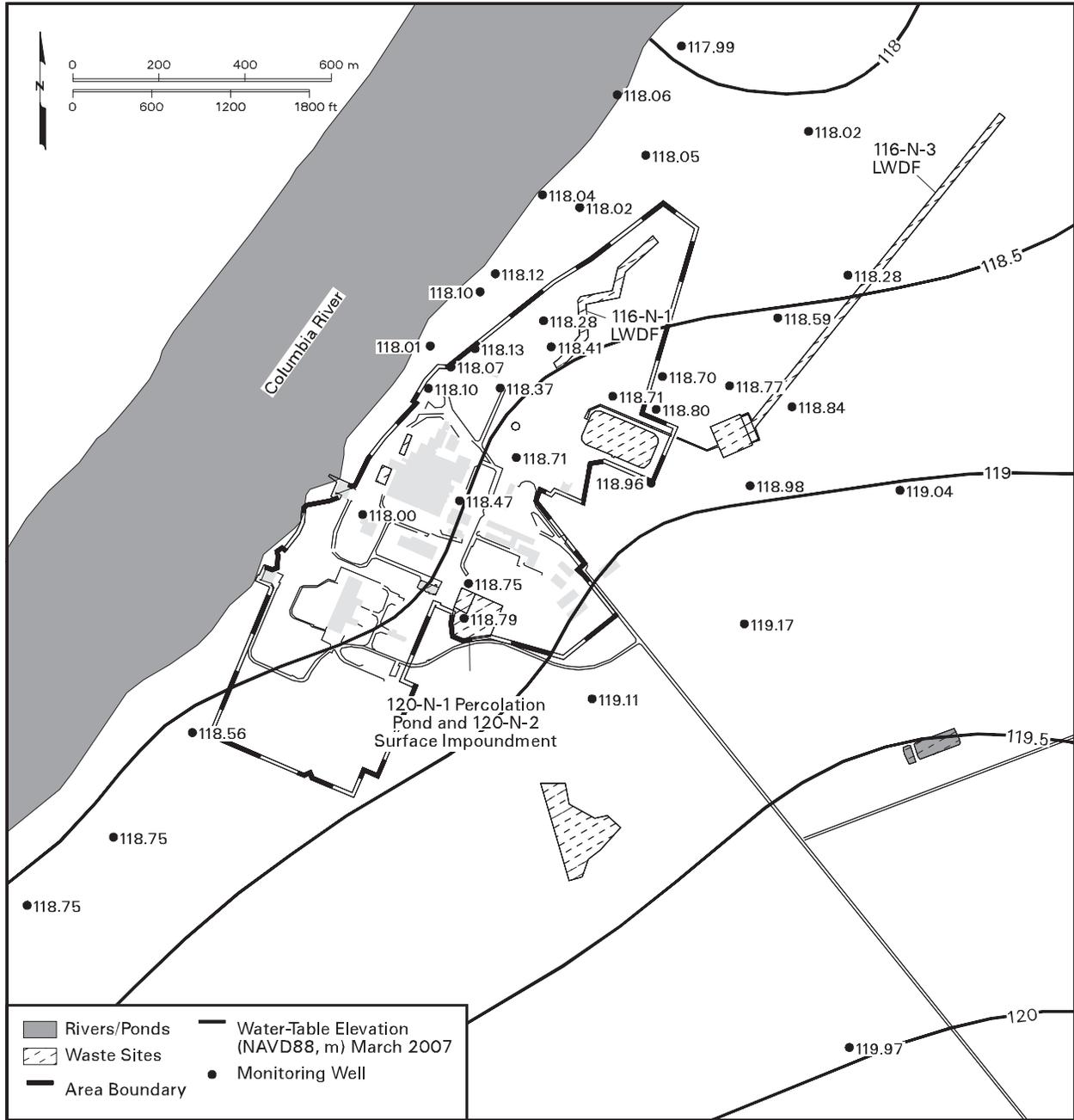
(c) Letter from KM Thompson (U.S. Department of Energy, Richland, Washington) to J Hedges (Washington State Department of Ecology), Results of Assessment at the 1325-N Facility, dated July 22, 2000.



