PNNL-13645

Pacific Northwest
National Laboratory
Operated by Battelle for the
U.S. Department of Energy

300 Area Process Trenches Groundwater Monitoring Plan

J. W. Lindberg
C. J. Chou

August 2001

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RL01830

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831;
prices available from (615) 576-8401.

Available to the public from the National Technical Information Service,
U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

The 300 Area process trenches, also designated 316-5 process trenches, were operated to receive effluent containing dangerous wastes from nuclear research and fuel fabrication laboratories in the 300 Area between 1975 and 1994. They are regulated as a treatment, storage, or disposal facility under the *Resource Conservation and Recovery Act of 1976* (RCRA) and are within the 300-FF-5 Operable Unit regulated under the *Comprehensive Environmental Response, Compensation, and Recovery Act of 1980* (CERCLA). Currently, the trenches are included in the Hanford Site RCRA Dangerous Waste Permit, have an approved closure/post-closure plan, and are regulated under a RCRA final-status, corrective action groundwater monitoring program (WAC 173-303-645, and by reference 40 CFR 264). They are also in a CERCLA remedial action process under a record of decision allowing natural attenuation as a groundwater cleanup remedy.

The objective of groundwater monitoring during the corrective-action period is to monitor the trend of the constituents of concern to confirm that they are attenuating naturally, as expected by the CERCLA record of decision for the 300-FF-5 Operable Unit. In addition, the corrective-action groundwater monitoring program must be at least as effective as the previous compliance monitoring program in determining compliance with groundwater protection standards.

The existing groundwater monitoring plan (Lindberg et al. 1995) is being replaced by this document. This monitoring plan includes well and constituent lists; summarizes sampling, analytical, and quality control requirements; and incorporates all the interim changes made since the last revision of the groundwater monitoring plan for the 300 Area process trenches. Changes from the previous monitoring plan include updating the discussion on hydrogeology and conceptual model, redesigning the monitoring well network to include 11 wells rather than the previous eight, and adopting a control chart statistical approach that will track the contamination trends better than the previous plan with reduced costs.

Analytes to be tested in groundwater samples from network wells are uranium, cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene. Uranium and cis-1,2-dichloroethene remain above drinking water standards in wells of the network, trichloroethene continues to be detected in network wells but there is an additional source offsite, and tetrachloroethene is no longer detected in the network wells, but exceeded the drinking water standard as recently as 1998.

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1.0 Introduction

This document is a proposed groundwater monitoring plan for the 300 Area process trenches to comply with Resource Conservation and Recovery Act (RCRA) final status, corrective-action groundwater monitoring requirements (WAC 173-303-645, and by reference 40 CFR 264). It will replace the existing groundwater monitoring plan for the 300 Area process trenches (Lindberg et al. 1995).

The 300 Area and 300 Area process trenches, also designated 316-5 process trenches, are located in the southeastern part of the U.S. Department of Energy's (DOE's) Hanford Site in southeastern Washington (Figure 1.1). They were operated between 1975 and 1994 as a waste facility to receive process wastewater containing dangerous waste constituents (up until 1985) from nuclear research and nuclear fuel fabrication laboratories. The Washington State Department of Ecology (Ecology) regulates the trenches under the *Resource Conservation and Recovery Act of 1976* (RCRA). Because the trenches are within the 300-FF-1 and 300-FF-5 Operable Units (source and groundwater operable units, respectively) (Figure 1.2), they also are regulated by the U.S. Environmental Protection Agency (EPA) under the *Comprehensive Environmental Response, Compensation, and Recovery Act of 1980* (CERCLA). Bechtel Hanford, Inc. (BHI) is responsible for remediating the 300 Area process trenches as part of the 300 FF-1 and 5 Operable Units for the U.S. Department of Energy, Richland Operations Office (DOE/RL). BHI is also responsible for post-operation administration of the 300 Area process trenches, and groundwater is monitored by Pacific Northwest National Laboratory.

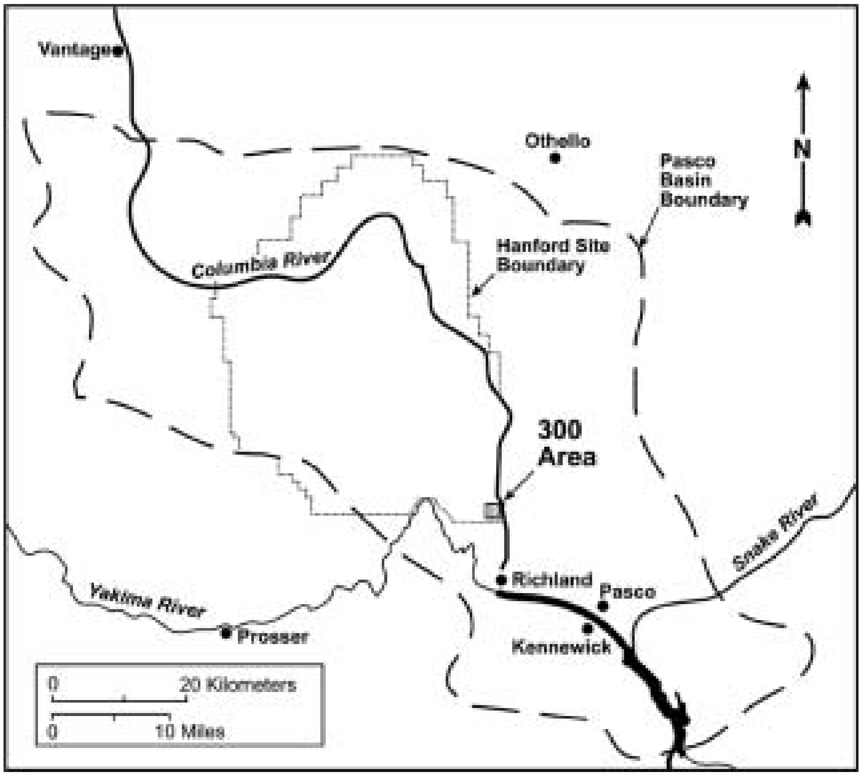

Figure 1.1. Location of the 300 Area at the Hanford Site, Washington

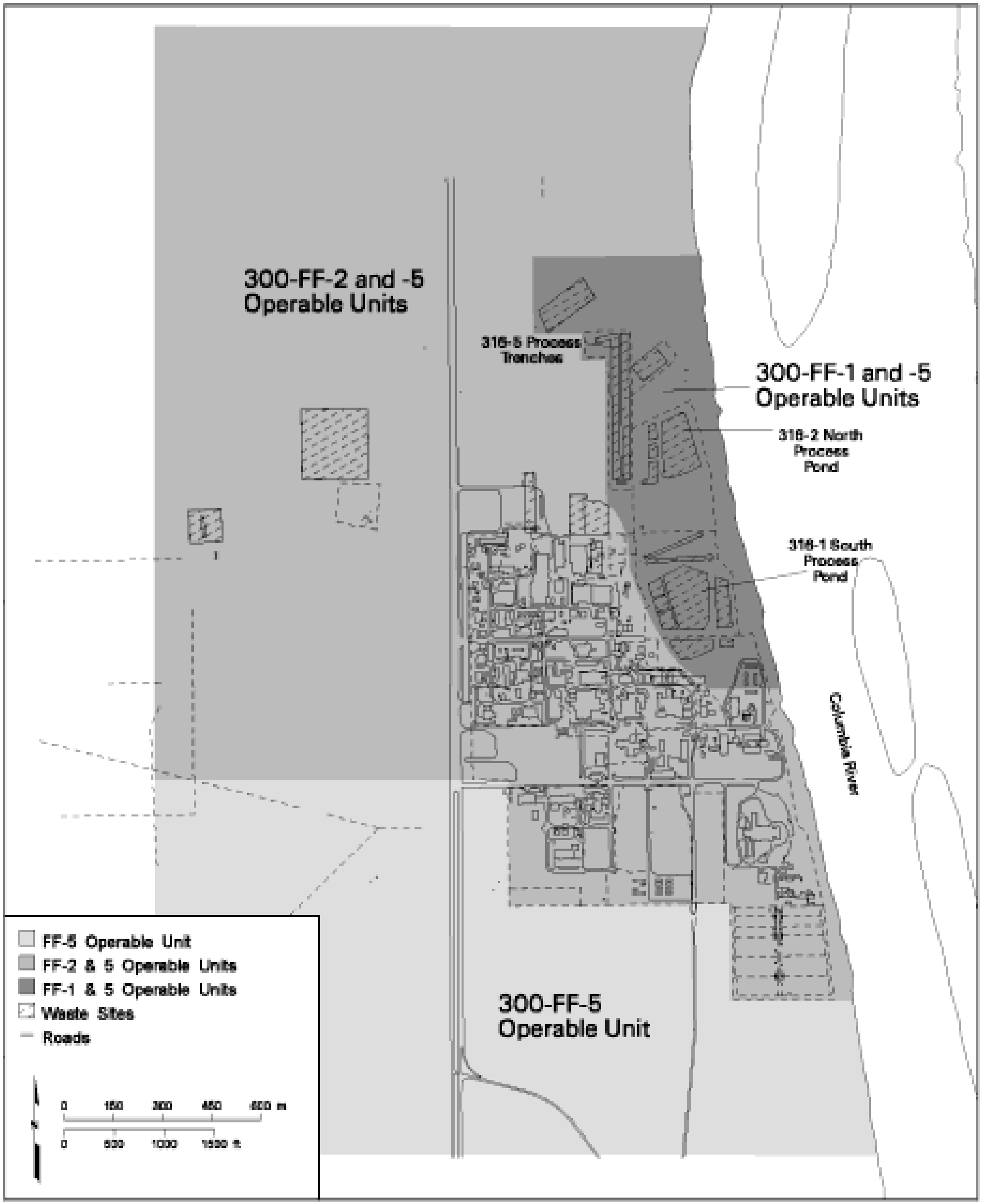

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Figure 1.2. Locations of Main Facilities in the 300 Area and Operable Unit Boundaries

The 300 Area process trenches are regulated by a number of documents because of the need to integrate compliance to both governmental acts (RCRA and CERCLA) administrated by the two governmental agencies (Ecology and EPA, respectively). The trenches were permanently removed from service in December 1994 in support of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Milestone M-17-10 for Project L045H, Treated Effluent Disposal Facility (Ecology et al. 1998), and they are included in the *Hanford Site Dangerous Waste Permit* Number WA7890008967 (DOE 1988), Revision 3, Part VI (Unit Specific Conditions For Units In Post-Closure). The applicable closure/post-closure plan is the *300 Area Process Trenches Modified Closure/Postclosure Plan* (DOE 1997a). The existing groundwater monitoring plan (Lindberg et al. 1995) is being replaced by this document.

From a CERCLA perspective, the 300 Area process trenches were involved in a succession of studies and documents that characterized the site, developed and examined multiple remedial strategies, and culminated in a record of decision for remedial action. The CERCLA documents include the following:

- *Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1 Operable Unit, Hanford Site, Richland, Washington* (DOE 1992a)

- *Phase I Remedial Investigation Report for the 300-FF-1 Operable Unit* (DOE 1993a)

- *Phase I and II Feasibility Study for the 300-FF-1 Operable Unit* (DOE 1993b)

- *Phase II Remedial Investigation Report for the 300-FF-1 Operable Unit: Physical Separation of Soils Treatability Study* (DOE 1994)

- *Phase I Remedial Investigation Report for the 300-FF-5 Operable Unit* (DOE 1993c)

- *Expedited Response Action Assessment for the 316-5 Process Trenches* (DOE 1992b)

- *Phase III Feasibility Study Report for the 300-FF-1 Operable Unit* (DOE 1995a)

- *Proposed Plan for the 300-FF-1 and 300-FF-5 Operable Units* (DOE 1995b)

With the release of the *Phase III Feasibility Study Report for the 300-FF-1 Operable Unit* (DOE 1995a), EPA selected a preferred alternative (or interim remedial action) for the remediation of groundwater in the 300-FF-5 Operable Unit that was identified in the record of decision (ROD 1996). For groundwater, the selected remedy was identified as follows:

- 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.

The *Operation and Maintenance Plan for the 300-FF-5 Operable Unit* (DOE 1996), which evolved from the record of decision and CERCLA documents, describes the monitoring program and administrative tasks that are being used to implement the selected remedy in the 300-FF-5 Operable Unit. The objectives of the operation and maintenance plan and this groundwater monitoring plan are very similar as both were derived from the record of decision; that is, they both monitor in order to "verify the effectiveness of the selected remedy." The main difference between the two plans is the scope (and the institutional controls that will not be addressed by this groundwater monitoring plan). The scope of this groundwater monitoring plan includes groundwater contamination by the contaminants of concern exclusively from the 300 Area process trenches, whereas the scope of the operation and maintenance plan includes groundwater contamination by contaminants of concern in the entire 300-FF-5 Operable Unit (see Figure 1.2).

In June 2000, the three members of the Tri-Party Agreement (Ecology et al. 1998) issued an *Explanation of Significant Difference for the 300-FF-5 Record of Decision* (EPA 2000a) which specified that the boundaries of the 300-FF-5 Operable Unit were to be moved outward to include five additional waste sites northeast of the 300 Area (Figure 1.3). These sites include the following:

- 618-10 burial ground
- 618-11 burial ground
- 316-4 crib source waste site
- 600-63 source waste site
- 600-259 source waste site.

These five sites are currently in the 300-FF-2 Operable Unit, but the underlying groundwater was not contained in the scope of 300-FF-5 as it was originally defined in the July 1996 record of decision. Because of the change in scope, the explanation of significant difference also required an update to the *Operation and Maintenance Plan for the 300-FF-5 Operable Unit* (DOE 1996) to ensure that an adequate monitoring and institutional control plan is in place for groundwater beneath 300-FF-1 and 300-FF-2 waste sites. This is significant because the operation and maintenance plan and the 300 Area process trenches groundwater monitoring plan (this document) have (at least in part) the same objectives, and the sampling and analysis efforts are complementary. At the time of release of this document, however, the update to the operation and maintenance plan will not have been released.

The CERCLA record of decision process required a review by the EPA after five years from the original time of issuance to assess the progress of the selected remedial remedy. This is significant because the results of the review would have an impact on the record of decision and the selected remedy. If the selected remedy changed, then the objectives of RCRA groundwater monitoring at the 300 Area process trenches would change also. The results of the first 5-year review (EPA 2001) indicated that the 300 Area cleanups were proceeding in a protective and effective manner. The EPA still considered that the cleanup goals and remedy selection decisions were appropriate at the time the 5-year review was released. Therefore, the objectives of RCRA groundwater monitoring at the 300 Area process trenches will remain the same.

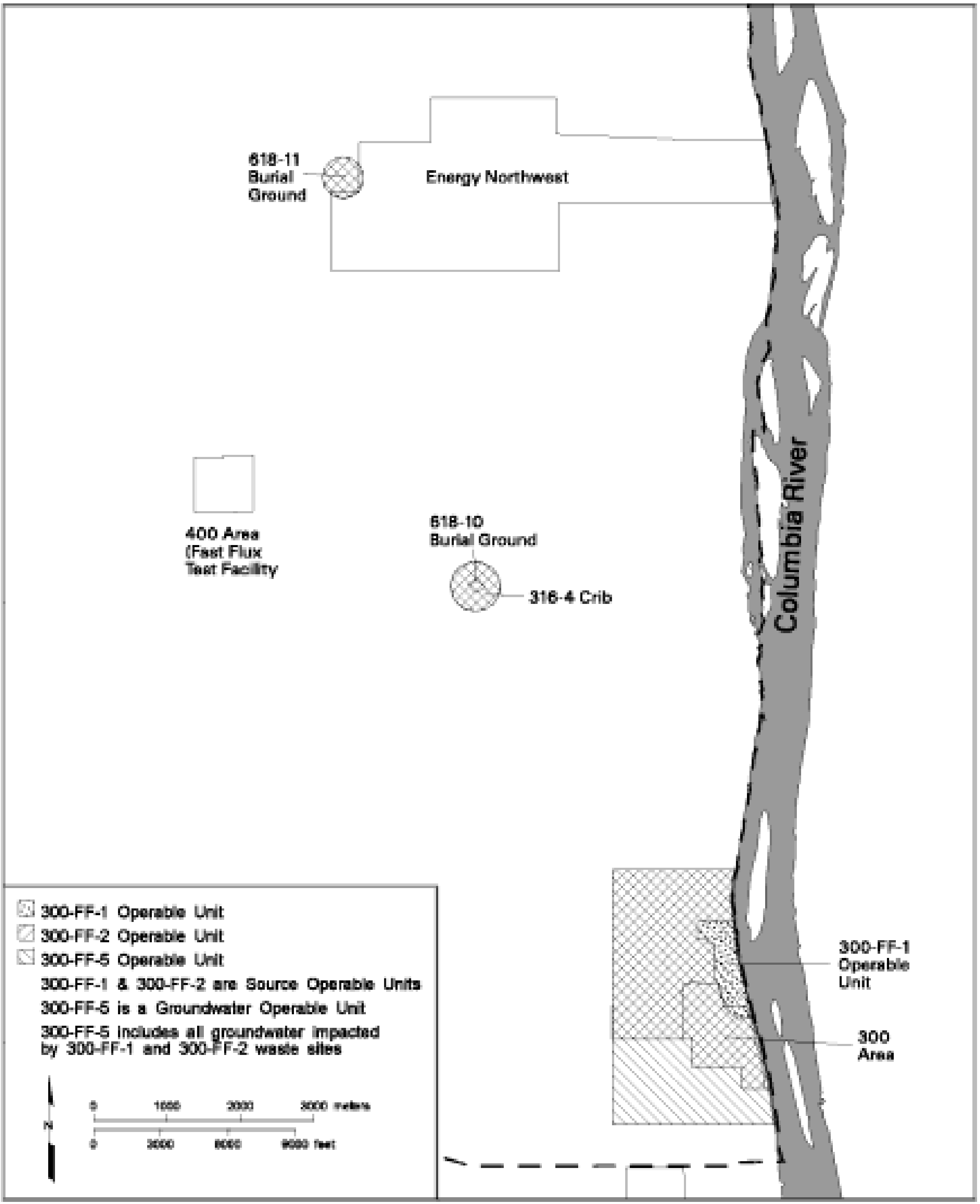

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Figure 1.3. Locations of the 300-FF-1, 300-FF-2, 300-FF-5 Operable Units; 618-10 Burial Ground; 316-4 Crib; and 618-11 Burial Ground

The proposed monitoring network for the 300 Area process trenches includes 11 wells located downgradient (predominantly southeast) of the trenches, an addition of five wells and removal of two wells from the previous version of the 300 Area process trenches groundwater monitoring plan (Lindberg et al. 1995). These 11 wells include all the existing WAC-173-160 compliant wells between the 300 Area process trenches and the Columbia River, the point where groundwater in the uppermost aquifer discharges. Five wells were added to the network to fully characterize the plumes of uranium and volatile organics (i.e., the contaminants of concern cis-1,2-dichloroethene [DCE], trichloroethene [TCE], and tetrachloroethene [PCE]) originating from the area between the trenches and the river. The two wells that were dropped from the network are the former upgradient wells. Upgradient wells are no longer needed because the purpose of the monitoring well network has changed (see Section 1.1). Other changes in the proposed plan include the use of the Combined Shewhart-CUSUM control chart statistical analysis method (See Section 6.3), which is an intra-well method to track the contaminant concentration trend with time within one well (upgradient well data not needed).

1.1 Purpose

The purpose of groundwater monitoring during the corrective action period is to monitor the trend of the concentrations of contaminants of concern downgradient in the groundwater from the 300 Area process trenches to confirm that they are attenuating naturally, as expected by the CERCLA record of decision for the 300-FF-5 Operable Unit (ROD 1996). The corrective action groundwater monitoring program must be at least as effective as the previous compliance monitoring program (Lindberg et al. 1995) in determining compliance with groundwater protective standards. This document supersedes all previous monitoring plans (Schalla et al. 1986; Schalla et al. 1988a; Lindberg et al. 1995). The monitoring program proposed in this document is based on current conceptualization of the site and is consistent with data collected during at least 24 years of monitoring the site.

1.2 RCRA Regulatory Status and History

An extensive groundwater monitoring program was carried out during the operational life of the 300 Area process trenches (1975 to 1994), and monitoring continues today. Prior to, and continuing beyond the time the trenches went into service, many of the wells in the 300 Area were monitored for both radioactive and nonradioactive constituents, as well as water levels. The groundwater near the 300 Area process trenches has been monitored by a RCRA well network since June 1985. However, since that time the status has changed several times.

Initially, the 300 Area process trenches were placed in an interim status groundwater quality “assessment” monitoring program by the *Consent Agreement and Compliance Order* (Ecology and EPA 1986) and bypassed the “detection” monitoring stage. The assessment-level status was based on the decision that

1) the well network to monitor groundwater around the trenches was considered inadequate for “alternate” groundwater monitoring as described in 40 CFR 265.90(d) and Washington Administrative Code (WAC) 173-303-400. This assessment was made because there were not enough wells around and downgradient of the 300 Area process trenches to adequately detect

groundwater contamination and the existing wells were mostly not compliant with up-to-date standards for resource protection wells such as WAC 173-160.

2) the groundwater quality in the 300 Area had been adversely affected by the operations of the 300 Area process trenches.

In response to the *Consent Agreement and Compliance Order*, the first RCRA groundwater monitoring plan (Schalla et al. 1986) was written for the site, and over 20 additional wells were installed and monitored. The trenches were extensively characterized (Schalla et al. 1988b), and a revised groundwater monitoring compliance plan (Schalla et al. 1988a) was implemented in 1988.

The interim status, groundwater quality assessment program continued until December 1996 when the program was changed to final status compliance monitoring. The schedule for modifying the Hanford Site RCRA Permit (Ecology 1994) required that a modified closure plan and accompanying revised groundwater monitoring plan be submitted. The documents were prepared, and the closure plan (DOE 1997a) accompanied the revised groundwater monitoring plan (Lindberg et al. 1995, ICN-WHC-SD-EN-AP-185.1). This documentation is referenced in the revised Hanford Site RCRA Permit (Ecology 1994) and became effective December 26, 1996. (Note: The 300 Area process trenches achieved closure in May 1998 in accordance with the closure plan [a revision of DOE 1997a] contained in Attachment 31 of the current permit revision [Number 6].)

As expected, groundwater samples from well 399-1-16B, a downgradient well sampling the base of the uppermost aquifer, showed that cis-1,2-dichloroethene (cis-DCE) and trichloroethene (TCE) were in concentrations higher than the specified concentration limits (70 µg/L and 5 µg/L maximum contaminant levels, respectively). Similarly, the three downgradient wells monitoring the aquifer at the water table (399-1-10A, 399-1-16A, and 399-1-17A) had concentrations of uranium that exceeded the 20 µg/L EPA-proposed maximum contaminant level (note: the new maximum contaminant level of 30 µg/L for uranium has been promulgated, but does not take effect until December 8, 2003). After the first four independent samples were collected in December 1996, and January, February, and March 1997, the exceedances of maximum contaminant levels for cis-DCE, TCE, and uranium were confirmed and the regulator (Ecology) was notified. The facility then entered a corrective action period.

Upon entering the corrective action period, the existing compliance monitoring plan became obsolete, and a new groundwater monitoring plan was required (WAC 173-303-645[2][a][ii]). A new plan was proposed, but it was not approved by the regulator because of unresolved issues over the proposed statistical procedures (statistical procedures similar to those in this document). As a result, the previous compliance-monitoring plan (Lindberg et al. 1995) remained in effect until May 2001 when the regulator accepted the proposed statistical procedures. Those statistical procedures are hereby included (see Section 7.3) in the new plan (this document) along with the other appropriate changes to the plan summarized in the introduction to this section (Section 1.0).

2.0 Description of the 300 Area Process Trenches

This section discusses the physical structures, operational history, and waste characteristics at the 300 Area process trenches and is taken largely from the previous groundwater monitoring plan (Lindberg et al. 1995), the *Phase I Remedial Investigation Report for the 300-FF-1 Operable Unit* (DOE 1993a), or the *300 Area Process Trenches Modified Closure/Postclosure Plan* (DOE 1997a).

2.1 Physical Structure and Operation History

The 300 Area process trenches are located in the northern part of the 300 Area about 300 meters west of the Columbia River (Figure 2.1). They began operating March 16, 1975, and were the main facility for disposal of most liquid process waste generated in the 300 Area until the trenches were remove from service in December 1994. The liquid waste discharged to the 300 Area process trenches came only from the 300 Area process sewer and consisted mostly of wastewater with relatively low concentrations of chemical contaminants. More concentrated waste was generally not discharged to the process sewer and trenches. The discharge rate varied over the years, but it reached a maximum average of about 8,648 liters per minute during 1979. Total discharge for that year was 4.5 billion liters. Between 1987, when fuels fabrication ceased in the 300 Area, and 1994, when waste discharges ceased, the wastewater has consisted of cooling water with small quantities of non-hazardous maintenance and process waste. When the 300 Area process trenches were in use, the east and west trenches were used alternately for periods of up to approximately 8 months. The west trench was removed from service in November 1992; the east remained in service with an average discharge of 814 liters per minute. The trenches were administratively isolated from receiving further discharges in December 1994 and were physically isolated in January 1995.

The 300 Area process trenches consisted of two separate 457-meter-long trenches excavated 3.7 meters into the subsurface and separated by an earthen berm. The unlined trenches were excavated into the sandy gravels of the Hanford formation, and the bottoms of the trenches were about 6 meters above the average water-table elevation (however, the water table elevation varies with river stage, which fluctuates several meters depending on the season and operation of the several dams on the Columbia River). Figure 2.2 contains a schematic cross-section showing the dimensions and relationship of the eastern trench to the water table and the nearby Columbia River. It also shows the area in view with the location of the schematic cross-section, some example well locations, and nearby facilities. If the cross-section were continued to the west to include the western trench, it would look similar to the eastern trench except for the enlarged northern end that is a natural depression (Figure 2.3). In 1990, the depression was separated from the west trench by a berm needed to support a bird-screen placed over the trench. From 1991 until surface restoration activities reclaimed the site, the northern 91meters of the original trenches, including the natural depression, were used as an impoundment for low-level radioactive and low-level, mixed waste soil dredged from the southern portions of the trenches.

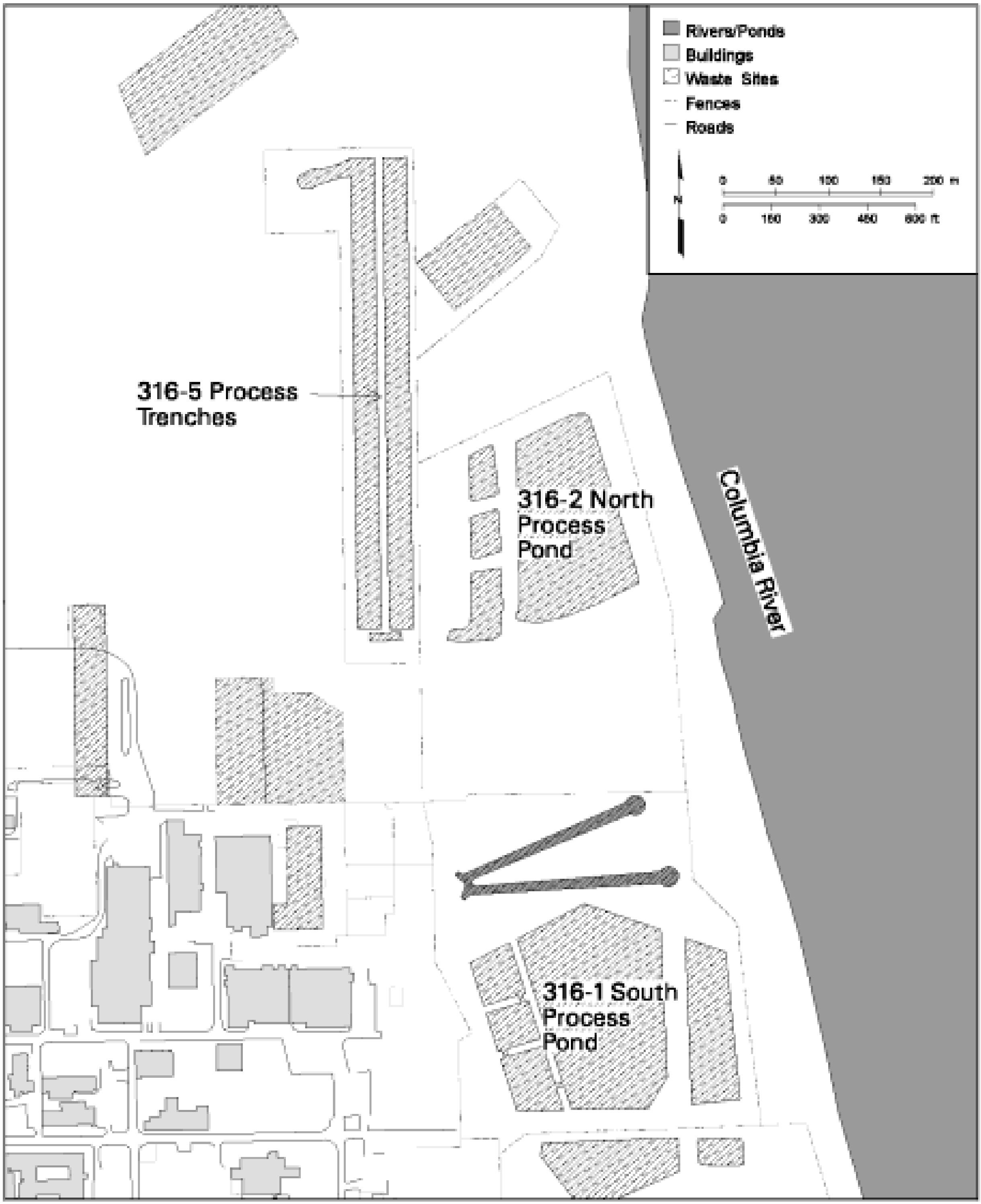

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Figure 2.1. Location of 300 Area Process Trenches in 300 Area

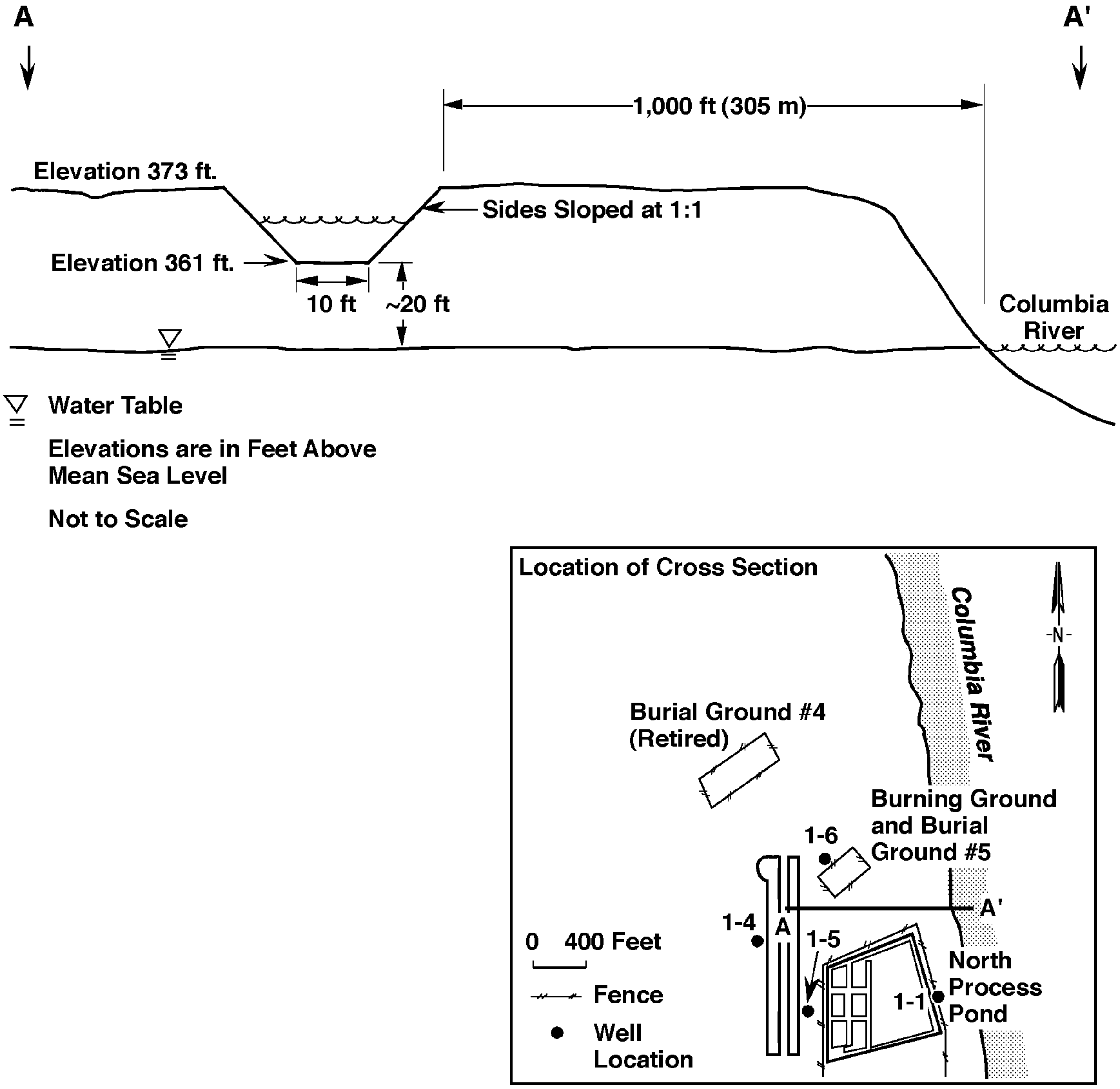

Figure 2.2. Schematic Cross Section of the 300 Area Process Trenches (modified from Schalla et al. 1988b)

A concrete weir box was located at the southern end of the trenches. Process sewer effluent reached the trenches through 0.6 meter diameter 300 Area Process Sewer System pipe that was connected to the weir box. The weir box measured 21.3 meters long (east-west dimension), 3 meters high, and 3 meters wide. It had two sluice gates that allowed the trenches to be operated alternately.

