2.12 300-FF-5 Operable Unit

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The 300-FF-5 Operable Unit includes groundwater affected by releases from sources in the 300 Area, 618-11 burial ground area, and 316-4 cribs/618-10 burial ground area. The operable unit lies within a larger groundwater interest area (see Figure 2.1-1 in Section 2.1), which has been defined by the Groundwater Performance Assessment Project (groundwater project) for scheduling, data evaluation, and interpretation purposes. Groundwater investigations are underway in the operable unit to (a) identify natural processes that reduce the levels of contaminants of potential concern, (b) track changes in the extent of contaminants and their concentration trends with time, and (c) comply with *Resource Conservation and Recovery Act* (RCRA) regulatory requirements associated with the 316-5 process trenches.

Uranium is the contaminant of greatest significance in groundwater at this operable unit.

The 300-FF-5 Operable Unit is divided into two geographical regions: the 300 Area and 300-FF-5 North, which includes the two outlying waste site areas (Figure 2.12-1). The 300 Area contains former nuclear fuel fabrication facilities, fuels research laboratories, liquid effluent disposal sites (e.g., process trenches, process ponds), and several solid waste burial grounds. An index map to 300 Area facilities, waste sites, groundwater wells, and shoreline monitoring sites is shown in Figure 2.12-2. Approximately 30 wells and 8 aquifer sampling tube sites along the Columbia River are in use to monitor groundwater conditions beneath the 300 Area. The 300-FF-5 North region includes groundwater beneath the 618-11 burial ground near Energy Northwest, and beneath the 618-10 burial ground and 316-4 cribs, which are located south of the 618-11 burial ground and northwest of the 300 Area. An index map to the 300-FF-5 North region is provided as Figure 2.12-3. The 300-FF-5 North region uses 11 of the 41 monitoring wells in service for the 300-FF-5 Operable Unit.

Groundwater flow in the unconfined aquifer beneath the 300-FF-5 groundwater interest area is generally to the east and southeast. Beneath the 300 Area, flow in the unconfined aquifer is generally to the southeast. Flow into the 300 Area converges from regions

Groundwater monitoring in the 300-FF-5 groundwater interest area includes the following monitoring activities:

CERCLA Long-Term Monitoring

- ***Twenty-six wells are sampled semiannually for uranium and volatile organic compounds.***
- ***Thirteen wells are sampled semiannually for nitrate (upgradient source).***
- ***Twelve wells are sampled semiannually for tritium (upgradient source).***
- ***Aquifer tubes, riverbank springs, sediment, and associated biota are sampled annually (coordinated with Public Safety and Resource Protection Program monitoring).***
- ***In FY 2004, all wells were sampled as planned.***

Facility Corrective Action Monitoring at 316-5 Process Trenches

- ***Eight wells were sampled eight times during FY 2004 for uranium and volatile organic carbons under existing groundwater monitoring plan.***
- ***In FY 2004, all wells were sampled as planned, except for three wells in December 2003 (see Section 2.12.3 and Appendix B).***
- ***Monitoring was coordinated with other programs to avoid duplication.***

AEA Monitoring

- ***Eight wells are sampled semiannually to annually for uranium to monitor deep unconfined and confined Ringold Formation aquifers.***
- ***Monitoring is coordinated with CERCLA and RCRA sampling to avoid duplication.***

to the northwest, west, and southwest, with ultimate discharge to the Columbia River (Figure 2.12-4). During fiscal year (FY) 2004, in the north and central portion of the 300 Area, flow direction was southeast during March 2004, and east in the south portion of the 300 Area, as inferred from water-table gradients. These are typical directions for groundwater flow when the river is at low-to-medium stage. As the river stage rises during late May or June, the direction of groundwater flow can temporarily shift to a more southward direction. Changes in river-stage elevation are correlated to changes in water-level elevations at wells located inland as much as 360 meters from the river (PNL-8580).

Groundwater flows toward the east and southeast across the 300-FF-5 interest area and discharges to the Columbia River.

The remainder of this section describes contaminant plumes and concentration trends for contaminants of potential concern listed in sampling and analysis plans that support *Comprehensive Environmental Resource, Compensation, and Liability Act* (CERCLA) and RCRA requirements.

2.12.1 Groundwater Contaminants

The contaminant of greatest significance in groundwater beneath the 300 Area is uranium, which has persisted as a plume for a long time. Additional contaminants of potential concern from 300 Area sources are volatile organic compounds (cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene) and strontium-90. Constituents from sources outside of the 300 Area that migrate into the region include tritium, nitrate, and trichloroethene.

For the 300-FF-5 North region, the contaminant of greatest significance is tritium at the 618-11 burial ground, where a high concentration plume of limited areal extent is present. Contaminants of potential concern being monitored at the 316-4/618-10 waste sites area are uranium and tributyl phosphate. Tritium and nitrate migrate into the 300-FF-5 North region from upgradient sources in the 200 East Area.

2.12.1.1 Uranium

Uranium is a contaminant of concern in groundwater beneath the 300 Area and 316-4/618-10 area. In the 300 Area, it was introduced to groundwater by disposal of fuel fabrication effluent to large infiltration ponds and trenches. At the 316-4 cribs, it was disposed to open-bottomed infiltration cribs along with liquid effluent containing organic compounds. Uranium is moderately mobile in groundwater, with some sorption onto sediment particles. The mobility of uranium within waste sites, the underlying vadose zone, and in the aquifer is highly variable and dependent on (a) the chemical makeup of the waste effluent and (b) the subsurface geochemical environment, especially the carbonate concentration, pH, and surface properties of minerals (PNNL-14022).

The U.S. Environmental Protection Agency (EPA) drinking water standard for uranium is 30 µg/L; uranium's toxicity for humans is associated with damage to internal organs. Protection standards for freshwater aquatic organisms have not been established, so the drinking water standard is used by default as criteria for protection. Uranium in groundwater is typically monitored using chemical analyses for total uranium in unfiltered samples. In the river environment, uranium in shoreline media and river water is monitored using analyses for specific isotopes. Results for each type of analysis can be converted to the other to provide comparable data sets.

Plume areas (square kilometers) above the drinking water standard at the 300-FF-5 Operable Unit:

**** Nitrate — 0.61***
Trichloroethene — 0.01
*****Tritium — 0.19***
Uranium — 0.42

**** Excludes nitrate from offsite sources.***
***** Excludes tritium from 200-PO-1 Operable Unit.***

300 Area Uranium Plume. The persistent uranium plume in the 300 Area, as defined by concentrations exceeding 10 µg/L, covers an area of ~1 square kilometer. The area of the plume where concentrations exceed the 30-µg/L drinking water standard is ~0.4 square kilometer (Figures 2.12-5 and 2.12-6). Although the areal extent of the plume is quite consistent from year to year, the concentrations of uranium within the plume vary throughout the year. These changes within the plume during various seasons are related to changes in river stage, which cause the water-table elevation beneath the 300 Area to fluctuate, and also result in river water infiltrating the near-river aquifer causing dilution of contaminants. Throughout most

of the year (i.e., August through April), the river maintains a low-to-moderate river stage elevation, while the stage is typically high during late May and June. Figure 2.12-5 shows the uranium plume indicated by results for samples collected in December 2003, which is considered representative of the August through April time period.

Seasonal river stage conditions cause variability in uranium concentrations in groundwater.

Uranium concentrations in 300 Area groundwater are influenced by fluctuations in water-table elevation, which are, in turn, influenced by river stage fluctuations. Higher concentrations during periods of high water-table elevations (usually in June of each year) may be associated with remobilization of uranium in the lower vadose zone at locations near former waste disposal sites (e.g., the 316-3 trenches). As an example, Figure 2.12-7 shows the effect of yearly rises in river level near the 300 Area process trenches (well 399-1-17A). Conversely, uranium concentrations at wells located close to the river during June (such as well 399-1-16A) may be lower than those observed during other seasons. The lower concentrations are caused by infiltrating river water mixing with groundwater, thus diluting the contamination (Figure 2.12-8). There is also the possibility of increased absorption of uranium onto aquifer solids in sediment saturated by river water, thus reducing the dissolved component of uranium. Investigations of uranium mobility have shown that sorption is increased in a chemical environment that is low in carbonate; river water contains less carbonate than groundwater (PNNL-SA-33304; PNNL-14022).

During June 2004, the elevated river stage typical of the spring runoff each year was not as pronounced compared to the typically higher stages of previous years. Therefore, the uranium plume for June 2004 (Figure 2.12-6) is very similar to the December 2003 plume. The most obvious difference in concentrations between the December 2003 and June 2004 conditions occurred at well 399-3-11, which is near the 316-3 trenches (also called the 307 trenches). The December 2003 result at that well was 24 µg/L, whereas the June 2004 result was 107 µg/L.

Uranium contamination is primarily limited to the uppermost part of the unconfined aquifer at the 300 Area.

Concentrations at a well located close to the most recently active waste site (i.e., well 399-1-17A at the 316-5 process trenches) indicate a gradual decline since the mid-1990s (Figure 2.12-9) though levels appear to have remained fairly constant for the most recent sampling results. At locations farther downgradient from this waste site, concentration trends reveal the passage of a relatively high concentration pulse (Figure 2.12-10), which is related to the high river stage during the spring runoffs of 1996 and 1997, and possibly to extensive source excavation activities that started in the mid-1990s. Concentrations at other locations within the plume area show variable trends. In the absence of current disposal of effluent to waste sites and the removal of some past-practice waste sites by excavation, the most likely controls on long-term concentration trends are (a) plume migration and (b) recharge of the plume by continuing releases from vadose zone sediment and possibly from aquifer solids as well. Short-term variability in concentrations is caused by seasonal changes in water-table elevation and groundwater/river water interaction near the shoreline.

Uranium contamination appears to be limited to the uppermost part of the unconfined aquifer, i.e., near the water table. The plume maps prepared for this report represent conditions near the water table. Several wells in the 300 Area are screened at the bottom of the unconfined aquifer; uranium concentrations in samples from these wells range from non-detect to ~14 µg/L in recent samples. The higher values are found near the most recently active source – the 316-5 process trenches. Uranium has not been detected at the few wells that monitor the uppermost confined aquifer.

New aquifer tubes adjacent to the Columbia River show high uranium concentrations near the core area of the groundwater plume.

During FY 2004, aquifer tubes were installed at eight locations along the 300 Area shoreline. The initial samples from these tubes revealed uranium concentrations ranging from 10 up to 241 µg/L, with the highest values adjacent to the central core area of the groundwater plume. Additional investigation of uranium in the zone of interaction between groundwater and river water is underway in FY 2005. Some preliminary results confirm the presumption that the uranium plume is primarily confined to the uppermost depths of the unconfined aquifer, and that the relatively high current concentrations observed near the river represent the passage of a "pulse" created during the mid-1990s.

Uranium Near 316-4 Cribs/618-10 Burial Ground. Uranium concentrations above natural background levels (i.e., 5 to 8 µg/L) are found in groundwater near the 316-4 cribs and 618-10 burial ground. Concentrations at wells 699-S6-E4A and 699-S6-E4L, which are located adjacent to the cribs and southeast perimeter of the burial ground, were higher than background but generally lower than the drinking water standard of 30 µg/L during FY 2004. The exceptions are the most recent values at well 699-S6-E4L, where concentrations appear to be gradually increasing and currently exceed the standard, with a high value of 30.6 µg/L in June 2004 (Figure 2.12-11). Uranium concentrations at well 699-S6-E4A also appear to be increasing slightly, as do results for gross alpha and gross beta. These gradually increasing trends apparently started in 2003 before excavation of the 316-4 cribs began in late September 2004.

2.12.1.2 Organic Compounds

Constituents of concern in groundwater of the 300 Area include cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene. In the 300-FF-5 North region, organic compounds previously identified as a potential concern are present at the 316-4/618-10 waste sites and include tributyl phosphate and petroleum hydrocarbons.

Several volatile organic compounds were detected in the 300-FF-5 Operable Unit during FY 2004, but only trichloroethene and cis-1,2-dichloroethene were reported in concentrations that exceeded the drinking water standards.

300 Area Organic Compounds. Cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene were detected in 300 Area groundwater samples during FY 2004, but only cis-1,2-dichloroethene and trichloroethene were found to be in concentrations exceeding the drinking water standards (70 and 5 µg/L, respectively). Cis-1,2-dichloroethene was detected in 11 wells near or downgradient of the 316-5 process trenches. Seven of the wells are screened at the water table and four at the base of the unconfined aquifer. Only well 399-1-16B, screened at the base of the unconfined aquifer, had reported cis-1,2-dichloroethene results that exceeded the 70-µg/L drinking water standard. During FY 2004, the reported values of cis-1,2-dichloroethene ranged from 95 and 150 µg/L at well 399-1-16B. Two other reported values were 200 and 280 µg/L, but they are potentially exaggerated because they exceeded the calibration range of the laboratory analytical equipment (gas chromatograph/mass spectrometer). The trend for cis-1,2-dichloroethene in this well is holding relatively steady between 100 and 200 µg/L (Figure 2.12-12).