can\_gwfd07\_111 January 17, 2008 10:32 AM

Figure 2.4-1. Groundwater Monitoring Wells in 100-N Area

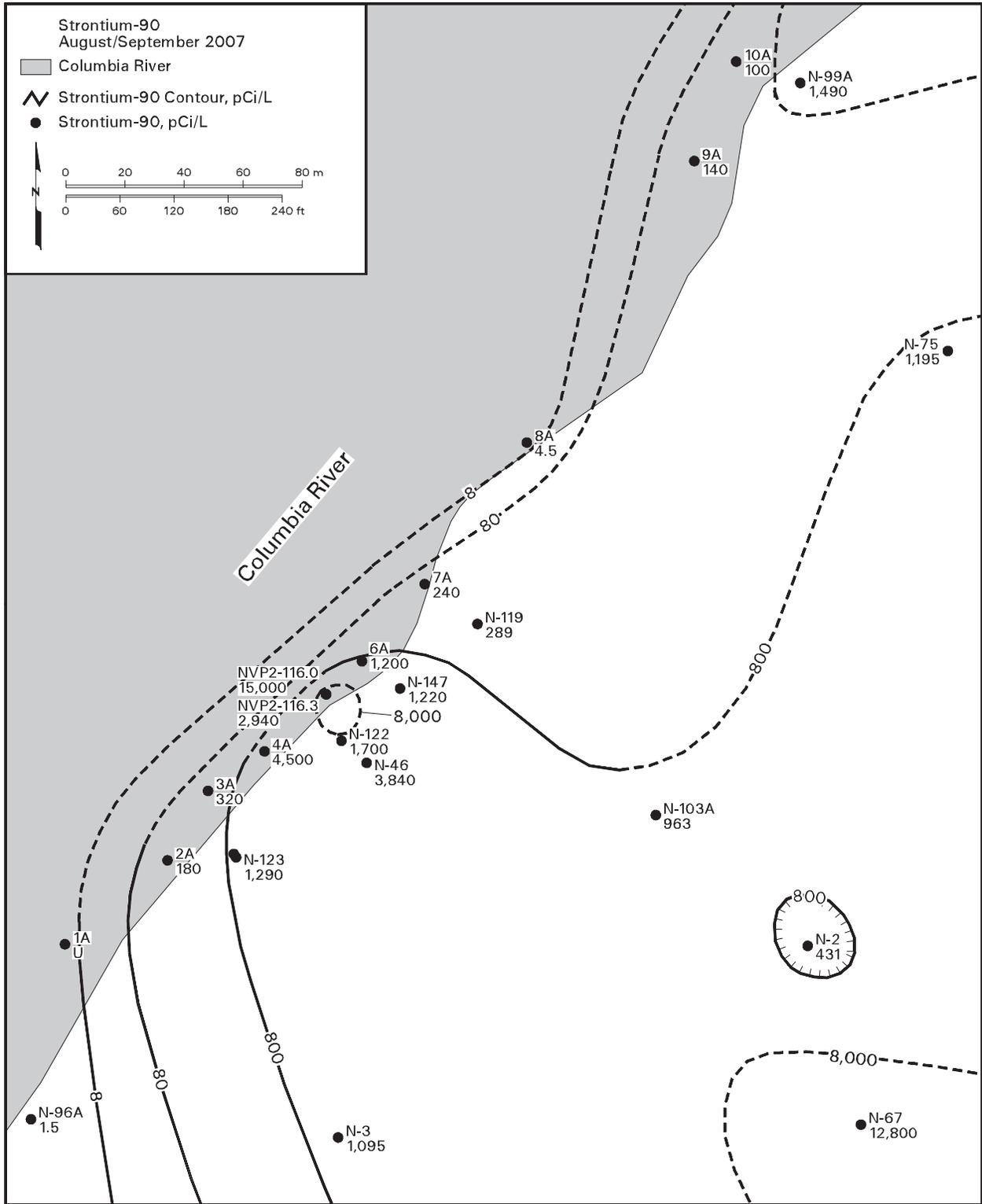




can qwf07 113 February 19, 2008 7:21 AM

Figure 2.4-3. 100-N Area Water-Table Map, March 2007





can qwf07 115 March 06, 2008 1:27 PM

**Figure 2.4-5. Strontium-90 in Groundwater at Shoreline Study Area, August/September 2007, Upper Part of Unconfined Aquifer**

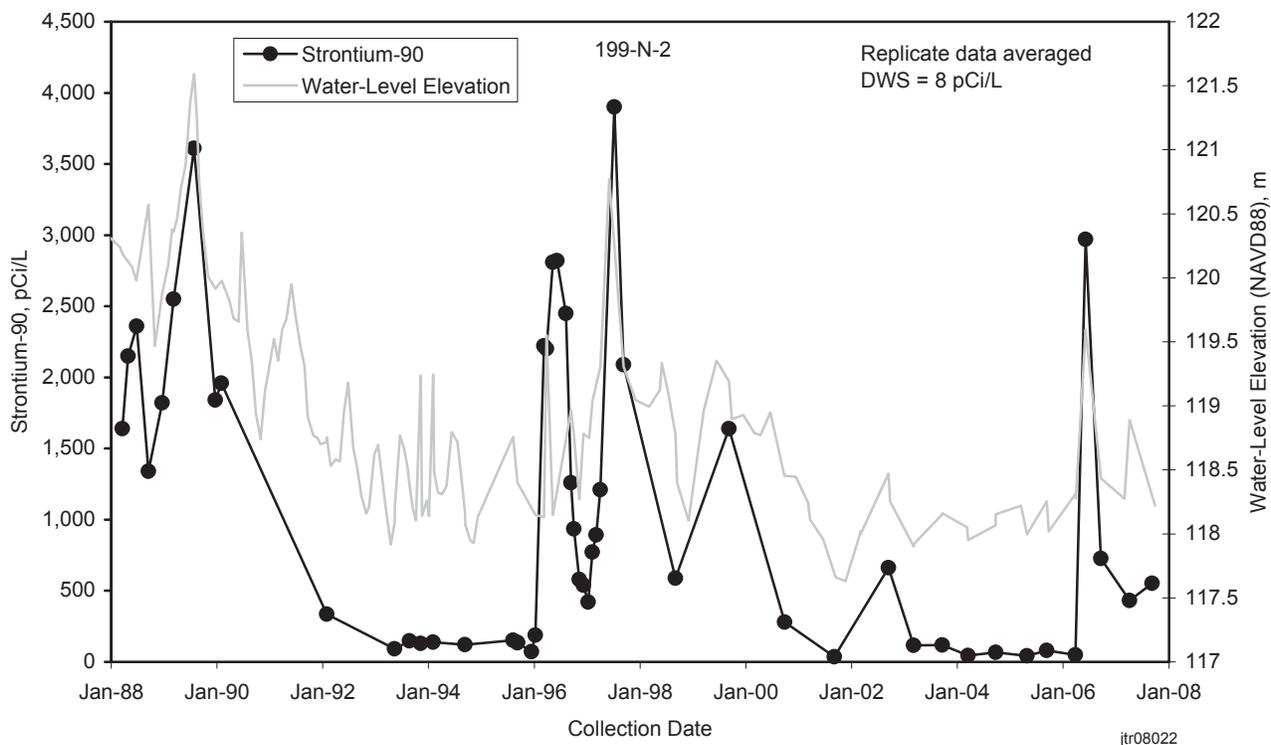
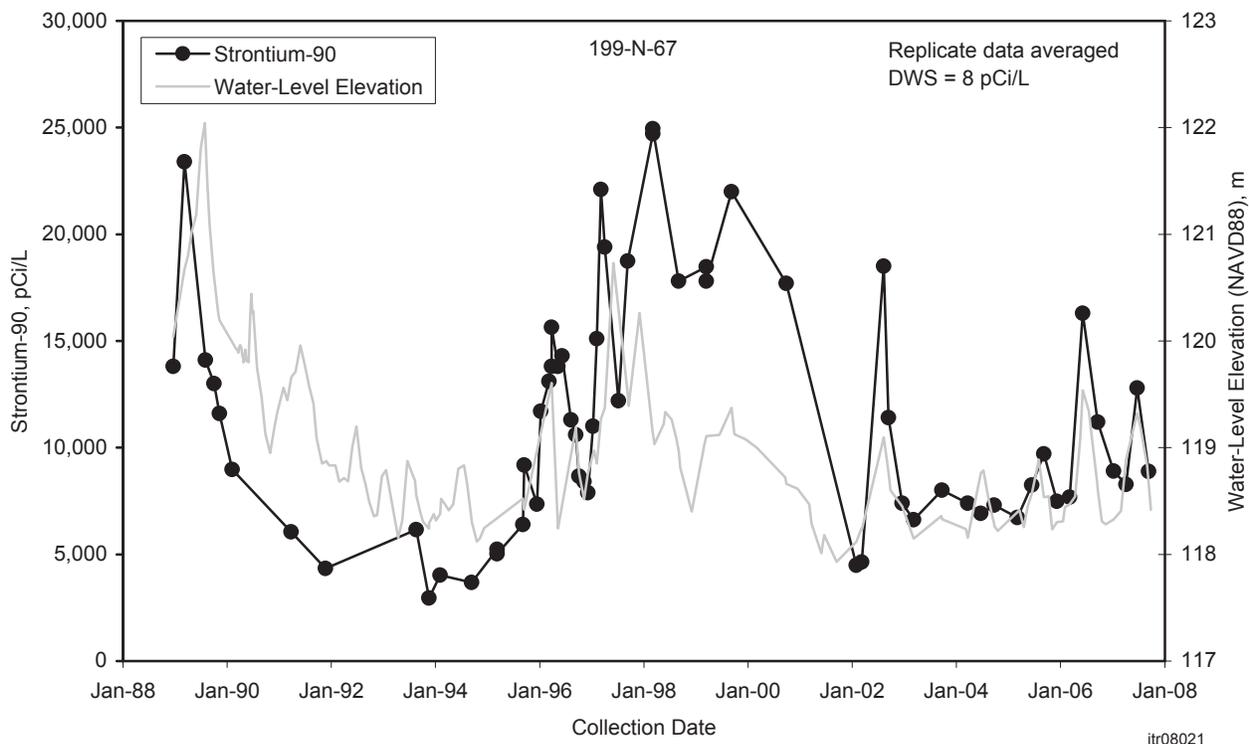