Administrative controls to prevent disposal of dangerous wastes to the 300 Area process trenches were instituted on February 1, 1985. Prior to that time, a variety of chemical waste was included with the wastewater. However, no large quantity of any one waste was included in the process waste. From the

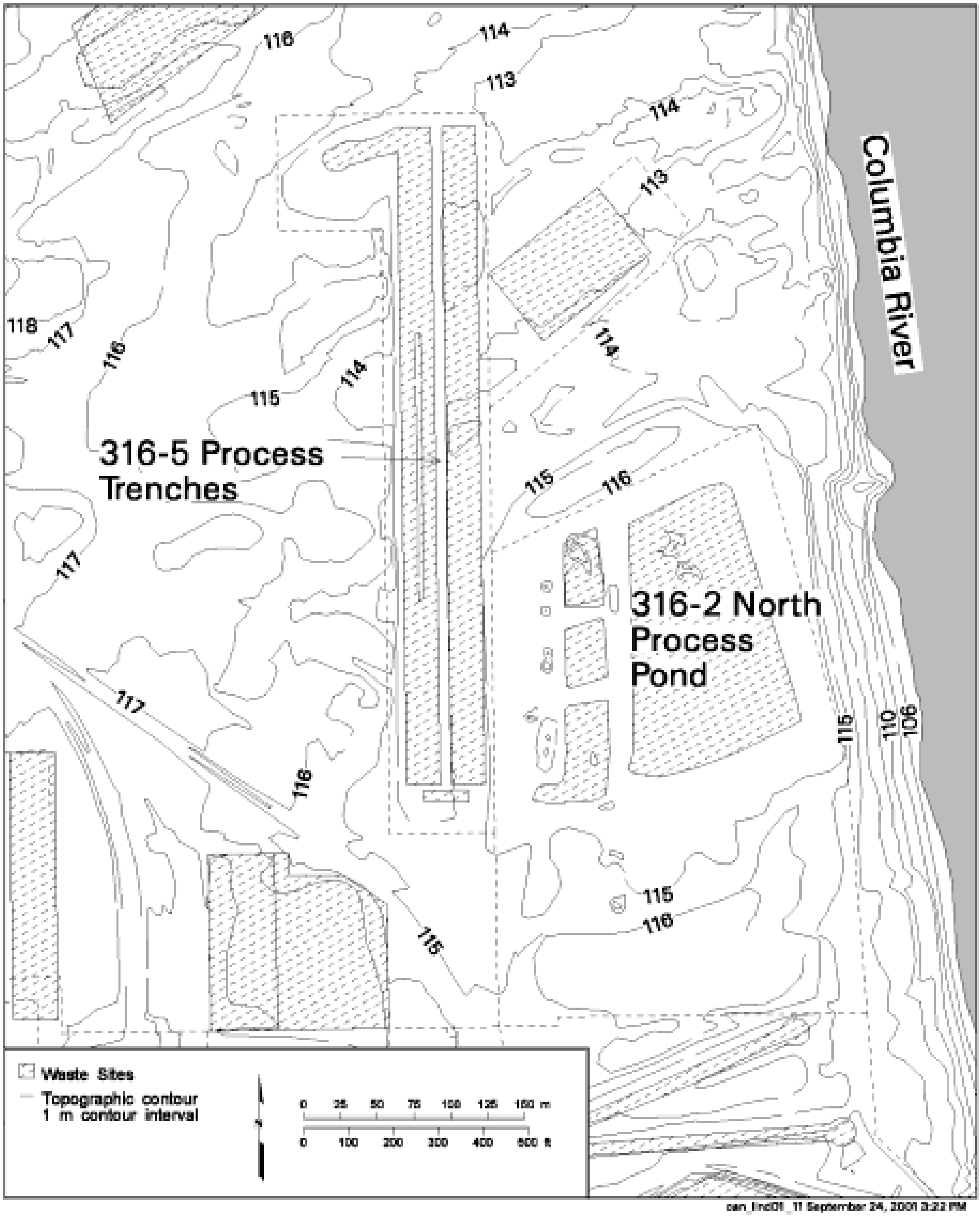

Figure 2.3. Topography in the Vicinity of the 300 Area Process Trenches

beginning of operations in 1975 until October 1993, a continuous, composite sampler was located at the headwall to analyze the wastewater at the point of discharge to the trenches. Subsequently, a sampler located outside the unit analyzed the effluent. In addition, chemical spills are known to have entered the process sewer through 300 Area building floor drains. The types and amounts of dangerous wastes discharged to the 300 Area process trenches are discussed in the following section (Section 2.2).

In 1991, at the request of the regulator (Ecology), an expedited response action was undertaken at the 300 Area process trenches. This action was based on regulator concerns of analytical results of trench sampling performed in 1986 (Table 15 of DOE 1992a). The data identified the presence of radioactive and inorganic contaminants (primarily heavy metals) in the trench soil at levels potentially harmful to groundwater and to the nearby Columbia River. The expedited response action was initiated under the authority of the Tri-Party Agreement Action Plan (Section 6.4) as an interim action pending final cleanup activities for the 300-FF-1 Operable Unit (Ecology et al. 1998). The results of the expedited response action are documented in DOE (1992b).

The objective of the expedited response action was to reduce the potential migration of contaminants to groundwater. The specific goal was to reduce the measurable level of radiation in the trenches to less than three times the upper tolerance limit of background. This was accomplished by removing contaminated sediment, using it to fill in the north ends of the trenches, and immobilizing the sediment. The removal of sediment contaminated with radionuclides also reduced the levels of inorganic constituents remaining in the trenches. Approximately 5,400 cubic meters of sediment were removed and relocated in each trench. About 0.3 meter of contaminated soil was removed from the sides and 1.3 meters from the bottom of each trench. The less radioactively contaminated sediment (less than 2,000 counts/second) was relocated to the north end of each trench. The more radioactively contaminated sediment (greater than 2,000 counts/second) was consolidated in the depression located at the northwest corner of the west trench. The contaminated sediments were isolated from the effluent and then covered with a plastic barrier and a layer of clean aggregate. Results of pre- and post-ERA sampling and analysis of the sediments indicate that the ERA successfully reduced trench contamination at all areas of the trenches other than the positions where contaminated sediment was stockpiled (DOE 1992b). Results of groundwater sampling and analysis after the expedited response action also showed a drop in concentrations of groundwater contamination, but the effects were only temporary (see Section 3.2 of this document).

In fiscal year 1997, remediation of the 300-FF-1 Operable Unit started by removing the contaminated sediment at the 300 Area process trenches that had been stockpiled earlier during the 1991 expedited response action. By the end of fiscal year 1999, the stockpiled contaminated sediment had been completely removed and replaced with clean soil. Remediation of soil at the 300 Area process trenches is now considered complete, and the soil has been clean closed (BHI 1998a; BHI 1998b).

2.2 Waste Characterization

The waste generating processes in the 300 Area that produced liquid waste that, in turn, was sent to the 300 Area process trenches by way of the process sewer, include fuel fabrication process waste, laboratory process waste, unplanned waste releases, and some miscellaneous waste. Highly radioactive liquid waste was generally diverted away from the process sewer and went to the Radioactive Liquid Waste

Sewer (RLWS). Estimated quantities for all chemicals discharged to the process sewer from 1975 until the implementation of administrative controls in 1985 are listed in Table 2.1. Table 2.2 provides the flow history for the process sewer.

From 1975 when the trenches entered service until 1987 when fuel fabrication essentially ceased, fabrication of fuel elements was primarily for N Reactor. The primary discharge from fuel fabrication was cooling and rinse water. However, fuel fabrication activities routinely used a broad range of organic and inorganic lubricants, organic solvents, and other chemicals that were discharged to the process sewer. (These chemicals, along with radionuclides generated by fuel fabrication, are listed in Table 2.3.) Fuel fabrication was also a source of approximately 1% enriched uranium discharged to the trenches, but was not the source of the types of fission products found in the 300 Area process trenches. These radionuclides other than uranium, originated from the re-anodizing of aluminum spacers used in the old reactors before 1975. Most of this waste was supposed to have gone to the RWLS but occasionally may have entered the process sewer. Also, some of these radionuclides were likely deposited in process sewer sludge and could have been released to the 300 Area process trenches after 1975 during high sewer flows or deviations from normal pH trends.

The chemical makeup and quantity of 300 Area laboratory waste has not been documented. Although a wide variety of laboratory activities occurred in the 300 Area, laboratory waste is considered to be similar to fuel fabrication process waste because most of the buildings supported fuel fabrication. Typical laboratory waste could also have consisted of standard laboratory cleaners, reagents, organic solvents, neutralizers, and drying agents. These chemical wastes could have been discharged directly to the process sewer through laboratory drains or from the retention process sewer in quantities insignificant to the waste stream.

Chemical spills are known to have entered the process sewer through 300 Area building floor drains. The majority of these releases were of spent uranium-contaminated acid etch solutions. Other unplanned releases to the process sewer system include two spills of tetrachloroethene in 1982 (455 liters) and 1984 (76 liters), and two releases of ethylene glycol in April 1993 (1,364 liters) and October 1993 (7.6 liters).

While the 300 Area process trenches were in operation, some of the facilities in the 300 Area connected to the process sewer performed activities related to reactor operations, irradiated fuel examinations, chemical separations processes, photographic processing, and waste management. Other facilities also supported such activities as peaceful uses of plutonium, reactor fuels development, liquid metal technology, environmental remediation technology development, and life science programs. Although such facilities may have contributed small quantities of radioactive or dangerous waste to the process sewer, trench soil analytical results indicate that their contribution to the waste stream and to subsequent trench soil and potential groundwater contamination is insignificant compared to that of fuel fabrication.

Table 2.1. Estimated Nonradiological Chemical Waste Inventory for the Process Trenches

Total of Intermittent Discharges of Dangerous Chemicals Ending February 1, 1985[a,b]		Larger Discharges[c] Continuing until September 1986[d]		Total of Larger Discharges[e] (1975-1986)
Less than 1g	Less than 1kg			
Ammonium biofluoride	Benzene	Copper	= 30 kg/mo[f]	3,960 kg
Antimony	Carbon tetrachloride	Detergents	≤30 kg/mo[f]	3.460 kg
Arsenic	Chromium	Ethylene glycol	≤200 L/mo[f]	26,400 L
Barium	Chlorinated benzenes	Heating oil	= 300 L[g]	300 L
Cadmium	Formaldehyde	Hydrofluoric acid	= 100 kg/mo[f]	13,200 kg
Dioxine	Formic acid	Nitrates	≤2000kg/mo[f]	264,000 kg
Dioxin	Hexachlorophene	Nitric acid	≤300 L/mo[f]	39,600 L
Hydrocyanic acid	Kerosene	Paint solvents	≤100 L/mo[f]	13,200 L
Pyridine	Lead	Tetrachloro-ethene	= 450 L[g]	450 L
Selenium compounds	Methyl ethyl ketone	Photo chemicals	≤700 L/mo[f]	92,400 L
Thiourea	Mercury	Sodium chloride	= 75 tons/yr[f]	825 ton
Misc. lab. chemicals	Sulfuric acid	Sodium hydroxide	≤300 L/mo[f]	39,600 L
	Tetrachloroethene	Uranium	= 20 kg/mo[f]	2,640 kg
	Toluene			
	Tri-butyl-phosphate			
	1,1,1-trichloro-ethane			
	Trichloroethene			
	Xylenes			

Source: Adapted from DOE (1992b).
(a) February 1, 1985, is date of administrative controls disallowing discharge of dangerous waste to the process sewer.
(b) Includes organics that were not analyzed for by process sewer effluent sampling.
(c) These discharges, except for the spills, were relatively continuous.
(d) September 1986 is approximate end of fuel fabrication activities.
(e) Total is monthly average discharge x 12 (mo per yr) x 11 (operating year from March 1975 to September 1986).
(f) Monthly or annual quantity is an average over a 17-month period February 1985 – September 1986.
(g) Known spills.

Table 2.2. Flow History for the 300 Area Process Trenches

Year	Amount Discharged (millions of liters)	Liters/Minute
1975	682	1,298
1976	3,447	6,554
1977	1,894	3,601
1978	1,894	3,601
1979	4,545	8,642
1980	3,180	6,050
1981	3,218	6,122
1982	3,218	6,122
1983	3,445	6,554
1984	3,520	6,698
1985	3,558	6,770
1986	3,407	6,482
1987	3,255	6,194
1988	1,628	3,097
1989	1,893	3,601
1990	1,968	3,745
1991	1,287	2,449
1992	568	1,080
1993	416	792
1994	379	720

Table 2.3. Fuel Fabrication Chemicals and Radionuclides

Chemicals Routinely Used in Fuel Fabrication	Radionuclides Generated by Fuel Fabrication
Chromic acid Chromium trioxide Copper sulfate Hydrofluoric acid Nitric acid Oxalic acid Phosphoric acid Potassium nitrite Sodium aluminate Sodium bisulfate Sodium carbonate Sodium dichromate Sodium fluorosilicate Sodium gluconate Sodium hydroxide Sodium nitrate Sodium nitrite Sodium pyrophosphate Sodium silicate Sulfuric acid Trichloroethene	Scandium-46 Chromium-51 Cobalt-58 Iron-59 Cobalt-60 Zinc-65 Zirconium/niobium isotopes Cesium-137 Promethium-147 Thorium-234 Uranium isotopes Plutonium isotopes
Source: DOE (1992a).	

3.0 Hydrogeology

Information about geology, groundwater hydrology, and groundwater contamination in the vicinity of the 300 Area process trenches has been derived predominantly from wells (see Figure 3.1 for the location of existing 300 Area groundwater monitoring wells). Since the first 300 Area groundwater monitoring well was installed in 1943 (well 399-3-6), many additional wells of a variety of construction types have been installed to monitor the groundwater and characterize the geology. Most wells fit into one of two types: 1) a pre-1985 type that is nominally 0.15 to 0.30-meter-diameter carbon steel casing that is perforated (early design) or screened (later design) in the saturated zone, and 2) a 1985 to recent type that meets the requirements of WAC 173-160, *Minimum Standards for Construction and Maintenance of Wells*. These more modern regulatory-compliant wells have nominal 10-centimeter or 15-centimeter stainless steel casing with stainless steel, wire-wrap screens in the saturated zone, and extensive annular and surface seals.

3.1 Geology

This section summarizes the geology and groundwater hydrology in the vicinity of the 300 Area process trenches. More detailed discussions of these subjects are found in Lindberg and Bond (1979); Schalla et al. (1988b); Delaney et al. (1991); Gaylord and Poeter (1991); and Swanson et al. (1992).

The 300 Area process trenches are underlain by (from upper to lower) zero to 2 meters of eolian sand or fluvial deposits, approximately 15 meters of Hanford formation (an informal name) composed of cataclysmic flood deposits, and about 37 meters of the fluvial Ringold Formation (Figure 3.2). The bedrock below this sediment is the Saddle Mountains Basalt.

The surficial Holocene sediment in the 300 Area, and elsewhere at Hanford, are eolian deposits that are in the form of thin sheets (0 to 2 meters thick) and thicker dunes (2 to 5 meters), and fluvial deposits associated with the Columbia River. Dunes are especially well developed and remain active in the area to the north of the 300 Area. Inside the 300 Area the eolian deposits are mostly absent or reduced in thickness as a result of construction activities. Recent fluvial deposits such as overbank silts and channel deposits of sand and gravel are found in, and immediately adjacent to, the river.

Delaney et al. (1991) discuss three main facies associated with the Hanford formation, the sediment deposited by cataclysmic floods during the late Pleistocene. The three facies include the gravel-dominated facies, the sand-dominated facies, and the slackwater deposits composed of silts and fine sands. The Hanford formation in the vicinity of the 300 Area contains only the first two facies. Slackwater deposits are missing. In the vicinity of the 300 Area process trenches, the Hanford formation is about 15 meters thick and is mostly the gravel-dominated facies (see Figure 3.2). Locally, the gravel-dominated facies can be further divided into two types, pebble to cobble gravel and boulder gravel. The pebble to cobble gravel is the most abundant Hanford formation sediment in the 300 Area. Except for minor interbedded strata consisting of boulder-rich deposits and a few sand-rich horizons (the sand-dominated facies), this

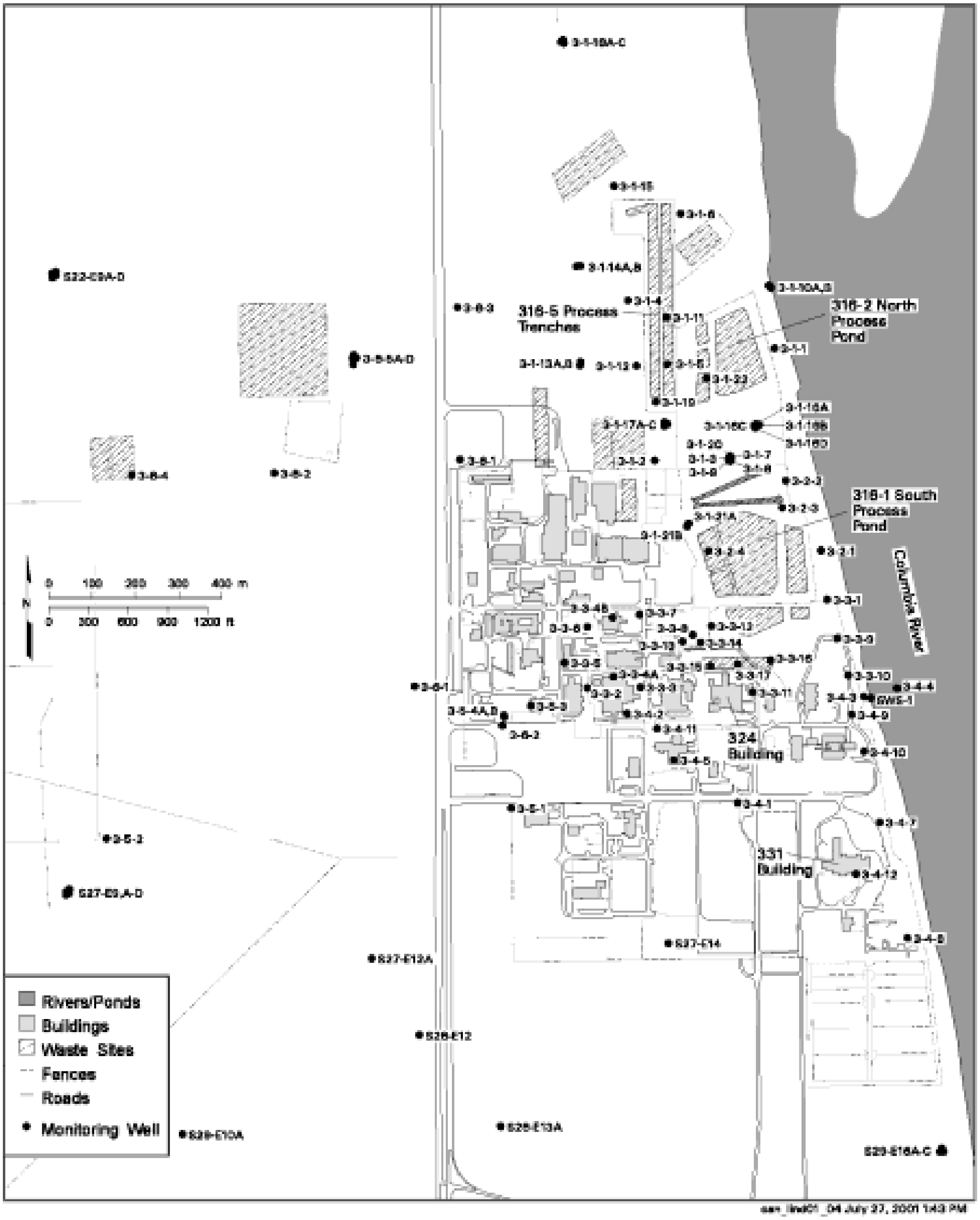

Figure 3.1. Existing Resource Protection Wells in the 300 Area. Note: Well numbers have been abbreviated. Well numbers starting with "3" should have the prefix "399," and well numbers starting with "6" should have the prefix "699."

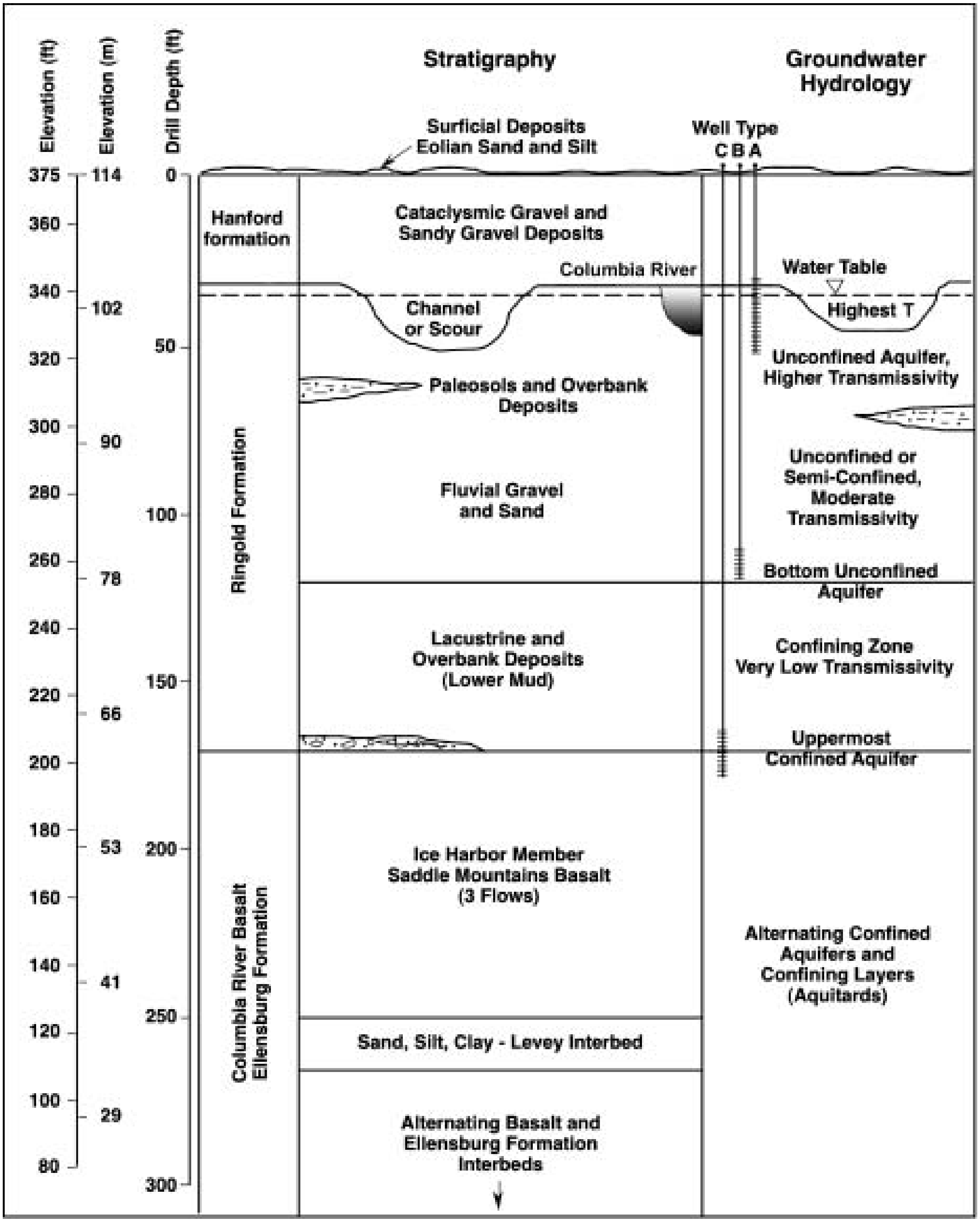

Figure 3.2. Generalized Hydrogeology Comparison of Geologic and Hydrologic Units in the 300 Area

this sediment type makes up the bulk of the Hanford formation. The thickest occurrence of boulder-rich gravels in the 300 Area is found southeast of the 300 Area process trenches along the Columbia River (Figure 2.1) where up to 18 meters of such strata have been logged. Thin beds of the sand-dominated facies are common and often intercalated with layers in the pebble to cobble gravel of the gravel-dominated facies.

The Ringold Formation near the 300 Area process trenches is about 37 meters thick and contains three facies. The three facies are the fluvial gravel facies, the overbank deposits facies, and the lacustrine deposits facies and they are described briefly below:

Fluvial Gravel – Clast-supported granule-to-cobble gravel with a sandy matrix dominates the facies. Intercalated lenses of sand and mud are common. The association was deposited in a gravelly fluvial braidplain characterized by wide, shallow, shifting channels.

Overbank Deposits – This facies dominantly consists of laminated to massive silt, silty fine-grained sand, and paleosols containing variable amounts of pedogenic calcium carbonate. Overbank deposits occur as thin (<0.5 to 2 meters) lenticular interbeds in the fluvial gravel facies and as thick (up to 10 meters) laterally continuous sequences. This sediment records deposition in proximal levee to more distal floodplain conditions.

Lacustrine Deposits – Plane laminated to massive clay with thin silt and silty sand interbeds displaying some soft-sediment deformation characterize this association. Coarsening upward sequences less than 1 to 10 meters thick are common. Strata comprising the association were deposited in a lake under standing water to deltaic conditions.

Ringold Formation strata in the 300 Area are generally divided into a lower, mud-dominated sequence and an upper, gravelly sequence (see Figure 3.2). The lower 17 meters composed of mud is laterally extensive and consists of lacustrine deposits overlying overbank deposits. It is correlated to the lower mud sequence found elsewhere throughout the Hanford Site near the bottom of the Ringold Formation. The gravelly sequence overlying the lower mud sequence is composed dominantly of the fluvial gravel facies and is roughly correlated to Ringold Formation units (B, C, and E) (Delaney et al. 1991; Lindsey 1991) or hydrostratigraphic units 5 and 7 of Thorne et al. (1993). Two mud-dominated intervals are found in the upper gravel sequence in the 300 Area. They are discontinuous, pinch out, and are not found in the immediate vicinity of the 300 Area process trenches. However, they do occur to the west and south and consist dominantly of paleosols typical of overbank deposits.

There is evidence of erosion and channelization of the top of the Ringold Formation throughout the 300 Area (Lindberg and Bond 1979; Schalla et al. 1988b; Swanson et al. 1992). These channels cause the upper Ringold Formation surface (and overlying contact with Hanford formation gravels) to be lower by approximately 3 to 9 meters in the channels. One of these channels may occur in the vicinity of the 300 Area process trenches as inferred by Lindberg and Bond (1979). However, well spacing in the 300 Area is too large to resolve structural details of these channels (such as size and orientation) on the Hanford formation-Ringold Formation contact.

Underlying the 52 meters of Hanford and Ringold formation sediments is the Saddle Mountain Basalt, which is a formation within the overall Columbia River Basalt Group. The uppermost basalt member of this formation in the vicinity of the 300 Area is the approximately 24-meter-thick Ice Harbor Member, which contains three flows that erupted from vents near Ice Harbor Dam on the Snake River east of Pasco, Washington (Helz 1978; Swanson et al. 1979; DOE 1988b) (see Figure 3.2). These basalt flows are typical in that they have rubbly or scoriacious flow tops and bottoms and relatively dense interiors. Underlying the lowest Ice Harbor Member flow is the Levey interbed, which is one of the intercalated members of the Ellensburg Formation. The Levey interbed is probably stratigraphically equivalent to the lower portion of the Ringold Formation further westward because the Ice Harbor flows pinch out westward. Below the Levey interbed is the Elephant Mountain Member, and below the two flows of the Elephant Mountain Member there are other basalt formations, members, and interbeds for over 3,000 meters.

3.2 Groundwater Hydrology

This section discusses the different aquifers within the suprabasalt aquifer system (Delaney et al. 1991). Aquifers below the suprabasalt aquifer system, although mentioned, are not relevant to this groundwater monitoring plan and are not discussed in detail.

Aquifers within the suprabasalt aquifer system are those that are above the uppermost, regionally extensive, confining layer (generally the dense interior of the uppermost basalt flow). In the 300 Area, there is another confining layer above the basalt and within the lower portion of the Ringold Formation, the lower mud unit (see Figure 3.2). Other mud units above the lower mud unit exist within the Ringold Formation, but they are discontinuous. Therefore, the uppermost or unconfined aquifer beneath the 300 Area extends from the water table (at about 10.1 meters below the ground surface) to the top of the Ringold Formation lower mud unit. Elsewhere, in the 300 Area where one or more of the upper muds are present, the aquifer(s) between the partially confining mud units is (are) partially confined. In the immediate vicinity of the 300 Area process trenches, the uppermost aquifer (unconfined or at most partially confined aquifer) is composed of a few meters of Hanford formation (depending on Columbia River stage) and 20 to 25 meters of Ringold Formation. The Hanford formation there is composed primarily of the gravel-dominated facies, and the Ringold Formation above the lower mud unit is dominantly the fluvial-gravel facies.

Aquifers below the Ringold Formation lower mud unit are confined. These confined aquifers include any coarse-grained Ringold Formation sediment below the lower mud unit, high permeability zones within basalt flows such as rubbly or scoriacious flow tops and bottoms, and interbeds of the Ellensburg Formation if the permeability is high. Except for the uppermost confined aquifer, they are intercalated with – and confined by – dense interiors of the basalt flows.

3.2.1 Aquifer Properties

The most recent aquifer tests and laboratory tests of drill core or borehole samples are reported in Swanson et al. 1992. The following are pertinent conclusions of the reported testing:

- The best estimate for unconfined aquifer properties came from multiple-well analysis of constant discharge tests. Test results for the uppermost portion of the unconfined (uppermost) aquifer at well clusters 699-S22-E9ABCD and 699-S27-E9ABCD (see Figure 3.1 for well locations) were, respectively, 36 and 49 meters per day for horizontal hydraulic conductivity, 2.1 and 5.5 meters per day for vertical hydraulic conductivity, 0.37 and 0.02 for specific yield, and 0.013 and 0.005 for storativity.

- Water levels measured at the two sites (cluster wells in lower Ringold Formation confined aquifer, lower unconfined aquifer, and upper portion of unconfined aquifer) show an upward hydraulic gradient, demonstrating that this area is probably a discharge area for the semiconfined and confined aquifers below the unconfined aquifer. (The unconfined aquifer, in turn, discharges to the Columbia River.)

- Barometric efficiencies estimated for wells screened at the bottom of the unconfined aquifer (B wells) are 10% and 18% for the two cluster sites. For the uppermost confined aquifer (C wells) the efficiencies are 28% and 22% for the two cluster sites.

- The specific yield result of 0.02 may indicate a semiconfining condition.

- Laboratory test results on split-tube samples yielded vertical hydraulic conductivities that were at least one order of magnitude lower than the best estimated horizontal values.

The well clusters used for the aquifer testing reported in Swanson et al. (1992) are effectively screened entirely in the Ringold Formation because the water table is either at or lower than the Ringold/Hanford formation contact at those cluster sites. However, the water table near the 300 Area process trenches is at or above the Ringold/Hanford formation contact, depending on river stage, possibly because of channeling in the top of the Ringold Formation.

Table 3.1 shows previously collected hydraulic conductivity data derived from well pumping tests (Schalla et al. 1988b, Appendix D). These data are from wells that are closer to the 300 Area process trenches than the wells reported in Swanson et al. (1992). As expected, hydraulic conductivities are higher at the top of the unconfined aquifer in wells near the trenches than they are at the well clusters reported in Swanson et al. (1992). These higher hydraulic conductivities in the wells closer to the 300 Area process trenches are the result of a greater contribution of groundwater from the Hanford formation which generally has a higher hydraulic conductivity than the Ringold Formation.

Table 3.1. Hydraulic Conductivities Estimated from Aquifer Tests in Wells Near the 300 Area Process Trenches (from Schalla et al. 1988b)

Well	Hydraulic Conductivity (m/d)	Aquifer
A-Wells		
399-1-13	3,353	Top unconfined(a)
399-1-18A	15,240	Top unconfined(a)
399-1-16A	152	Top unconfined(a)
B-Wells		
399-1-18B	0.58	Bottom of unconfined
399-1-17B	3.66	Bottom of unconfined
399-1-16B Test #1	0.61	Bottom of unconfined
399-1-16B Test #2	0.91	Bottom of unconfined
C-Wells		
399-1-18C	1.83	Uppermost confined
399-1-17C	79.2	Uppermost confined
399-1-16C	2.72	Uppermost confined
399-1-9	1.83	Uppermost confined

(a) Top of the unconfined aquifer at this well is mostly within the lower portion of the Hanford formation.

3.2.2 Groundwater Flow

Groundwater in the uppermost aquifer flows into the 300 Area from the northwest, west, and southwest (Hartman et al. 2001, Plate 1). Groundwater flow direction near the 300 Area process trenches, which is in the northern portion of the 300 Area, is predominantly to the east-southeast, as is determined from depth-to-water measurements at 300 Area wells, but is affected by fluctuations in Columbia River stage. Figure 3.3 is a water-table map with the depth-to-water measurements collected March 2000 and shows the configuration of the water table when river stage is normal to low (typical throughout most of the year). However, when the river stage is high, as it often is in the late spring and early summer during heavy runoff, the configuration changes because of the elevated river level and bank storage of river water that occurs temporarily during high river stage events. Figure 3.4 is an example of the water table configuration during high river stage, and represents the water table June 1997 when the groundwater flow direction in the vicinity of the trenches changed to a south or southwesterly flow direction. Also, during the high river stage events the lowest portions of the vadose zone become saturated and temporarily become part of the uppermost (or unconfined) aquifer.

There is an upward gradient between the uppermost confined aquifer and the unconfined aquifer. At wells 399-1-17A (screened at the water table) and 399-1-17C (screened within the uppermost confined aquifer) the head difference is about 11 m with the higher head in the deeper well. This supports the

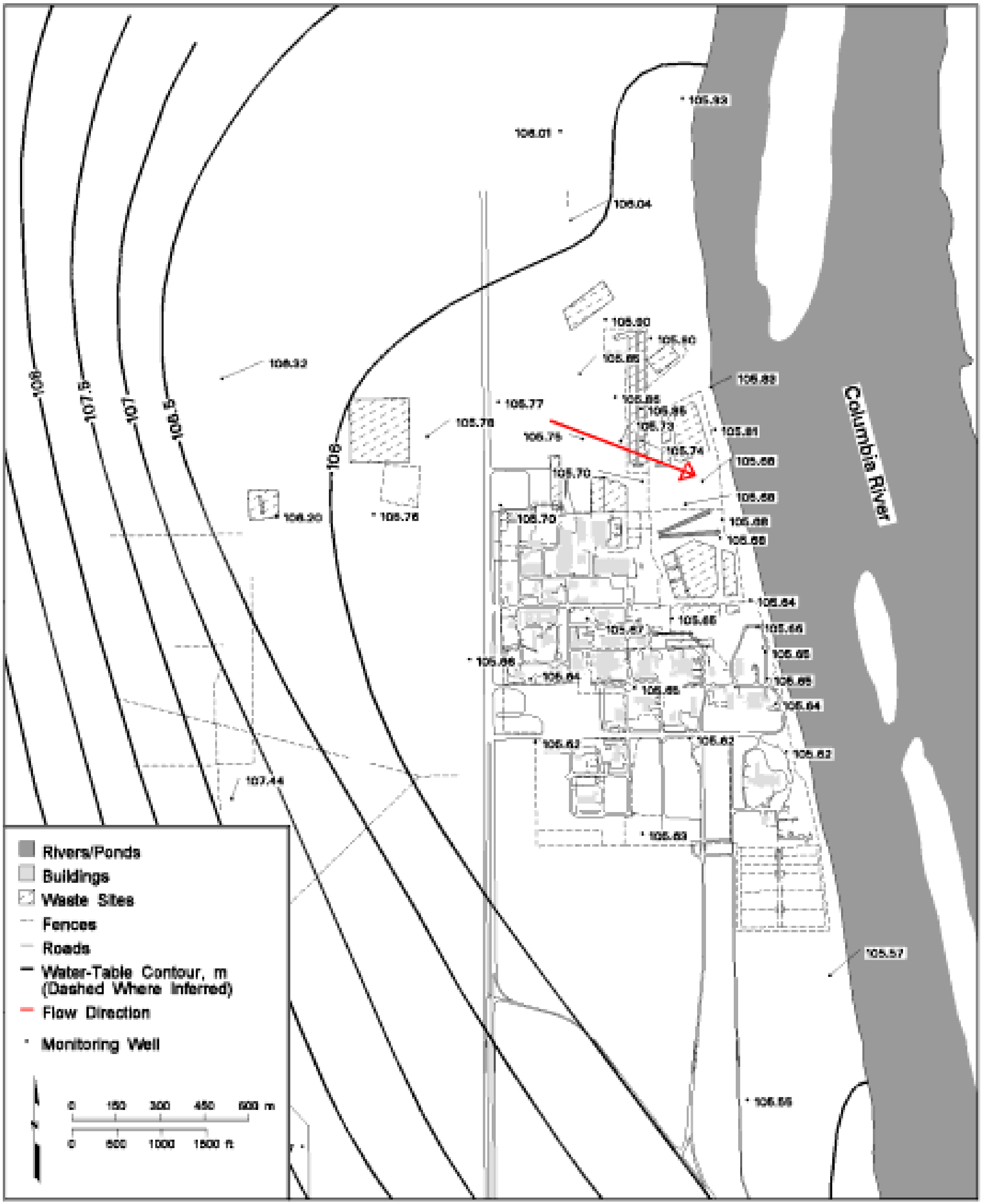

Figure 3.3. 300 Area Water-Table Map, March 2000

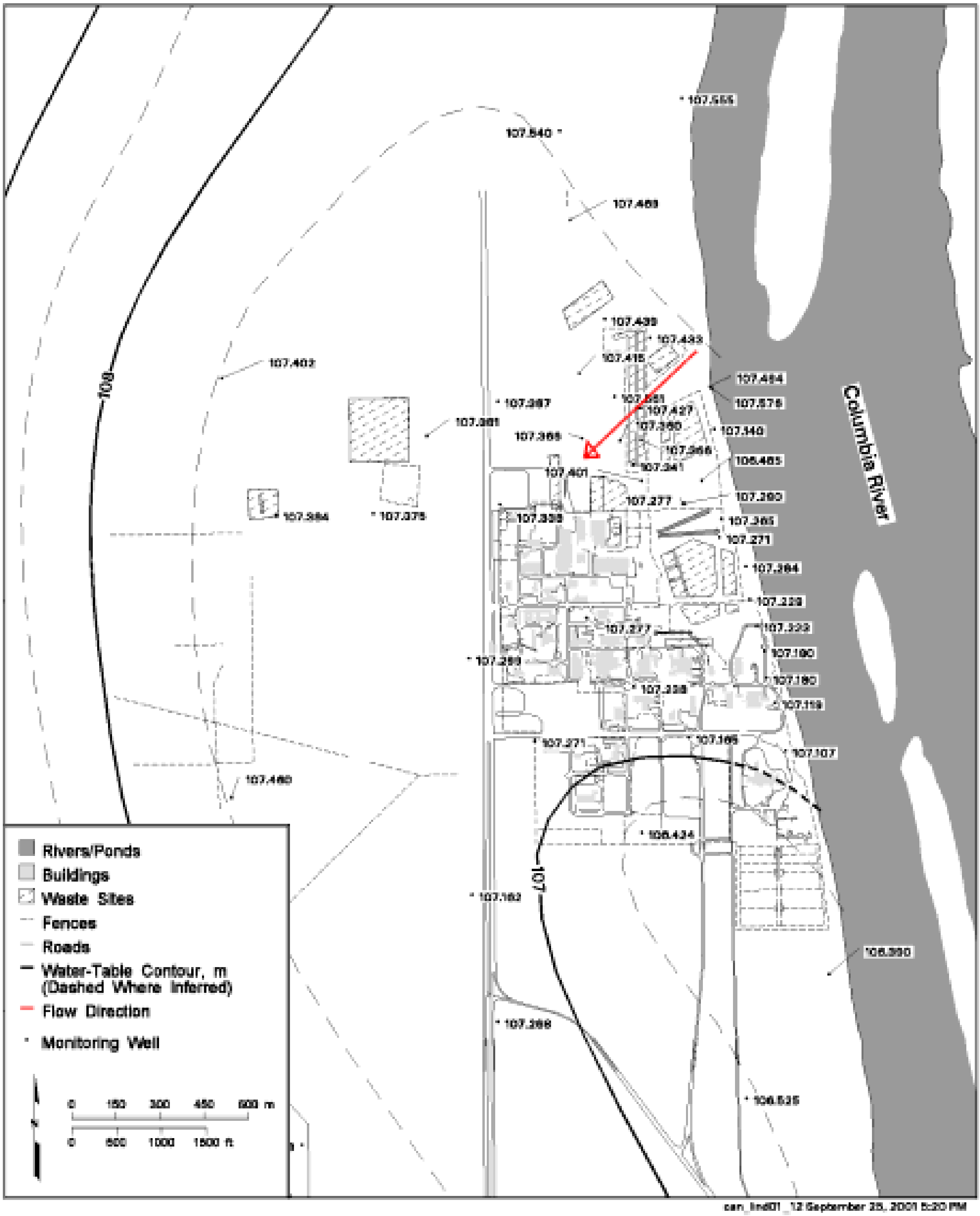

Figure 3.4. 300 Area Water-Table Map, June 1997

conclusion of Swanson et al. (1992) that the 300 Area is within a discharge area for the uppermost confined aquifer, and that, if communication is established between the confined aquifer and overlying unconfined aquifer, the flow direction is upward.