Trichloroethene was detected in 24 wells in the 300 Area and also in other wells offsite to the southwest where there is a source of trichloroethene groundwater contamination (Figure 2.12-13). Another source of trichloroethene groundwater contamination is the 316-5 process trenches. Of the 24 wells in the 300 Area where trichloroethene was detected during FY 2004, all but two are screened at the water table. The two wells screened at the base of the unconfined aquifer where trichloroethene was detected are wells 399-1-16B and 399-1-8, which are downgradient of the 316-5 process trenches. The only well in the 300 Area where trichloroethene was reported above the drinking water standard (5 µg/L) was well 399-1-7, which is also located downgradient of the 316-5 process trenches. Although the average concentration of uranium in well 399-1-7 was lower than the drinking water standard during FY 2004, the reported value for June 2004 was 5.4 µg/L. The trend for trichloroethene in well 399-1-7 is erratic with elevated values reported in the June samples of 2002, 2003, and 2004 (Figure 2.12-14). The reason for the elevated levels in June is unknown, but it may be related to higher water-table conditions in June (similar to trend for uranium in some wells). A value of 6.8 µg/L was measured in a sample from a newly installed aquifer tube located along the downgradient flow path from well 399-1-7.

Tetrachloroethene (drinking water standard 5.0 µg/L) was detected at very low concentrations in 14 wells in the 300 Area during FY 2004. Most of these wells are downgradient of the 316-5 process trenches, and all but one of these wells is screened at the water table. The one well where tetrachloroethene was detected at the base of the unconfined aquifer (well 399-1-16B) is also the same well with the highest reported concentration during FY 2004 (1.7 µg/L). The other 13 wells had reported levels of tetrachloroethene

that ranged from 0.18 to 0.59 µg/L. Reported levels of tetrachloroethene in wells downgradient of the 316-5 process trenches have been as high as 38 µg/L (July 1998 in well 399-1-17A) in previous years, but during FY 2004 reported concentrations remained low.

Elsewhere in the 300 Area, contamination by petroleum hydrocarbons was suspected during remedial actions at the 618-4 and 618-5 burial grounds. However, groundwater samples from wells 399-1-15 and 399-1-6 have not revealed petroleum hydrocarbon contamination to date.

Organic Compounds in the 300-FF-5 North Region. Tributyl phosphate has been detected in the past at well 699-S6-E4A located adjacent to the 316-4 cribs. The cribs received effluent containing tributyl phosphate, among other contaminants such as uranium. The single tributyl phosphate result for that well during FY 2004 indicated non-detect. Samples from nearby newly constructed wells 699-S6-E4K and 699-S6-E4L also indicate non-detections. Tributyl phosphate became of interest in 1996 following refurbishment of well 699-S6-E4A, when contamination in the vadose zone and/or within the well was remobilized. A value of 1,500 µg/L was observed at that time. Subsequent monitoring showed that the occurrence is very localized. The semivolatile compound tends to bind in the vadose zone beneath waste sites that received effluent containing tributyl phosphate, where it slowly degrades with time. It is not very soluble in water and, therefore, not widely dispersed via water transport mechanisms. There is no drinking water standard for tributyl phosphate.

Petroleum hydrocarbons (both diesel and gasoline) were also detected in groundwater near the 316-4 cribs during well refurbishment activities in the mid-1990s (well 699-S6-E4A). Monitoring conducted since that time has shown non-detections.

2.12.1.3 Strontium-90

Strontium-90 has been detected as an isolated occurrence at well 399-3-11 in previous years (PNNL-13788). The drinking water standard is 8 pCi/L. The highest concentration measured in recent years was 8.7 pCi/L in 1995. Since then, concentrations have varied between 3 and 8 pCi/L. Reported results from well 399-3-11 during FY 2004 were 3.4 and 3.8 pCi/L for samples collected during December 2003 and June 2004, respectively. The source of the strontium-90 is unknown, but it may be from the location of the decommissioned (and backfilled) 316-3 trenches ~60 meters north-northwest of well 399-3-11.

2.12.1.4 Nitrate

Groundwater in the 300 Area and 300-FF-5 North region is contaminated with nitrate from upgradient sources. In the 300 Area the source is to the southwest, while in the 300-FF-5 North region, the source is the 200 East Area (see Section 2.11.1.3).

Groundwater in the 300 Area and 300-FF-5 North region is contaminated with nitrate from sources outside of the operable unit. Concentrations are generally below the drinking water standard (45 mg/L).

Nitrate in the 300 Area. Nitrate was detected in all wells in the 300 Area during FY 2004. Figure 2.12-15 shows the distribution of nitrate in the 300 Area and 1100-EM-1 Operable Unit (see Figure 2.1-6 in Section 2.1 for map of nitrate across the entire Hanford Site). Wells within the 300 Area have nitrate concentrations below the 45-mg/L drinking water standard, but concentrations increase to the southwest toward the groundwater contamination source. The highest concentration reported during FY 2004 was at well 399-5-1 (southwest 300 Area) with a reported level of 21.8 mg/L.

Nitrate in the 300-FF-5 North Region. The 300-FF-5 North region is within the large nitrate plume coming from the 200 East Area. Background levels of nitrate upgradient of the 618-11 burial ground are in the range of 20 to 40 mg/L. In the vicinity of the 618-11 burial ground, the concentrations of nitrate are somewhat higher, with values at wells 699-13-3A and 699-12-2C as high as ~80 mg/L during FY 2004. These higher values may reflect the influence of an active septic system operated by Energy Northwest.

2.12.1.5 Tritium

Tritium contamination in groundwater in the 300-FF-5 Operable Unit has two sources. One is the site-wide tritium plume that originates in the 200 East Area (see Figure 2.1-5 in Section 2.1 and Section 2.11.1.1). The other is the 618-11 burial ground in the 300-FF-5 North region. Concentrations attributed to the site-wide tritium plume as it reaches the 300 Area are shown in Figure 2.12-16 and range from 100 to 10,000 pCi/L, depending on location. Wells located toward the northeast have higher concentrations than those toward the southwest. Contours on tritium maps similar to Figure 2.12-16 in the last few years have shifted very little, thus indicating that the tritium plume in the north part of the 300 Area has changed very little.

High concentrations of tritium detected in 1999 at the 618-11 burial ground are believed to be the result of tritium release from buried material.

Tritium at 618-11 Burial Ground. High concentrations of tritium were detected in early 1999 at well 699-13-3A, which is located immediately to the east of the 618-11 burial ground fence. Following this unexpected discovery, investigations were undertaken to characterize the plume (PNNL-13228) and to learn more about the source for the tritium (PNNL-13675). These investigations revealed that the 618-11 burial ground was the likely source for the tritium, and that the extent of the plume was a relatively narrow tongue extending east-northeast (Figure 2.12-17). Concentrations of tritium within the narrow plume ~1 kilometer distance from the burial ground were indistinguishable from background levels associated with the site-wide plume.

Since 1999, the concentration of tritium at well 699-13-3A, where the high concentrations of tritium were first discovered in 1999, rose to >8 million pCi/L in 2000, and then started a rapid decrease to current levels, which have been in the 1.9 to 2.2 million pCi/L range for sampling events during FY 2004 (Figure 2.12-18). This trend suggests that an episodic event may have occurred that caused a release of tritium from buried materials and/or a remobilization of tritium in the vadose zone sufficient to impact groundwater.

2.12.2 Operable Unit Monitoring and Interim Action

Groundwater investigations associated with the 300-FF-5 Operable Unit continued during FY 2004 under a revised operation and maintenance plan (DOE/RL-95-73). This document was revised in response to an action item contained in the first 5-year review of the record of decision for interim remedial action (Action Item 300-4; ROD 1996b). The geographical scope of the operable unit was subsequently expanded via an explanation of significance difference to include two additional outlying areas (EPA 2000). The operable unit currently includes groundwater beneath the 300 Area, 618-11 burial ground, and 618-10 burial ground and adjacent 316-4 cribs (Figure 2.12-1). The following discussion refers to two sub-divisions of the operable unit: 300 Area and 300-FF-5 North region, the latter containing the outlying waste sites.

The remedial action objectives for groundwater in the 300-FF-5 Operable Unit (ROD 1996b) are:

- ***Protect human and ecological receptors from exposure to contaminants in the soil and debris.***
- ***Protect receptors from exposure to contaminants in the groundwater and control the sources of contamination to minimize future impacts to groundwater.***
- ***Protect the Columbia River such that contaminants in the groundwater or soil after remediation do not result in an impact to the river that would exceed the Washington State surface water quality standards.***

The record of decision sets the objective concentrations as the drinking water standards for cis-1,2-dichloroethene, trichloroethene, and uranium. In 2000, EPA expanded the record of decision to include groundwater beneath the 300-FF-5 North region (EPA 2000).

2.12.2.1 Monitoring Activities

Forty-one monitoring wells, eight aquifer tubes sites (installed in February 2004), and two riverbank springs were sampled as planned in FY 2004, with the exception of three wells being missed in December 2003 for logistical reasons. See Appendix A for the list of sites.

Groundwater monitoring for the 300 Area portion of the operable unit included semiannual

sampling at monitoring wells during December and June, with the intent of characterizing average seasonal conditions (December) and the spring period of high water-table elevations (June) that are caused by the spring runoff to the Columbia River (see Figures 2.12-5 and 2.12-6). Along the 300 Area shoreline, sampling and analysis at various sites and of various media are being conducted under several programs, with primarily annual sampling. Under CERCLA, near-river wells, shoreline aquifer tubes, and riverbank springs are sampled to provide data on the distribution and concentration trends of contaminants in groundwater near the point-of-discharge to the river ecosystem. Under the Public Safety and Resource Protection Program, an integrated effort involving the Surface Environmental Surveillance Project and the Ecological Monitoring and Compliance Project is producing additional data on contaminants at the groundwater/river interface. Media sampled include riverbed pore water and sediment, river water, and various aquatic biota. To date, clams have been shown to be good indicators of environmental health where uranium-contaminated groundwater discharges to the riverbed (PNNL-13692). Also during 2004, additional research on the interaction between groundwater and surface water at the 300 and 100-N Areas was initiated by the Remediation Science and Technology Project and continues for 2005. Finally, the 300 Area is included as part of the River Corridor Baseline Risk Assessment, which started in 2004.

In the 300-FF-5 North region, monitoring the tritium plume that extends downgradient of the 618-11 burial ground continued during FY 2004, primarily with quarterly sampling of wells used to define the plume. For wells closest to the burial ground, concentrations show a declining trend (see Section 2.12.1.6 and Figures 2.12-17 and 2.12-18). At other wells, changes in concentrations seem to reflect lateral spreading and gradual migration of the plume to the east. An updated characterization of this plume is being prepared to support the focused feasibility study for 300-FF-5, which is in progress during 2005, and also the 5-year review of the record of decision for the operable unit.

Monitoring results from two new wells do not reveal any evidence that a groundwater plume originates from the 618-10 burial ground.

At the 316-4/618-10 waste sites, monitoring frequency was increased during late FY 2004 to better detect changes associated with excavation of the 316-4 cribs. Remedial action associated with the cribs began near the end of FY 2004 with site preparation activities (actual excavation began in October 2004). A slight rise in uranium concentrations was observed at two nearby wells (Figure 2.12-11), which raised suspicions that contamination in the vadose zone was being remobilized. Near the 618-10 burial ground, an earlier soil-gas investigation around the perimeter fence was completed as part of planning for two new monitoring wells, 699-S6-E4K and 699-S6-E4L (PNNL-14320). Slightly elevated helium-3/helium-4 ratios were observed at several soil-gas sample sites and were attributed to tritium in the site-wide plume, whose leading edge is in this area. Subsequent sampling of the two new wells has not revealed any evidence for a groundwater plume whose origin is the burial ground. Water-quality conditions at those wells reflect the site-wide tritium plume from 200 East Area, which contains co-contaminants nitrate and iodine-129.

2.12.2.2 Interim Remedial Action Progress

The record of decision for the operable unit (ROD 1996b; EPA 2000) describes the selected interim action remedy as:

- Continued monitoring of groundwater that is contaminated above health-based levels to ensure that concentrations continue to decrease.
- Institutional controls to ensure that groundwater use is restricted to prevent unacceptable exposures to groundwater contamination.