Figure 2.4-6. Strontium-90 Concentrations and Water Level Near 116-N-1 Facility

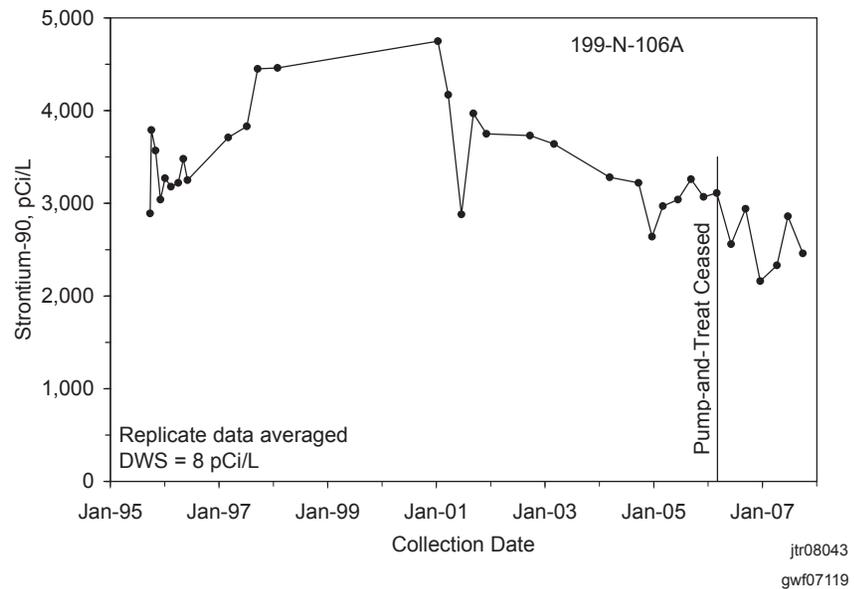
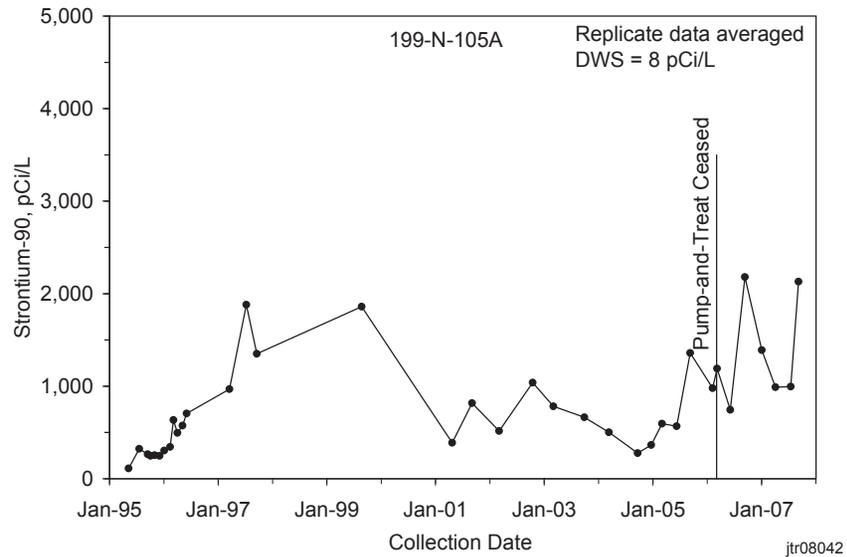
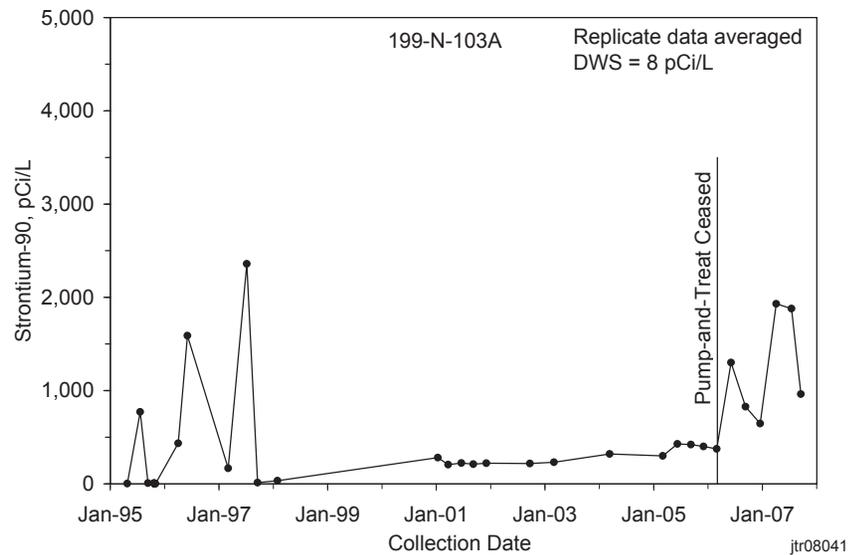
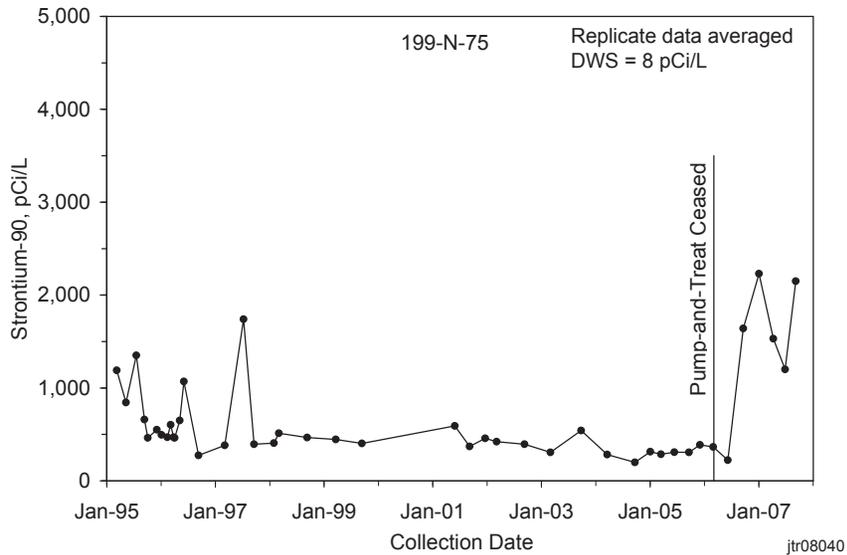