The groundwater flow rate at the top of the unconfined aquifer was estimated to be approximately 10.7 meters per day near the 300 Area process trenches based on evaluating groundwater chemistry data following a tetrachloroethene spill (Cline et al. 1985). The average groundwater flow rate can also be estimated roughly by using the Darcy equation.

$$v = \frac{Ki}{n_e} \tag{1}$$

where v = average linear groundwater flow rate
K = hydraulic conductivity
I = hydraulic gradient
n_e = effective porosity.

Schalla et al. (1988b) reported values of hydraulic conductivity for the unconfined aquifer in the vicinity of the trenches from 150 to 15,000 meters per day (see Table 3.1). Swanson et al. (1992) reported hydraulic conductivities for the Ringold Formation as 36 and 49 meters per day for two well sites southwest of the 300 Area process trenches. The hydraulic gradient near the trenches was 0.00031 for the water table depicted in Figure 3.3 (March 2000) and 0.00023 for the water table depicted in Figure 3.4 (June 1997). Estimates of effective porosity for the unconfined aquifer range from 0.10 to 0.30. Using the above-stated values for input parameters to the Darcy equation (1), the range of average linear groundwater flow rate is 0.12 to 46.5 meters per day. The large range in flow rate values is a result of the large range in values of hydraulic conductivity reported for the aquifer. If it is assumed that the Hanford formation is a major contributor to the hydraulic conductivity parameter in the vicinity of the 300 Area process trenches, then the average flow rate may actually be closer to the upper portion of the range, which is supported by the estimate of Cline et al. (1985).

By examining specific conductance versus time plots of wells at increasing distances from the Columbia River it is possible to estimate the distance from the Columbia River that river water displaces or mixes with groundwater during times of high river stages. The distance from the river that river water displaces groundwater during high river stages is significant because during high river stages the wells near the river may actually be sampling a mixture of groundwater and river water. Figures 3.5, 3.6, and 3.7 (respectively) show trend plots of specific conductance at wells 399-1-10A (34 meters from river), 399-1-16A (122 meters from river), and 399-1-17A (335 meters from river). Typically, Columbia River water has a specific conductance of about 120 to 150 µS/cm, and groundwater entering the 300 Area in the upper portion of the unconfined aquifer has a specific conductance in the range of 400 to 500 µS/cm. Figure 3.5 shows that in the late spring to early summer of each year the specific conductance drops below about 250 µS/cm at well 399-1-10A.

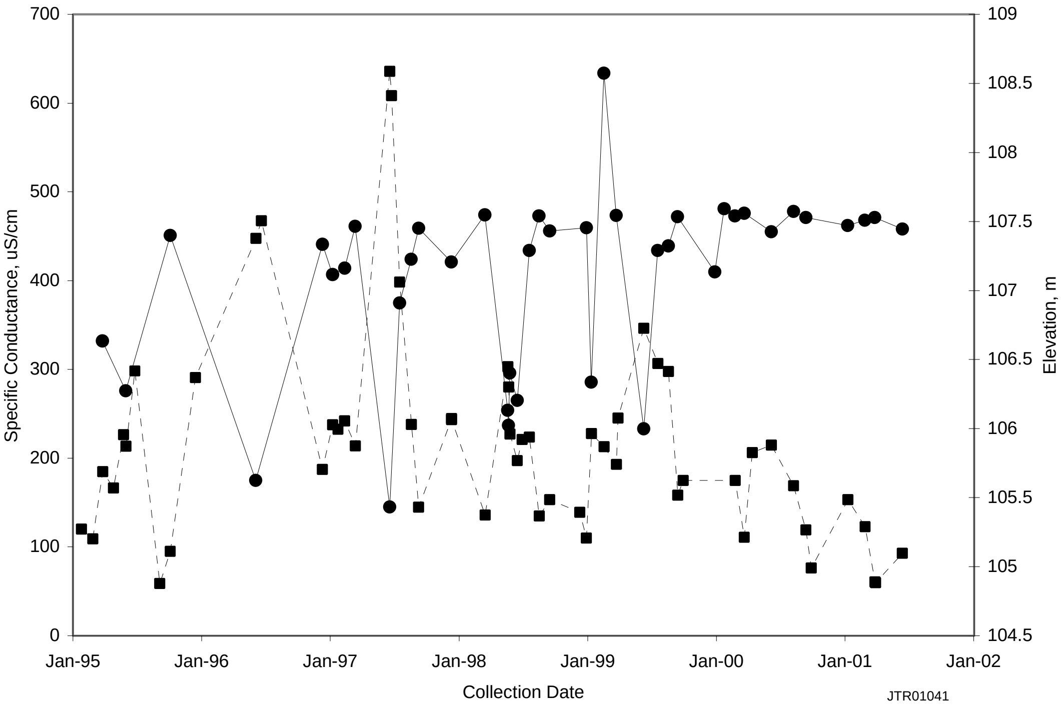

Figure 3.5. Specific Conductance and Water Level at Well 399-1-10A

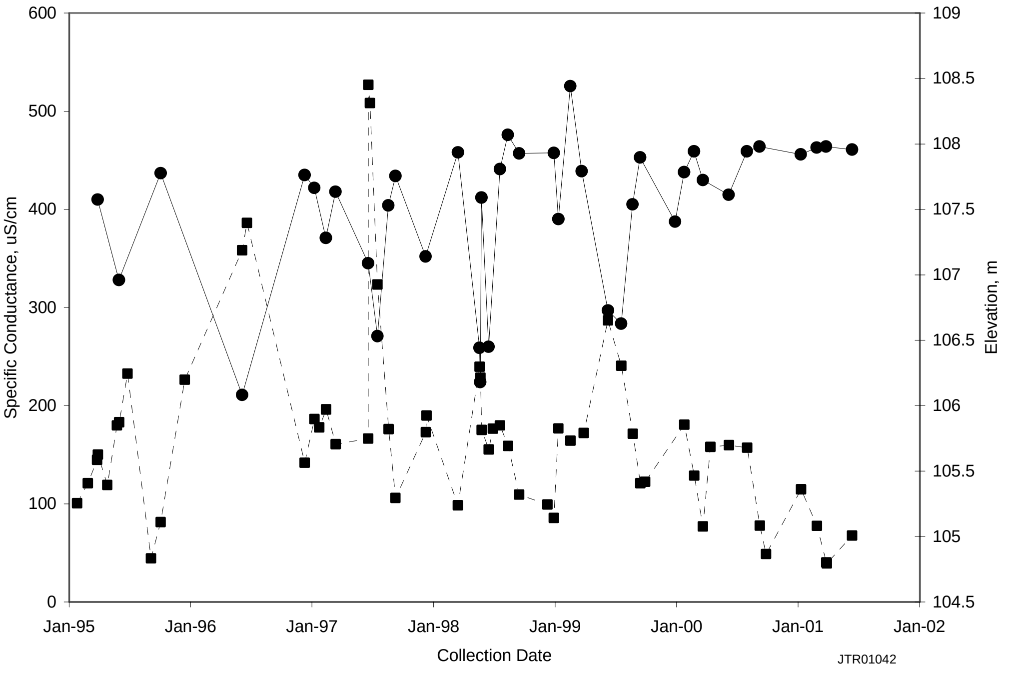

Figure 3.6. Specific Conductance and Water Level at Well 399-1-16A

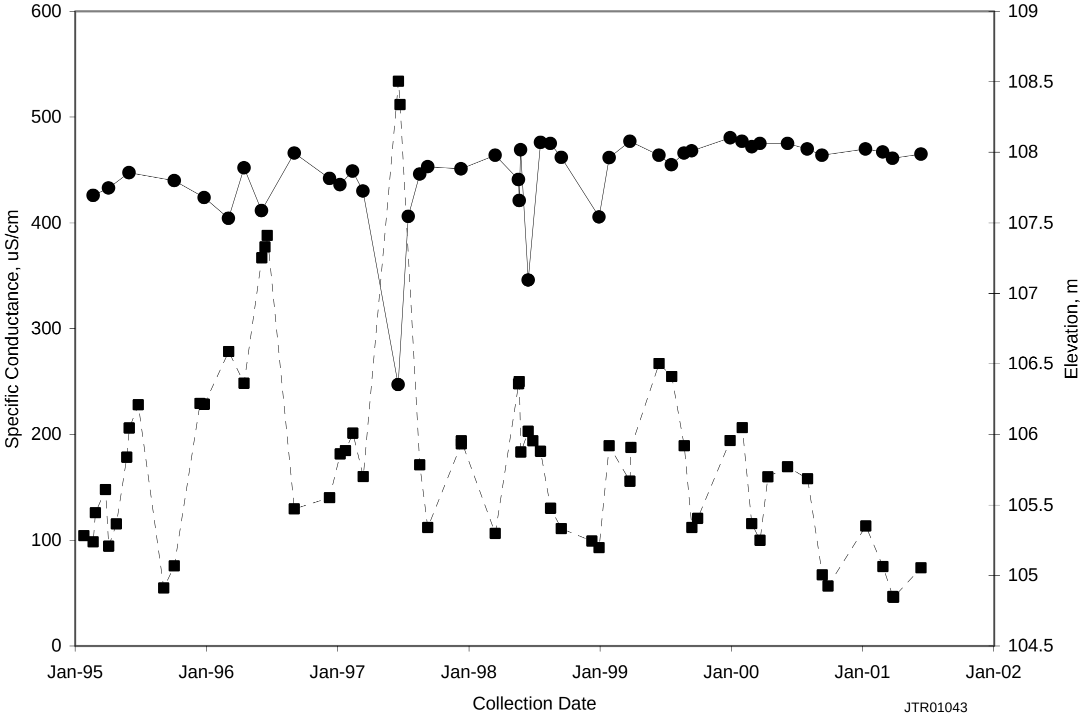

Figure 3.7. Specific Conductance and Water Level at Well 399-1-17A

These decreases in specific conductance correspond to high river stages of the Columbia River that, in turn, correspond to the annual spring runoff. Specific conductance dipped as low as 150 µS/cm during the 1997 spring runoff and indicates an almost complete displacement of groundwater with river water. (Note: This reported value of 150 µS/cm during June 1997 is about the same time as the water table map in Figure 3.4.) Figure 3.6 shows that specific conductance dipped to the range of 200 to 300 µS/cm at well 399-1-16A during high river stages each spring. Specific conductance in the range of 200 to 300 would indicate partial mixing. Figure 3.7 shows that specific conductance dipped slightly (to 250 to 350 µS/cm) in the high river stages of the years 1997 and 1998 at well 399-1-17A. Apparently, it was only during the high river stages of those years that the river was high enough for sufficient enough time to allow river water to flow inward as far as well 399-1-17A. In other years, the water table was affected as far west as well 399-1-17A, but river water did not reach that distance.

4.0 Summary of Groundwater Monitoring Results

Groundwater monitoring results associated with the three groundwater monitoring plans (Lindberg and Bond 1979; Schalla et al. 1988a; Lindberg et al. 1995) are discussed in this section. Appendix A lists groundwater monitoring analytical results for wells in the proposed groundwater monitoring well network.

4.1 Geohydrology and Groundwater Quality Beneath the 300 Area, Hanford Site, Washington

The earliest major study of groundwater contamination in the 300 Area is reported in Lindberg and Bond (1979). In that study, groundwater samples were collected monthly for one year (during calendar year 1977) from 29 wells in the 300 Area. The samples were analyzed for the following constituents:

Radioactive Constituents	**Nonradioactive Constituents**
Gross alpha	Bicarbonate
Gross beta	Carbonate
Gamma scan	Calcium
Uranium	Magnesium
Tritium	Sodium
	Chloride
	Sulfate
	Nitrate
	Chromium
	Copper
	Potassium
	Fluoride
	pH
	Specific conductivity

At that time, the 29 wells in the sampling network were all constructed of perforated carbon steel casing with dedicated submersible electric pumps. This well type does not meet current regulatory standards (WAC 173-160).

Results showed that calcium, magnesium, sodium, bicarbonate, and sulfate were lower in concentration near the 300 Area process trenches than in background wells (dilution). Constituents that were found to be in higher concentrations (or activity) near and downgradient of the trenches were gross alpha, uranium, chloride, and nitrate. Presumably, discharges to the trenches were responsible for the constituents with the higher concentrations.

4.2 Tetrachloroethene Spill

Following two accidental releases of tetrachloroethene (PCE) to the 300 Area process trenches (455 liters on November 4, 1982, and 76 liters on July 6, 1984), several wells were closely monitored to track the plume. The following wells shows elevated levels of PCE (see Figure 3.1):

399-1-5
399-1-2
399-1-3
399-2-1
399-2-2
399-3-1
399-4-7
399-4-10

Peak concentrations of PCE (1,840 μg/L) was found in well 399-1-5 about 5 days after the first release. Movement of the peak concentration was estimated at 10.7 m/d (Cline et al. 1985).

4.3 Early RCRA Monitoring

By 1985, a RCRA interim status groundwater monitoring program for the 300 Area process trenches was in effect (see Section 1.2). The effort was based on the groundwater monitoring requirements in 40 CRF 265.90, WAC 173-303-400, and past groundwater monitoring conducted in the 300 Area. The well network consisted of the following 16 wells (see Figure 4.1 for their locations).

399-1-1
399-1-2
399-1-3
399-1-4
399-1-5
399-1-6
399-1-7
399-1-8
399-2-1
399-3-7
399-3-10
399-4-1
399-4-7
399-8-2
699-S19-E13
699-S30-E15A

Fourteen monitored the upper portion of the unconfined aquifer near the water table and two wells (399-1-8 and 399-4-1) monitored the base of the unconfined aquifer. Six of the wells have stainless-steel screens, and the other 10 have perforated casings.

Based on instructions given in *Test Methods for Evaluating Solid Waste* (EPA 1986) and information provided by the facility manager concerning the composition of the wastes, the constituents listed in Table 4.1 were analyzed in the groundwater samples collected from the 16 wells. EPA guidance suggested that analyses should be conducted for the Primary Drinking Water Standards (DWS) and for specific dangerous waste constituents known to have been discharged to the 300 Area process trenches. Additional parameters, such as the contamination indicator parameters that are required for a detection-level program, but not necessary for an alternate or assessment-level program, were added to provide consistency with other interim-status programs. In addition, samples from two wells sampled quarterly were also being analyzed for some additional parameters, including the dangerous waste constituents in WAC 173-303-9905). These additional analyses (Table 4.2) provided information needed for the permitting process and to further ensure that potential contaminants were not overlooked. The two wells chosen for the extra analyses included one upgradient well (699-S19-E13) and one downgradient (399-1-3).

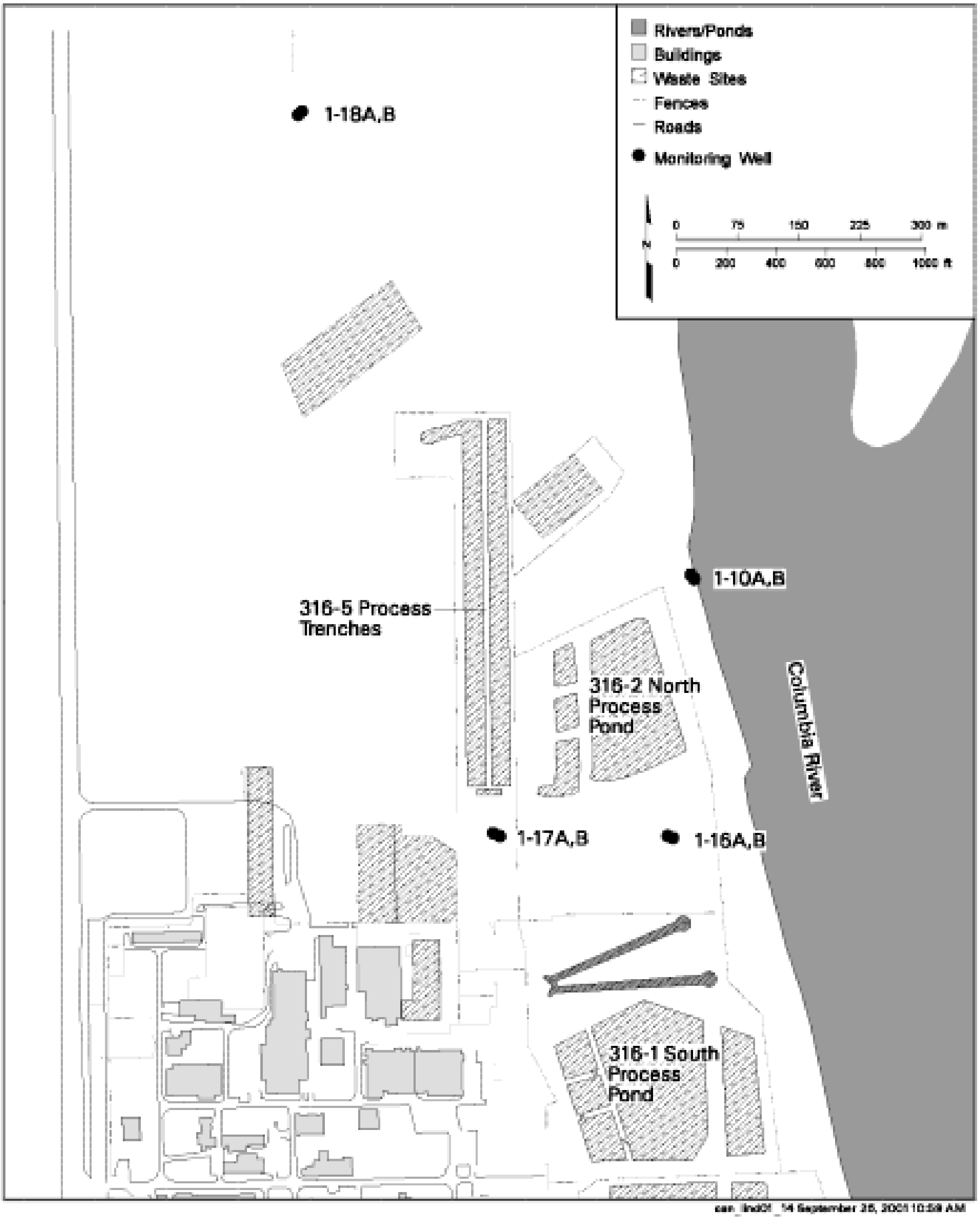

Figure 4.1. Locations of Monitoring Wells of 300 Area Process Trenches Groundwater Monitoring Plan (Lindberg et al. 1995)

Table 4.1. Standard List of Analytes for the 300 Area Process Trenches Groundwater Monitoring Network (Schalla et al 1988a)

Barium	Cadmium	Chromium
Silver	Sodium	Nickel
Copper	Aluminum	Manganese
Iron	Calcium	Zinc
Arsenic	Mercury	Selenium
Lead	Nitrate	Sulfate
Fluoride	Chloride	Cyanide
Sulfide	Radium	Gross Alpha
Gross Beta	Uranium	Strontium-90
Gamma Scan	Total organic halogen	Total organic carbon
Ammonium Ion	Hydrazine	Endrin
Methoxychlor	Toxaphene	Lindane
2,4-D	2,4,5-TP silvex	1,1,1-trichloroethane
Tetrachloroethene (PCE)	Chloroform	Methylene chloride
1,1,2-trichloroethane	1,1,2-trichloroethene	Methylethyl ketone
Coliform bacteria	Temperature	Specific conductance
pH		

The dangerous waste constituents list in WAC 173-303-9905 is very similar to Appendix IX of 40 CFR 264, Subpart F. However, there are some differences. Those constituents in Appendix IX that are not in WAC 173-303-9905 are listed in Table 4.3. All of the constituents listed in Table 4.3 were analyzed later in the 300 Area process trenches monitoring well network.

Results of the early analyses under the interim-status program are documented in Schalla et al. (1988b, Tables 6 and 7) and Schalla et al. (1988a). Schalla et al. (1988b), Table 6 (Summary of Constituents Sampled to Date), shows that the herbicides and pesticides on the interim primary drinking water standards list were never reported above the detection limits nor were the phenols in the list of water quality parameters. Very few of the constituents in the site-specific list and almost none of the additional constituents sampled as part of the WAC 173-303-9905 list were detected. Several other constituents have only been reported above detection limits sporadically. Among those constituents that are regularly reported as being above the detection limit are gross alpha, gross beta, barium, nitrate, sodium, iron, sulfate, chloride, copper, ammonium, vanadium, potassium, chloroform, and methylchloride.

Schalla et al. (1988b), Table 7 (Analytical Data, June 1988-May 1986), compiles the results for those constituents that had at least one value reported above detection limits. Gross alpha and beta both exceeded their screening limit for Interim Primary DWS. Gross alpha and uranium are closely correlated because uranium is an alpha emitter. However, subtraction of uranium from gross alpha would probably bring gross alpha to below the “adjusted” gross alpha limit of 15 pCi/L. Chromium, mercury, selenium, and fluoride were reported as being above interim primary drinking water standard at least once.

Table 4.2. Additional Analytical Parameters (Schalla et al. 1988a)

Beryllium	Osmium	Strontium
Antimony	Vanadium	Potassium
Thallium	Thiourea	1-acetyl-2-thiourea
1-(o-chlorophenyl) thiourea	Diethylstilbesterol	Ethylenethiourea
1-naphthyl-2-thiourea	N-phenylthiourea	DDD
DDE	DDT	Heptachlor
Heptachlor epoxide	Dieldrin	Aldrin
Chlordane	Endosulfan I	Endosulfan II
Chlorobenzilate	2,4,5-T	Perchlorate
Phosphate	Carbophenothion	Tetraethylpyrophosphate
Disolfoton	Dimethoate	Methyl parathion
Parathion	Citrus red #2	Paraldehyde
Cyanogen bromide	Cyanogen chloride	Acrylamide
Allyl alcohol	Chloral	Chloroacetaldehyde
3-chloropropionitrile	Cyanogen	Dichloropropanol
Ethyl carbamate	Ethyl cyanide	Ethylene oxide
Fluoroacetic acid	Glycidylaldehyde	Isobutyl alcohol
Methyl hydrazine	n-propylamine	2-propyn-1-ol
1,1-dimethyl hydrazine	1,2 dimethyl hydrazine	Acetronitrile
Tetrachloromethane	Xylene-o,p	Xylene-m
Formaldehyde	Additional volatiles	Hexachlorophene
Naphthalene	Phenol	Kerosene
Hexachlorobenzene	Pentachlorobenzene	1,2-dichlorobenzene
1,3-dichlorobenzene	1,4-dichlorobenzene	1,2,3-trichlorobenzene
1,3,5-trichlorobenzene	1,2,3,4-tetrachlorobenzene	1,2,3,5-tetrachlorobenzene
Additional semi-volatiles	Ethylene glycol	

Table 4.3. Appendix IX Contaminants not in WAC 173-303-9905 List

Acenaphthalene	Acetone	Allyl chloride
Aniline	Anthracene	Antimony
Aramite	Benzo[k]fluoranthene	Benzo[ghi]perylene
Benzyl alcohol	Alpha-BHC	Beta-BHC
Delta-BHC	Gamma-BHC	Lindane
Bis(2-chloro-1-methyl-ethyl) ether		2,2’-dichlorodiisopropyl ether
Bromodichloromethane	4-chlorophenyl phenyl	Chloroprene
Cobalt	Copper	Dibenzofuran
Dibromochloromethane	Chlorodibromomethane	1,2-Dibromo-3-chloro-propane
DBCP	p-(Dimethylamino) azobenzene	Dinoseb
DNBP	2-sec-butyl-4,6-dinitrophenol	Ethylbenzene
Fluorene	Isodrin	Isophorone
Methoxychlor	Methylene bromide	Dibromomethane
Methylene Chloride	Dichloromethane	2-methylnaphthalene
4-methyl-2-pentanone	Methyl isobutyl ketone	o-nitroaniline
m-nitroaniline	Nitrobenzene	p-nitrophenol
N-Nitrosodipropylamine	Di-n-propylnitrosamine	Phenanthrene
Pyrene	Safrole	Styrene
Sulfide	Tin	Vanadium
Vinyl acetate	Xylene	Zinc

In 1986 and 1987, 19 new wells were installed to enhance the understanding of the hydrogeology at the 300 Area process trenches and to help characterize the direction and extent of contamination in Hanford and Ringold Formation sediment. The new wells, which were designed to meet WAC 173-160 standards, included five well clusters (399-1-16ABCD, 399-1-17ABC, 399-1-18ABC, 399-1-14AB, and 399-1-10AB) and five single wells, including the following (see Figure 3.1 for locations):

399-1-11
399-1-12
399-1-13
399-1-15
399-1-19

Each well cluster included one well in the upper portion of the unconfined aquifer (the “A” well), one well at the bottom of the unconfined aquifer (the “B” well), and sometimes one well in the uppermost confined aquifer below the Ringold Formation lower mud unit (“C” well), or in a basalt aquifer (“D” well). Total number of wells in the network temporarily rose to 35 (17 original plus 19 newer wells). The samples from the network of 35 monitoring wells were analyzed for a list of constituents that included the list of dangerous waste constituents in WAC 173-303-9905 (PNL 1988).

During the years 1989 to 1994, wells were periodically dropped from the network and the sampling schedule was changed from monthly to quarterly and eventually to semiannually. These changes were made because data quality objectives in the groundwater monitoring plan (Schalla et al. 1988a) regarding hydrogeology and contamination were satisfied, the expedited response action in 1991 appeared to have significantly reduced contamination in the trenches, and fewer wells sampled less frequently would still provide adequate groundwater monitoring. The well network was dropped to 11 wells sampled semiannually. The 11 wells included the following (see Figure 3.1 for well locations):

399-1-10
399-1-11
399-1-12
399-1-14
399-1-16AB
399-1-17AB
399-1-18A
399-2-1
399-3-10

Table 4.4 lists the contaminant analyzed and the frequency of the sampling.

Chromium, lead, selenium, lindane, and gross alpha had reported results greater than the maximum contaminant levels. Chromium exceedances have been the result of an excessive amount of suspended particles (turbidity) in groundwater samples because the exceedances are associated with unfiltered samples. Lead exceedances occurred prior to the expedited response action in 1991 in two wells that did not meet WAC 173-160 standards for construction. Since the expedited response action and prior to 1994, lead concentrations have been below the maximum contaminant level of 50 μg/L. Exceedances of selenium and lindane may actually be analytical problems due to detection limits that were greater than respective maximum contaminant levels. Other constituents of interest such as gamma-emitting radionuclides and strontium-90, copper, sulfate, zinc, chloride, and silver were all below the primary and secondary drinking water standard or the 4 mrem/yr equivalent activity level for radionuclides.

Table 4.4. Groundwater Contaminants Analyzed from Schalla et al. (1988a) Before Discharges Ended at the 300 Area Process Trenches

Semiannual Schedule – All 11 300 Area Process Trenches Network Wells
Alkalinity
Gross alpha
Gross beta
Uranium
Coliform bacteria
Specific conductance (lab)
ICP metals (including arsenic, selenium, and lead) unfiltered and filtered
Mercury (filtered and unfiltered)
pH (lab)
Radium
TOC
TOX
Tritium
Volatile organics analysis (GC)
Quarterly Schedule – Well 399-1-17A Only
Anions
Specific conductance (lab)
Gamma scan
pH (lab)
Strontium-90
TOX
TOC
Isotropic uranium
Uranium (chemical)
Volatile organics analysis (GC)

Volatile organic analysis (VOA) results indicate that several constituents were detected downgradient of the 300 Area process trenches during this period. The detected VOA constituents include PCE, toluene, xylene, benzene, TCE, chloroform, ethylbenzene, and cis-DCE. However, only TCE and cis-DCE were consistently above the drinking water standard of 5 and 70 μg/L, respectively. The well showing the exceedances of TCE and cis-DCE was 399-1-16B.

Concentrations of iron and manganese in filtered samples were consistently higher than drinking water standard for two wells (399-1-16B and 399-1-17B). Both wells are screened at the bottom of the unconfined aquifer. These results may be due to reducing conditions and the effect on well structures such as stainless steel casing and the effects of drilling. A similar relationship between sampling depth and concentration profiles for redox-sensitive species has been documented in Johnson and Chou (1994).

Uranium continued to be detected in several wells in the vicinity of the 300 Area process trenches during this period and was correlated to gross alpha. The expedited response action in 1991 reduced the concentrations of uranium significantly in all the network wells such that uranium exceeded the 20-μg/L EPA-proposed guidance in only two wells (399-1-17A and 399-1-10A).

4.4 Groundwater Monitoring After Discharges Ceased

In December 1994, wastewater discharges from the 300 Area process trenches ceased, and shortly thereafter, the current groundwater monitoring plan (Lindberg et al. 1995) was prepared and implemented. The revision was done because the trenches were initially scheduled to be included in the final status RCRA Permit as a treatment, storage, and disposal unit undergoing closure through the permit modification process originally planned for September 1995. The groundwater monitoring plan was changed because groundwater near the 300 Area process trenches needed to be monitored under a final status/compliance monitoring program.

4.4.1 Changing from Assessment to Compliance Monitoring

The major objective of the compliance monitoring program was to determine whether appropriate concentration limits for the identified groundwater contaminants were exceeded. For the constituents of concern, the proposal was to use the maximum contaminant levels as the concentration limits. However, for uranium, there was no drinking water standard established, so the 20-µg/L EPA-proposed limit was used until the rule containing the subject standard was promulgated. (Note: The final rule for the uranium drinking water standard was promulgated December 7, 2000, at 30 µg/L, and becomes effective December 8, 2003 [EPA 2000b].)

Based on the results of previous groundwater monitoring, the revised groundwater monitoring plan stipulated a network of eight well (4 well pairs of “A” and “B” wells) that were to be sampled initially on a semiannual basis (see Figure 4.1). The constituent list included chemical uranium, VOAs (especially TCE and cis-DCE), and the metals iron and manganese. At the request of the regulator (Ecology), thallium, PCBs, chrysene, and benzo(a)pyrene were added to the constituent list because of their concern about dangerous waste leaching from the relocated sediment stockpiled at the northern ends of the trenches.

Final status/compliance monitoring officially commenced at the 300 Area process trenches in December 1996, and at that time the sampling schedule changed from semiannual (as it was under interim status/assessment monitoring) to a modified semiannual sampling schedule. The modified semiannual schedule included two sets of sampling efforts per year (therefore retaining the semiannual classification), but collecting four time-independent samples during each semiannual sampling period for each well in the network (as required by WAC 173-303-645 for compliance monitoring). Using EPA guidelines (EPA 1989), the time duration between the independent samples was calculated to be at least 48 hours. However, to reduce any potential for autocorrelation and to better accommodate the normal sampling schedules of the sampling teams, the sampling interval was lengthened to one month. Therefore, the resulting sampling schedule was set such that the wells in the network were sampled in June (when the Columbia River was likely to be in its highest stages), July, August, and September, and in December (when the Columbia River was likely to be in low stages), January, February, and March. During this more rigorous sampling schedule, the constituents to be analyzed were uranium and the VOAs. Samples were analyzed for the metals, iron and manganese, and for the four Ecology-requested constituents during the June and December sampling events only.

4.4.2 Changing from Compliance Monitoring to Corrective Action Monitoring

As was expected, cis-DCE, TCE, and uranium exceeded their concentration limits (70 μg/L, 5 μg/L, and 20 μg/L, respectively) in wells downgradient of the 300 Area process trenches during the first series of time-independent samples (December 1996; January, February, and March 1997). Cis-DCE and TCE exceeded the limits in the deeper well 399-1-16B, and uranium exceeded its limit in 399-1-10A, 399-1-16A, and 399-1-18A. The regulator was notified and the groundwater monitoring plan was modified to become a corrective action plan. At that point, the objective of the groundwater monitoring plan changed from determining if concentration limits were exceeded to monitoring the concentration trends of the constituents of concern to confirm that they were naturally attenuating, as expected by the CERCLA record of decision for the 300-FF-5 Operable Unit (ROD 1996). (Note: The RCRA modified closure/ post-closure plan [DOE 1997a, Rev. 2, page 6-4] remediation goals for groundwater are deferred to the CERCLA 300-FF-5 Operable Unit.) A revised groundwater monitoring plan was proposed to sample the network wells only once per semiannual sampling period, and to initiate a control chart method of statistics (similar to the proposed plan in this document – see Section 7.3). The plan was written and submitted to the regulator for approval, but the statistical approach was not approved until May 7, 2001[1] (Ecology Letter 2001). Therefore, in the period between March 1997 and the present, the current groundwater monitoring plan remained in effect with a sampling schedule requiring eight independent samples collected per year from each of the eight network wells. The proposed groundwater monitoring plan in this document will implement the changes approved by the regulator.[2]

4.4.3 Reported Values of the Constituents of Concern in Groundwater

Each of the constituents of concern was detected in groundwater samples from 300 Area process trenches network wells. Tritium and nitrate were detected also, but these constituents are from upgradient sources. The source of tritium is the 200 East Area, and the source of nitrate is outside the Hanford Site area to the southwest (Hartman et al. 2001). (Note: Appendix B contains concentration versus time plots for the four constituents of interest, uranium, TCE, cis-DCE, and PCE for each of the wells in the proposed well network.)