Implementation of the interim remedy is described in the updated and expanded operations and maintenance plan (DOE/RL-95-73) and a sampling and analysis plan (DOE/RL-2002-11). Key elements of the remedy include (a) continued monitoring of groundwater to verify previously modeled predictions of contaminant attenuation, and (b) evaluating the

need for active remedial measures. Continued monitoring involves sampling and analysis of groundwater collected from wells and shoreline sites, and also developing new information on (1) the recharge of mapped plumes because of release from the vadose zone and/or aquifer solids, (2) the characteristics of discharge from the aquifer to the Columbia River, and (3) dispersal of contaminants in the river environment via biota pathways. The intent of monitoring during the interim action period is to build a technical basis for including monitored natural attenuation as a component in a future record of decision, which may also involve active remedial measures.

As stated in the operations and maintenance plan's Executive Summary (DOE/RL-95-73), specific monitoring objectives include the following:

"1. Verify that natural attenuation reduces groundwater contamination concentrations to drinking water maximum contaminant levels over a reasonable time period.

2. Confirm that contaminant concentrations in the river seeps do not exceed ambient water-quality criteria or established remediation goals (drinking water standards).

3. Validate contaminant fate and transport conceptual models."

Dissemination of new information on achieving these objectives has been accomplished via monthly briefings at the 300 Area Unit Managers' Meetings. Minutes of these meetings are included in the U.S. Department of Energy's (DOE) Administrative Record for the 300-FF-5 Operable Unit. During FY 2005, additional reports are being prepared that describe in detail the natural processes that control the level of contamination in the operable unit.

Analytical results for samples of groundwater, surface water, sediment, and biota are stored in the Hanford Environmental Information System database (HEIS 1994). Groundwater data are summarized in an annual report (this document), while results for other media are described in an annual environmental report (e.g., PNNL-14687). Data and interpretations are also presented in topical reports as the need arises.

The CERCLA process includes a requirement to review the effectiveness of records of decision every 5 years, if contamination remains in the operable unit involved. The results of the first 5-year review (EPA 2001) indicated that the remedial actions at 300 Area source waste sites were proceeding in an effective manner to protect human health and the environment. EPA re-affirmed that the cleanup goals and remedy selection for groundwater are still appropriate at the time the first 5-year review was released. The next 5-year review will be conducted during 2005 and made available to the public by spring 2006.

During FY 2004, new work was started on computer simulation of the uranium plume and review of remedial action alternatives for uranium.

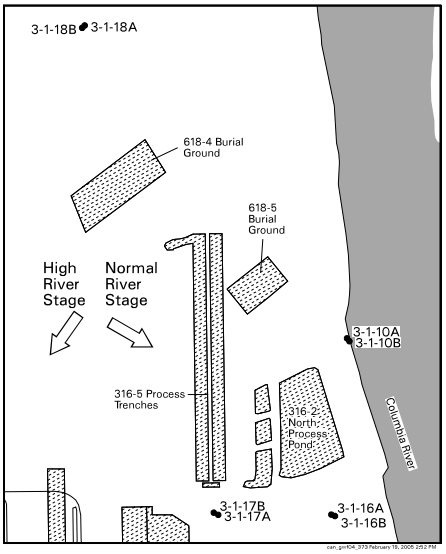
Numerous activities were initiated during FY 2004 to provide updated information on contamination in the subsurface at the 300 Area and outlying waste sites. These activities are part of extending the scope of the original remedial investigation (DOE/RL-94-85) to provide more information on what controls the persistence of the 300 Area uranium plume and how contaminant levels have changed during the 10 years since the original record of decision (ROD 1996b). Several projects were started to develop computer simulations for groundwater flow and contaminant transport in the 300 Area. An update to the original focused feasibility study for remedial action alternatives for groundwater was also started. Published reports containing the results of these investigations will become available during FY 2005.

The following is a brief status of how well the monitoring objectives for contaminants of concern are being met for the 300-FF-5 Operable Unit. Contaminants of concern for the 300 Area region, as identified in the record of decision (ROD 1996b), are uranium, trichloroethene, and cis-1,2-dichloroethene. Contaminants of concern for the 300-FF-5 North region, as identified in the explanation of significant differences (EPA 2000), are tritium at the 618-11 waste site and uranium and tributyl phosphate at the 316-4/618-10 waste sites.

1. Objective: "Verify that natural attenuation reduces groundwater contamination concentrations to drinking water maximum contaminant levels over a reasonable time period."
    - Since ~1998, uranium concentrations at many 300 Area monitoring wells have shown a declining trend, although not necessarily to the 30-µg/L standard or lower. Investigation of changes in the areal extent, contaminated volume, and mass of dissolved uranium are consistent with the interpretation of an overall declining level of contamination for recent years. Dispersion by groundwater flow and a reduction in the rate of uranium recharge from the vadose zone appear to have the largest effect on the level of contamination in the aquifer.
    - Uranium near the 316-4 waste site increased during 2004 to slightly exceed the drinking water standard; the cause of this trend is currently not known.
    - Volatile organic compounds in the 300 Area are generally present at concentrations below the drinking water standard. The exceptions are cis-1,2-dichloroethene at one well, which remains relatively constant at concentrations approximately twice the standard, with no apparent attenuation. Also, trichloroethane exceeds the standard at one well and one aquifer tube.
    - Volatile organic compounds at the 316-4 waste site remain undetected in groundwater, though significant concentrations are present in the vadose zone at the waste site, as revealed by sampling during excavation activities in fall 2004.
    - A tritium plume created by releases from the 618-11 burial ground has not changed shape appreciably or migrated a significant distance during the past year. Concentrations have decreased at wells nearest the source but remain well above the drinking water standard. Attenuation appears to be primarily controlled by radioactive decay.
2. Objective: "Confirm that contaminant concentrations in the river seeps do not exceed ambient water-quality criteria or established remediation goals (drinking water standards)."
    - Uranium concentrations remain above the drinking water standard at several riverbank spring locations. The gross alpha associated with this uranium also exceeds the 15-pCi/L drinking water standard. The maximum concentrations for trichloroethene are below the standard, and cis-1,2-dichloroethene was not detected in riverbank springs (PNNL-14687; fall 2003 results)
    - Groundwater contamination associated with the outlying waste sites (i.e., 300-FF-5 North region) has not been identified in riverbank springs.
3. Objective: "Validate contaminant fate and transport conceptual models."
    - Considerable effort has gone into developing groundwater flow and contaminant transport computer models for the aquifer beneath the 300 Area during FY 2004. Useable output from these models is expected to become available during early 2005 and will support the focused feasibility study for uranium remedial action options, as well as other objectives not related to the CERCLA program.
    - Research activities associated with the mobility of uranium have produced new information that will be incorporated into computer models for uranium transport. Although transport modeling will always include some degree of uncertainty caused by a lack of data on uranium inventory in the subsurface, the new flow and transport models should provide much better predictions for the future behavior of the uranium plume than those previously available (e.g., DOE/RL-94-85).

2.12.3 Facility Monitoring — 316-5 Process Trenches

This section describes results of monitoring groundwater at the 316-5 process trenches, a RCRA treatment, storage, or disposal unit in the Hanford Facility RCRA Permit (Ecology 1994a). This facility is monitored under the requirements of RCRA for hazardous waste constituents and *Atomic Energy Act of 1954* for radionuclides. Hazardous constituents and radionuclides are discussed jointly in this section to provide comprehensive interpretations of groundwater contamination for the facility. As discussed in Section 2.1, with respect to RCRA sites, DOE has the sole and exclusive responsibility and authority to regulate source, special nuclear, and by-product materials at DOE-owned nuclear facilities.



The 300 Area process trenches received effluent discharges of dangerous mixed waste from fuel fabrication and nuclear research laboratories in the 300 Area from 1975 through 1994. Groundwater monitoring at the 300 Area process trenches is conducted in accordance with Washington Administrative Code (WAC) 173-303-645(11), Corrective Action Program, and Part VI, Chapter 1 of the Hanford Facility RCRA Permit (Ecology 1994a). The modified closure plan (DOE/RL-93-73), which is incorporated into the Hanford Facility RCRA Permit, indicates that groundwater remediation is deferred to the CERCLA 300-FF-5 Operable Unit.

During FY 2004, RCRA groundwater monitoring at the 300 Area process trenches was operated under an existing plan (WHC-SD-EN-AP-185) that has been in effect since 1997. Appendix B lists groundwater monitoring wells and constituents monitored for the 300 Area process trenches. Constituents monitored under RCRA are uranium, cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene. (Note: Uranium is not regulated under RCRA but was included in the monitoring plan for completeness and incorporated by reference into the Hanford Facility RCRA Permit [Ecology 1994b].) The characteristics in the groundwater flow affected by discharges to the 316-5 process trenches are discussed in Section 2.12.1. The sampling frequency at the eight wells of the monitoring network is monthly for eight months of the fiscal year (December, January, February, March, June, July, August, and September). This sampling schedule was designed to accommodate two semiannual sampling periods with four time-independent samples collected during each period. During FY 2004, the December 2003 samples were not collected from three wells (399-1-16A, 399-1-16B, and 399-1-18A) because sampling teams fell behind schedule. All other sampling events were accomplished as scheduled.

Only two of the contaminants of concern remain above drinking water standards, uranium and cis-1,2-dichloroethene.

Only two contaminants of concern for RCRA monitoring remain above the drinking water standards, uranium and cis-1,2-dichloroethene. Uranium concentrations in the well nearest the process trenches have decreased or remained constant during recent years (Figure 2.12-9). Farther downgradient along the flow path from the process trenches, concentrations increased, then decreased, suggesting the passage of higher concentrations created by high water-table conditions during high river stages of 1997 and 1998 (Figure 2.12-10).

Well 399-1-16B, a well installed a the base of the unconfined aquifer downgradient of the 300 Area process trenches, is the only network well having reported levels of cis-1,2-dichloroethene above the drinking water standard (70 μg/L). The concentration appears to be holding steady, neither significantly increasing or decreasing in concentration with time (Figure 2.12-12), although fluctuating between 100 and 200 μg/L. Other volatile organic compounds such as trichloroethene and tetrachloroethene continue to be detected in network wells at the 300 Area process trenches but generally at levels lower than drinking water standards, except for June samples at one well (399-1-7) (Section 2.12.1.2).