Figure 2.4-7. Strontium-90 Concentrations in Former Extraction Wells in 100-N Area

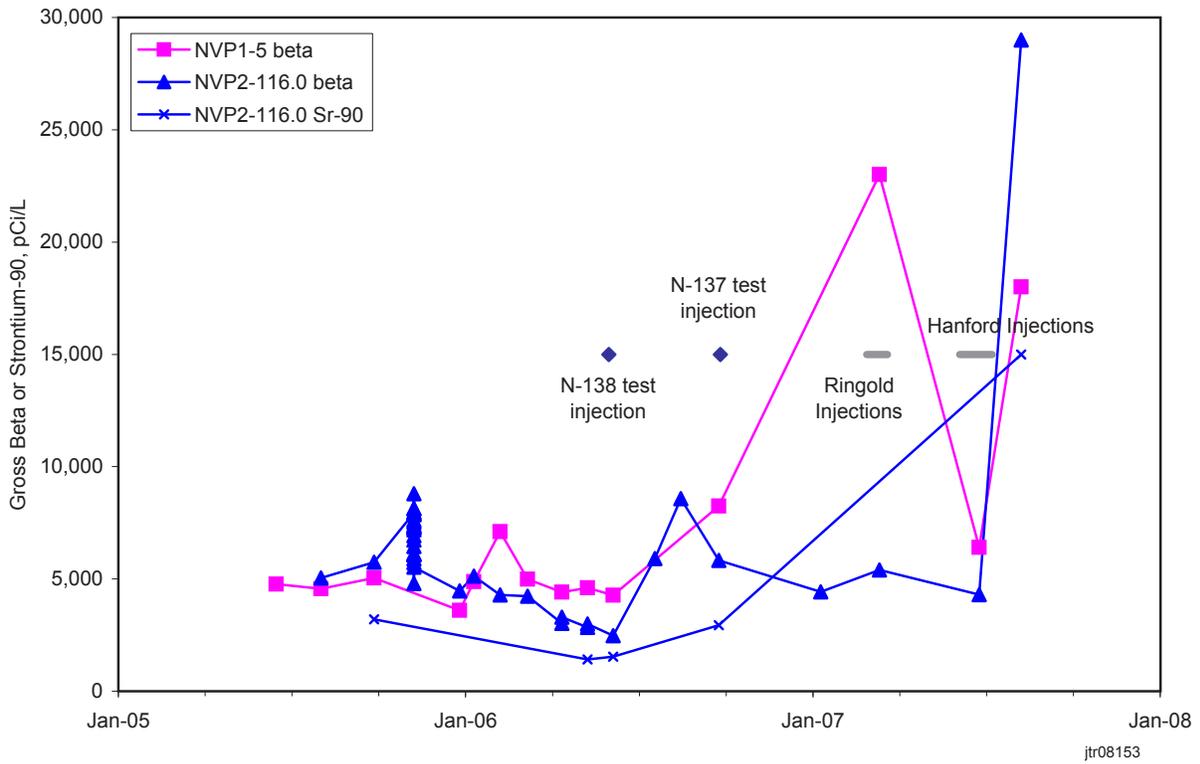


Figure 2.4-8. Gross Beta and Strontium-90 Concentrations in 100-N Area Aquifer Tubes