Uranium. Since the expedited response action in 1991, the concentration of uranium in wells downgradient of the 300 Area process trenches initially decreased in two of the three wells monitoring the unconfined aquifer near the water table (wells 399-1-10A [Figure 4.2] and 399-1-17A [Figure 4.3]) and then increased again when the wastewater discharges ceased in December 1994. The concentration of uranium at the other downgradient well screened at the water table (well 399-1-16A [Figure 4.4]) remained relatively steady except for two questionable results in late 1993 and late 1994. In the "B" wells (wells at the bottom of the unconfined aquifer) downgradient of the trenches, the concentration

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[1] Letter from Dib Goswami (Washington State Department of Ecology, Olympia, Washington) to Marvin Furman (U.S. Department of Energy, Richland, Washington), *Statistical Assessment for the 300 Area Resource Conservation and Recovery Act of 1976 (RCRA) Ground Water Monitoring Plan*, dated May 7, 2001 (see Appendix D).

[2] Ibid.

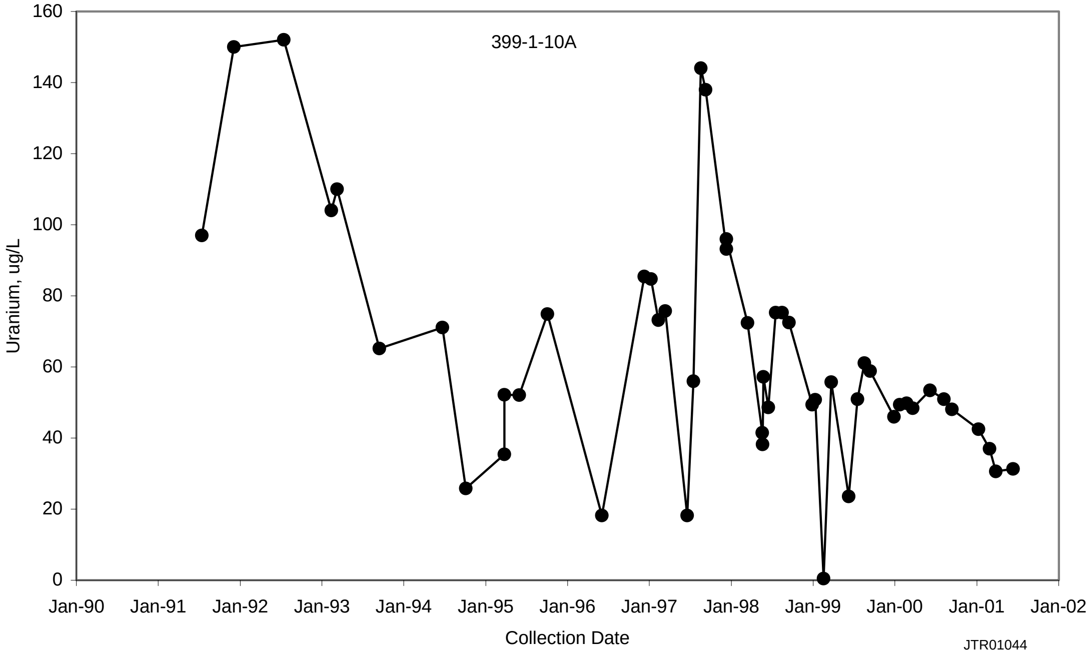

Figure 4.2. Uranium Concentration in Well 399-1-10A

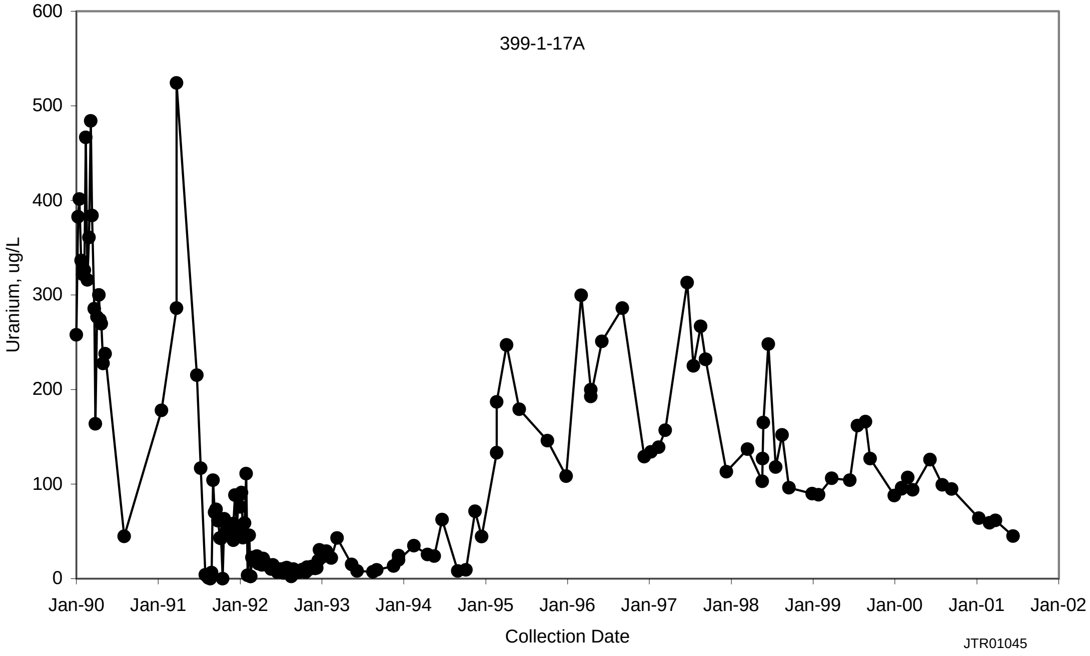

Figure 4.3. Uranium Concentration in Well 399-1-17A

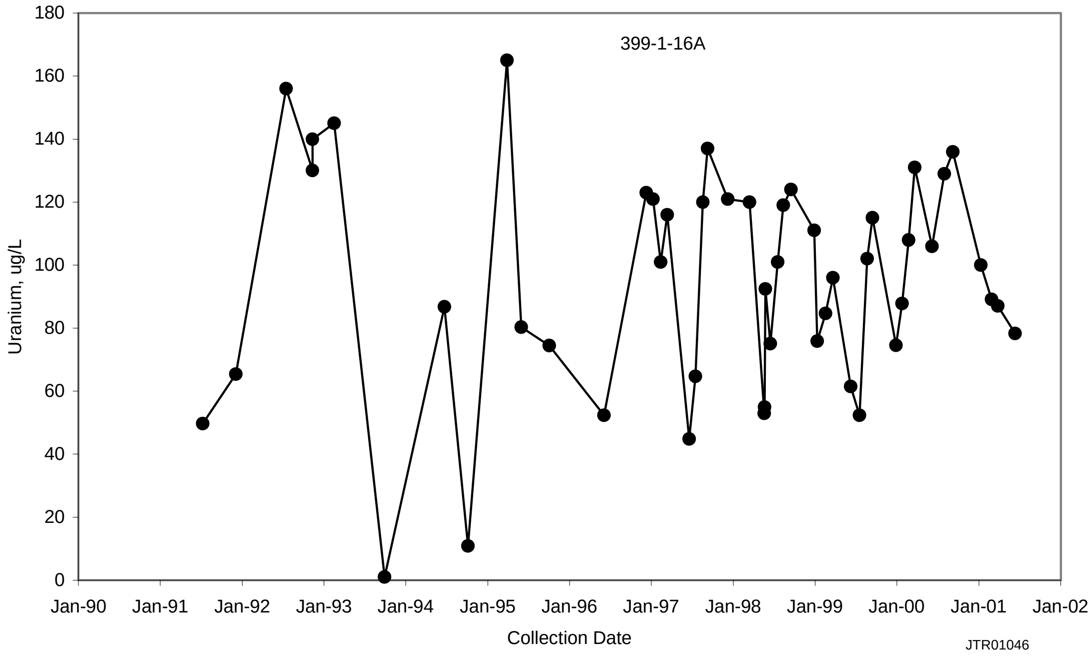

Figure 4.4. Uranium Concentration in Well 399-1-16A

remained below 1.0 pCi/L except for well 399-1-16B (Figure 4.5) where uranium concentrations have been rising since the expedited response action, but never exceeding the proposed 20 µg/L drinking water standard.

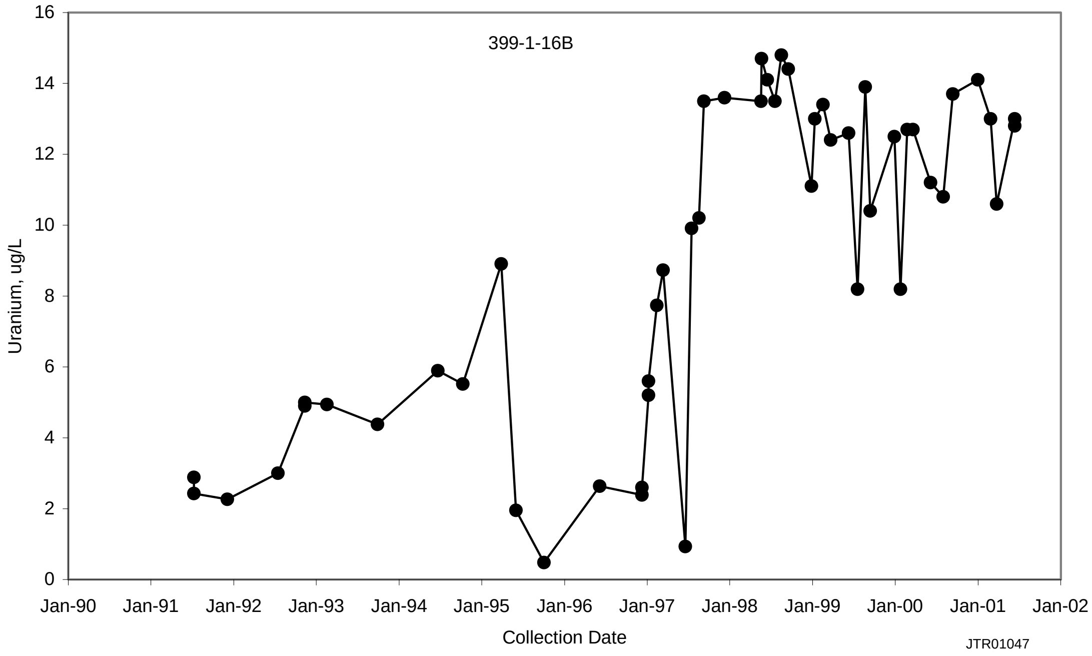

Figure 4.5. Uranium Concentration in Well 399-1-16B

Efforts during the expedited response action to reduce the amount of uranium in groundwater appeared to be at least partially successful because the trend plot of uranium concentration with time at well 399-1-17A (immediately downgradient of the trenches) (see Figure 4.3) shows that uranium concentration dropped dramatically immediately after the expedited response action. Low levels of uranium continued for 3 to 4 years until wastewater discharges ceased at the 300 Area process trenches. Subsequently, reported uranium results at well 399-1-17A rose again to levels as high as 300 μg/L in 1997 before decreasing to more recent reported levels around 50 μg/L. Apparently, when the trenches were in operation between 1991 and 1994, dilution by the large quantities of relatively clean process water (largely composed of cooling water) kept the concentration of uranium at the relatively low levels detected during that period. However, when use of the trenches stopped in late 1994 and the dilution no longer occurred, uranium concentration in the groundwater rose to the higher levels measured after 1994. In addition, this dilution effect was only slightly apparent at well 399-1-16A (see Figure 4.4) and was not observed at all at well 399-1-10A (see Figure 4.2).

Figure 4.6 shows that the distribution of uranium in the upper part of the unconfined aquifer was widespread throughout the 300 Area during the year 2000 but is concentrated in the plume downgradient (southeast) of the 300 Area process trenches. The uranium in the concentrated portion of the plume is probably from the process trenches, but much of the rest of the plume may have come from other sources in the 300 Area (e.g., North and South Process Ponds). Trend plots of uranium concentration versus time at wells 399-10A, -16A, and -17A show an annual cyclical pattern related to the water levels in those wells, which in turn is directly related to river stage of the Columbia River (see Figures 4.2, 4.4, and 4.3, respectively). Figure 4.2 shows that when the water level rose in well 399-1-10A, the concentration of uranium decreased as would be expected with the mixing of river water as discussed in Section 3.2.2. Similar results are noted in Figure 4.4 for well 399-1-16A. When river level rose, uranium concentration tended to decrease. However, in Figure 4.3, uranium concentration seemed to rise rather than decrease at well 399-1-17A during periods of high river stage. Apparently, well 399-1-17A (near the trenches) is far enough from the river that there is reduced amount of river water incursion at that distance, as discussed in Section 3.2.2. Furthermore, as the water table rises with high river stages, uranium waste retained in the vadose zone is mobilized temporarily, increasing uranium concentration in groundwater. As the magnitude of high river stages decreased from 1997 to 2001, the levels of reported uranium at well 399-1-17A have also decreased. An important consideration in future years will be to determine whether the reported levels of uranium at well 399-1-17A will increase when river stages rise again to (or near) the levels experienced in 1997.

The increased concentration in uranium found in groundwater during higher river stages is most likely from a secondary source of uranium in the lower portion of the vadose zone and/or upper portions of the aquifer. This has to be the case because only the lower portions of the vadose zone become saturated during high river stages, thus providing the potential for leaching uranium from the sediment. In turn, this secondary source of uranium is most likely from the uranium-bearing waste discharged to the 300 Area process trenches from 1975 to 1985 (or earlier from the process ponds). The uranium in the wastewater discharges may have been in the form of uranyl nitrate, uranium oxides, elemental uranium from millings, uranium tetrafluoride, or other forms (Young and Fruchter 1991). These forms of uranium are known to have entered the process sewer during the fuel fabrication process and may have been discharged to the 300 Area process trenches as both suspended solids (uranium metal and oxides) or as

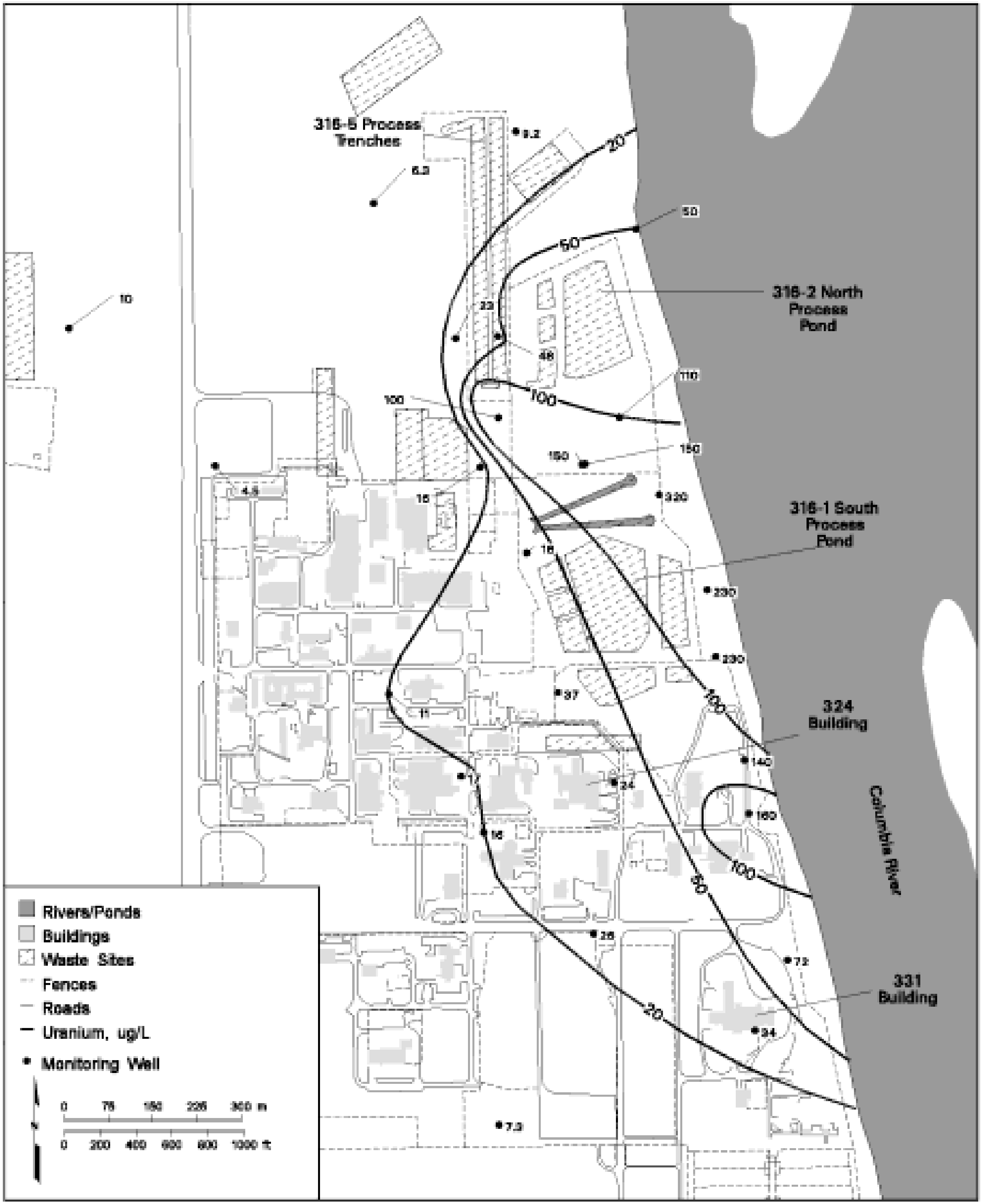

Figure 4.6. Average Uranium Concentrations in Groundwater at the 300 and Richland North Areas, Top of Unconfined Aquifer

dissolved solutes (uranyl nitrate). The suspended uranium-bearing solids likely were filtered out close to the trench bottoms, but the soluble uranium likely migrated deeper into the vadose zone where it interacted with sediment. The uranium was retained in the lower vadose zone by either a surface site adsorption process or a co-precipitation process whereby the uranium is removed from pore fluids. In both cases (surface site adsorption/desorption or co-precipitation), the amount and rates of adsorption or leaching of uranium are sensitive to environmental parameters such as pH or alkalinity (in this case bicarbonate/carbonate concentration) and possibly ionic strength (i.e., competing cations and anions) (EPA 1999). What is not yet known is the precise nature of the chemical species of uranium in the sediment near the fluctuating water table and specific details about the adsorption/desorption and/or co-precipitation processes that control the partitioning of uranium between sediment and groundwater.

Trichloroethene. TCE exceeded the maximum contaminant level (5.0 μg/L) in the 300 Area process trenches only at well 399-1-16B (Figure 4.7), though it was detected in most wells of the network. Since well 399-1-16B was first sampled in 1987, the concentration of TCE has steadily decreased from about 24.0 μg/L to below 1.0 μg/L in 1995. However, the concentration rose again to over 10 μg/L by early 1997, and then decreased steadily to approximately 2.0 μg/L in 2001. The lower concentrations reported more recently are approaching the values reported in the upper portion of the unconfined aquifer in wells 399-1-16A and 399-1-17A. The lower reported values of 0.5 to 2.0 μg/L in the wells of the upper portion of the unconfined aquifer most likely are caused by a source upgradient and offsite to the southwest (Hartman et al. 2001) (Figure 4.8).

TCE was apparently discharged to the trenches as a separate waste product from PCE (i.e., it was not a degradation product of PCE). Because PCE was never detected in well 399-1-16B in more than trace concentrations, it was not available in sufficient quantities to be the source of the TCE detected.

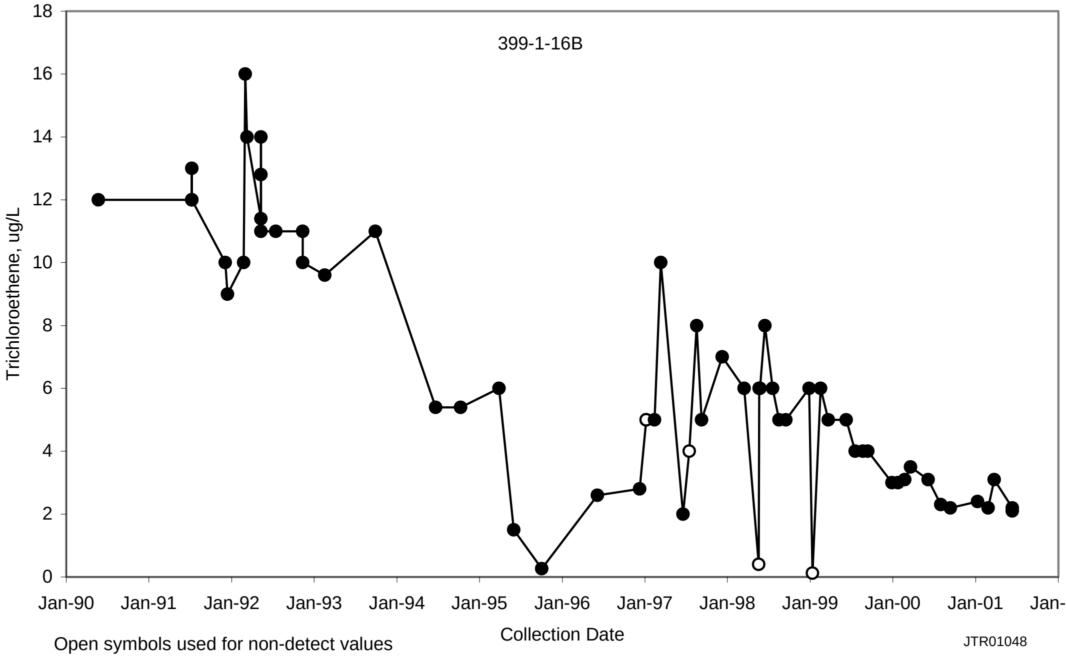

Figure 4.7. Trichloroethene Concentration in Well 399-1-16B

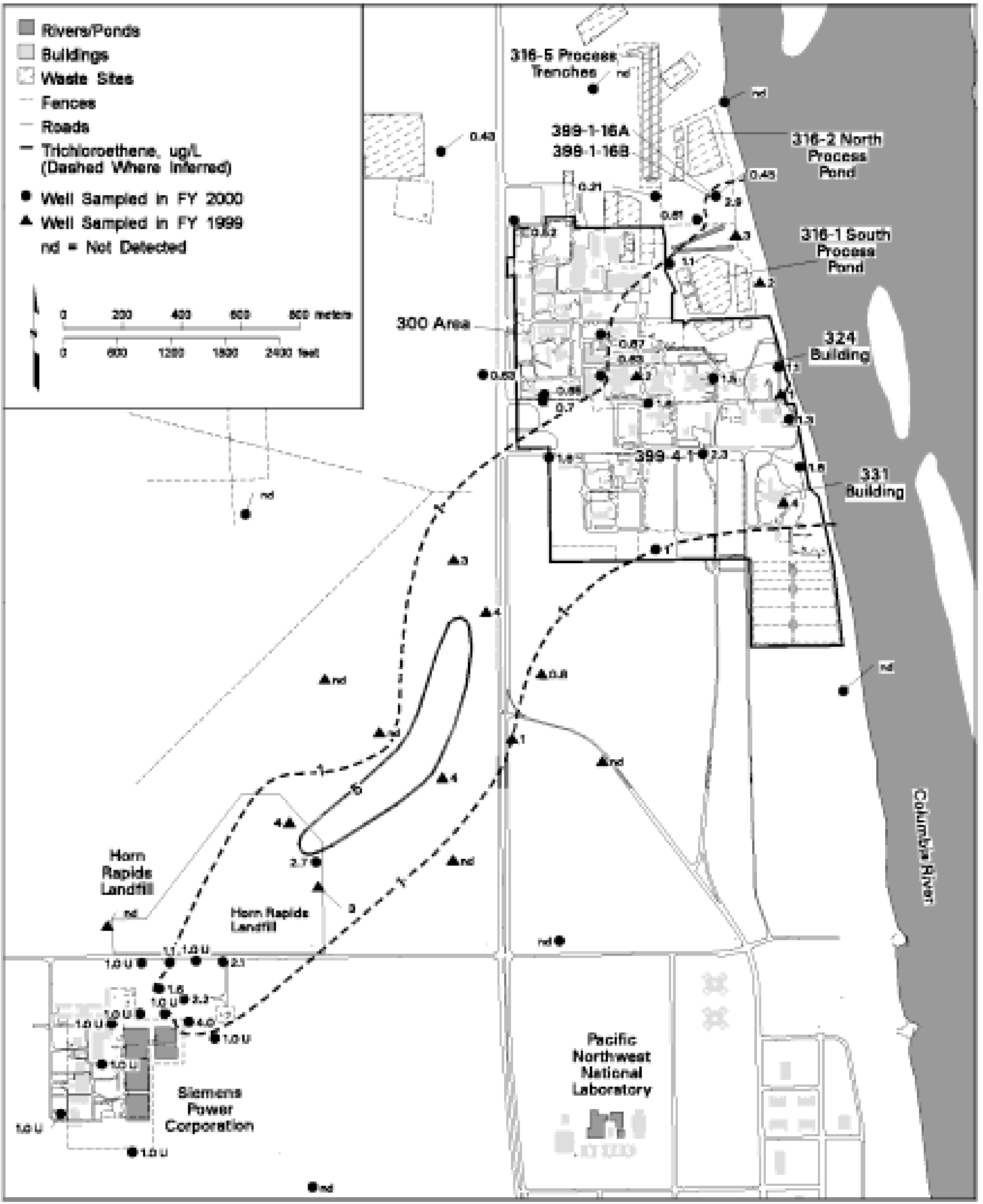

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Figure 4.8. Average Trichloroethene Concentrations in the 300 and Richland North Areas, Top of the Unconfined Aquifer

The nature of the TCE in the aquifer beneath the 300 Area process trenches is unknown, but because TCE is detected mostly in the well screened at the bottom of the unconfined aquifer, it is possible that the nature of the TCE discharged was at least in part a dense non-aqueous phase liquid. This is consistent with its position in the aquifer and the length of time to disperse. That is, in its dissolved phase it moves in the aquifer much quicker. On the other hand, the groundwater flow rates in the deeper part of the unconfined aquifer are probably much lower than in the upper portions of the unconfined aquifer, and a dissolved phase of TCE could then disperse slowly at its position at the bottom of the aquifer.

Cis-1,2-Dichloroethene. Cis-DCE (maximum contaminant level = 70 µg/L) was detected at several wells downgradient of the 300 Area process trenches, but results at only three wells were significant. The network well with the highest levels of cis-DCE was well 399-1-16B (Figure 4.9), which is screened at the bottom of the unconfined aquifer. After 1991, the concentration of cis-DCE rose steadily to over 180 µg/L by 1997 and remained over 100 µg/L since that time. Cis-DCE was detected continuously since 1994 at well 399-1-17B (Figure 4.10) but never higher than 5.0 µg/L. One reported result for cis-DCE at well 399-1-17A had a value of 5.0 µg/L. However, a sample collected 4 days earlier had a reported value of 0.10 µg/L, and another sample collected 21 days later had a reported value of 0.8 µg/L. Therefore, the 5.0 µg/L result is suspected to be an analytical or sampling error.

Cis-DCE may be a degradation product of TCE because the concentration of cis-DCE rose in well 399-1-16B while the concentration of TCE steady decreased (see section on TCE). However, it is difficult to reconcile that the highest concentrations of TCE never exceeded 25 µg/L, whereas the concentration of cis-DCE was as high as 180 µg/L in early 1997.

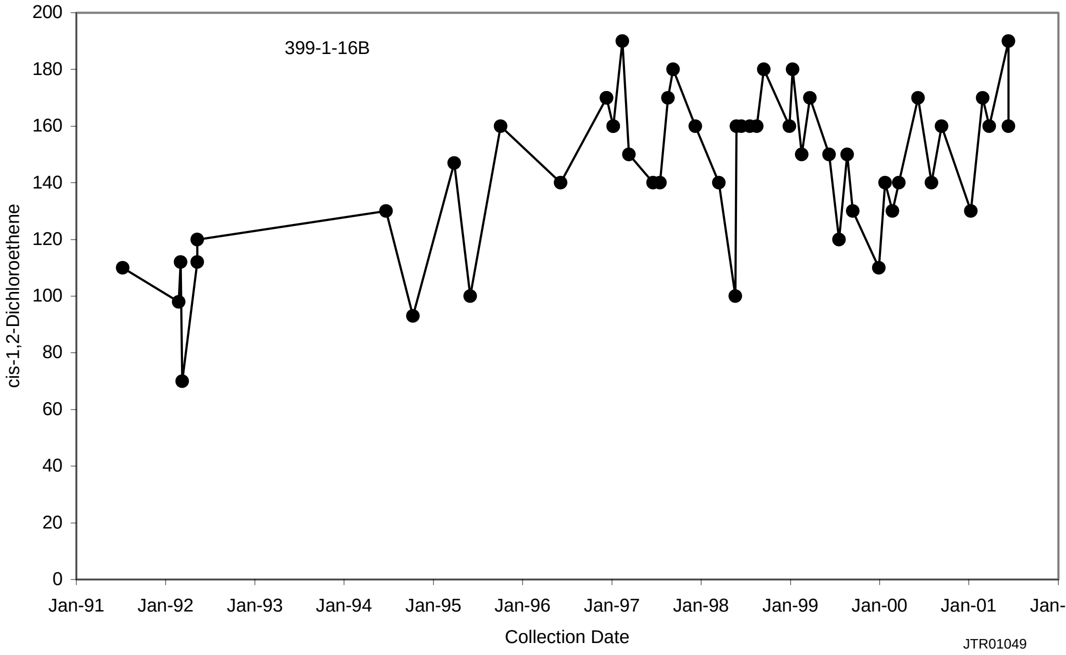

Figure 4.9. Cis-1,2-Dichloroethene Concentration in Well 399-1-16B

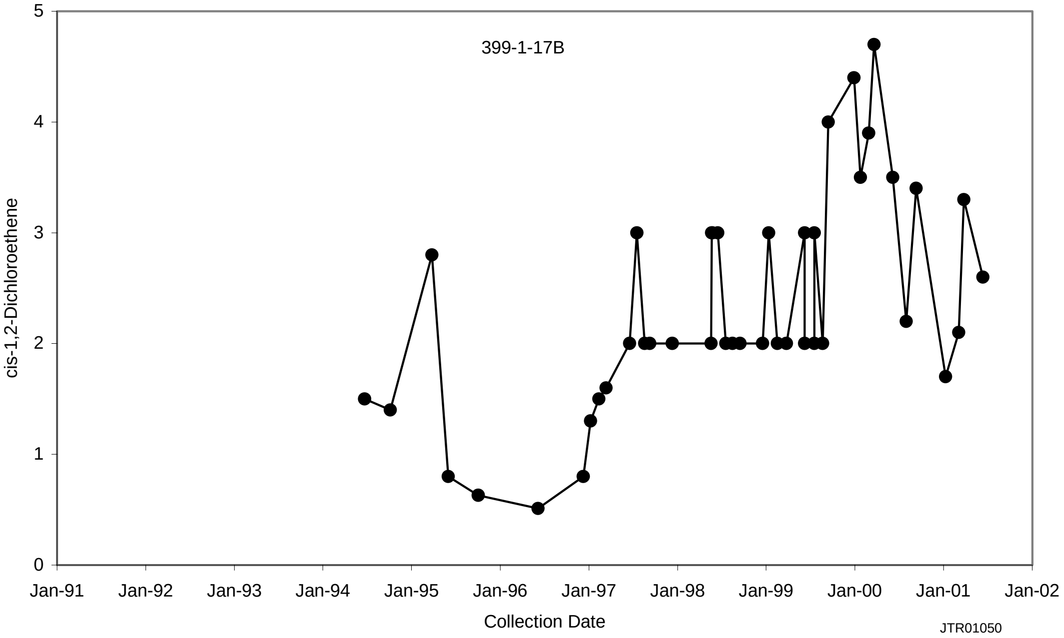

Figure 4.10. Cis-1,2-Dichloroethene Concentration in Well 399-1-17B

Tetrachloroethene. Other than the known accidental releases discussed earlier, PCE (maximum contaminant level = 5.0 µg/L) was detected as a short-duration plume in 1998 and early 1999 at three wells downgradient of the 300 Area process trenches that are screened at the water table. The highest detected value was 38 µg/L at well 399-1-17A (Figure 4.11). In the other two wells where the plume was detected during that time, it reached a concentration of 17 µg/L at well 399-1-16A (Figure 4.12) and 8.0 µg/L at well 399-1-10A (Figure 4.13). PCE was only detected in trace amounts in well 399-1-16B, indicating that the occurrence was mostly restricted to the upper portion of the unconfined aquifer. By the end of 1999, the concentration of PCE in all these wells had returned the to low concentrations detected before the plume was detected.

The source of the temporary PCE plume is unknown, but probably came from the vicinity of the 300 Area process trenches or upgradient of the trenches. However, by 1998 the wastewater discharges at the trenches had been turned off for more than three years. The most likely scenario for this surge or pulse of PCE is that the higher than normal Columbia River stages of 1997 may have remobilized PCE in the vadose zone near or upgradient of the trenches when the water table rose to record levels during that period. The time lag from the high river stage and the arrival of the pulse of PCE is 6 to 12 months. A more accurate estimate of the time lag is not possible because there were no samples collected between December 1997 and May 1998. Using the 10.7 meter per day estimate of PCE velocity in 300 Area groundwater, the distance traveled in 365 days would range from 1,950 to 3,900 meters, which would put the source nearly 2 to 4 kilometers upgradient of the trenches. However, it is unknown what amount of time that PCE would take to travel through the vadose zone after saturation by the higher-than-normal water table rises in 1997. Therefore, the source could be considerably closer to the 300 Area process trenches than the 2 to 4 kilometer estimate. In addition, at a source distance of 2 to 4 kilometers, the expected dispersion of PCE in the groundwater would probably cause the PCE to be detected in additional wells than the three wells in which it was detected near the trenches.