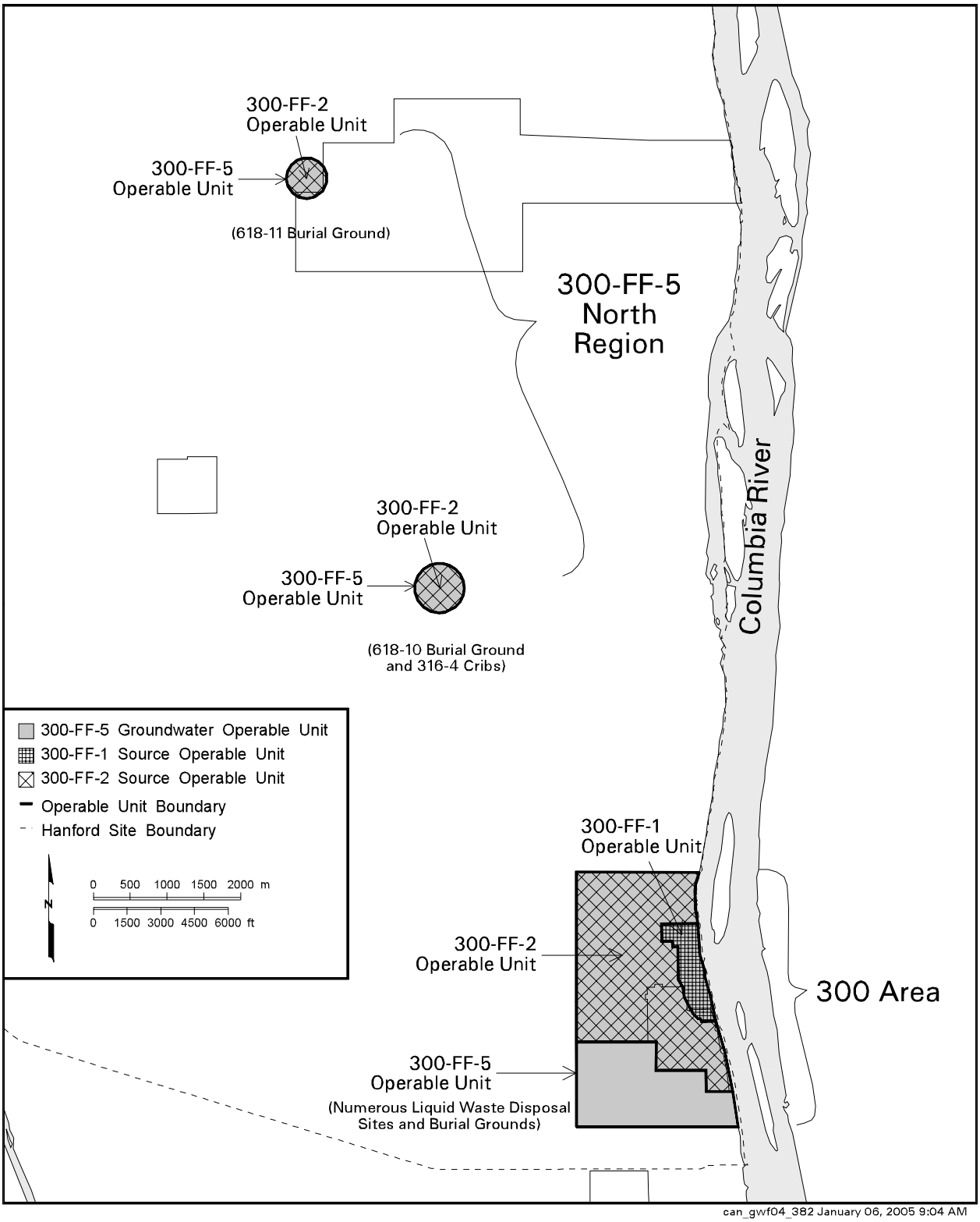


Figure 2.12-1. Geographical Subdivisions of the 300-FF-5 Operable Unit

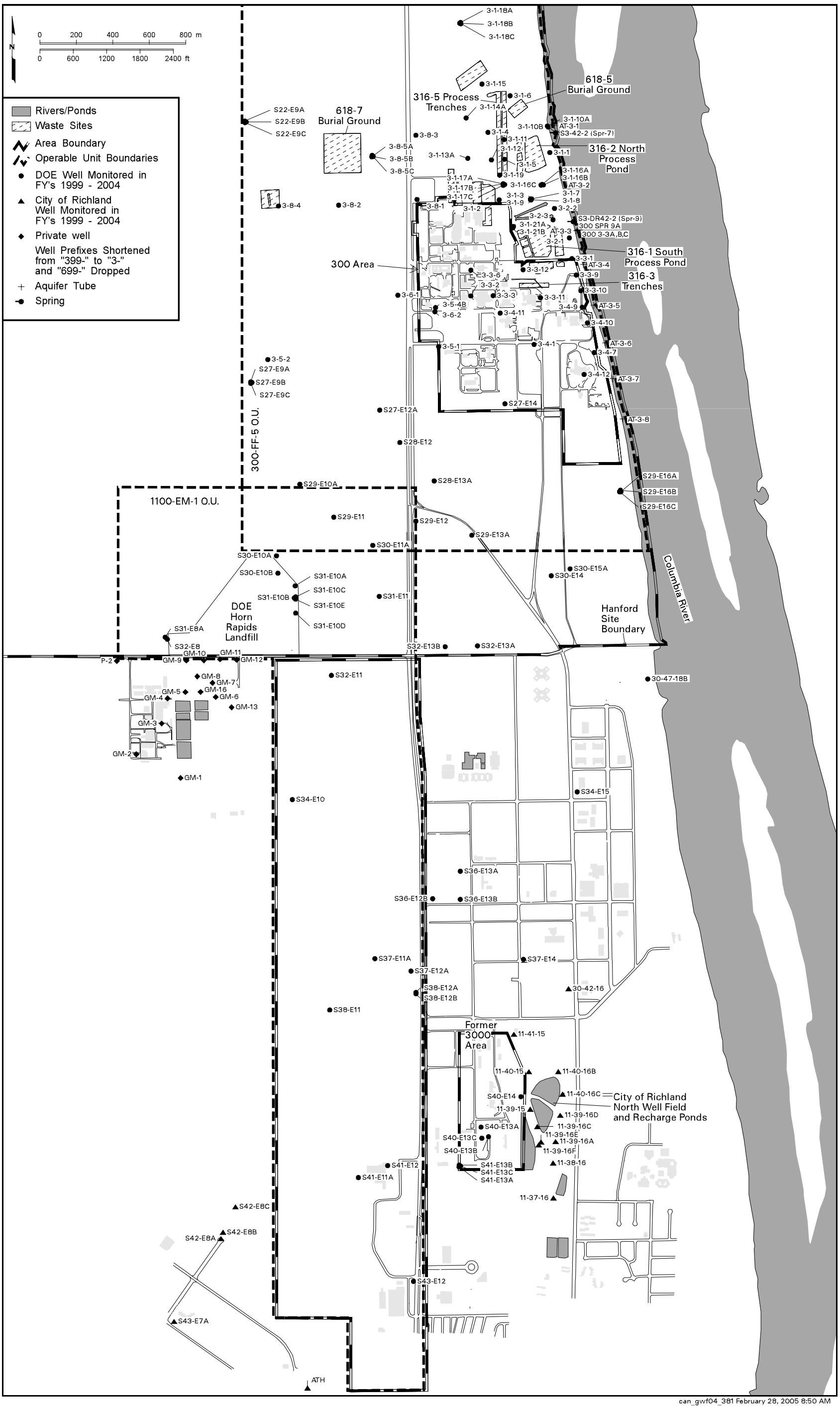
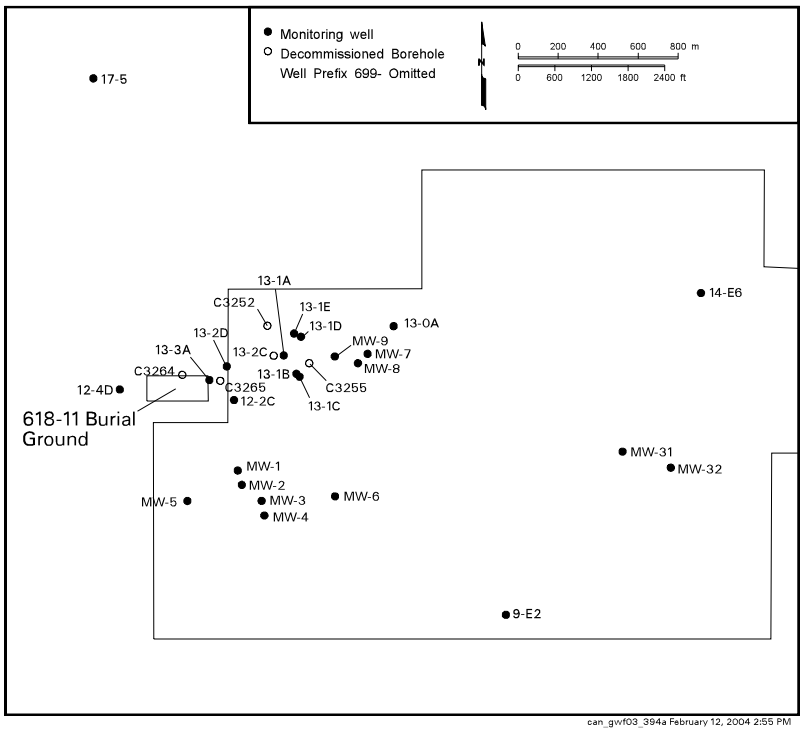