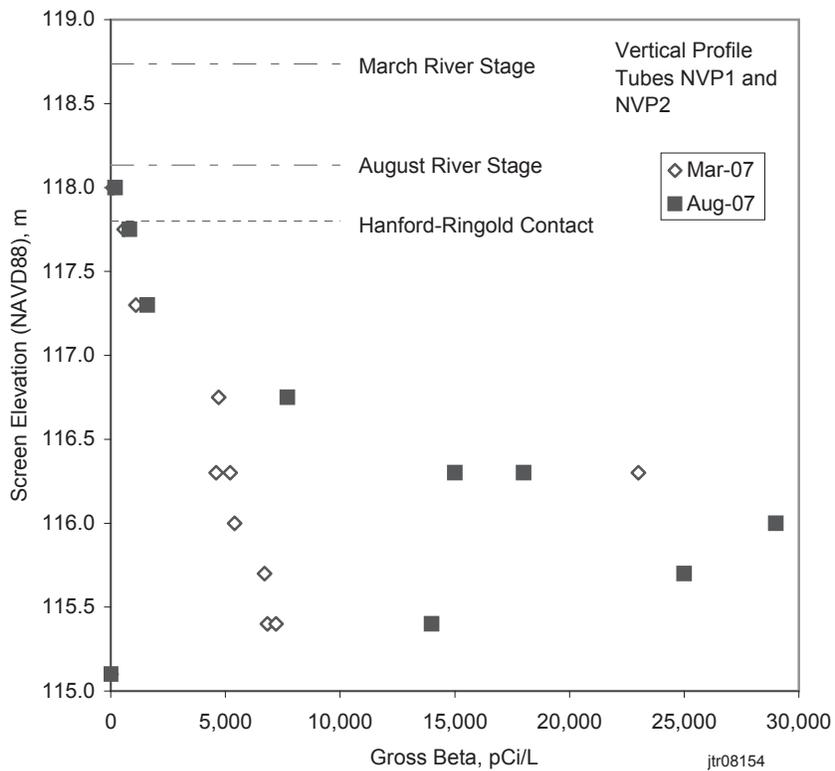


Figure 2.4-9. Strontium-90 Concentrations With Depth at 100-N Area Shoreline, March and August 2007