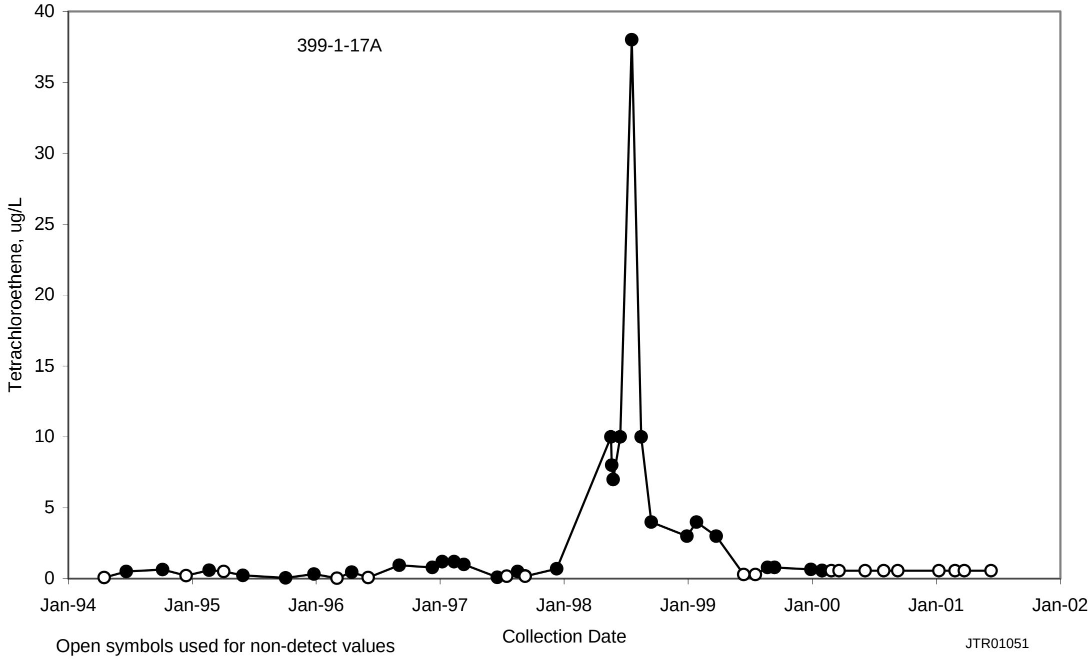

Figure 4.11. Tetrachloroethene Concentration in Well 399-1-17A

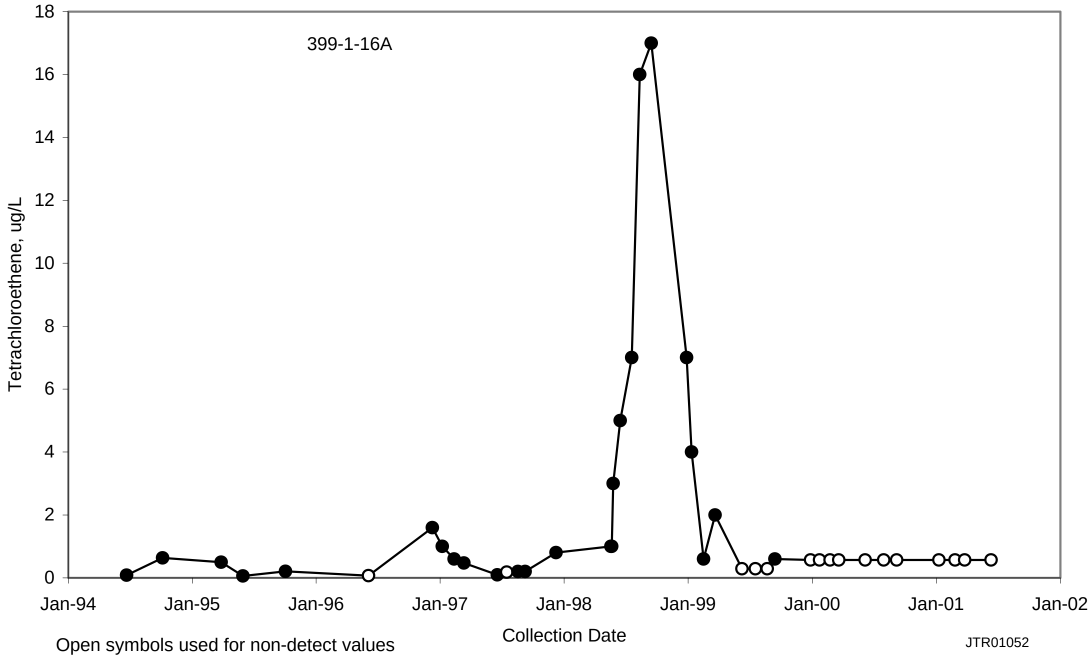

Figure 4.12. Tetrachloroethene Concentration in Well 399-1-16A

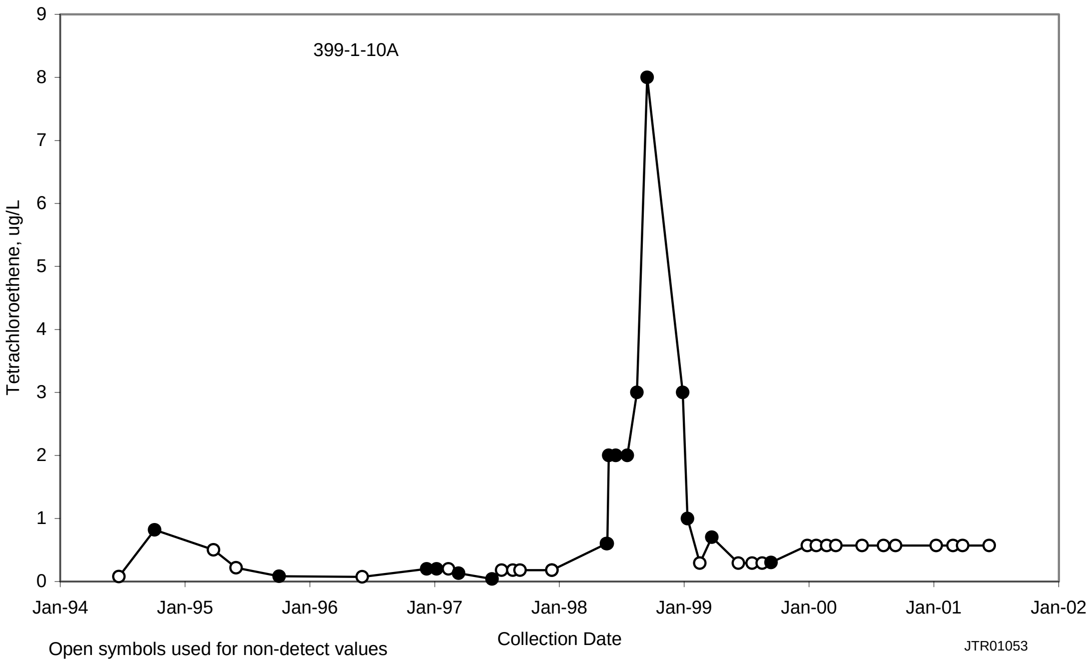

Figure 4.13. Tetrachloroethene Concentration in Well 399-1-10A

5.0 Conceptual Model

Waste disposal at the 300 Area process trenches has affected groundwater quality downgradient. The following statements summarize the current interpretation ("Conceptual Model") of groundwater flow, waste characterization, and the current situation at the site.

- Wastewater from the process sewer (containing fuels fabrication and other laboratory waste) was discharged to the 300 Area process trenches, two unlined trenches that allowed wastewater to flow directly into the ground. The trenches were in used from 1975 to 1994.

- The wastewater discharged to the 300 Area process trenches contaminated the vadose zone beneath the trenches, as well as the aquifer.

- The concentration of waste constituents in the wastewater that was discharged to the 300 Area process trenches decreased with time. Administrative controls to prevent hazardous waste from entering the process sewer were put into effect in 1985. After that time, the amount of hazardous waste reaching the trenches was very low even though the rate of discharge remained above 750 liters per minute.

- The expedited response action in 1991 removed some contaminated sediment from the sides and bottoms of the trenches, but soil contamination extended below and to the side of the material removed.

- Although the expedited response action appeared to significantly lower the concentration of uranium at well 399-1-17A (immediately downgradient of the trenches), four years later the concentration rose again after waste discharges at the 300 Area process trenches ceased. The previously lower concentrations in the groundwater were due to the dilution by large quantities of relatively clean cooling water that were discharged to the trenches. When the discharges to the trenches stopped, the concentration of uranium rose to levels that would occur without dilution.

- Although there was a large list of potential waste constituents discharged to the 300 Area process trenches, the only constituents of concern that continue to be detected in the aquifer are uranium, cis-DCE, and TCE.

- Cis-DCE and TCE from the 300 Area process trenches remain in the lower portion of the unconfined aquifer downgradient of the trenches. Levels of TCE have dropped to below the MCL (5 µg/L). Levels of cis-DCE are still above the MCL (70 µg/L) in only one well (399-1-16B). TCE detected in the upper portions of the unconfined aquifer (below the MCL) is most likely from upgradient sources to the southwest.

- Nitrate and tritium are detected in network wells, but the sources of these constituents are upgradient.

- The Hanford formation (sand and gravel deposits of Pleistocene cataclysmic flooding) overlies the Ringold Formation (fluvial gravel, sand, and mud) with the contact near the water table. The Hanford formation has higher hydraulic conductivity than the Ringold Formation, thereby allowing higher groundwater flow rates when the water table extends above the contact.

- The silt and clay of the lower mud unit of the Ringold Formation constitute the base of the unconfined aquifer. This lower mud unit also effectively prevents groundwater contamination in the unconfined aquifer from contaminating groundwater below the lower mud unit. Hydraulic head below the mud unit is higher than above the unit, indicating that if communication were established between the confined aquifer below and unconfined aquifer above that the general flow would be upward.

- Groundwater in the unconfined aquifer (the uppermost aquifer beneath the 300 Area process trenches) flows into the 300 Area from the northwest, west, and southwest, and then discharges to the Columbia River. During normal to low stages of the river, the flow direction beneath the trenches is toward the east-southeast. The average or cumulative ground water flow direction (including periods of high river stage) is southeast.

- Fluctuating river stages cause water table fluctuations, which in turn, affects water table gradient and groundwater flow direction in the vicinity of the 300 Area process trenches. During high river stages, the water table gradient can be reversed causing bank storage of river water and a temporary groundwater flow direction to the south or southwest.

- The annual cyclical nature of uranium concentration in downgradient wells is due to fluctuations in river stage (Figure 5.1). Near the trenches (well 399-1-17A), uranium concentration rises with higher water-table levels due to increased amounts of uranium coming from the upper portion of the aquifer (secondary source) that were vadose zone prior to the rise in water-table elevation. Near the Columbia River shore (well 399-1-10A), uranium concentration deceases with higher water-table levels due to mixing of groundwater and river water accompanied with bank storage of river water.

- The secondary source of uranium is an accumulation of uranium in the lower portions of the vadose zone from earlier 300 Area process trenches releases. This secondary source of uranium is desorbed from the lower vadose zone (which becomes upper aquifer) during high river stages. The adsorption/desorption properties of uranium are sensitive to changes in pH and alkalinity (bicarbonate/carbonate concentrations) (see Section 4.4.3 for more details).

- Fluctuations in river level do not have much of an effect on cis-DCE because it is mostly within the lower portions of the unconfined aquifer.

- The more recent remediation activities from 1997 to 1999, including the removal of the stockpiled contaminated sediment at the north ends of the trenches, has had little affect on the concentrations of uranium and volatile organic compounds in the groundwater thus far. However, removal has eliminated potential leaching of contaminants from the stockpiled sediment and additional contamination of groundwater in the future.

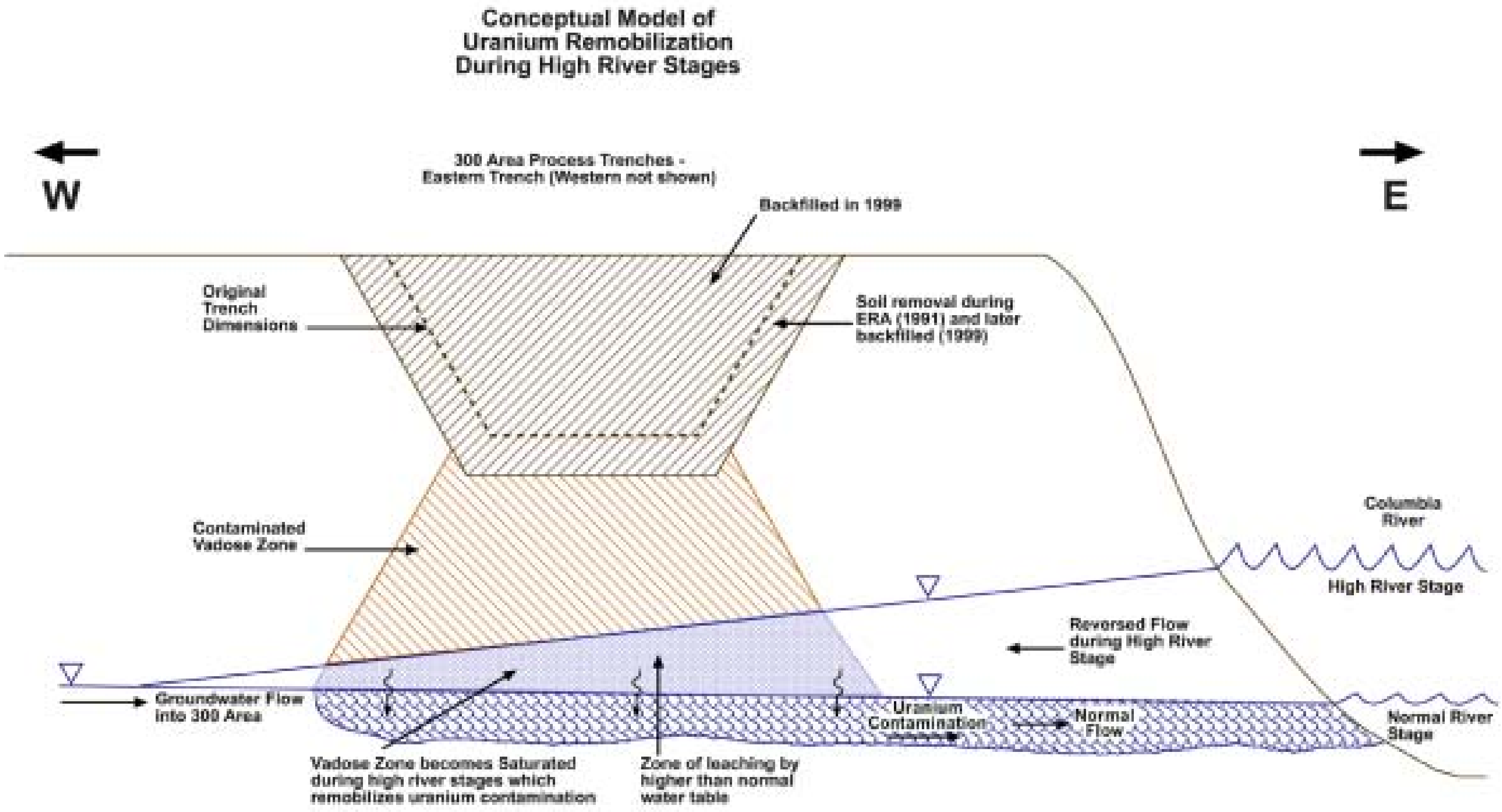

Figure 5.1. Near River Contaminant Fate and Transport Conceptual Model

6.0 Groundwater Monitoring Program

Concentration limits (in this case, drinking water standards or EPA-proposed drinking water standards) for two of the constituents of interest (cis-DCE and uranium) have been, and still are, exceeded in some downgradient wells at the 300 Area process trenches. Therefore, a plan for corrective action groundwater monitoring is required.

6.1 Objectives

In accordance with WAC-173-303-645(11)(d), the groundwater monitoring program must demonstrate the effectiveness of the corrective action and must be at least as effective as a compliance monitoring program in determining compliance with the groundwater protection standards. The compliance monitoring program must, in turn, provide for a sufficient number of samples (a sequence of at least four samples collected at least semiannually, unless an alternative sampling procedure has been approved in accordance with WAC 173-303-645[8][g][ii]). Additionally, a compliance monitoring program should use one of four specified statistical methods (including control charts), unless an alternative method has been approved by Ecology in accordance with WAC 173-303-645(8)(h)(iv).

This corrective action program proposes to use both an alternative sampling procedure and a revised statistical method (see Section 7.3) to satisfy the corrective action groundwater monitoring requirements. These alternative approaches will improve the ability of the monitoring program to monitor for trends and to detect impacts to groundwater quality while achieving significant savings by reducing the number of routine groundwater samples required for statistical testing purposes. The proposed alternate corrective action program will

1. meet the needs of final status compliance monitoring

2. provide for an efficient sampling plan that relies on only one groundwater sample per well per sampling period.

6.2 Special Conditions

There are two conditions that are of special concern to the development of this groundwater monitoring plan. The first concern is related to the depth in the aquifer of the residual contamination. Uranium and the contaminants from upgradient sources are in the upper part of the unconfined aquifer. Therefore, they need to be monitored by wells that are screened at the water table (the “A” wells). Volatile organic compounds such as cis-DCE and TCE are found in higher concentrations at the bottom of the unconfined aquifer (the “B” wells), and, thus, need to be monitored by wells screened at the bottom of the aquifer. Therefore, the monitoring well network needs to be a combination of “A” and “B” wells.

The second special condition is the relationship of the water table to fluctuations in Columbia River stage. How quickly river stage fluctuates and the magnitude of the fluctuations determines the water table gradient and overall elevation of the water table. In turn, the water-table gradient influences the direction and rate of groundwater flow beneath the 300 Area process trenches. The overall elevation of the water table determines whether the lower vadose zone becomes temporarily saturated, mobilizing waste constituents stored in the vadose zone. Selection of wells for the monitoring network must consider the variability in groundwater flow direction and rate due to the river fluctuations. Furthermore, the sampling schedule must be consistent with high and low stages of the river in order to test the full variability of contaminant concentration as it is affected by river stage.

6.3 Monitoring Well Network

The 11 downgradient wells of the proposed monitoring well network (Figure 6.1) are located downgradient of the 300 Area process trenches in an eastward to southward direction. (Upgradient wells are no longer needed to support the objectives of this groundwater monitoring plan.) The network includes all the available wells in this arc that meet the requirements of WAC 173-160 for resource protection wells and are within 300 meters of the 300 Area process trenches. The location of these wells is designed to intercept existing or potentially new plumes originating at the trenches during low to high stages of the Columbia River. Wells that do not meet WAC 173-160 requirements are not included in the network in order to avoid making decisions on the effectiveness of the corrective action by the use of data from wells that do not meet the minimum requirements of WAC 173-160.

The six wells monitoring the upper portion of the uppermost aquifer (the unconfined aquifer) include

399-1-7
399-1-10A
399-1-11
399-1-16A
399-1-17A
399-1-21A

With the exception of well 399-1-11, each of the wells listed above has a corresponding deeper well screened in the lower portion of the unconfined aquifer. The deeper wells include

399-1-8 (near 399-1-7)
399-1-10B
399-1-16B
399-1-17B
399-1-21B

Appendix C contains construction details of the proposed wells.

In addition to using “A” and “B” wells (bottom and top of aquifer) to differentiate groundwater contamination in the lower versus upper portions of the unconfined aquifer, further discrimination of contaminant stratification can be tested with the Spider sampler. This tool will be used on a limited basis in a few wells (e.g., 399-1-16B) to determine the vertical profile for contaminants across the screened interval. At well 399-1-16B, screened at the bottom of the unconfined aquifer, the tool will be used to determine if the contamination is localized at the base of the aquifer (due to volatile organic compounds as dense non-aqueous phase liquids) or more dilute over a larger portion of the screened interval.

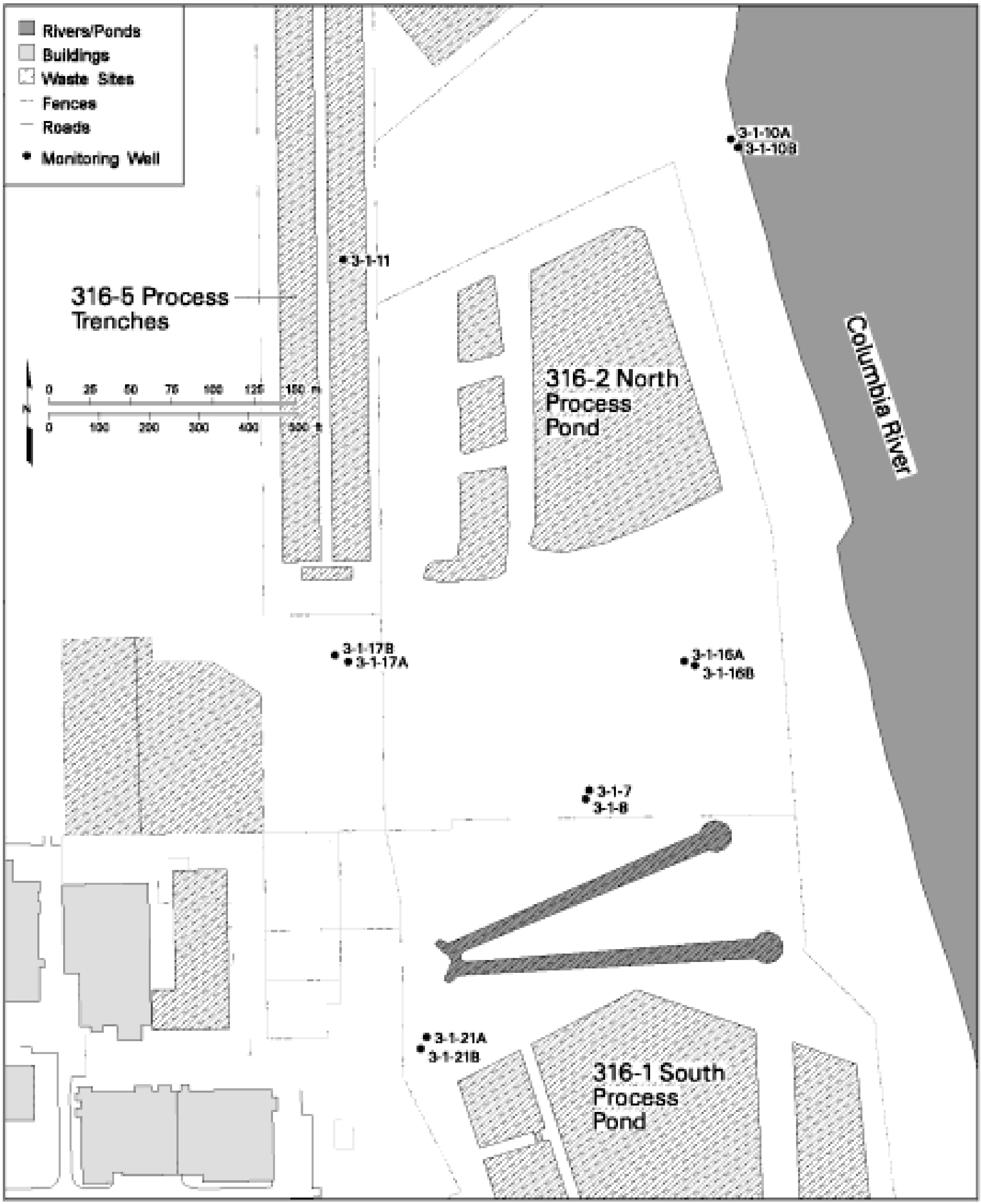

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Figure 6.1. Location of Wells in the Proposed Well Network

6.4 Constituent List and Sampling Frequency

As discussed in Section 4.4.3 the constituents of concern that remain above the groundwater quality criteria are uranium and cis-DCE. (Note: The maximum contaminant levels are the groundwater quality criteria at this site.) These two constituents constitute the main constituent list. TCE and PCE no longer exceed the maximum contaminant levels, but remain as contaminants of concern because of their exceedances in recent years and potential to reappear.

Tritium from one or more upgradient sources to the northwest and nitrate from offsite sources to the southwest (Hartman et al. 2001) are not included as contaminants of concern for the 300 Area process trenches and will not be monitored for RCRA objectives by this groundwater monitoring program. However, they will be monitored by the Hanford Groundwater Monitoring Project for the *Atomic Energy Act of 1954*.

While analyzing groundwater samples from the 300 Area process trenches for cis-DCE, TCE, and PCE, other volatile organic compounds are included also because of the nature of the volatile organic analysis (8260_VOA_GCMS – Gas Chromatograph/Mass Spectroscopy). Therefore, other volatile organic compounds such as 1,2-dichloroethane, 1,1,1-trichloroethane, acetone, benzene, carbon tetrachloride, and many others are included also. This will provide confidence that additional volatile organic compounds are not escaping detection by this groundwater monitoring program.

Sampling frequency will depend on the recent history for each groundwater analyte at each network well. A guidance letter from the regulator (Ecology 2001) requires that at wells where the contaminant of concern exceeds the groundwater quality criteria (i.e., maximum contaminant level) the sampling frequency shall be quarterly. In wells where the concentration of constituents of concern is less than the groundwater quality criteria the sampling frequency shall be semiannually (see Section 7.3). Table 6.1 provides the details about whether the contaminants of concern are currently exceeding the groundwater quality criteria and the resulting sampling frequency for each well of the proposed network.

In addition to the contaminants of concern mentioned above, groundwater samples will occasionally be tested on a limited basis in a few selected wells for ICP metals, anions, and alkalinity. The purpose of these additional tests is to characterize the groundwater for parameters that may affect the amount and rates of adsorption or leaching of uranium.

6.5 Groundwater Parameter Analyses and Method Detection Limit

Table 6.2 lists the groundwater analysis method detection limits currently in use for groundwater parameters required in Section 6.3.2, as well as the groundwater quality criteria of this groundwater monitoring program. Uranium will be analyzed as total chemical uranium by one of two methods, either kinetic phosphorescence or laser induced phosphorimetry. The volatile organic compounds will be analyzed by method SW-846 8260 gas chromatography/mass spectroscopy.

Table 6.1. Well Sampling Frequency Based on Current Concentration Levels of Contaminants of Concern in Network Monitoring Wells

Well	Uranium	Cis-DCE	TCE	PCE	Frequency[d]
GWQC	20 µg/L[a]	70 µg/L[a]	5 µg/L[a]	5 µg/L[a]	
399-1-7	Y[b]	N[c]	N	N	Quarterly
399-1-8	N	N	N	N	Semiannual
399-1-10A	Y	N	N	N	Quarterly
399-1-10B	N	N	N	N	Semiannual
399-1-11	Y	N	N	N	Quarterly
399-1-16A	Y	N	N	N	Quarterly
399-1-16B	N	Y	N	N	Quarterly
399-1-17A	Y	N	N	N	Quarterly
399-1-17B	N	N	N	N	Semiannual
399-1-21A	N	N	N	N	Semiannual
399-1-21B	N	N	N	N	Semiannual

(a) Groundwater quality criteria (maximum contaminant levels at this site).
(b) Y = Yes, the groundwater quality criterion is exceeded.
(c) N = No, the groundwater quality criterion is not exceeded.
(d) Resultant frequency based on current concentration levels of contaminants of concern. The concentration levels may change in the future causing the sampling frequencies to change appropriately.

Table 6.2. Groundwater Quality Criteria for the 300 Area Process Trenches Groundwater Waste Parameters (Constituents of Concern) and Associated Method Detection Limits

Groundwater Contaminant	GWQC[a] (MCL)	MDL[b]
Uranium	20 µg/L	0.1 µg/L
Cis-1,2-Dichloroethene	70 µg/L	0.5 µg/L
Trichloroethene	5 µg/L	0.31 µg/L
Tetrachloroethene	5 µg/L	0.36 µg/L

(a) Groundwater quality criteria are federal drinking water standards and maximum contaminant levels.
(b) Method detection level.

6.6 Determination of Groundwater Flow

Depth to water measurements will continue to be collected from each monitoring well when each is sampled. In addition, a complete list of wells sampled for this plan, for the *Atomic Energy Act of 1954*, and for the CERCLA 300-FF-5 Operable Unit Operations and Maintenance Plan will be measured annually in March to provide a detailed water-table map. The water-table maps, in turn, will provide the information necessary to estimate groundwater flow direction by “contouring” the water-table surface and to estimate flow rate from the water-table gradient. Using the Darcy equation (1), the average flow rate of groundwater will be calculated from estimates of hydraulic conductivity, the water-table gradient, and effective porosity.

Another method of determining groundwater flow direction and flow rate is the use of a down-well flow meter. One type of flow meter currently being used at the Hanford Site uses a down-hole camera capable of viewing colloidal-size particles. The probe containing the down-hole camera is coupled to a magnetometer for orientation. The flow meter tracks the movement of the colloidal-size particles, and flow rate and direction of the particles are recorded and used to calculate groundwater flow rate and flow direction. This type of flow meter will be used at one or more of the wells in the 300 Area process trenches network. The flow meter also has continuous mode capabilities that make it useful for tracking the flow direction and rate of groundwater for extended periods (e.g., days or weeks). By applying this flow meter to wells near the river, the tool may provide a better understanding of the movement of water under the transitory conditions that exist in the zone of groundwater/river interaction. The data obtained can be used to refine and calibrate numerical models for groundwater and contaminant transport through this zone.

6.7 Sampling and Analysis Protocol

Groundwater monitoring at the 300 Area process trenches well network is part of the Hanford Groundwater Monitoring Project. Procedures for groundwater sampling, documentation, sample preservation, shipment, and chain-of-custody requirements are described in PNNL or subcontractor procedures manuals (ES-SSPM-001) and quality requirements are provided in the quality assurance plan[3]. Samples generally are collected after three casing volumes of water have been purged from the well or after field parameters (pH, temperature, specific conductance, and turbidity) have stabilized. For routine groundwater samples, preservatives are added to the collection bottles before their use in the field. Samples to be analyzed for metals are usually filtered in the field so that the results represent dissolved metals.

Procedures for field measurements are specified in the subcontractor's or manufacturer's manuals. Analytical methods are specified in contracts with laboratories, and most are standard methods from *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* (EPA 1986). Alternate procedures meet the guidelines of SW-846, Chapter 10. Analytical methods are described in Gillespie (1999).

6.8 Quality Assurance and Quality Control

The groundwater monitoring project's quality assurance/quality control (QA/QC) program is designed to assess and enhance the reliability and validity of groundwater data. The primary quantitative measures or parameters used to assess data quality are accuracy, precision, completeness, and the method detection limit. Qualitative measures include representativeness and compatibility. Goals for data representativeness for groundwater for groundwater monitoring projects are addressed qualitatively by the

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[3] PNNL ETD-012, *Quality Assurance Plan*, Rev. 1. Hanford Groundwater Monitoring Project, Pacific Northwest National Laboratory, Richland, Washington.

specifications of well locations, well construction, sampling intervals, and sampling and analysis techniques in the groundwater monitoring plan for each facility. Comparability is the confidence with which one data set can be compared to another.

The QC parameters are evaluated through laboratory checks (e.g., matrix spikes, laboratory blanks), replicate sampling and analysis, analysis of blind standards and blanks, and interlaboratory comparisons. Acceptance criteria have been established for each of these parameters, based on guidance from EPA (1986). When a parameter is outside the criteria, corrective actions are taken to prevent a future occurrence and affected data are flagged in the database.

7.0 Data Management, Evaluation, and Reporting

This section describes how groundwater data are stored, retrieved, evaluated, and interpreted. Statistical evaluation methods and reporting requirements are also described.

7.1 Data Management

The contract laboratories report analytical results electronically. The results are loaded into the Hanford Environmental Information System (HEIS) database. Field-measured parameters are entered manually or through electronic transfer. Paper data reports and field records are considered to be the record copies and are stored at PNNL.

The data undergo a validation/verification process according to a documented procedure (Procedure QC-5, RCRA Groundwater Data Validation and Verification Process in PNL-MA-567 Manual) cited in the project QA plan[4]. QC data are evaluated against the criteria listed in the project QA plan and data flags are assigned when the data do not meet those criteria. In addition, data are screened by scientists familiar with the local hydrogeology, compared to historical trends or spatial patterns, and flagged if they are not representative. If necessary, the lab may be asked to check calculations or reanalyze the sample, or the well may be resampled.

7.2 Interpretation

After data are validated and verified, the data are used to interpret groundwater conditions at the site. Interpretive techniques include

- Hydrographs – graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.

- Water-table maps – use water-table elevations from multiple wells to construct contour maps to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.

- Flow meter – results provide highly localized measurements of groundwater flow directions and flow rates at the locations of wells where the tools are used.

- Spider sampler – allows collection of groundwater at discrete intervals within a monitoring well's screened portion thereby helping to characterize the vertical profile of groundwater contamination.

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[4] PNNL ETD-012, *Quality Assurance Plan*, Rev. 1. Hanford Groundwater Monitoring Project, Pacific Northwest National Laboratory, Richland, Washington.

- Trend plots – graph concentrations of chemical or radiological constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water-table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.

- Plume maps – map distributions of chemical or radiological constituents areally in the aquifer to determine the source and extent of contamination. Changes in plume distribution over time aid in determine of movement of plumes and direction of flow.

- Contaminant ratios – can sometimes be used to distinguish between different sources of contamination.

7.3 Statistical Evaluation

This section describes the statistical evaluation methods, their objectives, and provides agreed upon control limits for the 300 Area process trenches specified in Ecology letter (2001). Some wells (i.e., 399-1-10A and 399-1-10B) and their respective control limits, however, are not provided in the letter to DOE from Ecology[5]. For these wells, control limits are established in this document following Ecology guidance. Statistical evaluations are not performed on some of the proposed network wells at the 300 Area process trenches (i.e., wells 399-1-7, 399-1-8, 399-1-11, 399-1-21A, and 399-1-21B) because of insufficient data (less than the minimum required eight baseline data points). Control limits for the constituents of concern (cis-DCE, TCE, and uranium) for these wells will be established as soon as sufficient baseline data become available.

7.3.1 Objectives of Statistical Evaluation

Concentration limits for the constituents of concern have been, and still are exceeded in some compliance wells at the 300 Area process trenches. Therefore, a plan for a corrective action groundwater monitoring program is required (WAC 173-303-645[2][a][iii]). The objective of the groundwater monitoring program at the trenches during the corrective action period is to demonstrate the effectiveness of the corrective action program (WAC 173-303-645[11][d]). Such a monitoring program must be as effective as the compliance monitoring program in determining compliance with the groundwater protection standards (WAC 173-303-645[11][d]). Accordingly, the objective of the statistical evaluation for the trenches is to monitor the trend of the contaminants of concern to confirm that natural attenuation is occurring as expected by the CERCLA record of decision for the 300-FF-5 Operable Unit. This is best achieved through the use of the combined Shewhart-CUSUM (cumulative sum) control chart approach as depicted in the next section.

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[5] Letter from Dib Goswami (Washington State Department of Ecology, Olympia, Washington) to Marvin Furman (U.S. Department of Energy, Richland, Washington), *Statistical Assessment for the 300 Area Resource Conservation and Recovery Act of 1976 (RCRA) Ground Water Monitoring Plan*, dated May 7, 2001 (see Appendix D).

7.3.2 Rationale for Using Shewhart-CUSUM Control Chart Method

In accordance with WAC 173-303-645(8)(h), acceptable statistical methods include analysis of variance (ANOVA), tolerance intervals, prediction intervals, control charts, test of proportions, or other statistical methods approved by Ecology. The type of monitoring, the nature of the data, the proportions of non-detects, spatial and temporal variations are some of the important factors to be considered in the selection of appropriate statistical methods. One of the alternative statistical tests, allowable under final status regulations WAC 173-303-645(8)(h), is the use of a combined Shewhart-CUSUM control chart approach, first referenced by Westgard et al. (1977) and further developed by Lucas (1982). This method is also discussed in a groundwater context by Starks (1989), Gibbons (1994), and ASTM (1996) and first adopted into EPA guidance in 1989 (EPA 1989, 1992). Statisticians of Washington State University evaluated the efficacy of this method for monitoring groundwater quality on behalf of Ecology (WSU 1999). In their report, the university endorsed the control chart method of monitoring groundwater quality. There are several advantages in applying the control chart procedure:

- This method can be implemented with a single observation at any monitoring event (i.e., this method is efficient).

- This method could be applied to monitoring each well individually and yet maintain desired site-wide false positive and false-negative error rates. That is, this method is effective. The spatial variations that adversely affect the ANOVA procedure do not play a role under the control chart procedure. (Note: Due to the elimination of spatial variability, the uncertainty in measured concentrations is decreased making intra-well comparisons more sensitive to a real release [that is, false negatives] and false positive results [ASTM 1996]).

- The power of the control chart method could be enhanced by the combined Shewhart and CUSUM procedures. It is well known that the Shewhart procedure is sensitive to sudden shifts and the CUSUM procedure is sensitive to gradual changes in the mean concentrations. A combined Shewhart and CUSUM procedure, therefore, is well designed to detect both types of changes.