Figure 2.12-2. Groundwater Monitoring Wells in the 300 and 1100-EM-1 Areas



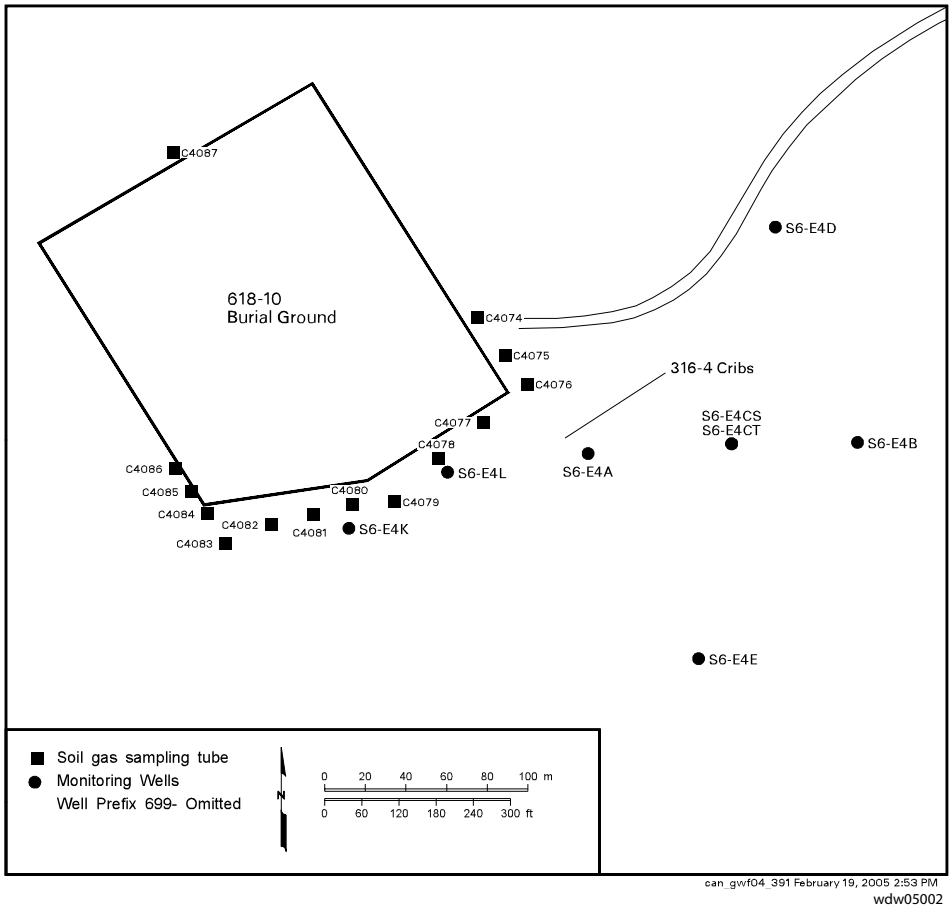


Figure 2.12-3. Groundwater Monitoring Wells in the 300-FF-5 North Region

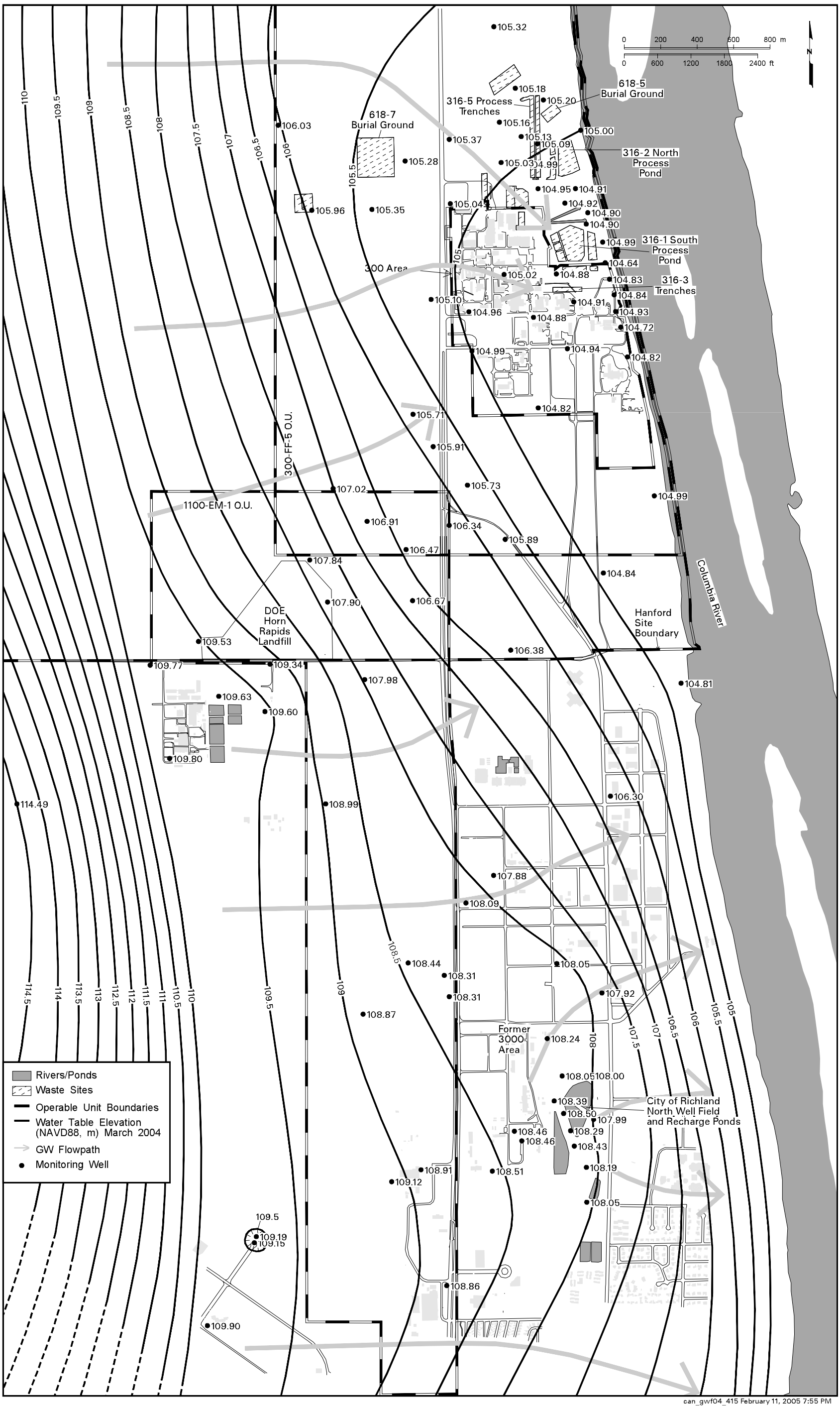


Figure 2.12-4. Water-Table Map for the 300 and 1100-EM-1 Areas, March 2004

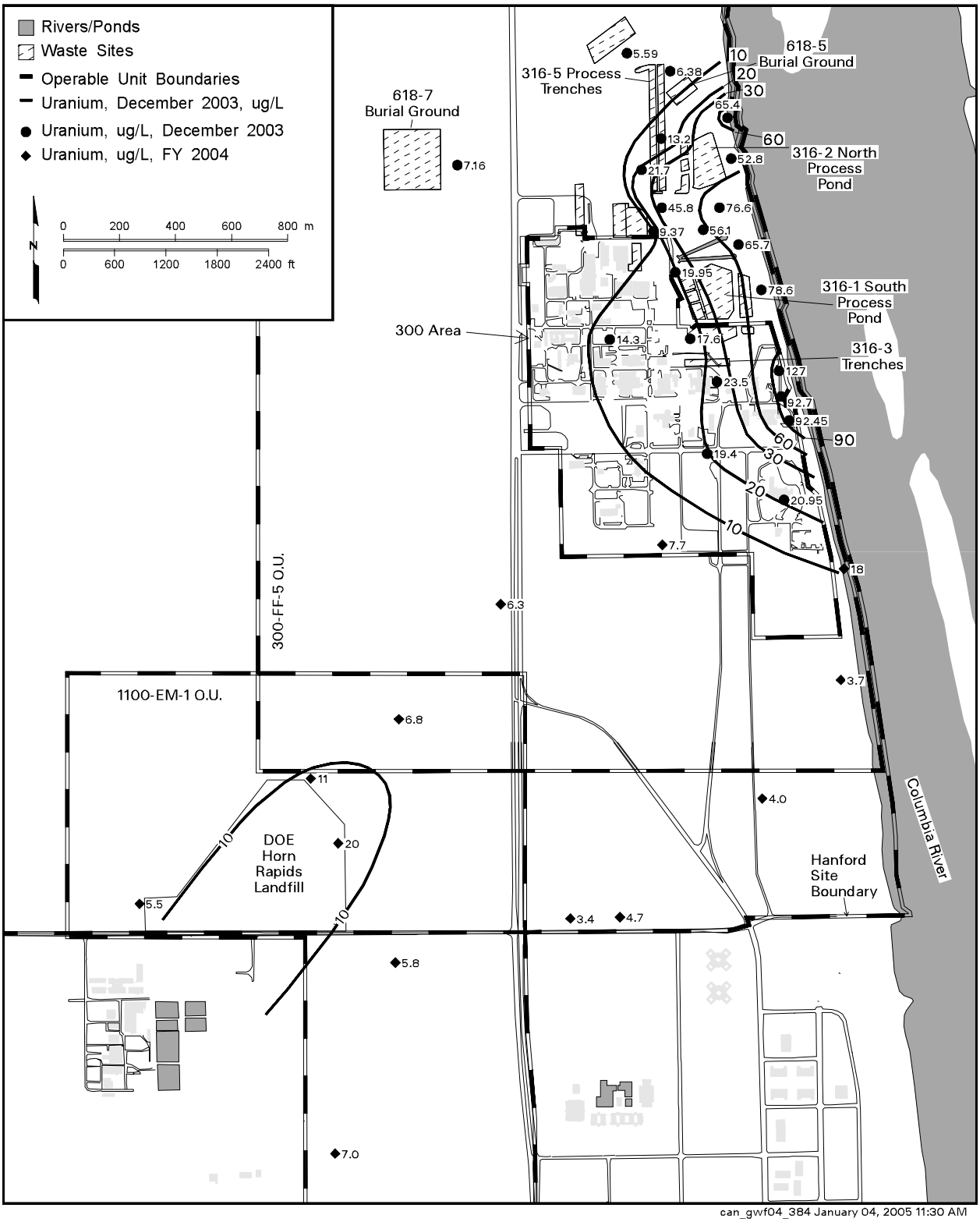


Figure 2.12-5. Uranium Concentrations at Wells in the 300 Area, December 2003, Top of Unconfined Aquifer

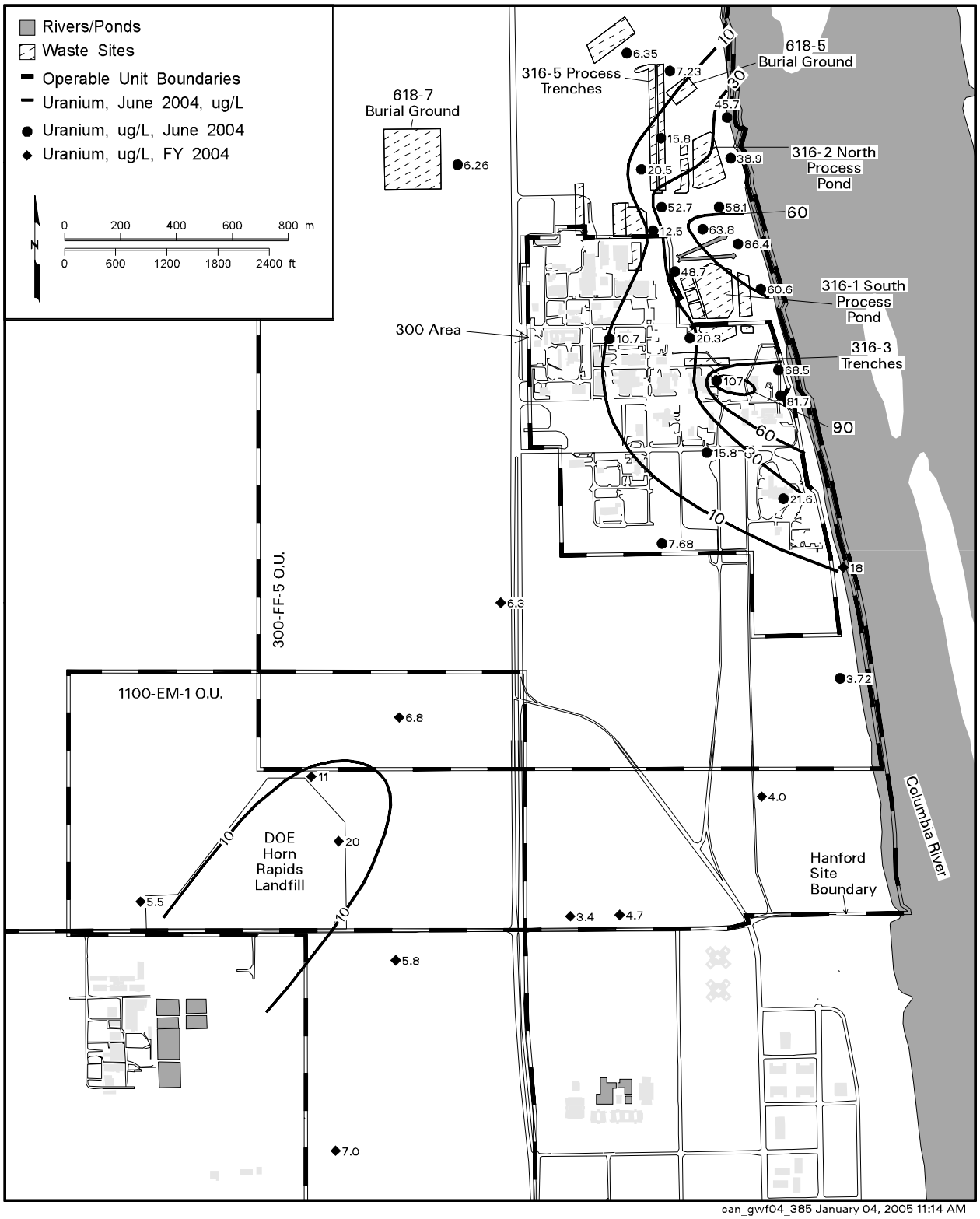


Figure 2.12-6. Uranium Concentrations at Wells in the 300 Area, June 2004, Top of Unconfined Aquifer

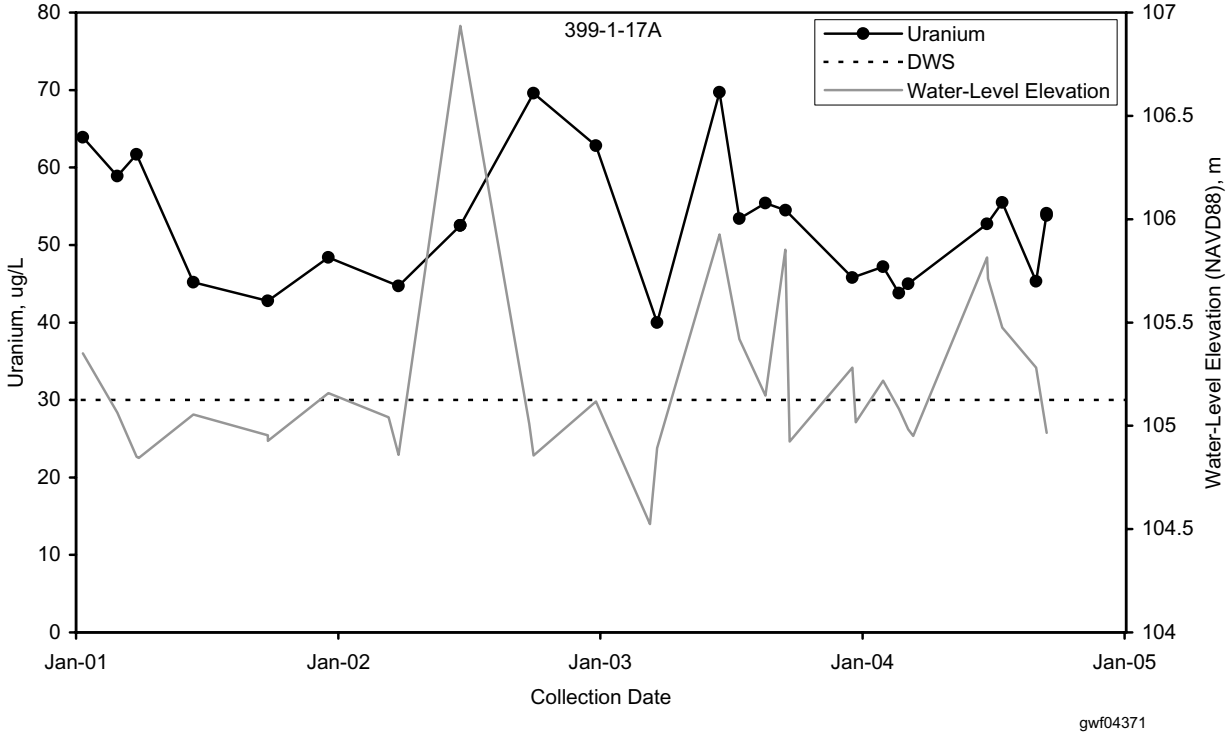


Figure 2.12-7. Uranium Concentrations in Well 399-1-17A Showing Positive Correlation with Rising Water-Table Elevations. This well location is far enough from the Columbia River to generally avoid mixing of groundwater and river water.