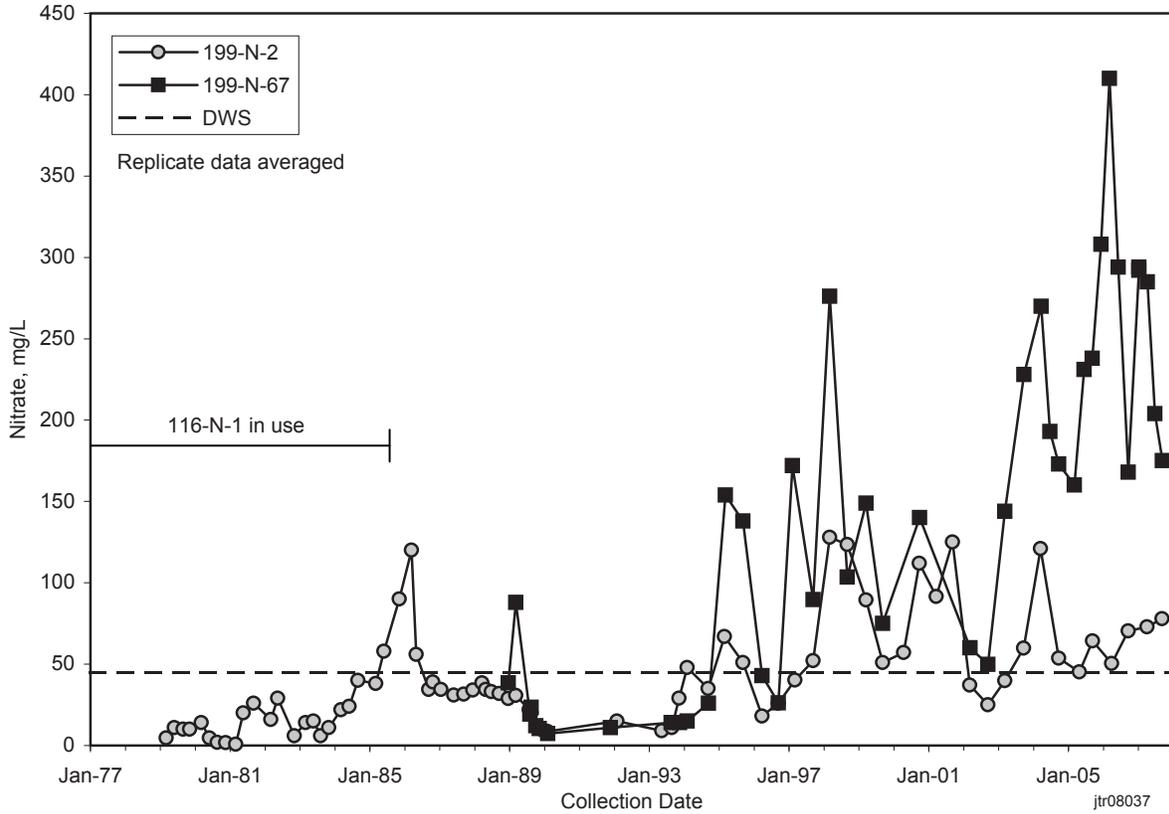


Figure 2.4-10. Nitrate Concentrations Near 116-N-1 Facility

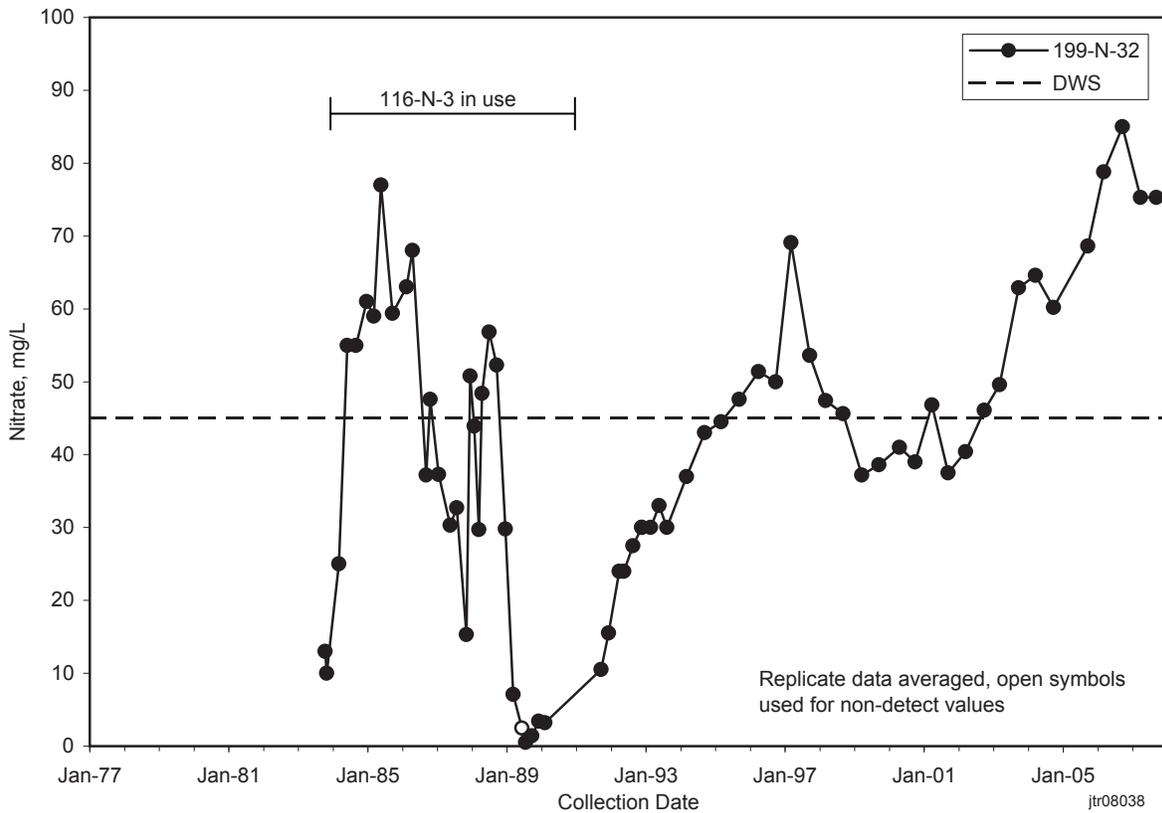


Figure 2.4-11. Nitrate Concentrations Near 116-N-3 Facility

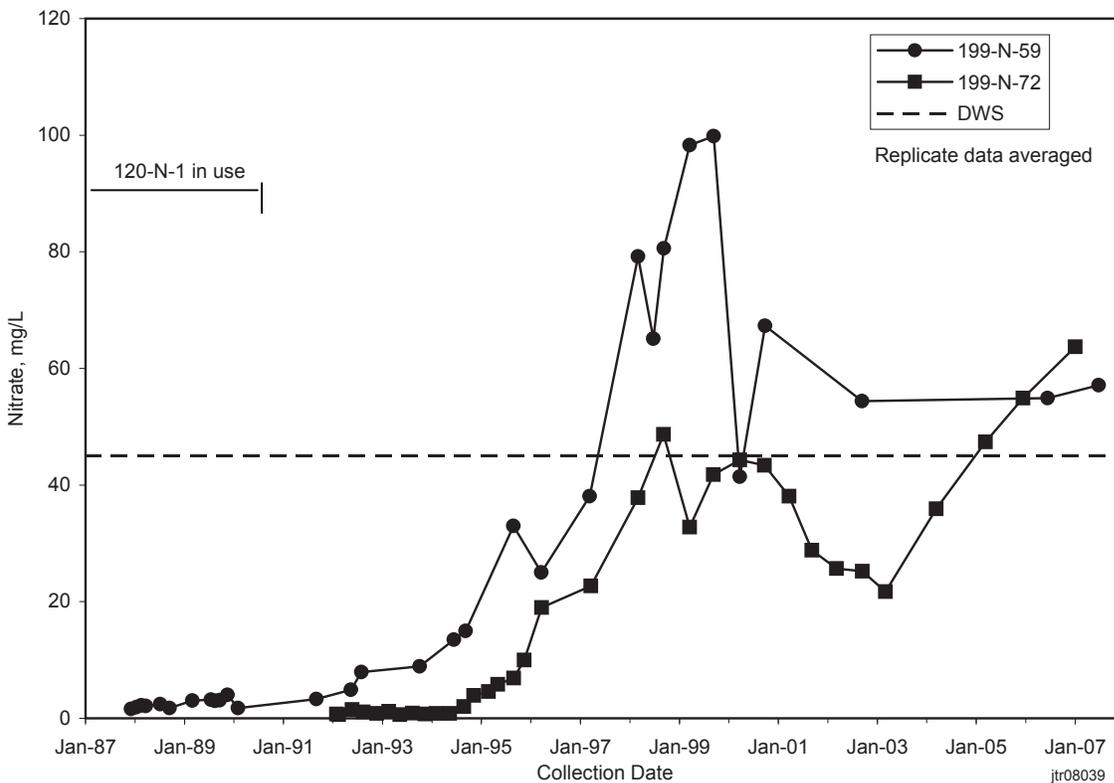


Figure 2.4-12. Nitrate Concentrations Near 120-N-1 Percolation Pond in South 100-N Area