7.3.3 Shewhart-CUSUM Control Chart Procedures

The combined Shewhart–CUSUM method can be implemented following a baseline of eight or more independent sampling periods for a given well (ASTM 1996). The method assumes that the groundwater baseline data and future observations will be independent and normally distributed. The most important assumption is that the data are independent. The assumption of normality can usually be met by log-transforming the data or by other Box-Cox transformations. The method is more fully discussed in Lucas (1982), Starks (1989), Gibbons (1994), ASTM (1996), and Montgomery (1997).

The method is a sequential testing procedure to test for an upward shift in the mean concentration of a contaminant of concern. The Shewhart portion of the test checks for any sudden upward shift in groundwater quality parameters based on a single observation, while the CUSUM checks for any gradually increasing trend in the groundwater quality parameters. The procedure can be implemented as follows: Let x'_i be a series of independent baseline observations i = 1,…., b (b = 8). Let x_i be a series of future monitoring measurements i = 1, 2, 3….. .

Then, using the baseline data, the following steps are applied:

1. Determine if the x'_i can be assumed to follow a normal distribution with mean μ and standard deviation σ. If not, transform the x'_i using the appropriate Box-Cox transformation and work with the transformed data.

2. Use the baseline data to compute the estimates $\overline{x}' = \sum_{i=1}^{b} x'_i/b$ for μ and $s' = \sqrt{\sum_{i=1}^{b} (x'_i - \overline{x}')^2/(b-1)}$ for σ.

3. Determine the upper Shewhart control limit (SCL) for the procedure by calculating $SCL = \overline{x}' + z_s s'$ where z_s is a percentile from the standard normal distribution used to set the false negative and false positive values of the Shewhart control limit. The value of z_s that is most often suggested for groundwater use is 4.5 by Lucas (1982), Starks (1989), EPA (1989), and ASTM (1996). Other values may also be used, depending on the sampling scheme used and whether verification sampling is used to modify the false positive and false negative error rates.

4. Determine the upper CUSUM control limit (CCL), with $CCL = \overline{x}' + z_c s'$. The value of z_c suggested by Lucas (1982), Starks (1988), and EPA (1989) is $z_c = 5$. This value can also be adjusted to reach desired false negative and false positive error rates. In practice setting $z_c = z_s = 4.5$ results in a single limits with no compromise in leak detection capabilities (ASTM 1996).

5. Determine the amount of increased shift in the mean of the water quality parameter of interest to detect an upward trend. This value is referenced as k and is usually measured in σ units of the water quality parameter. Lucas (1982), Starks (1988), and EPA (1989) suggest a value of k = 1 if there are less than 12 baseline observations; and a value of k = 0.75 if there are 12 or more baseline observations.

Using the monitoring data after the baseline measurements have been established:

6. Compute the CUSUM statistic as $S_i = \max\{0, (x_i - ks') + S_{i-1}s'\}$ as each new monitoring measurement, x_i becomes available, where i = 1,2,3,….. and $S_0 = 0$

7. Compute the Shewhart and CUSUM tests as each new monitoring measurement becomes available; a verification sampling will be conducted if either $x_i \geq SCL$ or $S_i \geq CCL$. A well is declared to be out of control only if the verification result also exceeds the SCL or the CCL. If both $x_i < SCL$ and $S_i < CCL$, then continue monitoring.

8. Update the baseline mean and standard deviation periodically (every year or two) to incorporate new data as monitoring continues and the process is shown to be in control. This updating process should continue for the life of the monitoring program.

If resampling is implemented during the monitoring, the analytical result from the resample is substituted into the above formulas for the original value obtained, and the CUSUM statistic is updated. Note in the above combined test that the Shewhart portion of the test will quickly detect extremely large deviations from the baseline period. The CUSUM portion of the combined test is sequential; thus, a small shift in the mean concentration over the baseline period will slowly aggregate in the CUSUM statistic and eventually cause the test to exceed the CUSUM control limit CCL.

7.3.4 Detection Status

In order to arrive at appropriate control limits, the detection history for each constituent of concern at each well must first be evaluated. Historical measurements subsequent to January 1995 were judged to be most relevant for data evaluation purposes because in December 1994 the trenches were administratively isolated and all discharges were terminated and complete physical isolation occurred in January 1995. Detection status of constituents of concern using data obtained from February 1995 through March 2001 is presented in Table 7.1.

7.3.5 Baseline Summary Statistics and Control Limits

The 300 Area process trenches were operated to receive effluent discharges containing dangerous waste from nuclear research and fuel fabrication laboratories in the 300 Area between 1975 and 1994. Uranium was one of the contaminants of concern. In July 1991, the trenches were modified as part of an expedited response action that involved removing bottom sediment from the inflow end of the trench and placing it at the opposite end of the trench behind a berm. In December 1994, the trenches were administratively isolated and all discharges were terminated. Complete physical isolation occurred in January 1995. In addition, the first proposal to change from a compliance monitoring plan to a corrective action plan was initiated in June 1997 when results from the first four independent samples confirmed the exceedance of maximum contaminant levels for cis-DCE, TCE, and uranium (see Section 1.2). The proposed baseline period (from February 1995 to July 1997) and sampling and statistical methods are adopted in Ecology letter[6] except for special conditions noted at the site. These special conditions included

1. Uranium in well 399-1-17A – This is a case where a steady process mean and less variability are noted subsequent to original baseline period, February 1995 – July 1997 (see concentration versus time plot in Appendix B). Use of data obtained from August 1998 – August 2000 as the revised baseline period results in a lower and tighter control limits.

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[6] Letter from Dib Goswami (Washington State Department of Ecology, Olympia, Washington) to Marvin Furman (U.S. Department of Energy, Richland, Washington), *Statistical Assessment for the 300 Area Resource Conservation and Recovery Act of 1976 (RCRA) Ground Water Monitoring Plan*, dated May 7, 2001 (see Appendix D).

Table 7.1. Detection Status of Contaminants of Concern Analyzed for the 300 Area Process Trenches (February 1995 through March 2001)

Contaminant of Concern	Total Number of Observations	Number of Detects	Number of Non-Detects	Detect Frequency[a] (%)	Maximum Detected Value (µg/L)
Well 399-1-16A					
cis-DCE	38	14	24	37	0.7
TCE	38	30	8	79	1
Uranium	39	39	0	100	165
Well 399-1-16B					
cis-DCE	38[b]	38	0	100	190
TCE	39[b]	35	4	90	10
Uranium	37	37	0	100	14.8
Well 399-1-17A					
cis-DCE	42	6	36	14	5
TCE	41	29	12	71	2
Uranium	43	43	0	100	313
Well 399-1-17B					
cis-DCE	38	38	0	100	4.7
TCE	38	1	37	3	0.03
Uranium	38	15	23	39	0.70
Well 399-1-10A					
cis-DCE	38	2	36	5	0.43
TCE	38	5	33	13	0.3
Uranium	39	39	0	100	144
Well 399-1-10B					
cis-DCE	35	1	34	3	0.25
TCE	35	0	35	0	ND
Uranium	33[b]	20	13	61	0.392

(a) Obtained by using the number of detected observations divided by the number of total observations.
(b) Outlier removed.
ND = Not detected.

2. TCE in well 399-1-16B – This is a case where a downward trend is observed subsequent to the original baseline period, February 1995 – June 1997 (see concentration versus time plot in Appendix B). Use of the maximum contaminant level (5 micrograms per liter) as the control limit is more protective of human health and the environment.

Table 7.2 provides respective baseline periods and the summary statistics for the contaminants of concern analyzed from samples from the wells monitoring the 300 Area process trenches where sufficient data exist. The baseline periods originally proposed to Ecology in 1997 were kept intact unless current site conditions warrant a revision (e.g., uranium in wells 399-1-16B and 399-1-10A, cis-DCE in well 399-1-17B).

Table 7.2. Baseline Summary Statistics for Contaminants of Concern Analyzed for the 300 Area Process Trenches

Contaminant	Baseline Period	Baseline Observation	Detected	Non-Detect	Detect %	√ (µg/L)	s (µg/L)
Well 399-1-16A							
cis-DCE	3/29/95 - 6/19/97	9	3	6	33	0.213	0.131
TCE	3/29/95 – 6/19/97	9	9	0	100	0.641	0.242
Uranium	3/29/95 – 6/19/97	9	9	0	100	97.55	38.33
Well 399-1-16B							
cis-DCE	3/29/95 – 6/19/97	9	9	0	100	150.8	24.8
TCE(a)	3/29/95 – 6/19/97	9	8	1	89	3.907	2.949
Uranium	8/17/98 –8/01/00(b)	16	16	0	100	12.02	1.94
Well 399-1-17A							
cis-DCE	2/21/95 – 6/19/97	14	2	12	14	NC	NC
TCE	2/21/95 – 6/19/97	13	10	3	77	0.346	0.255
Uranium(a)	8/17/98 –8/01/00(b)	16	16	0	100	112.3	26.40
Well 399-1-17B							
cis-DCE	8/17/98 –8/01/00(b)	16	16	0	100	2.888	0.969
TCE	3/27/95 – 7/18/97	10	1	9	10	NC	NC
Uranium	3/27/95 – 7/18/97	10	7	3	70	0.059	0.136
Well 399-1-10A							
cis-DCE	3/27/95 – 6/19/97	9	1	8	11	NC	NC
TCE	3/27/95 – 6/19/97	9	2	7	22	NC	NC
Uranium	8/17/98 – 8/8/00(b)	15	15	0	100	53.067	11.858
Well 399-1-10B							
cis-DCE	3/27/95 – 9/9/97	9	0	9	0	NC	NC
TCE	3/27/95 – 9/9/97	9	0	9	0	NC	NC
Uranium	3/27/95 – 12/9/97	8	8	0	100	0.097	0.104

(a) Special conditions adopted by Ecology (Letter from Dib Goswami [Washington State Department of Ecology, Olympia, Washington] to Marvin Furman [U.S. Department of Energy, Richland, Washington], *Statistical Assessment for the 300 Area Resource Conservation and Recovery Act of 1976 (RCRA) Ground Water Monitoring Plan*, dated May 7, 2001 [see Appendix D].)
(b) Revised baseline period (more representative of current site conditions).
NC = Not calculated.

A summary of various control limits for the 300 Area process trenches is presented in Table 7.3. It should be noted that one of the contaminants of concern, uranium, has a natural background resulting from water-rock reaction during evolution of the ambient groundwater. This natural background forms a permanent baseline above which changes due to addition from the regulated unit will be detected. Therefore, when the calculated control limits (SCL and CCL) are less than the natural background for uranium, the control limits should be set at the natural background 12.8 μg/L that is the maximum observed background value for the Hanford Site (see Table ES-1, DOE 1997b). This is consistent with ASTM guidance (1996) in using the nonparametric prediction limit (which is the maximum observed value) as the control limit. For contaminants other than uranium where detection frequency is less than 25% (i.e., cis-DCE in wells 399-1-17A, 399-1-10A, and 399-1-10B and TCE in wells 399-1-17B, 399-1-10A, and 399-1-10B), most recently determined quantitation limit (e.g., Hartman et al. 2001, Table B.20) will be used as control limits.

Special procedures to be used as specified by Ecology[7] are as follows:

1. For wells where the maximum contaminant level has been and still is exceeded, quarterly monitoring will be conducted. One sample will be collected from each well during each sampling event and compared to the agreed upon control limits (see Table 7.3) for each identified constituent of concern (i.e., cis-DCE, TCE, and uranium). If a control limit is exceeded (proof by verification sampling), a notification process will be followed.

2. For wells where the maximum contaminant level has not been exceeded, semiannual monitoring will be conducted. One sample will be collected from each well during each sampling event and compared to the agreed upon control limits (see Table 7.3) for each identified constituent of concern (i.e., cis-DCE, TCE, and uranium). A notification process will be followed after a confirmed exceedance (by verification sampling).

3. Currently, tetrachloroethene (PCE) is not detected in the wells monitoring the 300 Area process trenches. However, it has been detected in the past. PNNL will continue to monitor PCE and report detected results.

The proposed statistical approach shall be in effect for a period of two years. Based on the results of this evaluation period, Ecology will decide whether to continue, modify, or abandon the proposed approach at the 300 Area process trenches.

7.4 Reporting

Chemistry and water-level data are reviewed at least quarterly and are available in HEIS.

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[7] Letter from Dib Goswami (Washington State Department of Ecology, Olympia, Washington) to Marvin Furman (U.S. Department of Energy, Richland, Washington), *Statistical Assessment for the 300 Area Resource Conservation and Recovery Act of 1976 (RCRA) Ground Water Monitoring Plan*, dated May 7, 2001 (see Appendix D).

Table 7.3. Summary of Various Control Limits at the 300 Area Process Trenches

Contaminant of Concern	Shewhart-CUSUM Parameter Value	Control Limit[(a)] (µg/L)
Well 399-1-16A		
cis-DCE	4.5	0.803
TCE	4.5	1.72
Uranium	4.5	270
Well 399-1-16B		
cis-DCE	4.5	[39, 262][(c)]
TCE	NA	5[(d)]
Uranium	4[(b)]	[4.3, 19.8]
Well 399-1-17A		
cis-DCE	NA	0.81[(e)]
TCE	4[(b)]	1.36
Uranium	4[(b)]	[7, 218]
Well 399-1-17B		
cis-DCE	4[(b)]	6.77
TCE	NA	0.72[(e)]
Uranium	NA	12.8[(f)]
Well 399-1-10A		
cis-DCE	NA	0.81[(e)]
TCE	NA	0.72[(e)]
Uranium	4[(b)]	[6, 101]
Well 399-1-10B		
cis-DCE	NA	0.81[(e)]
TCE	NA	0.72[(e)]
Uranium	NA	12.8[(f)]

(a) Obtained by using applicable Shewhart-CUSUM parameter value times the baseline standard deviation (see Table 7.2) and adding the product to the baseline mean (see Table 7.2).

(b) Use 4 sigma because there are more than 12 data points in the baseline period (ASTM 1996).

(c) Numbers in brackets indicate upper and lower limits.

(d) Use maximum contaminant level MCL (5 µg/L) as the control limit because of the downward trend noted in this well subsequent to the baseline period.

(e) Use most recently determined quantification limit (see Table B.20, Hartman et al. 2001, Appendix B) because analyte detection frequency is less than 25% (ASTM 1996).

(f) Use maximum observed uranium background value (see Table ES-1, DOE 1997b) as the control limit because calculated control limit is less than the natural background level at the Hanford Site.

Semiannual reports on the current status of groundwater under corrective action are supplied to the regulator as required by sites in RCRA final status.

Results and interpretations of groundwater monitoring data will be reported in the annual groundwater monitoring report of the Hanford Site Groundwater Monitoring Project (e.g., Hartman et al. 2001).

When a statistical control limit has been exceeded and verification sampling has confirmed the exceedance, the regulator will be notified of the exceedance by phone and, if follow-up action is required, the phone call and action required will be confirmed by written notification. PNNL will keep a phone log.

8.0 References

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Appendix A

Results of Groundwater Monitoring (1986-2001) at Wells in the Proposed Monitoring Network

Appendix A

Results of Groundwater Monitoring (1986-2001) at Wells in the Proposed Monitoring Network

Table A.1 contains minimum, maximum, and average concentrations of constituents detected at least once in the proposed monitoring network for the 300 Area process trenches. Obvious outliers were assumed to be erroneous and were removed before calculating summary values. Values below detection limits (flagged “U” in HEIS) were changed to zero to prevent historical, high detection limits from skewing ranges and averages.

Table A.1. Minimum, Maximum, and Average Concentrations of Constituents Detected in the 300 Area Process Trenches

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
1,1,1-Trichloroethane	399-1-10A	N	ug/L	0.00	1.40	0.02	63
1,1,1-Trichloroethane	399-1-11	N	ug/L	0.00	5.00	0.09	75
1,1,1-Trichloroethane	399-1-16A	N	ug/L	0.00	2.00	0.03	65
1,1,1-Trichloroethane	399-1-16B	N	ug/L	0.00	2.00	0.04	73
1,1,1-Trichloroethane	399-1-17A	N	ug/L	0.00	9.00	0.09	230
1,1,1-Trichloroethane	399-1-17B	N	ug/L	0.00	2.30	0.04	64
1,1,1-Trichloroethane	399-1-21B	N	ug/L	0.00	2.00	0.33	6
1,1,2,2-Tetrachloroethane	399-1-18B	N	ug/L	0.00	3.00	0.50	6
1,1,2-Trichloro-1,2,2-trifluoroethane	399-1-18A	N	ug/L	7.00	7.00	7.00	1
1,1-Dichloroethane	399-1-16B	N	ug/L	0.00	0.90	0.01	67
1,2-Dichloroethane	399-1-11	N	ug/L	0.00	8.00	0.32	25
1,2-Dichloroethane	399-1-16B	N	ug/L	0.00	0.80	0.01	67
1,2-Dichloroethene(Total)	399-1-16A	N	ug/L	0.00	31.00	3.88	8
1,2-Dichloroethene(Total)	399-1-16B	N	ug/L	88.00	180.00	120.73	11
1,2-Dichloroethene(Total)	399-1-17B	N	ug/L	0.00	9.00	5.02	10
1,4-Dichlorobenzene	399-1-10A	N	ug/L	0.00	0.26	0.01	54
1,4-Dichlorobenzene	399-1-10B	N	ug/L	0.00	0.11	0.00	43
1,4-Dichlorobenzene	399-1-16A	N	ug/L	0.00	0.08	0.00	54
1,4-Dichlorobenzene	399-1-16B	N	ug/L	0.00	1.80	0.05	59
1,4-Dichlorobenzene	399-1-17A	N	ug/L	0.00	0.10	0.00	182
1,4-Dichlorobenzene	399-1-17B	N	ug/L	0.00	0.50	0.01	57
1,4-Dichlorobenzene	399-1-18A	N	ug/L	0.00	0.08	0.00	65
1,4-Dichlorobenzene	399-1-18B	N	ug/L	0.00	0.08	0.00	42
1,4-Dichlorobenzene	399-1-21A	N	ug/L	0.00	0.21	0.03	7
2,4,5-T	399-1-11	N	ug/L	0.00	0.38	0.04	9
2,4,5-TP	399-1-11	N	ug/L	0.00	0.36	0.03	14
2,4-Dichlorophenoxyacetic acid	399-1-11	N	ug/L	0.00	0.91	0.07	14
2,4-Dichlorophenoxyacetic acid	399-1-17A	N	ug/L	0.00	0.68	0.05	14
2,6-Bis(1,1-dimethylethyl)-4-methyl phenol	399-1-8	N	ug/L	3.20	3.20	3.20	1
2-Butanone	399-1-10B	N	ug/L	0.00	0.80	0.02	36
2-Butanone	399-1-16A	N	ug/L	0.00	44.00	1.20	55
2-Butanone	399-1-16B	N	ug/L	0.00	23.00	0.46	55
2-Butanone	399-1-17A	N	ug/L	0.00	11.00	0.05	213
2-Butanone	399-1-17B	N	ug/L	0.00	2.10	0.04	54

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
2-Butanone	399-1-18A	N	ug/L	0.00	45.00	0.69	65
2-Butanone	399-1-18B	N	ug/L	0.00	21.00	0.49	43
2-Butanone	399-1-21A	N	ug/L	0.00	11.00	0.92	12
4-Methyl-2-Pentanone	399-1-10B	N	ug/L	0.00	2.00	0.06	36
4-Methyl-2-Pentanone	399-1-16B	N	ug/L	0.00	0.20	0.00	50
4-Methyl-2-Pentanone	399-1-18B	N	ug/L	0.00	3.00	0.08	39
4-Methyl-2-Pentanone	399-1-8	N	ug/L	0.00	3.00	0.43	7
Acetone	399-1-10A	N	ug/L	0.00	10.00	0.73	45
Acetone	399-1-10B	N	ug/L	0.00	32.00	1.03	36
Acetone	399-1-11	N	ug/L	0.00	6.10	0.32	19
Acetone	399-1-16A	N	ug/L	0.00	12.00	0.65	43
Acetone	399-1-16B	N	ug/L	0.00	9.00	0.67	46
Acetone	399-1-17A	N	ug/L	0.00	84.00	2.44	162
Acetone	399-1-17B	N	ug/L	0.00	9.00	0.66	47
Acetone	399-1-18A	N	ug/L	0.00	18.00	0.63	52
Acetone	399-1-18B	N	ug/L	0.00	250.00	7.50	36
Acetone	399-1-21A	N	ug/L	0.00	10.00	0.83	12
Acetone	399-1-7	N	ug/L	0.00	42.00	4.32	19
Alkalinity	399-1-10A	N	ug/L	67,000.00	130,000.00	104,909.09	11
Alkalinity	399-1-10B	N	ug/L	150,000.00	160,000.00	152,800.00	5
Alkalinity	399-1-11	N	ug/L	120,000.00	130,000.00	123,000.00	10
Alkalinity	399-1-16A	N	ug/L	58,000.00	122,000.00	99,416.67	12
Alkalinity	399-1-16B	N	ug/L	124,000.00	140,000.00	132,615.38	13
Alkalinity	399-1-17A	N	ug/L	0.00	120,000.00	76,866.67	15
Alkalinity	399-1-17B	N	ug/L	160,000.00	190,000.00	174,800.00	10
Alkalinity	399-1-18A	N	ug/L	120,000.00	140,000.00	128,181.82	11
Alkalinity	399-1-21A	N	ug/L	90,000.00	121,000.00	105,500.00	2
Alkalinity	399-1-21B	N	ug/L	148,000.00	151,000.00	149,500.00	2
Alkalinity	399-1-7	N	ug/L	51,000.00	60,000.00	57,000.00	3
Alkalinity	399-1-8	N	ug/L	79,000.00	87,000.00	83,000.00	2
Alpha	399-1-10A	N	pCi/L	8.75	25.00	18.62	3
Alpha	399-1-11	N	pCi/L	10.10	22.60	16.35	2
Alpha	399-1-16A	N	pCi/L	6.93	17.80	12.37	2
Alpha	399-1-16B	N	pCi/L	0.00	1.97	0.99	2
Alpha	399-1-17A	N	pCi/L	64.90	162.00	125.90	6
Alpha	399-1-18A	N	pCi/L	2.62	3.51	3.07	2
Alpha	399-1-7	N	pCi/L	54.30	100.00	69.10	4
Aluminum	399-1-10A	N	ug/L	0.00	31.20	2.68	21

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Aluminum	399-1-10A	Y	ug/L	0.00	55.30	3.50	26
Aluminum	399-1-10B	N	ug/L	0.00	278.00	69.50	4
Aluminum	399-1-10B	Y	ug/L	0.00	32.50	3.25	10
Aluminum	399-1-16A	N	ug/L	0.00	24.00	2.37	20
Aluminum	399-1-16A	Y	ug/L	0.00	26.00	0.87	30
Aluminum	399-1-16B	Y	ug/L	0.00	43.00	2.81	29
Aluminum	399-1-17A	N	ug/L	0.00	169.00	14.41	22
Aluminum	399-1-17A	Y	ug/L	0.00	66.00	4.95	37
Aluminum	399-1-17B	Y	ug/L	0.00	35.90	2.90	23
Aluminum	399-1-18A	N	ug/L	0.00	55.40	6.44	17
Aluminum	399-1-18A	Y	ug/L	0.00	52.60	3.67	22
Aluminum	399-1-18B	Y	ug/L	0.00	25.20	2.56	17
Aluminum	399-1-21A	N	ug/L	0.00	1,600.00	505.00	5
Aluminum	399-1-21A	Y	ug/L	0.00	150.00	25.00	6
Aluminum	399-1-21B	N	ug/L	260.00	997.00	746.00	4
Aluminum	399-1-21B	Y	ug/L	0.00	51.30	16.95	6
Aluminum	399-1-7	N	ug/L	0.00	1,350.00	46.42	31
Aluminum	399-1-7	Y	ug/L	0.00	117.00	7.31	16
Aluminum	399-1-8	N	ug/L	0.00	326.00	13.73	25
Aluminum	399-1-8	Y	ug/L	0.00	18.60	1.09	17
Ammonia	399-1-10A	N	ug/L	0.00	130.00	47.50	4
Ammonia	399-1-10B	N	ug/L	50.00	160.00	95.00	4
Ammonia	399-1-16A	N	ug/L	0.00	60.00	30.00	2
Ammonia	399-1-16B	N	ug/L	0.00	110.00	55.00	2
Ammonia	399-1-17A	N	ug/L	0.00	70.00	23.33	3
Ammonia	399-1-17B	N	ug/L	80.00	80.00	80.00	2
Ammonia	399-1-18A	N	ug/L	50.00	200.00	125.00	2
Ammonia	399-1-18B	N	ug/L	70.00	180.00	102.50	4
Ammonia	399-1-21A	N	ug/L	0.00	70.00	23.33	3
Ammonia	399-1-21B	N	ug/L	60.00	100.00	76.67	3
Ammonia	399-1-7	N	ug/L	0.00	50.00	16.67	3
Ammonia	399-1-8	N	ug/L	0.00	90.00	47.50	4
Ammonium ion	399-1-10A	N	ug/L	0.00	73.00	15.88	8
Ammonium ion	399-1-11	N	ug/L	0.00	70.00	17.00	8
Ammonium ion	399-1-16B	N	ug/L	71.00	125.00	96.00	7
Ammonium ion	399-1-17B	N	ug/L	0.00	125.00	89.71	7
Ammonium ion	399-1-18A	N	ug/L	0.00	63.00	7.88	8
Ammonium ion	399-1-18B	N	ug/L	0.00	129.00	92.86	7

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Ammonium ion	399-1-7	N	ug/L	0.00	67.00	6.55	20
Ammonium ion	399-1-8	N	ug/L	0.00	102.00	26.35	19
Antimony	399-1-17B	N	ug/L	0.00	37.00	2.18	17
Antimony	399-1-18A	Y	ug/L	0.00	24.10	1.27	19
Antimony	399-1-21A	Y	ug/L	0.00	41.00	6.83	6
Antimony	399-1-8	Y	ug/L	0.00	15.10	3.02	5
Antimony-125	399-1-17A	N	pCi/L	0.00	19.50	2.50	102
Arsenic	399-1-10A	N	ug/L	0.00	4.80	0.18	37
Arsenic	399-1-10A	Y	ug/L	0.00	3.50	0.51	11
Arsenic	399-1-11	N	ug/L	0.00	3.70	0.28	31
Arsenic	399-1-11	Y	ug/L	0.00	4.10	1.53	10
Arsenic	399-1-16A	N	ug/L	0.00	3.10	0.09	33
Arsenic	399-1-16A	Y	ug/L	0.00	3.10	0.71	11
Arsenic	399-1-16B	N	ug/L	0.00	2.40	0.14	32
Arsenic	399-1-16B	Y	ug/L	0.00	2.00	0.17	12
Arsenic	399-1-17A	N	ug/L	0.00	2.30	0.13	36
Arsenic	399-1-17A	Y	ug/L	0.00	2.40	0.20	12
Arsenic	399-1-17B	N	ug/L	0.00	0.00	0.00	32
Arsenic	399-1-17B	Y	ug/L	0.00	0.00	0.00	12
Arsenic	399-1-18A	N	ug/L	0.00	10.70	4.46	34
Arsenic	399-1-18A	Y	ug/L	0.00	7.40	5.57	12
Arsenic	399-1-18B	N	ug/L	0.00	1.90	0.09	22
Arsenic	399-1-21A	N	ug/L	0.00	2.80	0.93	3
Arsenic	399-1-7	N	ug/L	0.00	8.50	0.18	46
Arsenic	399-1-7	Y	ug/L	0.00	2.30	0.46	5
Barium	399-1-10A	N	ug/L	21.00	60.00	40.81	26
Barium	399-1-10A	Y	ug/L	17.90	67.30	39.00	29
Barium	399-1-10B	N	ug/L	34.90	48.30	41.08	4
Barium	399-1-10B	Y	ug/L	35.50	58.80	44.88	12
Barium	399-1-11	N	ug/L	11.00	45.00	27.59	20
Barium	399-1-11	Y	ug/L	11.00	45.00	26.08	29
Barium	399-1-16A	N	ug/L	23.00	62.00	37.53	25
Barium	399-1-16A	Y	ug/L	22.00	68.90	40.31	33
Barium	399-1-16B	N	ug/L	44.00	56.00	49.25	26
Barium	399-1-16B	Y	ug/L	42.00	165.00	52.79	33
Barium	399-1-17A	N	ug/L	0.00	45.20	19.63	26
Barium	399-1-17A	Y	ug/L	0.00	52.60	26.61	39
Barium	399-1-17B	N	ug/L	62.00	70.00	65.24	23

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Barium	399-1-17B	Y	ug/L	56.00	80.00	64.72	27
Barium	399-1-18A	N	ug/L	39.00	56.00	46.41	24
Barium	399-1-18A	Y	ug/L	43.00	64.50	47.55	26
Barium	399-1-18B	N	ug/L	35.00	48.00	39.38	13
Barium	399-1-18B	Y	ug/L	36.00	50.00	40.08	17
Barium	399-1-21A	N	ug/L	34.70	49.00	42.28	5
Barium	399-1-21A	Y	ug/L	33.70	47.50	39.80	6
Barium	399-1-21B	N	ug/L	47.50	59.00	52.53	4
Barium	399-1-21B	Y	ug/L	29.90	52.00	45.80	6
Barium	399-1-7	N	ug/L	0.00	59.60	23.27	35
Barium	399-1-7	Y	ug/L	0.00	30.00	20.20	18
Barium	399-1-8	N	ug/L	27.00	43.40	32.35	25
Barium	399-1-8	Y	ug/L	26.00	43.80	32.45	17
Benzene	399-1-10A	N	ug/L	0.00	0.03	0.00	55
Benzene	399-1-11	N	ug/L	0.00	0.04	0.00	25
Benzene	399-1-16B	N	ug/L	0.00	0.06	0.00	67
Benzene	399-1-17A	N	ug/L	0.00	1.50	0.01	180
Benzene	399-1-17B	N	ug/L	0.00	0.06	0.00	58
Benzene	399-1-7	N	ug/L	0.00	5.00	0.22	23
Beryllium	399-1-10A	Y	ug/L	0.00	1.10	0.14	22
Beryllium	399-1-10B	Y	ug/L	0.00	0.50	0.04	12
Beryllium	399-1-16A	Y	ug/L	0.00	1.40	0.07	27
Beryllium	399-1-16B	Y	ug/L	0.00	1.20	0.09	27
Beryllium	399-1-17A	N	ug/L	0.00	1.00	0.08	19
Beryllium	399-1-17A	Y	ug/L	0.00	1.30	0.08	24
Beryllium	399-1-17B	N	ug/L	0.00	0.00	0.00	17
Beryllium	399-1-17B	Y	ug/L	0.00	1.20	0.06	21
Beryllium	399-1-18A	N	ug/L	0.00	5.00	0.31	16
Beryllium	399-1-18A	Y	ug/L	0.00	1.60	0.12	19
Beryllium	399-1-18B	Y	ug/L	0.00	0.68	0.06	11
Beryllium	399-1-21B	Y	ug/L	0.00	1.20	0.20	6
Beryllium	399-1-7	Y	ug/L	0.00	8.00	0.62	13
Beryllium-7	399-1-17A	N	pCi/L	0.00	29.00	3.20	19
Bis(2-ethylhexyl) phthalate	399-1-10A	N	ug/L	0.00	9.00	2.25	4
Bis(2-ethylhexyl) phthalate	399-1-10B	N	ug/L	0.00	9.00	5.00	3
Bis(2-ethylhexyl) phthalate	399-1-16A	N	ug/L	0.00	9.00	1.80	5
Bis(2-ethylhexyl) phthalate	399-1-17A	N	ug/L	0.00	9.00	1.80	5
Bis(2-ethylhexyl) phthalate	399-1-17B	N	ug/L	0.00	9.00	1.80	5

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Bis(2-ethylhexyl) phthalate	399-1-18A	N	ug/L	0.00	9.00	2.25	4
Bis(2-ethylhexyl) phthalate	399-1-18B	N	ug/L	0.00	9.00	3.00	3
Boron	399-1-10A	N	ug/L	0.00	24.00	12.00	2
Boron	399-1-10A	Y	ug/L	11.00	24.00	17.50	2
Boron	399-1-11	N	ug/L	11.00	14.00	12.50	2
Boron	399-1-11	Y	ug/L	13.00	14.00	13.50	2
Boron	399-1-16A	N	ug/L	12.00	15.00	13.75	4
Boron	399-1-16A	Y	ug/L	0.00	17.00	11.50	4
Boron	399-1-16B	N	ug/L	40.00	51.00	43.25	4
Boron	399-1-16B	Y	ug/L	36.00	47.00	42.00	4
Boron	399-1-17A	N	ug/L	11.00	20.00	15.50	2
Boron	399-1-17A	Y	ug/L	14.00	26.00	20.00	2
Boron	399-1-17B	N	ug/L	36.00	41.00	38.50	2
Boron	399-1-17B	Y	ug/L	42.00	42.00	42.00	2
Boron	399-1-18A	N	ug/L	25.00	50.00	37.67	3
Boron	399-1-18A	Y	ug/L	23.00	26.00	24.50	2
Boron	399-1-18B	N	ug/L	77.00	77.00	77.00	1
Boron	399-1-18B	Y	ug/L	59.00	59.00	59.00	1
Boron	399-1-7	N	ug/L	12.00	19.00	15.50	4
Boron	399-1-7	Y	ug/L	0.00	74.00	26.50	4
Bromide	399-1-10A	N	ug/L	0.00	60.00	10.00	6
Bromide	399-1-10B	N	ug/L	0.00	30.00	7.50	4
Bromide	399-1-16A	N	ug/L	0.00	100.00	14.29	7
Bromide	399-1-16B	N	ug/L	0.00	40.00	5.71	7
Bromide	399-1-17A	N	ug/L	0.00	190.00	3.93	148
Bromide	399-1-17B	N	ug/L	0.00	80.00	20.00	4
Bromide	399-1-18A	N	ug/L	0.00	110.00	15.26	19
Bromide	399-1-21A	N	ug/L	0.00	155.00	101.25	4
Bromide	399-1-21B	N	ug/L	0.00	140.00	46.67	3
Bromide	399-1-7	N	ug/L	0.00	100.00	14.29	7
Bromide	399-1-8	N	ug/L	0.00	70.00	35.00	2
Cadmium	399-1-10A	N	ug/L	0.00	0.98	0.04	26
Cadmium	399-1-10A	Y	ug/L	0.00	1.00	0.03	29
Cadmium	399-1-11	N	ug/L	0.00	2.60	0.13	20
Cadmium	399-1-11	Y	ug/L	0.00	1.90	0.07	29
Cadmium	399-1-16A	N	ug/L	0.00	3.00	0.17	25
Cadmium	399-1-16A	Y	ug/L	0.00	2.90	0.24	33
Cadmium	399-1-16B	Y	ug/L	0.00	2.00	0.12	33