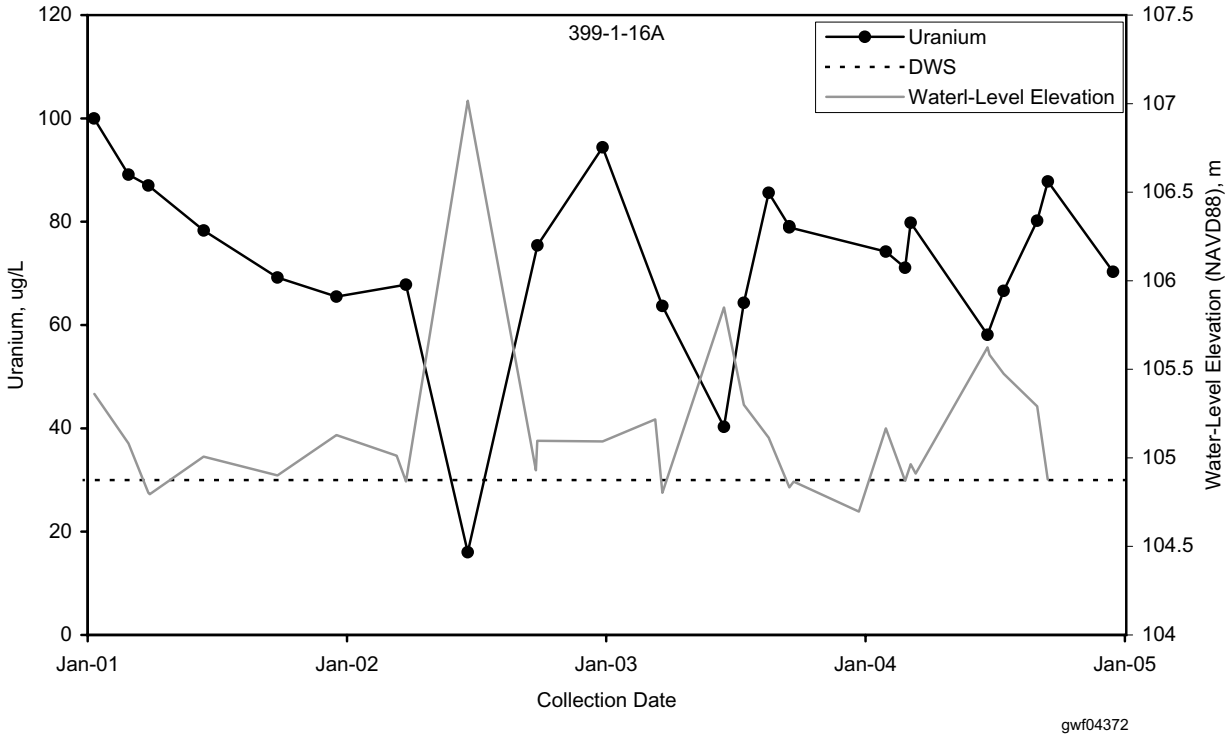


Figure 2.12-8. Uranium Concentrations in Well 399-1-16A Showing Positive Correlation with Rising Water-Table Elevations. This well location is close to the Columbia River and groundwater mixes with river water during high river stages (June).

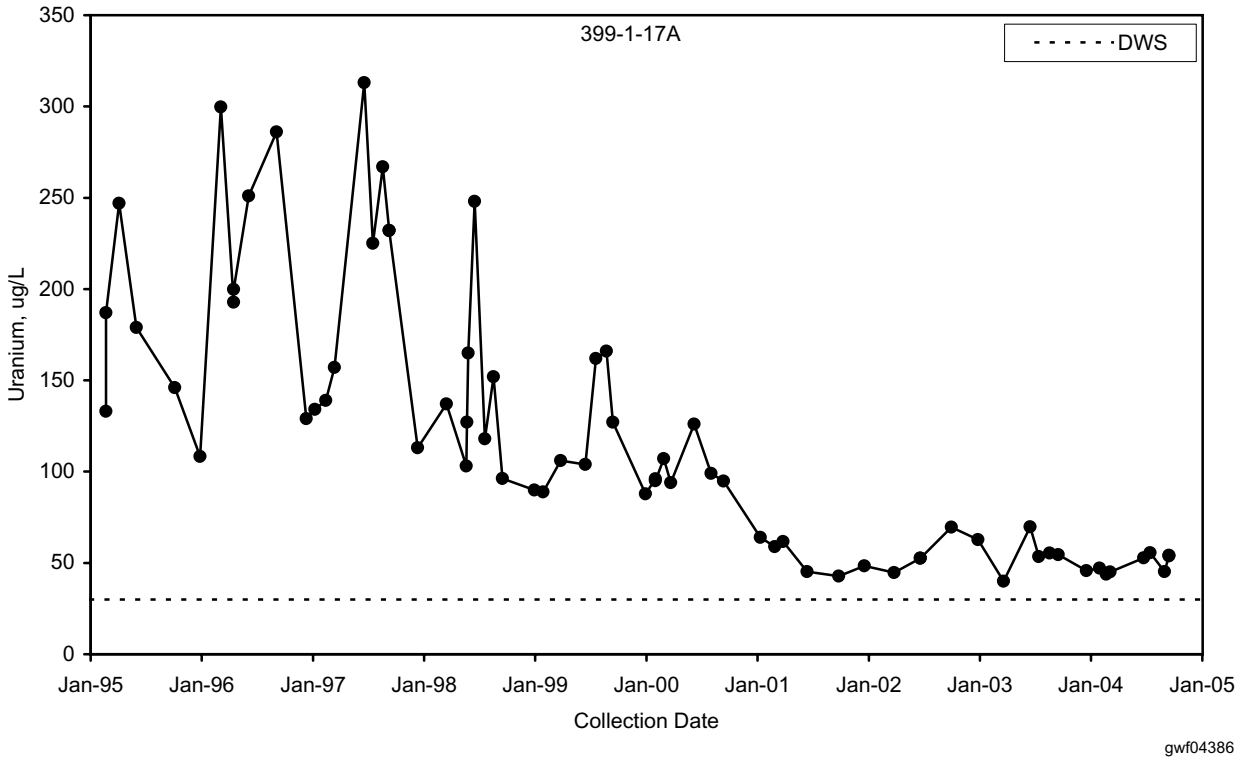


Figure 2.12-9. Uranium Concentrations at Well 399-1-17A Showing Long-Term Gradual Decline Since 1997

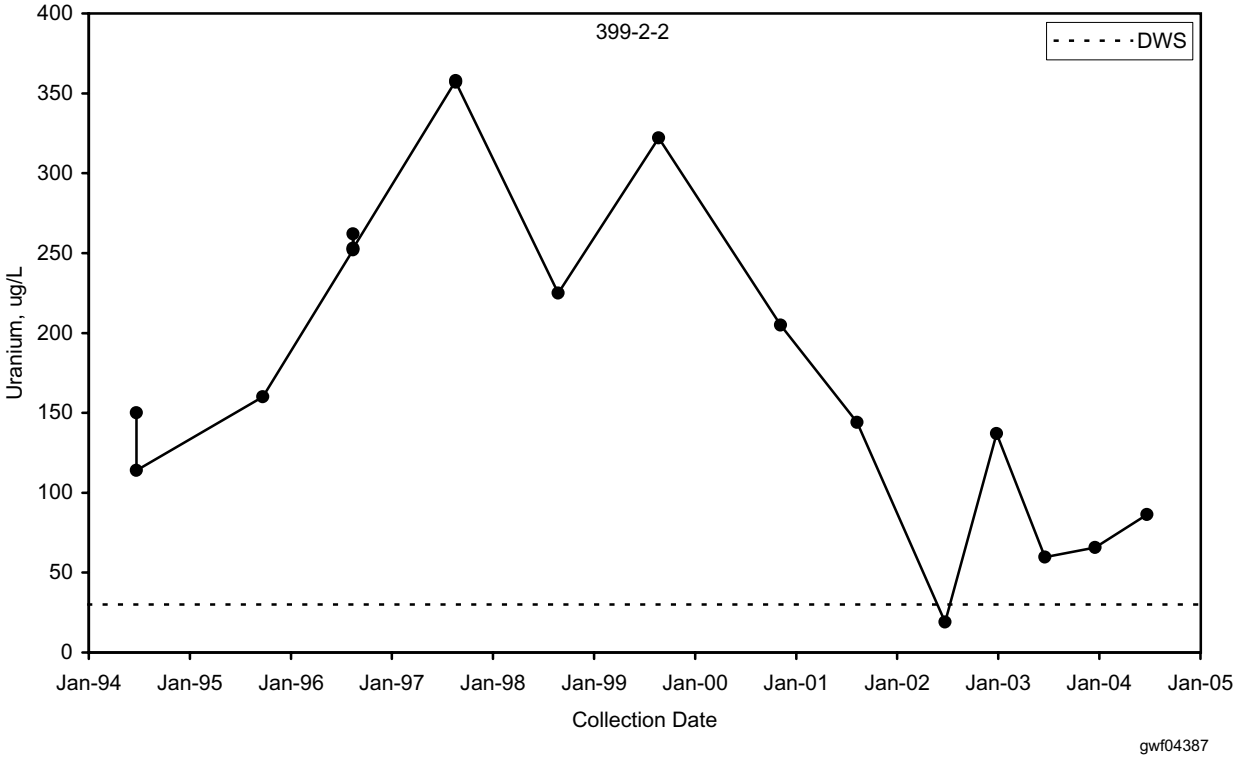


Figure 2.12-10. Uranium Concentrations at Well 399-2-2 Showing Increase and Decrease Since 1994

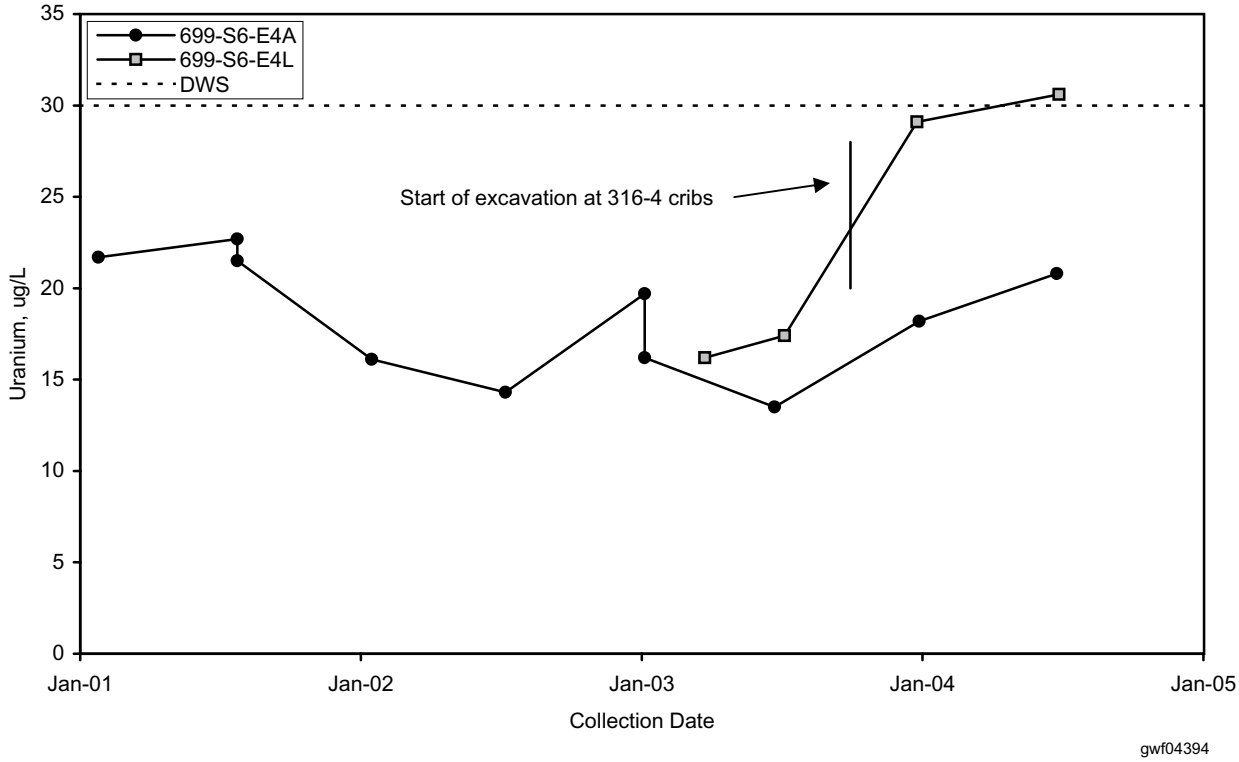


Figure 2.12-11. Uranium Concentrations at Wells Near the 316-4 Cribs Remedial Action Site