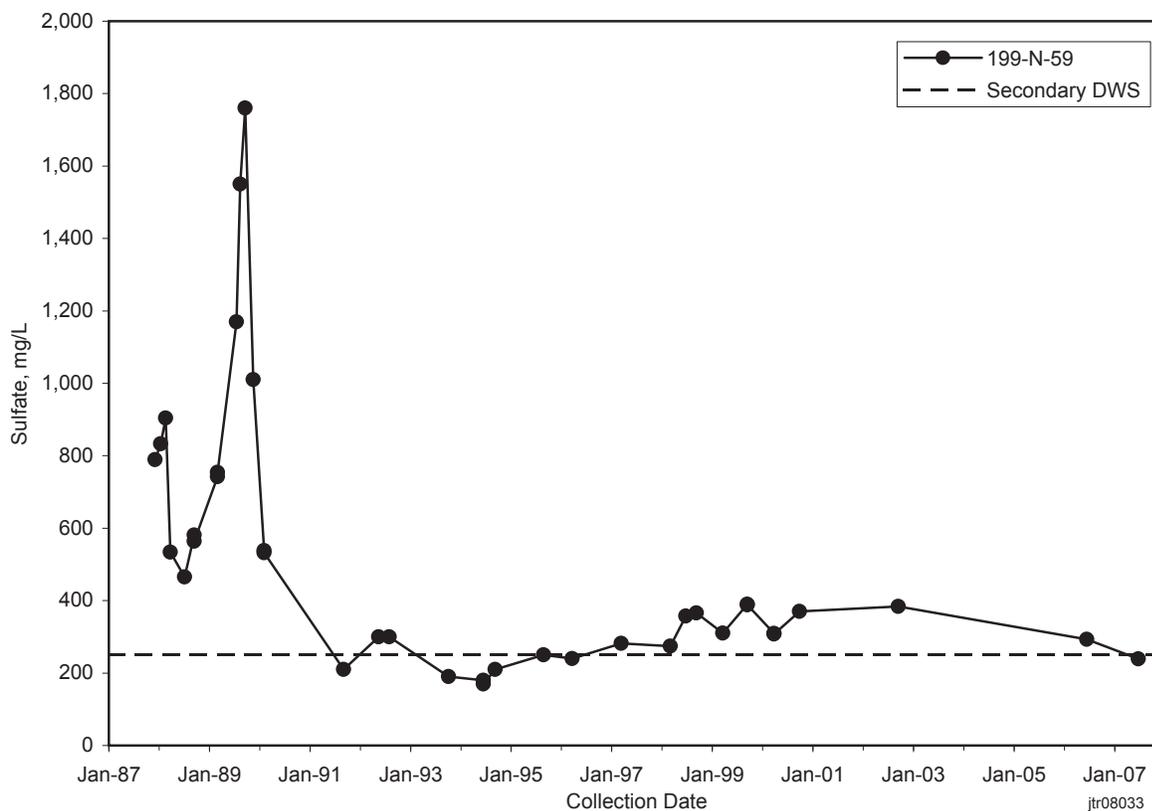
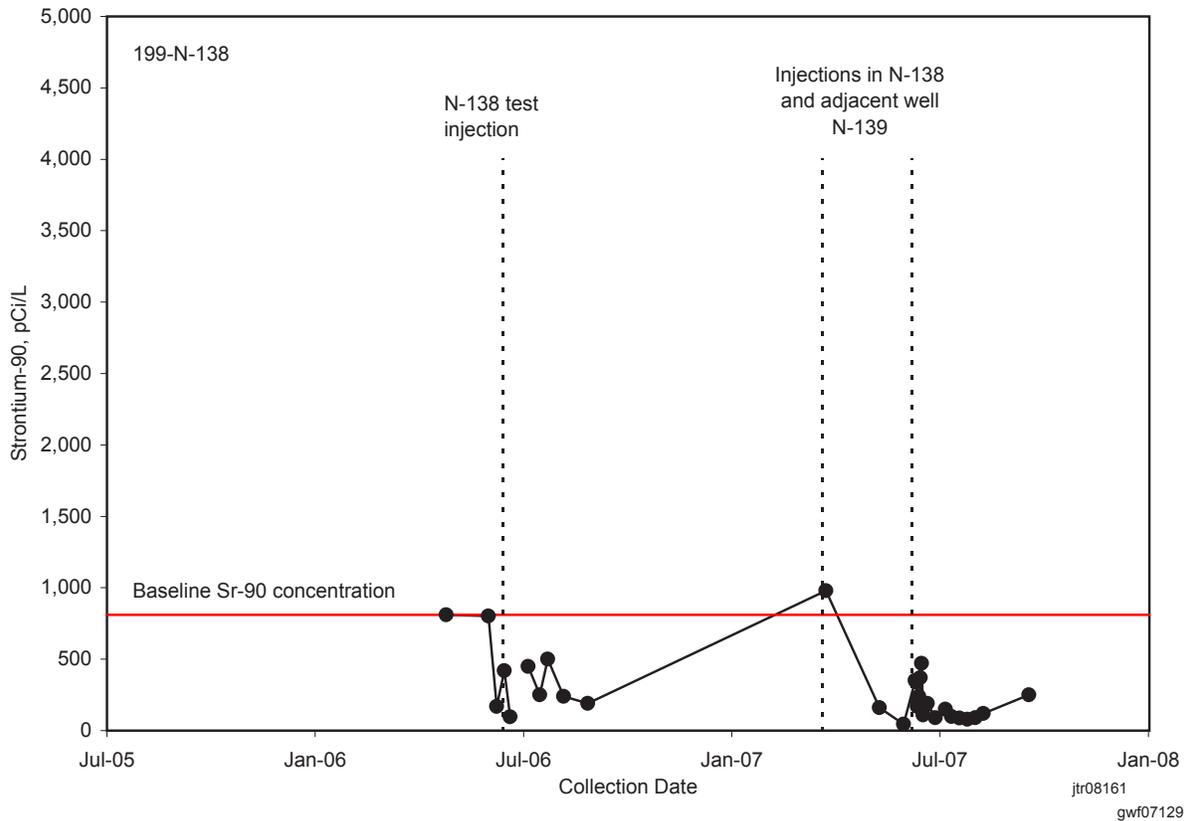
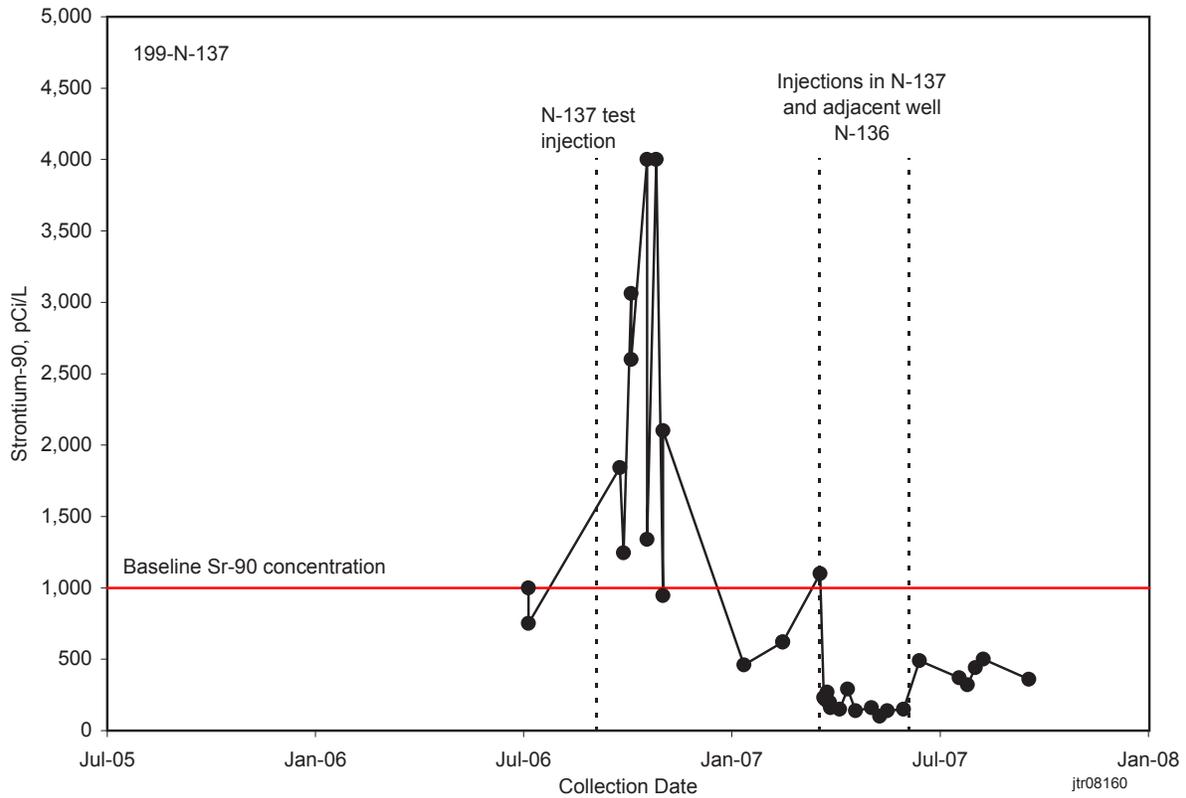
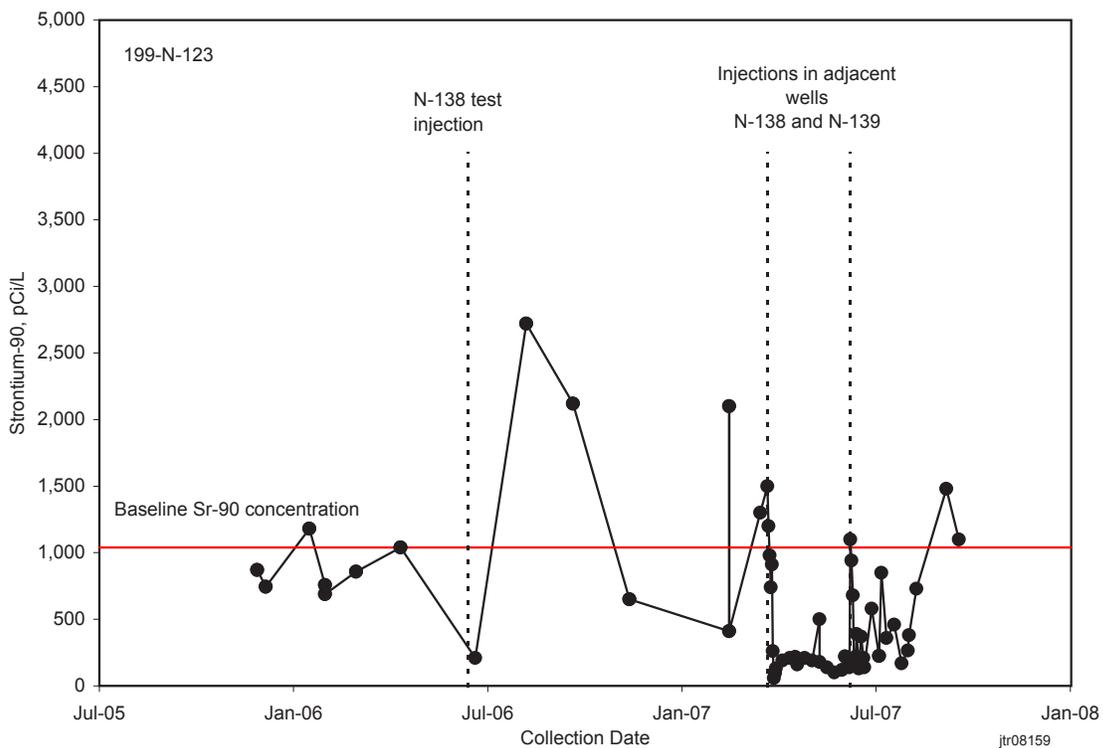
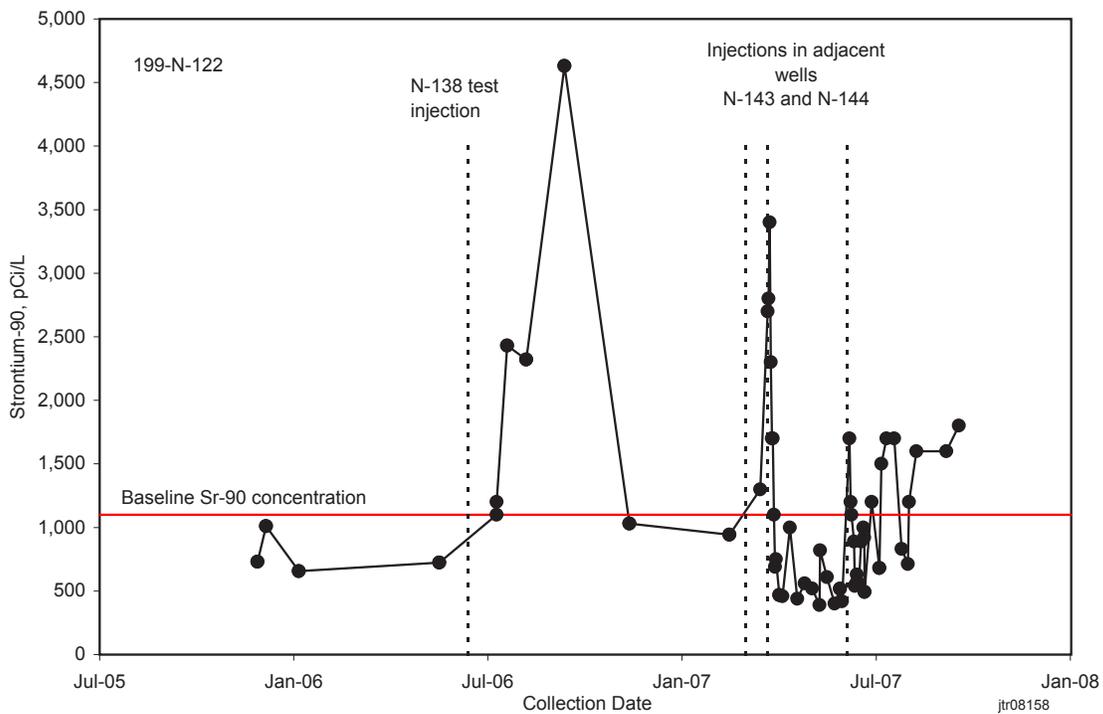


Figure 2.4-13. Sulfate Concentrations Near 120-N-1 Percolation Pond in South 100-N Area



**Figure 2.4-14. Strontium-90 Concentrations in Two Apatite Injection Wells (Data from HEIS and project database)**



gwf07128

**Figure 2.4-15. Strontium-90 Concentrations in Monitoring Wells Downgradient of Apatite Treatment Zone (Data from HEIS and project database)**