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Cadmium	399-1-17A	Y	ug/L	0.00	2.00	0.12	39
Cadmium	399-1-17B	N	ug/L	0.00	1.40	0.10	23
Cadmium	399-1-17B	Y	ug/L	0.00	3.40	0.38	27
Cadmium	399-1-18A	N	ug/L	0.00	1.60	0.07	24
Cadmium	399-1-18A	Y	ug/L	0.00	1.50	0.06	26
Cadmium	399-1-18B	Y	ug/L	0.00	3.00	0.29	17
Cadmium	399-1-21B	Y	ug/L	0.00	2.20	0.37	6
Cadmium	399-1-7	N	ug/L	0.00	2.00	0.11	35
Cadmium	399-1-8	N	ug/L	0.00	4.00	0.16	25
Calcium	399-1-10A	N	ug/L	14,900.00	52,400.00	35,661.54	26
Calcium	399-1-10A	Y	ug/L	15,200.00	55,500.00	33,855.17	29
Calcium	399-1-10B	N	ug/L	13,100.00	14,900.00	14,075.00	4
Calcium	399-1-10B	Y	ug/L	13,800.00	16,000.00	14,625.00	12
Calcium	399-1-11	N	ug/L	15,600.00	51,000.00	33,445.00	20
Calcium	399-1-11	Y	ug/L	15,700.00	50,000.00	28,679.31	29
Calcium	399-1-16A	N	ug/L	15,800.00	52,000.00	30,064.00	25
Calcium	399-1-16A	Y	ug/L	16,700.00	54,700.00	32,206.06	33
Calcium	399-1-16B	N	ug/L	16,000.00	21,000.00	17,823.08	26
Calcium	399-1-16B	Y	ug/L	14,000.00	21,500.00	17,787.88	33
Calcium	399-1-17A	N	ug/L	14,100.00	47,300.00	23,315.38	26
Calcium	399-1-17A	Y	ug/L	14,700.00	53,500.00	27,517.95	39
Calcium	399-1-17B	N	ug/L	14,500.00	21,600.00	18,760.87	23
Calcium	399-1-17B	Y	ug/L	16,000.00	21,400.00	18,577.78	27
Calcium	399-1-18A	N	ug/L	36,900.00	57,200.00	45,187.50	24
Calcium	399-1-18A	Y	ug/L	37,500.00	50,500.00	45,380.77	26
Calcium	399-1-18B	N	ug/L	11,100.00	13,700.00	12,153.85	13
Calcium	399-1-18B	Y	ug/L	10,100.00	14,400.00	12,517.65	17
Calcium	399-1-21A	N	ug/L	34,700.00	45,200.00	38,940.00	5
Calcium	399-1-21A	Y	ug/L	36,500.00	49,200.00	40,733.33	6
Calcium	399-1-21B	N	ug/L	15,600.00	17,000.00	16,275.00	4
Calcium	399-1-21B	Y	ug/L	15,700.00	17,000.00	16,250.00	6
Calcium	399-1-7	N	ug/L	16,200.00	46,500.00	24,828.57	28
Calcium	399-1-7	Y	ug/L	15,600.00	32,700.00	24,027.78	18
Calcium	399-1-8	N	ug/L	14,400.00	30,300.00	20,827.78	18
Calcium	399-1-8	Y	ug/L	15,700.00	31,300.00	20,976.47	17
Carbon disulfide	399-1-10A	N	ug/L	0.00	0.84	0.04	38
Carbon disulfide	399-1-10B	N	ug/L	0.00	0.52	0.01	35
Carbon disulfide	399-1-18A	N	ug/L	0.00	1.00	0.03	35

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Carbon disulfide	399-1-18B	N	ug/L	0.00	18.00	0.50	36
Carbon tetrachloride	399-1-10A	N	ug/L	0.00	0.05	0.00	63
Carbon tetrachloride	399-1-16A	N	ug/L	0.00	0.60	0.01	65
Carbon tetrachloride	399-1-16B	N	ug/L	0.00	0.90	0.01	73
Carbon tetrachloride	399-1-17A	N	ug/L	0.00	3.10	0.01	230
Carbon tetrachloride	399-1-18A	N	ug/L	0.00	6.00	0.08	76
Carbon tetrachloride	399-1-21A	N	ug/L	0.00	0.90	0.06	15
Cesium-134	399-1-17A	N	pCi/L	0.00	2.00	0.33	23
Cesium-137	399-1-17A	N	pCi/L	0.00	10.50	0.98	109
Chemical Oxygen Demand	399-1-10A	N	ug/L	0.00	9,300.00	4,650.00	2
Chemical Oxygen Demand	399-1-10B	N	ug/L	0.00	53,000.00	17,666.67	3
Chemical Oxygen Demand	399-1-21B	N	ug/L	0.00	32,000.00	16,000.00	2
Chloride	399-1-10A	N	ug/L	3,610.00	19,500.00	11,082.86	21
Chloride	399-1-10B	N	ug/L	7,300.00	7,700.00	7,503.33	6
Chloride	399-1-11	N	ug/L	3,320.00	81,800.00	15,164.50	60
Chloride	399-1-16A	N	ug/L	10,700.00	27,700.00	17,137.50	24
Chloride	399-1-16B	N	ug/L	9,590.00	12,700.00	11,238.33	18
Chloride	399-1-17A	N	ug/L	1,200.00	150,000.00	26,206.23	207
Chloride	399-1-17B	N	ug/L	8,600.00	11,500.00	9,865.83	12
Chloride	399-1-18A	N	ug/L	14,100.00	23,700.00	17,636.84	38
Chloride	399-1-18B	N	ug/L	9,900.00	14,600.00	11,311.11	9
Chloride	399-1-21A	N	ug/L	15,000.00	24,400.00	20,022.22	9
Chloride	399-1-21B	N	ug/L	5,300.00	5,800.00	5,575.00	4
Chloride	399-1-7	N	ug/L	9,150.00	57,400.00	23,915.00	30
Chloride	399-1-8	N	ug/L	9,290.00	76,000.00	21,253.33	24
Chloroform	399-1-10A	N	ug/L	0.00	24.00	3.58	63
Chloroform	399-1-11	N	ug/L	0.00	37.00	14.21	75
Chloroform	399-1-16A	N	ug/L	0.00	24.00	4.72	64
Chloroform	399-1-16B	N	ug/L	0.00	6.20	0.26	73
Chloroform	399-1-17A	N	ug/L	0.00	36.00	11.45	230
Chloroform	399-1-18A	N	ug/L	0.00	5.00	0.07	76
Chloroform	399-1-18B	N	ug/L	0.00	4.00	0.08	48
Chloroform	399-1-21A	N	ug/L	0.00	9.00	2.28	15
Chloroform	399-1-7	N	ug/L	0.00	24.00	13.32	37
Chloroform	399-1-7	Y	ug/L	1.00	1.00	1.00	1
Chloroform	399-1-8	N	ug/L	0.00	16.00	4.28	24
Chromium	399-1-10A	N	ug/L	0.00	89.00	12.62	26
Chromium	399-1-10A	Y	ug/L	0.00	19.00	1.16	29

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Chromium	399-1-10B	N	ug/L	0.00	85.20	37.48	4
Chromium	399-1-11	N	ug/L	0.00	48.00	8.18	20
Chromium	399-1-11	Y	ug/L	0.00	21.00	1.23	29
Chromium	399-1-16A	N	ug/L	0.00	147.00	14.05	25
Chromium	399-1-16A	Y	ug/L	0.00	7.60	0.95	33
Chromium	399-1-16B	N	ug/L	0.00	88.30	17.12	26
Chromium	399-1-16B	Y	ug/L	0.00	3.50	0.11	33
Chromium	399-1-17A	N	ug/L	0.00	140.00	14.70	26
Chromium	399-1-17A	Y	ug/L	0.00	5.60	0.71	39
Chromium	399-1-17B	N	ug/L	0.00	76.00	13.80	23
Chromium	399-1-18A	N	ug/L	0.00	120.00	17.48	24
Chromium	399-1-18A	Y	ug/L	0.00	19.00	1.80	26
Chromium	399-1-18B	N	ug/L	0.00	52.00	18.09	13
Chromium	399-1-18B	Y	ug/L	0.00	16.00	0.94	17
Chromium	399-1-21A	N	ug/L	0.00	60.00	21.18	5
Chromium	399-1-21B	N	ug/L	17.10	150.00	70.40	4
Chromium	399-1-7	N	ug/L	0.00	219.00	13.12	35
Chromium	399-1-7	Y	ug/L	0.00	6.30	0.69	18
Chromium	399-1-8	N	ug/L	0.00	71.70	6.07	25
Chromium	399-1-8	Y	ug/L	0.00	3.20	0.36	17
cis-1,2-Dichloroethylene	399-1-10A	N	ug/L	0.00	0.43	0.01	41
cis-1,2-Dichloroethylene	399-1-10B	N	ug/L	0.00	0.25	0.01	41
cis-1,2-Dichloroethylene	399-1-16A	N	ug/L	0.00	0.70	0.13	40
cis-1,2-Dichloroethylene	399-1-16B	N	ug/L	0.00	190.00	140.86	49
cis-1,2-Dichloroethylene	399-1-17A	N	ug/L	0.00	5.00	0.14	48
cis-1,2-Dichloroethylene	399-1-17B	N	ug/L	0.51	4.70	2.35	42
cis-1,2-Dichloroethylene	399-1-8	N	ug/L	0.20	0.30	0.25	2
Cobalt	399-1-17A	Y	ug/L	0.00	5.80	0.28	21
Cobalt	399-1-17B	N	ug/L	0.00	7.60	0.51	15
Cobalt	399-1-21A	N	ug/L	0.00	1.40	0.28	5
Cobalt	399-1-21B	Y	ug/L	0.00	8.70	1.45	6
Cobalt	399-1-7	N	ug/L	0.00	5.40	0.45	12
Cobalt	399-1-8	Y	ug/L	0.00	1.60	0.40	4
Cobalt-60	399-1-17A	N	pCi/L	0.00	12.40	1.49	109
Cobalt-60	399-1-17B	N	pCi/L	0.00	6.42	1.28	5
Coliform (Membrane Filter Technique)	399-1-11	N	ug/L	0.00	4.00	2.00	2
Coliform Bacteria	399-1-11	N	MPN	0.00	5.10	0.51	10
Coliform Bacteria	399-1-16A	N	Col/10	0.00	3.00	0.33	9

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
			0mL				
Coliform Bacteria	399-1-16B	N	Col/100mL	0.00	1.00	0.11	9
Coliform Bacteria	399-1-17A	N	Col/100mL	0.00	1.00	0.11	9
Coliform Bacteria	399-1-18B	N	MPN	0.00	2.20	0.24	9
Copper	399-1-10A	N	ug/L	0.00	19.00	2.21	26
Copper	399-1-10A	Y	ug/L	0.00	29.10	3.76	29
Copper	399-1-10B	Y	ug/L	0.00	10.80	2.02	12
Copper	399-1-11	N	ug/L	0.00	31.00	9.25	20
Copper	399-1-11	Y	ug/L	0.00	31.00	11.30	29
Copper	399-1-16A	N	ug/L	0.00	21.00	5.55	25
Copper	399-1-16A	Y	ug/L	0.00	16.00	5.05	33
Copper	399-1-16B	N	ug/L	0.00	3.80	0.15	26
Copper	399-1-16B	Y	ug/L	0.00	7.80	0.24	33
Copper	399-1-17A	N	ug/L	0.00	32.00	10.60	26
Copper	399-1-17A	Y	ug/L	0.00	33.00	8.74	39
Copper	399-1-17B	Y	ug/L	0.00	2.90	0.11	27
Copper	399-1-18A	N	ug/L	0.00	5.30	0.37	24
Copper	399-1-18A	Y	ug/L	0.00	14.50	0.65	26
Copper	399-1-21A	N	ug/L	0.00	7.20	2.42	5
Copper	399-1-21A	Y	ug/L	0.00	6.90	1.15	6
Copper	399-1-21B	N	ug/L	0.00	8.60	3.05	4
Copper	399-1-7	N	ug/L	0.00	72.00	15.63	35
Copper	399-1-7	Y	ug/L	0.00	24.00	3.94	18
Copper	399-1-8	N	ug/L	0.00	42.00	8.57	25
Copper	399-1-8	Y	ug/L	0.00	11.00	1.82	17
Cyanide	399-1-21B	N	ug/L	21.10	21.10	21.10	1
Delta-BHC	399-1-10B	N	ug/L	0.00	0.05	0.01	4
Delta-BHC	399-1-16A	N	ug/L	0.00	0.01	0.00	17
Delta-BHC	399-1-16B	N	ug/L	0.00	0.05	0.00	18
Delta-BHC	399-1-18B	N	ug/L	0.00	0.05	0.00	11
Endosulfan sulfate	399-1-17B	N	ug/L	0.00	0.01	0.00	10
Endosulfan sulfate	399-1-18A	N	ug/L	0.00	0.05	0.00	10
Ethylbenzene	399-1-16B	N	ug/L	0.00	0.08	0.01	26
Ethylbenzene	399-1-21A	N	ug/L	0.00	0.06	0.01	10
Ethylbenzene	399-1-21B	N	ug/L	0.00	0.05	0.01	6
Europium-154	399-1-17A	N	pCi/L	0.00	11.20	1.50	22
Europium-155	399-1-17A	N	pCi/L	0.00	11.80	1.99	21

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Fluoride	399-1-10A	N	ug/L	0.00	700.00	233.45	22
Fluoride	399-1-10B	N	ug/L	1,000.00	1,400.00	1,233.33	6
Fluoride	399-1-11	N	ug/L	0.00	600.00	27.26	61
Fluoride	399-1-16A	N	ug/L	0.00	700.00	185.96	25
Fluoride	399-1-16B	N	ug/L	901.00	1,610.00	1,223.74	19
Fluoride	399-1-17A	N	ug/L	0.00	770.00	156.71	208
Fluoride	399-1-17B	N	ug/L	748.00	1,500.00	1,009.92	13
Fluoride	399-1-18A	N	ug/L	0.00	1,120.00	159.15	39
Fluoride	399-1-18B	N	ug/L	1,140.00	2,000.00	1,491.82	11
Fluoride	399-1-21A	N	ug/L	300.00	700.00	438.33	9
Fluoride	399-1-21B	N	ug/L	800.00	1,100.00	950.00	4
Fluoride	399-1-7	N	ug/L	0.00	602.00	176.35	31
Fluoride	399-1-8	N	ug/L	0.00	900.00	358.13	24
Gross alpha	399-1-10A	N	pCi/L	6.70	112.00	39.05	23
Gross alpha	399-1-11	N	pCi/L	5.53	156.00	45.21	20
Gross alpha	399-1-11	Y	pCi/L	80.00	80.00	80.00	1
Gross alpha	399-1-16A	N	pCi/L	6.82	126.00	43.43	25
Gross alpha	399-1-16B	N	pCi/L	0.00	7.37	2.03	23
Gross alpha	399-1-17A	N	pCi/L	1.75	200.00	67.18	54
Gross alpha	399-1-17B	N	pCi/L	0.00	2.24	0.20	22
Gross alpha	399-1-18A	N	pCi/L	0.00	5.49	2.95	22
Gross alpha	399-1-21A	N	pCi/L	12.00	34.00	20.30	5
Gross alpha	399-1-7	N	pCi/L	12.60	111.00	40.25	29
Gross alpha	399-1-8	N	pCi/L	5.42	93.00	23.23	25
Gross beta	399-1-10A	N	pCi/L	4.22	72.60	19.07	26
Gross beta	399-1-10B	N	pCi/L	2.62	5.90	3.70	4
Gross beta	399-1-11	N	pCi/L	4.17	51.80	16.62	22
Gross beta	399-1-11	Y	pCi/L	63.00	63.00	63.00	1
Gross beta	399-1-16A	N	pCi/L	5.21	88.00	20.84	27
Gross beta	399-1-16B	N	pCi/L	4.43	10.80	6.68	25
Gross beta	399-1-17A	N	pCi/L	1.18	113.00	31.85	61
Gross beta	399-1-17B	N	pCi/L	0.00	11.10	6.40	25
Gross beta	399-1-18A	N	pCi/L	5.10	22.40	10.36	24
Gross beta	399-1-18B	N	pCi/L	3.20	13.90	8.08	12
Gross beta	399-1-21A	N	pCi/L	11.00	27.00	18.02	5
Gross beta	399-1-21B	N	pCi/L	3.80	8.44	5.41	3
Gross beta	399-1-7	N	pCi/L	12.60	53.00	27.70	33
Gross beta	399-1-8	N	pCi/L	10.40	41.00	21.53	25

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Hardness	399-1-10B	N	mg/L	56.00	58.00	57.00	3
Hardness	399-1-21A	N	mg/L	113.00	163.00	138.00	2
Hardness	399-1-21B	N	mg/L	60.00	61.00	60.50	2
Hardness	399-1-8	N	mg/L	74.00	82.00	77.00	3
Hexane	399-1-16A	N	ug/L	14.00	14.00	14.00	1
Hexane	399-1-16B	N	ug/L	15.00	15.00	15.00	1
Hexane	399-1-17A	N	ug/L	14.00	14.00	14.00	1
Iodine-129	399-1-17A	N	pCi/L	0.00	0.26	0.05	6
Iodine-129	399-1-18A	N	pCi/L	0.43	0.43	0.43	1
Iron	399-1-10A	N	ug/L	0.00	392.00	73.09	234
Iron	399-1-10A	Y	ug/L	0.00	75.00	18.44	261
Iron	399-1-10B	N	ug/L	259.00	550.00	375.75	36
Iron	399-1-10B	Y	ug/L	85.90	740.00	305.91	108
Iron	399-1-11	N	ug/L	0.00	220.00	66.40	180
Iron	399-1-11	Y	ug/L	0.00	85.60	10.64	261
Iron	399-1-16A	N	ug/L	0.00	622.00	91.15	225
Iron	399-1-16A	Y	ug/L	0.00	79.70	17.03	297
Iron	399-1-16B	N	ug/L	90.00	577.00	175.85	234
Iron	399-1-16B	Y	ug/L	0.00	130.00	85.46	297
Iron	399-1-17A	N	ug/L	0.00	620.00	111.49	234
Iron	399-1-17A	Y	ug/L	0.00	167.00	16.12	351
Iron	399-1-17B	N	ug/L	152.00	730.00	377.83	207
Iron	399-1-17B	Y	ug/L	115.00	504.00	309.59	243
Iron	399-1-18A	N	ug/L	0.00	570.00	139.63	216
Iron	399-1-18A	Y	ug/L	0.00	96.70	16.62	234
Iron	399-1-18B	N	ug/L	175.00	617.00	289.69	117
Iron	399-1-18B	Y	ug/L	135.00	482.00	233.71	153
Iron	399-1-21A	N	ug/L	0.00	2,200.00	772.96	45
Iron	399-1-21A	Y	ug/L	0.00	38.00	13.93	54
Iron	399-1-21B	N	ug/L	631.00	2,400.00	1,752.75	36
Iron	399-1-21B	Y	ug/L	0.00	370.00	134.02	54
Iron	399-1-7	N	ug/L	0.00	2,500.00	163.97	315
Iron	399-1-7	Y	ug/L	0.00	105.00	26.05	162
Iron	399-1-8	N	ug/L	0.00	336.00	56.88	225
Iron	399-1-8	Y	ug/L	0.00	86.00	17.94	153
Lead	399-1-10A	N	ug/L	0.00	6.60	0.33	429
Lead	399-1-10A	Y	ug/L	0.00	3.10	0.66	121
Lead	399-1-10B	N	ug/L	0.00	2.90	1.50	44

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Lead	399-1-10B	Y	ug/L	0.00	3.00	1.28	44
Lead	399-1-11	N	ug/L	0.00	3.20	0.27	341
Lead	399-1-11	Y	ug/L	0.00	1.90	0.19	110
Lead	399-1-16A	N	ug/L	0.00	6.00	0.39	363
Lead	399-1-16A	Y	ug/L	0.00	2.20	0.32	110
Lead	399-1-16B	N	ug/L	0.00	5.20	0.34	352
Lead	399-1-16B	Y	ug/L	0.00	5.20	0.77	132
Lead	399-1-17A	N	ug/L	0.00	5.90	0.26	396
Lead	399-1-17A	Y	ug/L	0.00	4.10	0.79	132
Lead	399-1-17B	N	ug/L	0.00	3.50	0.33	352
Lead	399-1-17B	Y	ug/L	0.00	1.80	0.32	132
Lead	399-1-18A	N	ug/L	0.00	10.00	0.77	385
Lead	399-1-18A	Y	ug/L	0.00	1.70	0.14	132
Lead	399-1-18B	N	ug/L	0.00	3.20	0.25	242
Lead	399-1-18B	Y	ug/L	0.00	2.60	0.65	44
Lead	399-1-21A	N	ug/L	0.00	2.20	1.43	33
Lead	399-1-21B	N	ug/L	0.00	2.90	1.77	33
Lead	399-1-21B	Y	ug/L	0.00	3.10	1.40	33
Lead	399-1-7	N	ug/L	0.00	5.70	0.38	506
Lead	399-1-7	Y	ug/L	0.00	5.70	1.96	55
Lead	399-1-8	N	ug/L	0.00	5.60	0.44	418
Lead	399-1-8	Y	ug/L	0.00	2.10	1.03	44
Lithium	399-1-11	Y	ug/L	0.00	10.00	5.00	2
Lithium	399-1-16B	N	ug/L	0.00	12.00	5.75	4
Lithium	399-1-16B	Y	ug/L	11.00	11.00	11.00	4
Lithium	399-1-17A	N	ug/L	15.00	19.00	17.00	2
Lithium	399-1-17A	Y	ug/L	15.00	20.00	17.50	2
Lithium	399-1-17B	N	ug/L	12.00	13.00	12.50	2
Lithium	399-1-17B	Y	ug/L	0.00	13.00	6.50	2
Lithium	399-1-18B	N	ug/L	18.00	18.00	18.00	1
Lithium	399-1-18B	Y	ug/L	18.00	18.00	18.00	1
Lithium	399-1-7	N	ug/L	14.00	14.00	14.00	4
Lithium	399-1-7	Y	ug/L	12.00	14.00	13.25	4
Magnesium	399-1-10A	N	ug/L	3,630.00	11,000.00	7,390.77	104
Magnesium	399-1-10A	Y	ug/L	3,490.00	12,400.00	7,195.17	116
Magnesium	399-1-10B	N	ug/L	5,270.00	5,780.00	5,570.00	16
Magnesium	399-1-10B	Y	ug/L	5,460.00	6,310.00	5,853.33	48
Magnesium	399-1-11	N	ug/L	3,550.00	11,000.00	7,422.50	80

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Magnesium	399-1-11	Y	ug/L	3,520.00	11,000.00	6,472.07	116
Magnesium	399-1-16A	N	ug/L	3,380.00	9,600.00	5,661.20	100
Magnesium	399-1-16A	Y	ug/L	3,310.00	11,200.00	6,223.94	132
Magnesium	399-1-16B	N	ug/L	5,400.00	7,010.00	5,995.77	104
Magnesium	399-1-16B	Y	ug/L	4,900.00	6,990.00	5,988.48	132
Magnesium	399-1-17A	N	ug/L	3,110.00	11,000.00	5,081.92	104
Magnesium	399-1-17A	Y	ug/L	3,090.00	11,900.00	5,983.85	156
Magnesium	399-1-17B	N	ug/L	6,250.00	7,830.00	6,749.57	92
Magnesium	399-1-17B	Y	ug/L	5,800.00	7,550.00	6,667.41	108
Magnesium	399-1-18A	N	ug/L	11,000.00	14,600.00	12,533.33	96
Magnesium	399-1-18A	Y	ug/L	11,600.00	14,600.00	12,634.62	104
Magnesium	399-1-18B	N	ug/L	4,850.00	5,690.00	5,195.38	52
Magnesium	399-1-18B	Y	ug/L	5,030.00	6,100.00	5,277.06	68
Magnesium	399-1-21A	N	ug/L	6,950.00	9,100.00	7,904.00	20
Magnesium	399-1-21A	Y	ug/L	7,300.00	9,910.00	8,270.00	24
Magnesium	399-1-21B	N	ug/L	4,940.00	5,520.00	5,172.50	16
Magnesium	399-1-21B	Y	ug/L	4,900.00	5,270.00	5,063.33	24
Magnesium	399-1-7	N	ug/L	3,520.00	12,400.00	4,903.57	112
Magnesium	399-1-7	Y	ug/L	3,550.00	6,340.00	4,680.00	72
Magnesium	399-1-8	N	ug/L	5,030.00	7,940.00	6,109.44	72
Magnesium	399-1-8	Y	ug/L	5,060.00	8,190.00	6,191.18	68
Manganese	399-1-10A	N	ug/L	0.00	7.60	1.29	130
Manganese	399-1-10A	Y	ug/L	0.00	6.00	0.78	145
Manganese	399-1-10B	N	ug/L	77.80	170.00	129.95	20
Manganese	399-1-10B	Y	ug/L	82.20	224.00	130.07	60
Manganese	399-1-11	N	ug/L	0.00	5.90	0.71	100
Manganese	399-1-11	Y	ug/L	0.00	1.90	0.17	145
Manganese	399-1-16A	N	ug/L	0.00	20.00	2.89	125
Manganese	399-1-16A	Y	ug/L	0.00	10.00	1.92	165
Manganese	399-1-16B	N	ug/L	62.00	92.00	79.13	130
Manganese	399-1-16B	Y	ug/L	54.80	96.00	73.97	165
Manganese	399-1-17A	N	ug/L	0.00	170.00	9.41	130
Manganese	399-1-17A	Y	ug/L	0.00	170.00	5.43	195
Manganese	399-1-17B	N	ug/L	59.00	87.00	75.28	115
Manganese	399-1-17B	Y	ug/L	63.00	85.90	74.11	135
Manganese	399-1-18A	N	ug/L	0.00	11.00	1.58	120
Manganese	399-1-18A	Y	ug/L	0.00	7.60	0.68	130
Manganese	399-1-18B	N	ug/L	34.00	51.90	44.45	65

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Manganese	399-1-18B	Y	ug/L	34.20	49.90	43.18	85
Manganese	399-1-21A	N	ug/L	0.00	49.00	16.18	25
Manganese	399-1-21A	Y	ug/L	0.00	12.00	2.83	30
Manganese	399-1-21B	N	ug/L	118.00	190.00	154.00	20
Manganese	399-1-21B	Y	ug/L	71.00	160.00	135.00	30
Manganese	399-1-7	N	ug/L	0.00	59.70	2.46	175
Manganese	399-1-7	Y	ug/L	0.00	5.60	0.44	90
Manganese	399-1-8	N	ug/L	0.00	58.00	24.10	125
Manganese	399-1-8	Y	ug/L	0.00	42.00	19.56	85
Mercury	399-1-10A	N	ug/L	0.00	0.11	0.00	117
Mercury	399-1-10A	Y	ug/L	0.00	0.12	0.01	33
Mercury	399-1-11	N	ug/L	0.00	0.09	0.00	93
Mercury	399-1-11	Y	ug/L	0.00	0.14	0.01	30
Mercury	399-1-16A	N	ug/L	0.00	0.13	0.01	90
Mercury	399-1-16A	Y	ug/L	0.00	0.14	0.02	33
Mercury	399-1-16B	N	ug/L	0.00	0.09	0.00	93
Mercury	399-1-16B	Y	ug/L	0.00	0.09	0.02	36
Mercury	399-1-17A	N	ug/L	0.00	0.13	0.00	108
Mercury	399-1-17A	Y	ug/L	0.00	0.09	0.02	36
Mercury	399-1-17B	N	ug/L	0.00	0.13	0.01	102
Mercury	399-1-17B	Y	ug/L	0.00	0.07	0.02	36
Mercury	399-1-18A	N	ug/L	0.00	0.09	0.00	102
Mercury	399-1-18A	Y	ug/L	0.00	0.12	0.01	36
Mercury	399-1-8	N	ug/L	0.00	0.20	0.01	114
Methylenechloride	399-1-10A	N	ug/L	0.00	20.00	0.88	504
Methylenechloride	399-1-10B	N	ug/L	0.00	20.00	1.20	360
Methylenechloride	399-1-11	N	ug/L	0.00	18.00	0.27	600
Methylenechloride	399-1-16A	N	ug/L	0.00	18.00	0.89	520
Methylenechloride	399-1-16B	N	ug/L	0.00	97.00	3.60	584
Methylenechloride	399-1-17A	N	ug/L	0.00	15.00	0.40	1848
Methylenechloride	399-1-17B	N	ug/L	0.00	10.00	0.72	512
Methylenechloride	399-1-18A	N	ug/L	0.00	5.00	0.22	608
Methylenechloride	399-1-18B	N	ug/L	0.00	5.00	0.25	376
Methylenechloride	399-1-21A	N	ug/L	0.00	14.00	1.20	120
Methylenechloride	399-1-21B	N	ug/L	0.00	16.00	2.67	48
Methylenechloride	399-1-7	N	ug/L	0.00	370.00	13.29	248
Methylenechloride	399-1-8	N	ug/L	0.00	130.00	8.75	160
Nickel	399-1-10A	N	ug/L	0.00	99.60	7.65	104

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Nickel	399-1-10A	Y	ug/L	0.00	20.00	1.10	116
Nickel	399-1-10B	N	ug/L	0.00	44.60	19.73	16
Nickel	399-1-10B	Y	ug/L	0.00	14.90	1.24	48
Nickel	399-1-11	N	ug/L	0.00	48.00	3.30	80
Nickel	399-1-16A	N	ug/L	0.00	180.00	63.24	100
Nickel	399-1-16A	Y	ug/L	0.00	170.00	56.58	132
Nickel	399-1-16B	N	ug/L	0.00	106.00	11.29	104
Nickel	399-1-16B	Y	ug/L	0.00	4.50	0.14	132
Nickel	399-1-17A	N	ug/L	0.00	72.00	7.35	104
Nickel	399-1-17A	Y	ug/L	0.00	16.00	0.67	156
Nickel	399-1-17B	N	ug/L	0.00	50.00	6.19	92
Nickel	399-1-18A	N	ug/L	0.00	55.00	8.93	96
Nickel	399-1-18A	Y	ug/L	0.00	31.00	1.77	104
Nickel	399-1-18B	N	ug/L	0.00	37.10	8.05	52
Nickel	399-1-21A	N	ug/L	0.00	32.00	13.86	20
Nickel	399-1-21A	Y	ug/L	0.00	6.80	1.13	24
Nickel	399-1-21B	N	ug/L	9.10	83.00	38.00	16
Nickel	399-1-21B	Y	ug/L	0.00	69.00	15.33	24
Nickel	399-1-7	N	ug/L	0.00	89.80	5.96	140
Nickel	399-1-7	Y	ug/L	0.00	13.60	0.76	72
Nickel	399-1-8	N	ug/L	0.00	35.00	3.33	100
Nickel	399-1-8	Y	ug/L	0.00	13.40	2.10	68
Nitrate	399-1-10A	N	ug/L	1,250.00	27,003.48	12,771.68	120
Nitrate	399-1-11	N	ug/L	0.00	24,200.00	3,530.48	310
Nitrate	399-1-16A	N	ug/L	1,300.00	28,375.79	9,585.45	130
Nitrate	399-1-16B	N	ug/L	0.00	1,606.93	145.35	100
Nitrate	399-1-17A	N	ug/L	0.00	39,841.20	4,054.06	1070
Nitrate	399-1-17B	N	ug/L	0.00	12.00	0.86	70
Nitrate	399-1-18A	N	ug/L	19,400.00	30,544.92	22,660.99	200
Nitrate	399-1-18B	N	ug/L	0.00	885.36	136.21	65
Nitrate	399-1-21A	N	ug/L	9,738.96	27,800.30	20,208.07	55
Nitrate	399-1-21B	N	ug/L	0.00	885.36	230.89	30
Nitrate	399-1-7	N	ug/L	132.80	31,000.00	10,150.28	165
Nitrate	399-1-8	N	ug/L	0.00	17,600.00	5,654.93	135
Nitrite	399-1-10A	N	ug/L	0.00	100.00	13.00	26
Nitrite	399-1-17A	N	ug/L	0.00	105.11	0.71	298
Nitrite	399-1-18A	N	ug/L	0.00	100.00	4.00	50
Nitrite	399-1-18B	N	ug/L	0.00	100.00	50.00	8

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Nitrite	399-1-21A	N	ug/L	0.00	370.00	41.11	18
Nitrite	399-1-21B	N	ug/L	0.00	100.00	20.00	10
Oxidation Reduction Potential	399-1-10A	N	mV	214.00	214.00	214.00	1
Oxidation Reduction Potential	399-1-10B	N	mV	66.00	193.00	129.50	2
Oxidation Reduction Potential	399-1-16A	N	mV	212.00	212.00	212.00	1
Oxidation Reduction Potential	399-1-16B	N	mV	177.00	177.00	177.00	1
Oxidation Reduction Potential	399-1-17A	N	mV	55.00	55.00	55.00	1
Oxidation Reduction Potential	399-1-17B	N	mV	291.00	291.00	291.00	1
Oxidation Reduction Potential	399-1-18A	N	mV	190.00	190.00	190.00	1
Oxidation Reduction Potential	399-1-18B	N	mV	196.00	196.00	196.00	1
pH Measurement	399-1-10A	N	pH	6.60	7.70	7.38	142
pH Measurement	399-1-10B	N	pH	6.90	8.45	7.96	88
pH Measurement	399-1-11	N	pH	5.80	8.50	7.40	166
pH Measurement	399-1-16A	N	pH	6.10	8.08	7.42	152
pH Measurement	399-1-16B	N	pH	6.40	8.54	8.01	158
pH Measurement	399-1-17A	N	pH	5.80	9.22	7.36	600
pH Measurement	399-1-17B	N	pH	5.30	8.20	7.80	132
pH Measurement	399-1-18A	N	pH	7.32	8.60	7.89	168
pH Measurement	399-1-18B	N	pH	6.80	8.40	7.89	100
pH Measurement	399-1-21A	N	pH	6.92	9.13	7.59	34
pH Measurement	399-1-21B	N	pH	7.58	9.32	8.26	18
pH Measurement	399-1-7	N	pH	6.00	8.51	7.26	92
pH Measurement	399-1-8	N	pH	6.80	8.20	7.61	68
Phenol	399-1-8	N	ug/L	0.00	2.83	0.20	14
Phosphate	399-1-10B	N	ug/L	0.00	239.00	39.83	24
Phosphate	399-1-11	N	ug/L	0.00	357.00	5.95	240
Phosphate	399-1-17A	N	ug/L	0.00	690.00	12.59	788
Phosphate	399-1-21A	N	ug/L	0.00	434.00	166.80	20
Phosphate	399-1-21B	N	ug/L	0.00	400.00	100.00	16
Plutonium-239	399-1-10B	N	pCi/L	0.00	0.02	0.01	2
Potassium	399-1-10A	N	ug/L	2,040.00	4,190.00	2,904.62	104
Potassium	399-1-10A	Y	ug/L	0.00	4,570.00	2,875.86	116
Potassium	399-1-10B	N	ug/L	5,330.00	5,650.00	5,460.00	16
Potassium	399-1-10B	Y	ug/L	4,460.00	5,900.00	5,467.50	48
Potassium	399-1-11	N	ug/L	978.00	3,600.00	2,203.90	80
Potassium	399-1-11	Y	ug/L	908.00	3,900.00	2,062.34	116
Potassium	399-1-16A	N	ug/L	2,270.00	4,000.00	2,859.60	100
Potassium	399-1-16A	Y	ug/L	0.00	3,890.00	2,796.36	132