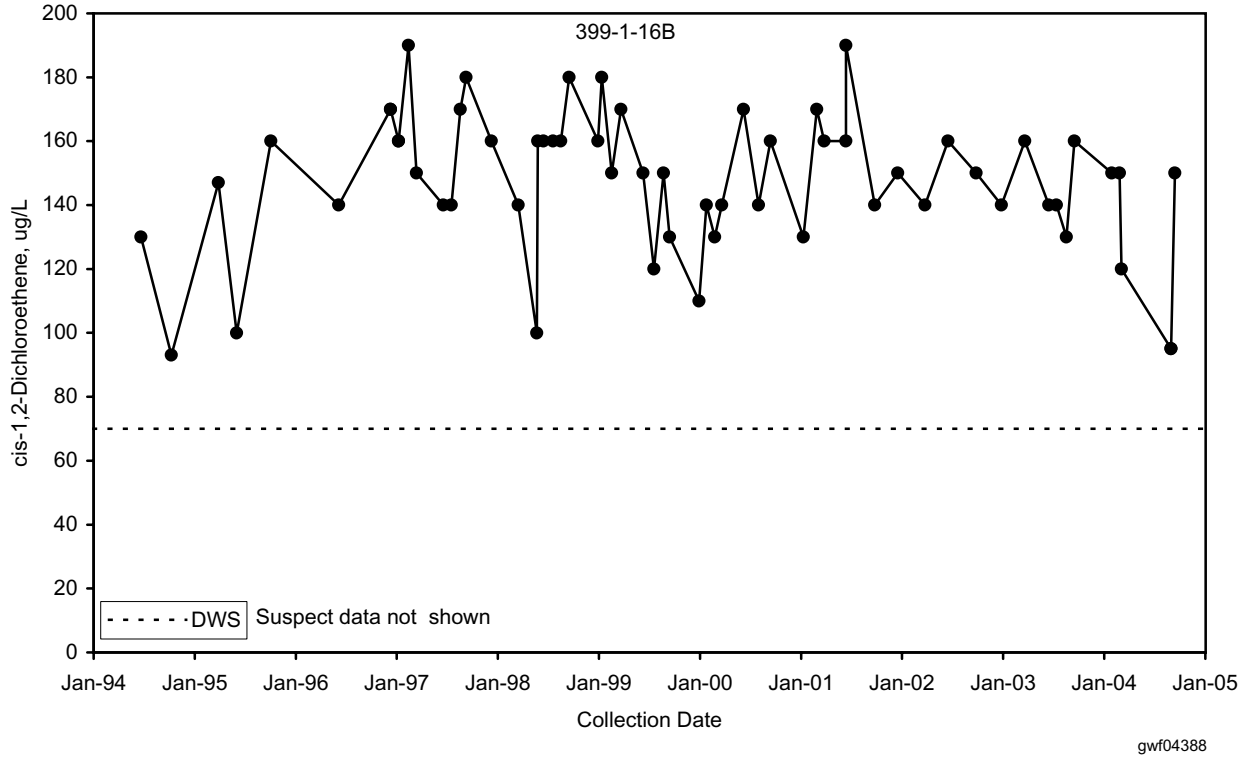


Figure 2.12-12. Concentrations of cis-1,2-Dichloroethene at Well 399-1-16B

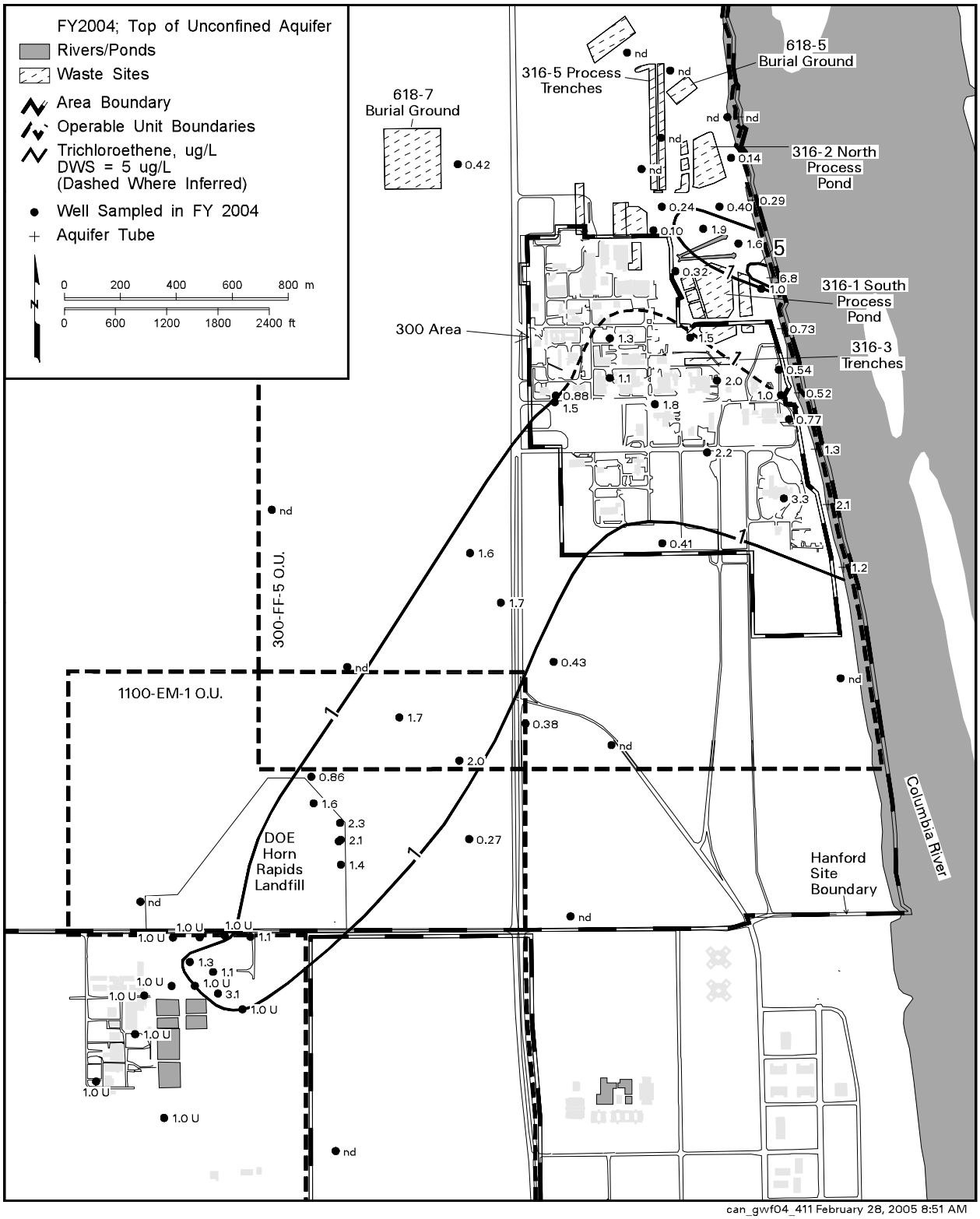


Figure 2.12-13. Average Trichloroethene Concentrations in the 300 and 1100-EM-1 Areas, Top of Unconfined Aquifer

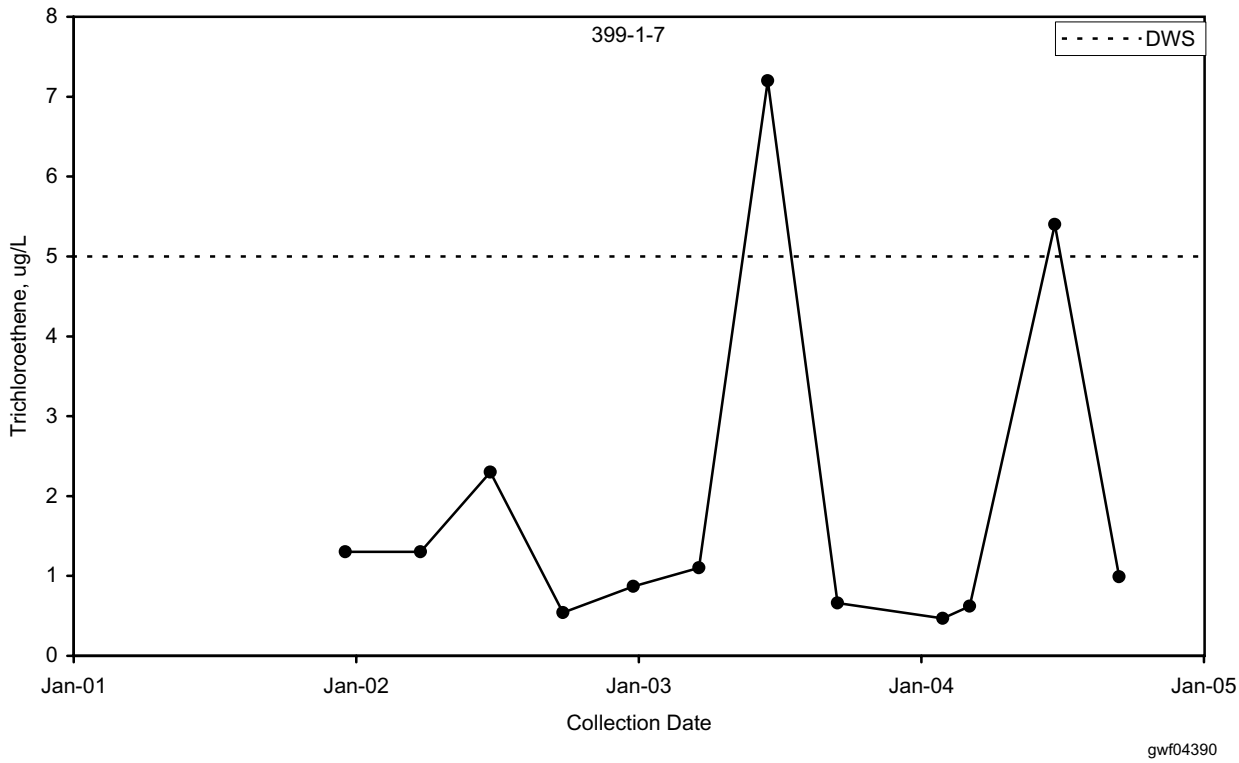


Figure 2.12-14. Trichloroethene Concentrations in Well 399-1-7

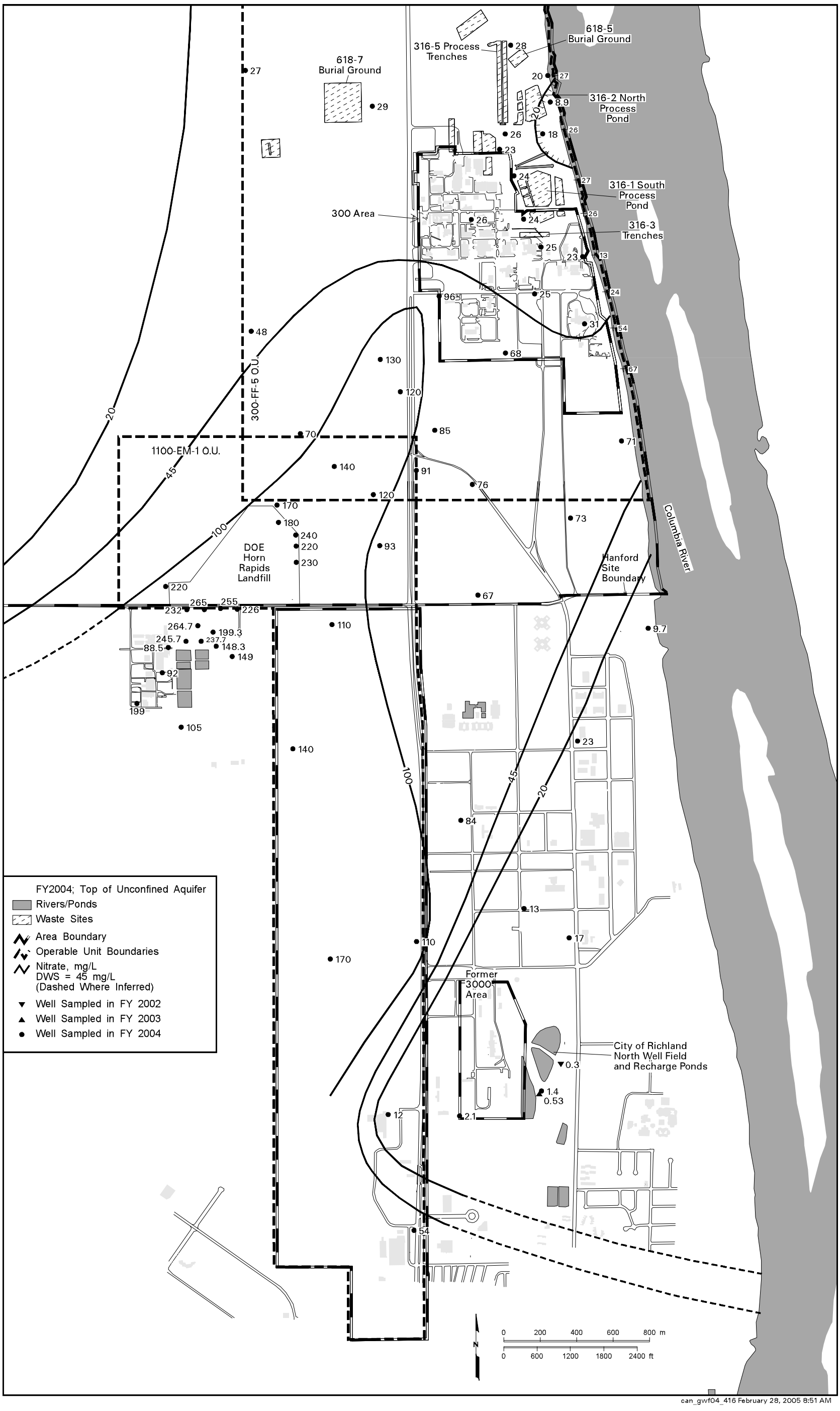


Figure 2.12-15. Nitrate Concentrations in the 300 and 1100-EM-1 Areas

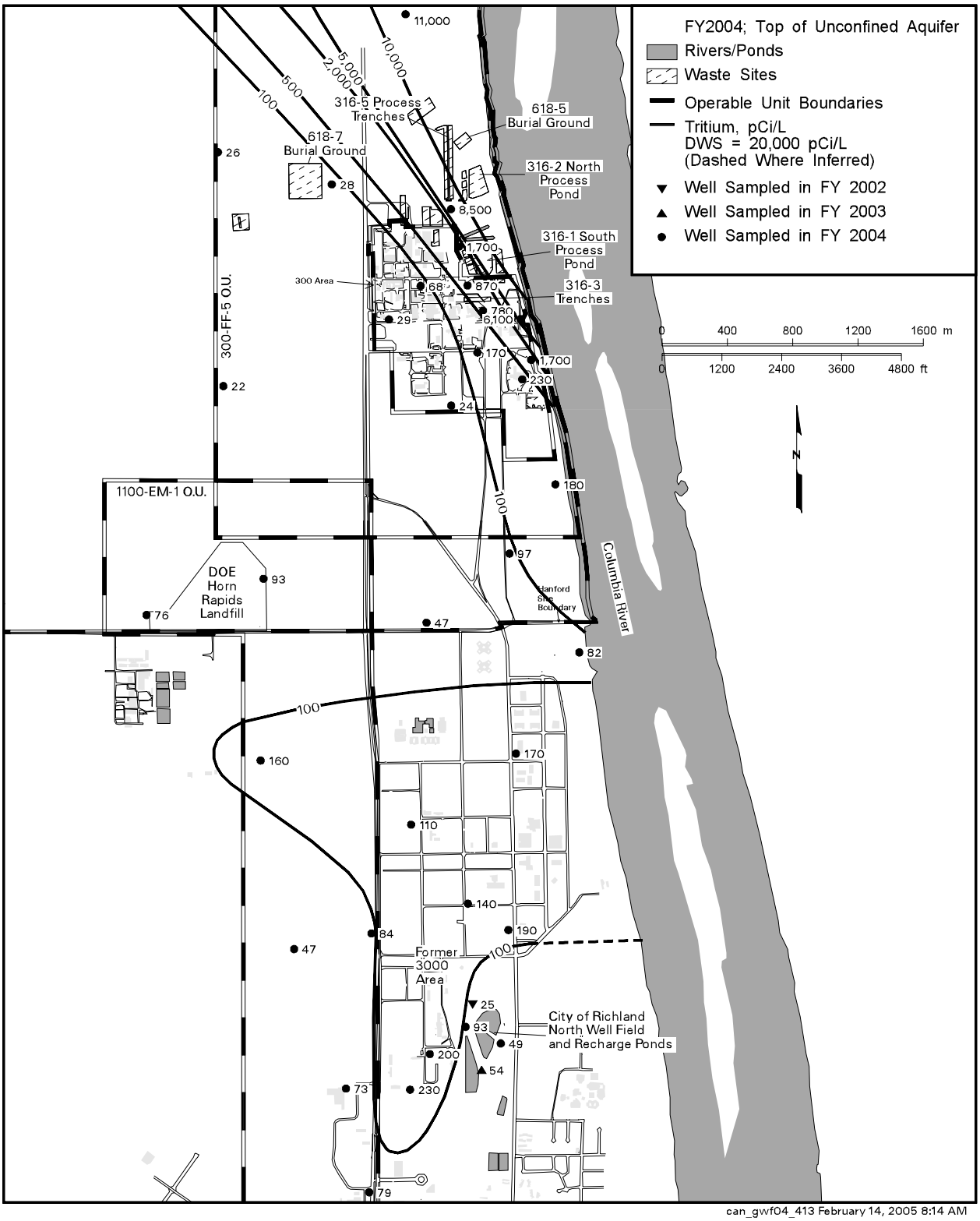


Figure 2.12-16. Average Tritium Concentrations in Groundwater in the 300 and 1100-EM-1 Areas, Top of Unconfined Aquifer

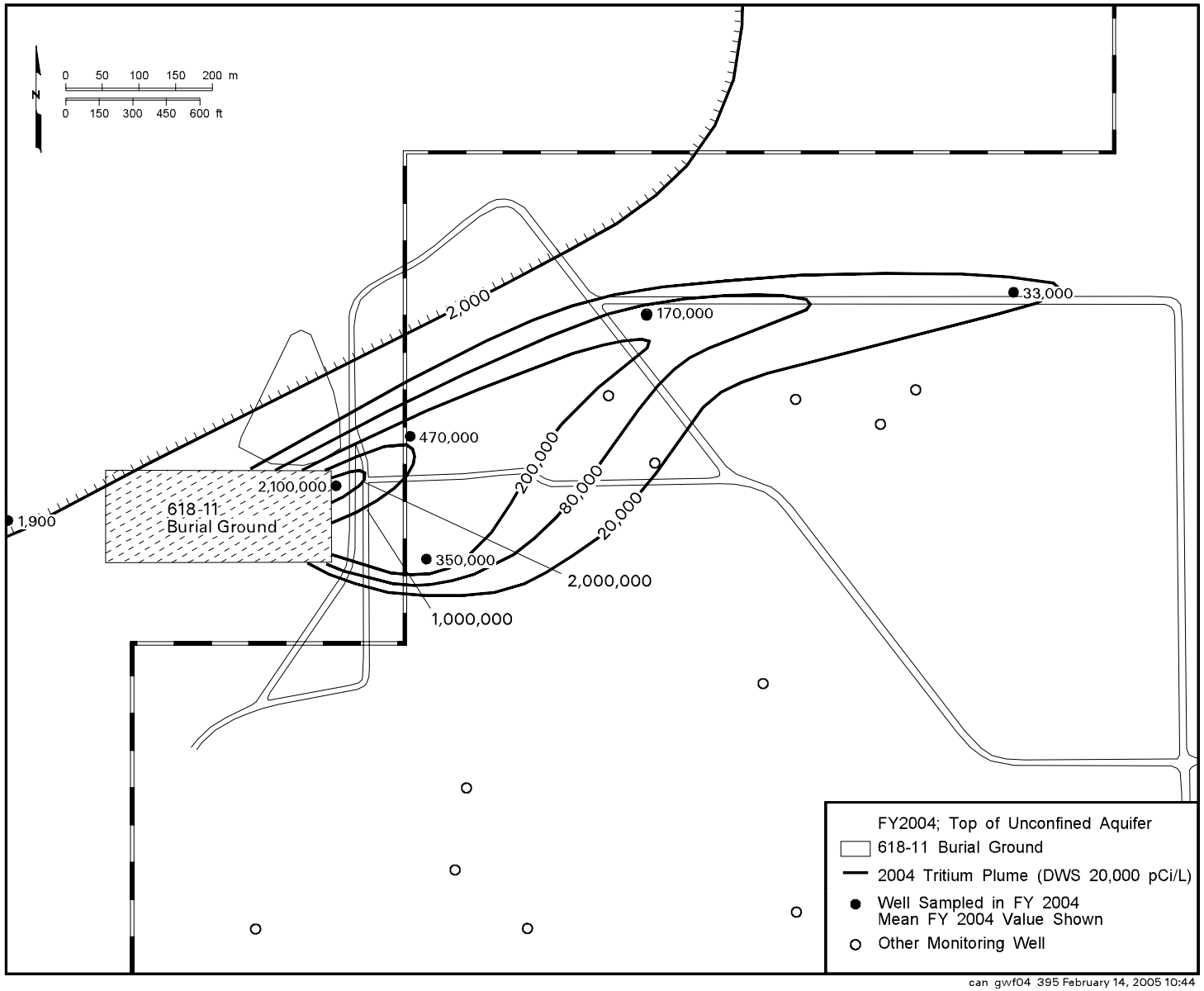


Figure 2.12-17. Tritium Concentrations from the 618-11 Burial Ground, Top of Unconfined Aquifer (Distribution was partially defined by soil-gas data collected in previous years.)

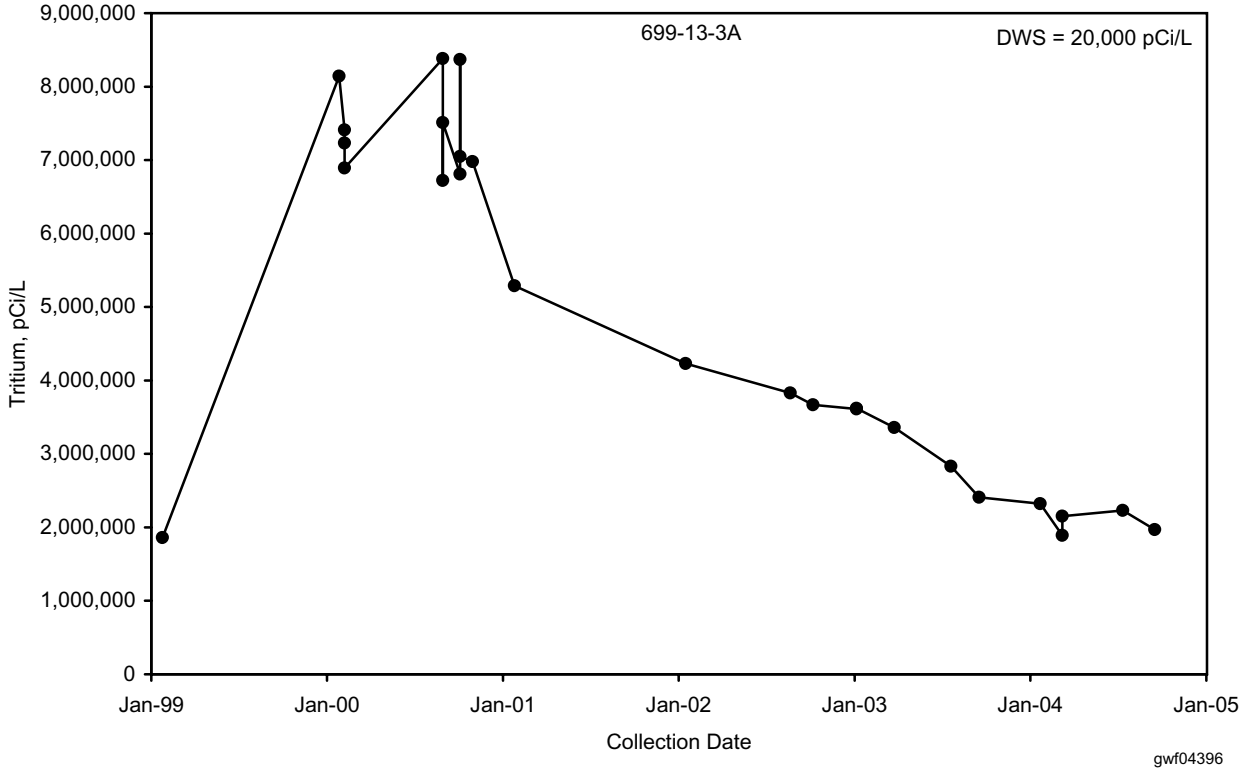


Figure 2.12-18. Tritium Concentrations at Well 699-13-3A Near 618-11 Burial Ground