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Potassium	399-1-16B	N	ug/L	3,600.00	5,580.00	5,065.77	104
Potassium	399-1-16B	Y	ug/L	3,490.00	5,840.00	5,082.73	132
Potassium	399-1-17A	N	ug/L	340.00	2,810.00	1,670.00	104
Potassium	399-1-17A	Y	ug/L	0.00	3,760.00	1,941.33	156
Potassium	399-1-17B	N	ug/L	5,400.00	7,100.00	6,150.00	92
Potassium	399-1-17B	Y	ug/L	4,760.00	7,120.00	5,845.19	108
Potassium	399-1-18A	N	ug/L	5,600.00	11,000.00	6,475.42	96
Potassium	399-1-18A	Y	ug/L	4,640.00	7,480.00	6,210.00	104
Potassium	399-1-18B	N	ug/L	6,000.00	7,460.00	6,402.31	52
Potassium	399-1-18B	Y	ug/L	5,670.00	7,630.00	6,396.47	68
Potassium	399-1-21A	N	ug/L	4,450.00	5,000.00	4,670.00	20
Potassium	399-1-21A	Y	ug/L	4,600.00	5,200.00	4,880.00	24
Potassium	399-1-21B	N	ug/L	4,610.00	5,400.00	4,945.00	16
Potassium	399-1-21B	Y	ug/L	4,500.00	5,500.00	4,866.67	24
Potassium	399-1-7	N	ug/L	1,800.00	5,080.00	2,619.43	140
Potassium	399-1-7	Y	ug/L	1,900.00	3,110.00	2,544.44	72
Potassium	399-1-8	N	ug/L	3,970.00	5,850.00	4,782.00	100
Potassium	399-1-8	Y	ug/L	3,710.00	5,920.00	4,751.18	68
Potassium-40	399-1-17A	N	pCi/L	0.00	228.00	87.31	21
Radium	399-1-10A	N	pCi/L	0.00	0.58	0.04	21
Radium	399-1-11	N	pCi/L	0.00	0.32	0.04	21
Radium	399-1-16A	N	pCi/L	0.00	0.40	0.08	20
Radium	399-1-16B	N	pCi/L	0.00	0.28	0.06	21
Radium	399-1-17A	N	pCi/L	0.00	0.01	0.00	23
Radium	399-1-17B	N	pCi/L	0.00	0.38	0.05	21
Radium	399-1-18A	N	pCi/L	0.00	0.21	0.04	22
Radium	399-1-18B	N	pCi/L	0.00	0.20	0.04	9
Radium	399-1-7	N	pCi/L	0.00	0.15	0.01	29
Radium	399-1-8	N	pCi/L	0.00	0.26	0.03	21
Radium-226	399-1-10B	N	pCi/L	0.00	27.34	6.84	4
Radium-226	399-1-17A	N	pCi/L	0.00	2.10	0.53	4
Ruthenium-106	399-1-17A	N	pCi/L	0.00	91.20	16.30	106
Selenium	399-1-10A	N	ug/L	0.00	10.10	0.75	444
Selenium	399-1-10A	Y	ug/L	0.00	4.80	0.96	132
Selenium	399-1-11	N	ug/L	0.00	2.70	0.16	372
Selenium	399-1-11	Y	ug/L	0.00	9.70	1.56	120
Selenium	399-1-16A	N	ug/L	0.00	17.20	0.88	396
Selenium	399-1-16A	Y	ug/L	0.00	3.00	0.93	132

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Selenium	399-1-16B	N	ug/L	0.00	2.00	0.06	384
Selenium	399-1-16B	Y	ug/L	0.00	2.50	0.21	144
Selenium	399-1-17A	N	ug/L	0.00	2.90	0.08	432
Selenium	399-1-17A	Y	ug/L	0.00	2.90	0.55	144
Selenium	399-1-17B	N	ug/L	0.00	4.00	0.13	384
Selenium	399-1-18A	N	ug/L	0.00	2.60	0.20	408
Selenium	399-1-18A	Y	ug/L	0.00	4.80	1.13	144
Selenium	399-1-21A	Y	ug/L	0.00	7.20	3.60	24
Selenium	399-1-21B	N	ug/L	0.00	20.00	6.67	36
Silicon	399-1-10A	N	ug/L	4,790.00	6,150.00	5,470.00	2
Silicon	399-1-10A	Y	ug/L	5,080.00	5,930.00	5,505.00	2
Silicon	399-1-11	N	ug/L	2,600.00	3,900.00	3,250.00	2
Silicon	399-1-11	Y	ug/L	2,580.00	3,890.00	3,235.00	2
Silicon	399-1-16A	N	ug/L	6,040.00	7,880.00	7,275.00	4
Silicon	399-1-16A	Y	ug/L	6,160.00	7,680.00	7,082.50	4
Silicon	399-1-16B	N	ug/L	19,900.00	21,100.00	20,575.00	4
Silicon	399-1-16B	Y	ug/L	19,600.00	21,700.00	20,650.00	4
Silicon	399-1-17A	N	ug/L	3,190.00	3,840.00	3,515.00	2
Silicon	399-1-17A	Y	ug/L	3,150.00	3,990.00	3,570.00	2
Silicon	399-1-17B	N	ug/L	21,300.00	21,900.00	21,600.00	2
Silicon	399-1-17B	Y	ug/L	20,500.00	21,900.00	21,200.00	2
Silicon	399-1-18A	N	ug/L	15,500.00	17,700.00	16,500.00	3
Silicon	399-1-18A	Y	ug/L	16,900.00	17,700.00	17,300.00	2
Silicon	399-1-18B	N	ug/L	24,600.00	24,600.00	24,600.00	1
Silicon	399-1-18B	Y	ug/L	23,900.00	23,900.00	23,900.00	1
Silicon	399-1-7	N	ug/L	5,440.00	6,710.00	6,105.00	4
Silicon	399-1-7	Y	ug/L	5,340.00	6,320.00	5,880.00	4
Silver	399-1-10A	Y	ug/L	0.00	6.10	0.21	87
Silver	399-1-10B	N	ug/L	0.00	2.30	0.58	12
Silver	399-1-10B	Y	ug/L	0.00	0.00	0.00	36
Silver	399-1-11	N	ug/L	0.00	9.60	0.48	60
Silver	399-1-11	Y	ug/L	0.00	8.90	0.31	87
Silver	399-1-16B	Y	ug/L	0.00	9.20	0.28	99
Silver	399-1-17A	Y	ug/L	0.00	3.60	0.09	117
Silver	399-1-17B	Y	ug/L	0.00	7.80	0.29	81
Silver	399-1-18A	Y	ug/L	0.00	6.40	0.25	78
Sodium	399-1-10A	N	ug/L	7,570.00	22,000.00	14,071.54	78
Sodium	399-1-10A	Y	ug/L	7,280.00	24,300.00	14,452.76	87

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Sodium	399-1-10B	N	ug/L	42,000.00	44,800.00	43,775.00	12
Sodium	399-1-10B	Y	ug/L	41,300.00	46,600.00	43,958.33	36
Sodium	399-1-11	N	ug/L	5,400.00	24,000.00	15,712.00	60
Sodium	399-1-11	Y	ug/L	5,130.00	24,000.00	13,794.48	87
Sodium	399-1-16A	N	ug/L	10,000.00	20,000.00	13,932.00	75
Sodium	399-1-16A	Y	ug/L	10,000.00	23,200.00	15,163.64	99
Sodium	399-1-16B	N	ug/L	44,000.00	55,500.00	48,723.08	78
Sodium	399-1-16B	Y	ug/L	39,600.00	57,800.00	48,193.94	99
Sodium	399-1-17A	N	ug/L	7,600.00	33,000.00	15,926.92	78
Sodium	399-1-17A	Y	ug/L	7,700.00	33,000.00	16,697.44	117
Sodium	399-1-17B	N	ug/L	43,700.00	54,700.00	49,560.87	69
Sodium	399-1-17B	Y	ug/L	44,000.00	56,100.00	49,940.74	81
Sodium	399-1-18A	N	ug/L	21,300.00	26,100.00	22,987.50	72
Sodium	399-1-18A	Y	ug/L	21,700.00	24,900.00	22,730.77	78
Sodium	399-1-18B	N	ug/L	59,600.00	70,600.00	63,430.77	39
Sodium	399-1-18B	Y	ug/L	58,300.00	75,400.00	64,676.47	51
Sodium	399-1-21A	N	ug/L	14,500.00	22,700.00	18,560.00	15
Sodium	399-1-21A	Y	ug/L	17,100.00	22,600.00	20,283.33	18
Sodium	399-1-21B	N	ug/L	37,000.00	40,000.00	38,775.00	12
Sodium	399-1-21B	Y	ug/L	37,900.00	42,000.00	39,933.33	18
Sodium	399-1-7	N	ug/L	10,300.00	31,600.00	15,380.00	105
Sodium	399-1-7	Y	ug/L	10,200.00	31,900.00	14,227.78	54
Sodium	399-1-8	N	ug/L	18,300.00	29,800.00	24,720.00	75
Sodium	399-1-8	Y	ug/L	17,500.00	29,500.00	23,535.29	51
Specific Conductance	399-1-10A	N	uS/cm	143.00	819.00	363.21	142
Specific Conductance	399-1-10B	N	uS/cm	204.00	567.00	312.61	92
Specific Conductance	399-1-11	N	uS/cm	126.00	523.00	229.17	154
Specific Conductance	399-1-16A	N	uS/cm	138.00	665.00	350.54	148
Specific Conductance	399-1-16B	N	uS/cm	247.00	570.00	328.32	156
Specific Conductance	399-1-17A	N	uS/cm	66.00	672.00	300.44	598
Specific Conductance	399-1-17B	N	uS/cm	237.00	639.00	352.08	142
Specific Conductance	399-1-18A	N	uS/cm	307.00	889.00	449.73	170
Specific Conductance	399-1-18B	N	uS/cm	278.00	577.00	365.04	106
Specific Conductance	399-1-21A	N	uS/cm	331.00	502.00	411.69	26
Specific Conductance	399-1-21B	N	uS/cm	288.00	304.00	297.60	10
Specific Conductance	399-1-7	N	uS/cm	152.00	474.00	272.83	84
Specific Conductance	399-1-8	N	uS/cm	190.00	495.00	279.28	58
Strontium	399-1-10A	N	ug/L	84.00	103.00	94.25	8

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Strontium	399-1-10A	Y	ug/L	75.00	245.00	152.70	24
Strontium	399-1-10B	Y	ug/L	87.60	93.60	90.20	8
Strontium	399-1-11	N	ug/L	78.00	95.00	85.00	8
Strontium	399-1-11	Y	ug/L	79.00	220.00	139.86	14
Strontium	399-1-16A	N	ug/L	82.00	110.00	94.33	18
Strontium	399-1-16A	Y	ug/L	83.00	236.00	129.94	34
Strontium	399-1-16B	N	ug/L	99.00	113.00	104.67	18
Strontium	399-1-16B	Y	ug/L	78.00	113.00	99.52	32
Strontium	399-1-17A	N	pCi/L	1.63	1.63	1.63	2
Strontium	399-1-17A	N	ug/L	80.00	222.00	125.83	12
Strontium	399-1-17A	Y	ug/L	78.00	244.00	175.46	26
Strontium	399-1-17B	N	ug/L	108.00	121.00	114.50	8
Strontium	399-1-17B	Y	ug/L	10.00	113.00	95.64	22
Strontium	399-1-18A	N	ug/L	190.00	244.00	221.60	10
Strontium	399-1-18A	Y	ug/L	218.00	259.00	233.11	18
Strontium	399-1-18B	N	ug/L	75.00	89.00	80.33	6
Strontium	399-1-18B	Y	ug/L	74.80	87.00	78.64	14
Strontium	399-1-21A	Y	ug/L	170.00	170.00	170.00	2
Strontium	399-1-21B	Y	ug/L	89.00	89.00	89.00	2
Strontium	399-1-7	N	ug/L	94.00	116.00	106.57	14
Strontium	399-1-7	Y	ug/L	89.00	112.00	99.86	14
Strontium	399-1-8	N	ug/L	109.00	109.00	109.00	2
Strontium	399-1-8	Y	ug/L	104.00	104.00	104.00	2
Strontium-90	399-1-10A	N	pCi/L	0.00	1.21	0.30	8
Strontium-90	399-1-11	N	pCi/L	1.96	1.96	1.96	2
Strontium-90	399-1-11	Y	pCi/L	1.60	1.60	1.60	2
Strontium-90	399-1-16A	N	pCi/L	0.00	0.94	0.47	4
Strontium-90	399-1-16B	N	pCi/L	0.00	2.94	0.49	12
Strontium-90	399-1-17A	N	pCi/L	0.00	2.12	0.28	166
Strontium-90	399-1-17B	N	pCi/L	0.00	5.28	0.75	14
Strontium-90	399-1-18B	N	pCi/L	0.00	0.93	0.16	12
Strontium-90	399-1-7	N	pCi/L	0.00	0.68	0.23	6
Strontium-90	399-1-8	N	pCi/L	0.00	4.10	1.11	8
Sulfate	399-1-10A	N	ug/L	12,900.00	62,200.00	32,018.18	110
Sulfate	399-1-11	N	ug/L	13,300.00	53,100.00	18,930.00	300
Sulfate	399-1-16A	N	ug/L	14,100.00	64,100.00	25,595.83	120
Sulfate	399-1-16B	N	ug/L	4,880.00	25,800.00	11,811.67	90
Sulfate	399-1-17A	N	ug/L	11,000.00	66,700.00	19,587.44	1035

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Sulfate	399-1-17B	N	ug/L	0.00	4,620.00	2,077.50	60
Sulfate	399-1-18A	N	ug/L	46,200.00	69,700.00	50,884.62	195
Sulfate	399-1-18B	N	ug/L	0.00	701.00	70.10	50
Sulfate	399-1-21A	N	ug/L	27,000.00	57,900.00	44,340.00	50
Sulfate	399-1-21B	N	ug/L	0.00	1,000.00	216.00	25
Sulfate	399-1-7	N	ug/L	12,400.00	34,200.00	17,680.00	150
Sulfate	399-1-8	N	ug/L	5,210.00	26,000.00	11,739.62	130
Sulfide	399-1-7	N	ug/L	0.00	1,100.00	55.00	20
Technetium-99	399-1-10A	N	pCi/L	10.00	10.00	10.00	1
Technetium-99	399-1-10B	N	pCi/L	0.00	15.10	3.22	5
Technetium-99	399-1-17A	N	pCi/L	2.08	54.40	23.03	3
Technetium-99	399-1-18A	N	pCi/L	8.63	8.78	8.70	2
Technetium-99	399-1-21A	N	pCi/L	0.00	5.46	2.63	4
Technetium-99	399-1-7	N	pCi/L	71.80	71.80	71.80	1
Technetium-99	399-1-8	N	pCi/L	0.00	2.26	0.56	4
Tetrachloroethene	399-1-10A	N	ug/L	0.00	8.00	0.39	189
Tetrachloroethene	399-1-11	N	ug/L	0.00	0.85	0.03	225
Tetrachloroethene	399-1-16A	N	ug/L	0.00	17.00	1.10	195
Tetrachloroethene	399-1-16B	N	ug/L	0.00	1.00	0.05	219
Tetrachloroethene	399-1-17A	N	ug/L	0.00	38.00	0.49	693
Tetrachloroethene	399-1-17B	N	ug/L	0.00	0.20	0.00	192
Tetrachloroethene	399-1-21A	N	ug/L	0.00	1.00	0.10	45
Tetrachloroethene	399-1-8	N	ug/L	0.00	0.30	0.02	81
Tetraethylpyrophosphate	399-1-7	N	ug/L	0.00	3.12	1.04	3
Tetrahydrofuran	399-1-10B	N	ug/L	0.00	3.60	0.18	40
Thallium	399-1-10A	Y	ug/L	0.00	2.40	0.28	26
Thallium	399-1-10B	Y	ug/L	0.00	2.40	0.16	30
Thallium	399-1-11	N	ug/L	0.00	23.40	4.68	10
Thallium	399-1-16B	Y	ug/L	0.00	2.40	0.18	26
Thallium	399-1-17A	Y	ug/L	0.00	1.80	0.14	26
Tin	399-1-10A	Y	ug/L	0.00	33.00	2.75	12
Tin	399-1-16A	N	ug/L	0.00	37.00	2.85	13
Tin	399-1-16A	Y	ug/L	0.00	53.00	3.79	14
Tin	399-1-16B	Y	ug/L	0.00	28.00	1.87	15
Tin	399-1-17A	N	ug/L	0.00	41.00	3.42	12
Tin	399-1-17A	Y	ug/L	0.00	34.00	2.62	13
Tin	399-1-18A	N	ug/L	0.00	65.00	5.42	12
Tin	399-1-18A	Y	ug/L	0.00	49.00	4.08	12

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Tin	399-1-21B	N	ug/L	53.00	53.00	53.00	1
Tin	399-1-21B	Y	ug/L	0.00	45.00	15.00	3
Toluene	399-1-10A	N	ug/L	0.00	0.06	0.00	220
Toluene	399-1-10B	N	ug/L	0.00	0.00	0.00	180
Toluene	399-1-11	N	ug/L	0.00	0.05	0.00	100
Toluene	399-1-16A	N	ug/L	0.00	3.00	0.05	232
Toluene	399-1-16B	N	ug/L	0.00	3.00	0.05	268
Toluene	399-1-17A	N	ug/L	0.00	3.00	0.02	724
Toluene	399-1-17B	N	ug/L	0.00	4.00	0.31	232
Toluene	399-1-18A	N	ug/L	0.00	0.03	0.00	252
Toluene	399-1-7	N	ug/L	0.00	1.00	0.04	92
Toluene	399-1-8	N	ug/L	0.00	0.90	0.06	56
Total carbon	399-1-10A	N	ug/L	16,400.00	16,700.00	16,550.00	2
Total carbon	399-1-11	N	ug/L	13,500.00	16,200.00	14,850.00	2
Total carbon	399-1-16A	N	ug/L	12,600.00	16,500.00	14,757.14	7
Total carbon	399-1-16B	N	ug/L	34,000.00	41,900.00	37,500.00	7
Total carbon	399-1-17A	N	ug/L	15,000.00	16,000.00	15,633.33	3
Total carbon	399-1-17B	N	ug/L	40,700.00	44,900.00	42,666.67	3
Total carbon	399-1-18A	N	ug/L	29,500.00	29,800.00	29,650.00	2
Total carbon	399-1-18B	N	ug/L	42,400.00	43,500.00	42,950.00	2
Total carbon	399-1-7	N	ug/L	16,500.00	17,200.00	16,850.00	2
Total carbon	399-1-8	N	ug/L	22,900.00	22,900.00	22,900.00	1
Total dissolved solids	399-1-10A	N	ug/L	221,000.00	248,000.00	234,500.00	4
Total dissolved solids	399-1-10B	N	ug/L	187,000.00	202,000.00	195,000.00	6
Total dissolved solids	399-1-21A	N	ug/L	217,000.00	260,000.00	238,500.00	4
Total dissolved solids	399-1-21B	N	ug/L	172,000.00	188,000.00	180,000.00	4
Total dissolved solids	399-1-8	N	ug/L	160,000.00	184,000.00	172,000.00	6
Total halogens (all)	399-1-17A	N	ug/L	5.40	14.60	7.80	4
Total organic carbon	399-1-10A	N	ug/L	0.00	2,000.00	231.71	84
Total organic carbon	399-1-11	N	ug/L	0.00	1,180.00	212.16	75
Total organic carbon	399-1-16A	N	ug/L	0.00	1,000.00	131.00	90
Total organic carbon	399-1-16B	N	ug/L	0.00	1,000.00	100.52	87
Total organic carbon	399-1-17A	N	ug/L	0.00	2,000.00	441.89	225
Total organic carbon	399-1-17B	N	ug/L	0.00	400.00	48.00	75
Total organic carbon	399-1-18A	N	ug/L	0.00	500.00	70.46	78
Total organic carbon	399-1-21A	N	ug/L	600.00	600.00	600.00	3
Total organic carbon	399-1-7	N	ug/L	0.00	4,670.00	282.06	102
Total organic carbon	399-1-8	N	ug/L	0.00	1,490.00	131.43	63

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Total organic halides	399-1-10A	N	ug/L	0.00	44.00	11.58	78
Total organic halides	399-1-11	N	ug/L	0.00	82.00	25.07	75
Total organic halides	399-1-16A	N	ug/L	0.00	52.00	16.31	84
Total organic halides	399-1-16B	N	ug/L	0.00	108.00	58.14	87
Total organic halides	399-1-17A	N	ug/L	0.00	100.00	28.27	204
Total organic halides	399-1-17B	N	ug/L	0.00	26.00	7.72	75
Total organic halides	399-1-7	N	ug/L	0.00	335.00	30.87	90
Total organic halides	399-1-8	N	ug/L	0.00	215.00	10.24	63
Total suspended solids	399-1-10A	N	mg/L	0.00	7.00	3.50	4
Total suspended solids	399-1-21A	N	mg/L	0.00	33.00	16.50	4
Total suspended solids	399-1-21B	N	mg/L	0.00	35.00	17.50	4
Total suspended solids	399-1-8	N	mg/L	0.00	5.00	3.33	6
trans-1,2-Dichloroethylene	399-1-10A	N	ug/L	0.00	0.04	0.00	90
trans-1,2-Dichloroethylene	399-1-11	N	ug/L	0.00	0.62	0.03	40
trans-1,2-Dichloroethylene	399-1-16B	N	ug/L	0.00	135.00	15.59	124
trans-1,2-Dichloroethylene	399-1-17B	N	ug/L	0.00	31.00	3.74	108
Trichloroethene	399-1-10A	N	ug/L	0.00	0.30	0.01	252
Trichloroethene	399-1-11	N	ug/L	0.00	0.43	0.01	300
Trichloroethene	399-1-16A	N	ug/L	0.00	3.00	0.57	260
Trichloroethene	399-1-16B	N	ug/L	0.00	24.10	8.45	292
Trichloroethene	399-1-17A	N	ug/L	0.00	2.00	0.08	916
Trichloroethene	399-1-17B	N	ug/L	0.00	0.03	0.00	256
Trichloroethene	399-1-21A	N	ug/L	0.00	3.00	1.54	60
Trichloroethene	399-1-21B	N	ug/L	0.00	0.41	0.07	24
Trichloroethene	399-1-7	N	ug/L	0.00	4.00	0.32	148
Trichloroethene	399-1-8	N	ug/L	0.00	3.00	0.24	108
Tritium	399-1-10A	N	pCi/L	0.00	12,300.00	7,282.82	40
Tritium	399-1-10B	N	pCi/L	0.00	113.00	22.65	24
Tritium	399-1-11	N	pCi/L	0.00	12,700.00	7,970.33	30
Tritium	399-1-16A	N	pCi/L	0.00	12,400.00	6,502.79	38
Tritium	399-1-16B	N	pCi/L	0.00	1,240.00	298.50	40
Tritium	399-1-17A	N	pCi/L	0.00	12,300.00	3,649.76	98
Tritium	399-1-17B	N	pCi/L	0.00	151.00	15.37	42
Tritium	399-1-18A	N	pCi/L	6,450.00	14,100.00	11,584.94	36
Tritium	399-1-18B	N	pCi/L	0.00	586.00	96.52	14
Tritium	399-1-21A	N	pCi/L	3,151.00	9,650.00	6,769.20	20
Tritium	399-1-21B	N	pCi/L	0.00	85.48	27.26	10
Tritium	399-1-7	N	pCi/L	0.00	2,290.00	376.75	24

Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Tritium	399-1-8	N	pCi/L	0.00	3,590.00	791.25	16
Turbidity	399-1-10A	N	NTU	0.10	7.03	1.36	39
Turbidity	399-1-10A	Y	NTU	0.48	0.48	0.48	1
Turbidity	399-1-10B	N	NTU	0.28	11.20	3.41	34
Turbidity	399-1-10B	Y	NTU	0.74	0.74	0.74	1
Turbidity	399-1-11	N	NTU	0.10	1.33	0.71	5
Turbidity	399-1-16A	N	NTU	0.12	4.20	1.01	40
Turbidity	399-1-16A	Y	NTU	0.14	0.53	0.34	2
Turbidity	399-1-16B	N	NTU	0.10	17.00	2.05	40
Turbidity	399-1-16B	Y	NTU	0.21	0.55	0.38	2
Turbidity	399-1-17A	N	NTU	0.00	5.26	1.55	44
Turbidity	399-1-17A	Y	NTU	0.73	1.21	0.97	2
Turbidity	399-1-17B	N	NTU	0.10	4.78	1.92	39
Turbidity	399-1-17B	Y	NTU	0.59	0.59	0.59	1
Turbidity	399-1-18A	N	NTU	0.00	4.33	1.15	39
Turbidity	399-1-18A	Y	NTU	0.31	0.68	0.50	2
Turbidity	399-1-18B	N	NTU	0.00	3.84	1.50	32
Turbidity	399-1-18B	Y	NTU	0.73	0.73	0.73	1
Turbidity	399-1-21A	N	NTU	0.64	84.50	15.47	6
Turbidity	399-1-21B	N	NTU	9.64	41.00	25.32	2
Turbidity	399-1-7	N	NTU	0.10	0.70	0.38	6
Unknown aliphatic hydrocarbon	399-1-10A	N	ug/L	90.00	90.00	90.00	1
Unknown amide	399-1-17A	N	ug/L	10.00	10.00	10.00	1
Unknown amide	399-1-17B	N	ug/L	31.00	31.00	31.00	1
Uranium	399-1-10A	N	ug/L	0.48	152.00	58.68	224
Uranium	399-1-10A	Y	ug/L	35.40	35.40	35.40	4
Uranium	399-1-10B	N	ug/L	0.00	141.00	3.61	160
Uranium	399-1-11	N	ug/L	13.59	279.00	66.61	280
Uranium	399-1-16A	N	ug/L	1.08	165.00	81.79	232
Uranium	399-1-16B	N	ug/L	0.48	14.80	7.94	232
Uranium	399-1-17A	N	ug/L	0.00	524.00	113.96	960
Uranium	399-1-17A	Y	ug/L	133.00	192.77	162.89	8
Uranium	399-1-17B	N	ug/L	0.00	17.40	0.40	224
Uranium	399-1-18A	N	ug/L	3.32	7.66	5.48	268
Uranium	399-1-18B	N	ug/L	0.00	0.53	0.06	168
Uranium	399-1-21A	N	ug/L	17.70	101.00	39.83	56
Uranium	399-1-21B	N	ug/L	0.04	0.37	0.18	16
Uranium	399-1-7	N	ug/L	27.80	329.00	104.25	104

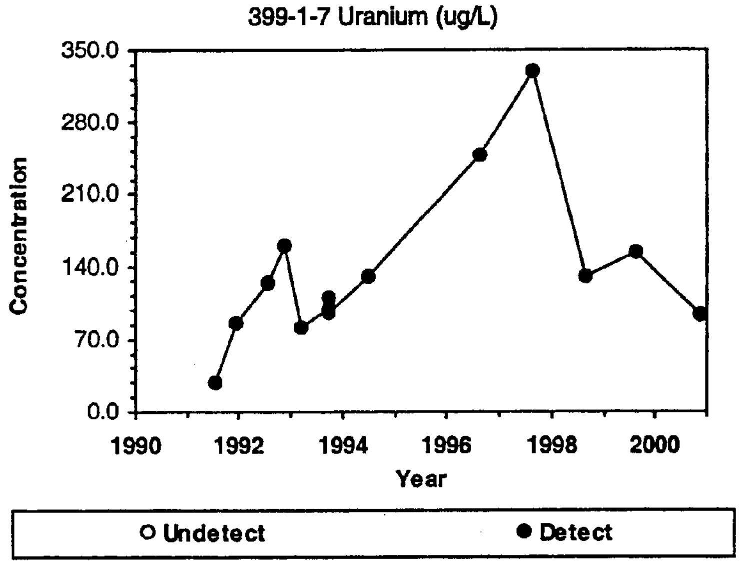
Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Uranium	399-1-8	N	ug/L	0.48	110.00	34.97	32
Uranium-233/234	399-1-10A	N	pCi/L	60.00	67.00	63.50	6
Uranium-233/234	399-1-11	Y	pCi/L	58.00	58.00	58.00	3
Uranium-233/234	399-1-16A	N	pCi/L	74.00	74.00	74.00	3
Uranium-233/234	399-1-16B	N	pCi/L	1.80	1.80	1.80	3
Uranium-233/234	399-1-17A	N	pCi/L	5.60	5.60	5.60	3
Uranium-233/234	399-1-18A	N	pCi/L	2.30	2.30	2.30	3
Uranium-233/234	399-1-18B	N	pCi/L	0.17	0.17	0.17	3
Uranium-233/234	399-1-21A	N	pCi/L	0.00	35.00	17.50	6
Uranium-233/234	399-1-21B	N	pCi/L	0.63	0.63	0.63	3
Uranium-233/234	399-1-7	N	pCi/L	45.00	45.00	45.00	3
Uranium-233/234	399-1-8	N	pCi/L	54.00	54.00	54.00	3
Uranium-234	399-1-10A	N	pCi/L	6.74	22.50	14.62	4
Uranium-234	399-1-10A	Y	pCi/L	20.90	20.90	20.90	2
Uranium-234	399-1-10B	N	pCi/L	0.23	0.36	0.30	4
Uranium-234	399-1-11	N	pCi/L	50.62	50.62	50.62	2
Uranium-234	399-1-16A	N	pCi/L	41.56	41.56	41.56	2
Uranium-234	399-1-16B	N	pCi/L	0.89	0.89	0.89	2
Uranium-234	399-1-17A	N	pCi/L	0.51	171.00	28.35	186
Uranium-234	399-1-17A	Y	pCi/L	88.80	89.68	89.24	4
Uranium-234	399-1-17B	N	pCi/L	0.07	0.12	0.09	4
Uranium-234	399-1-18A	N	pCi/L	2.27	2.27	2.27	2
Uranium-234	399-1-18B	N	pCi/L	4.53	4.53	4.53	2
Uranium-234	399-1-21A	N	pCi/L	11.30	11.30	11.30	2
Uranium-234	399-1-21B	N	pCi/L	1.50	1.50	1.50	2
Uranium-234	399-1-8	N	pCi/L	29.68	32.34	31.01	4
Uranium-235	399-1-10A	N	pCi/L	0.28	5.40	2.76	10
Uranium-235	399-1-10A	Y	pCi/L	1.02	1.02	1.02	2
Uranium-235	399-1-11	N	pCi/L	6.29	6.29	6.29	2
Uranium-235	399-1-11	Y	pCi/L	3.60	3.60	3.60	2
Uranium-235	399-1-16A	N	pCi/L	4.58	5.20	4.89	4
Uranium-235	399-1-16B	N	pCi/L	0.07	0.15	0.11	4
Uranium-235	399-1-17A	N	pCi/L	0.00	10.39	1.79	190
Uranium-235	399-1-17A	Y	pCi/L	2.92	11.00	6.96	4
Uranium-235	399-1-18A	N	pCi/L	0.06	0.19	0.12	4
Uranium-235	399-1-18B	N	pCi/L	0.00	0.34	0.11	6
Uranium-235	399-1-21A	N	pCi/L	1.10	4.00	1.95	8
Uranium-235	399-1-21B	N	pCi/L	0.00	0.09	0.03	6

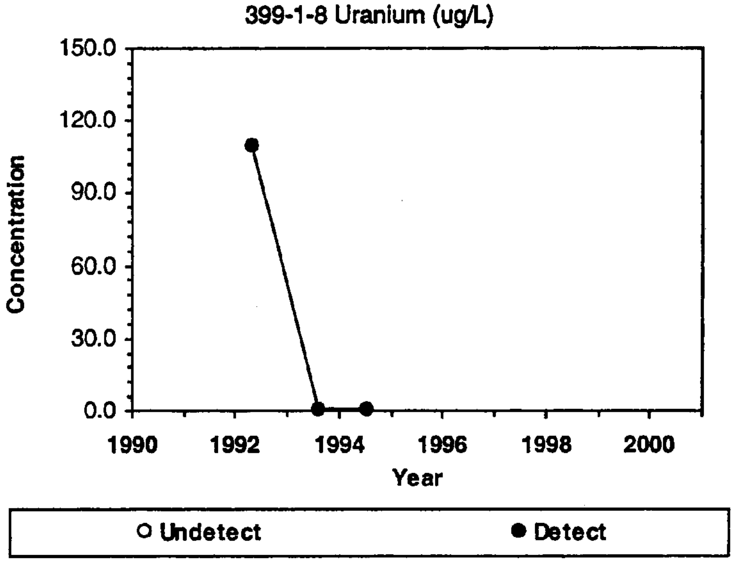
Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Uranium-235	399-1-7	N	pCi/L	5.90	7.70	6.80	4
Uranium-235	399-1-8	N	pCi/L	0.70	5.80	3.46	8
Uranium-238	399-1-10A	N	pCi/L	6.14	59.00	36.81	10
Uranium-238	399-1-10A	Y	pCi/L	18.40	18.40	18.40	2
Uranium-238	399-1-10B	N	pCi/L	0.00	0.36	0.17	8
Uranium-238	399-1-11	N	pCi/L	37.17	37.17	37.17	2
Uranium-238	399-1-11	Y	pCi/L	46.00	46.00	46.00	2
Uranium-238	399-1-16A	N	pCi/L	35.59	61.00	48.30	4
Uranium-238	399-1-16B	N	pCi/L	0.80	1.80	1.30	4
Uranium-238	399-1-17A	N	pCi/L	0.00	142.00	21.11	192
Uranium-238	399-1-17A	Y	pCi/L	64.40	65.61	65.01	4
Uranium-238	399-1-17B	N	pCi/L	0.01	0.04	0.03	6
Uranium-238	399-1-18A	N	pCi/L	1.60	1.74	1.67	4
Uranium-238	399-1-18B	N	pCi/L	0.00	3.78	1.32	6
Uranium-238	399-1-21A	N	pCi/L	9.10	27.00	14.31	8
Uranium-238	399-1-21B	N	pCi/L	0.00	1.29	0.62	6
Uranium-238	399-1-7	N	pCi/L	32.99	33.00	33.00	4
Uranium-238	399-1-8	N	pCi/L	7.50	37.00	22.31	8
Vanadium	399-1-10A	N	ug/L	0.00	9.70	1.29	78
Vanadium	399-1-10A	Y	ug/L	0.00	35.40	5.07	87
Vanadium	399-1-10B	Y	ug/L	0.00	12.20	1.99	36
Vanadium	399-1-11	N	ug/L	0.00	8.20	1.39	60
Vanadium	399-1-11	Y	ug/L	0.00	9.50	2.44	87
Vanadium	399-1-16A	N	ug/L	0.00	6.00	0.90	75
Vanadium	399-1-16A	Y	ug/L	0.00	38.70	2.98	99
Vanadium	399-1-16B	Y	ug/L	0.00	31.00	2.32	99
Vanadium	399-1-17A	N	ug/L	0.00	13.30	1.96	78
Vanadium	399-1-17A	Y	ug/L	0.00	43.70	4.61	117
Vanadium	399-1-17B	Y	ug/L	0.00	35.10	1.80	81
Vanadium	399-1-18A	N	ug/L	0.00	15.00	7.80	69
Vanadium	399-1-18A	Y	ug/L	0.00	55.40	11.04	78
Vanadium	399-1-18B	N	ug/L	0.00	2.00	0.31	39
Vanadium	399-1-18B	Y	ug/L	0.00	10.50	1.15	51
Vanadium	399-1-21A	N	ug/L	0.00	11.00	3.80	15
Vanadium	399-1-21A	Y	ug/L	0.00	6.50	1.70	18
Vanadium	399-1-21B	N	ug/L	0.00	4.70	1.98	12
Vanadium	399-1-7	N	ug/L	0.00	19.30	1.62	105
Vanadium	399-1-7	Y	ug/L	0.00	11.80	2.81	54

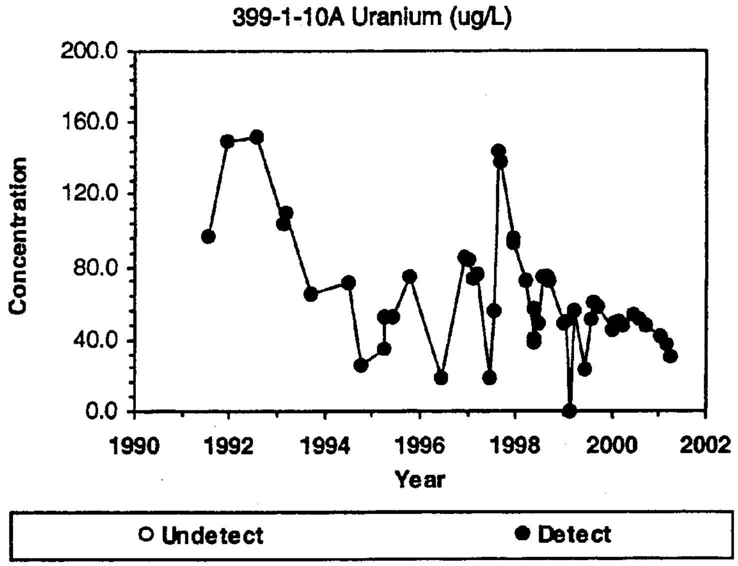
Constituent	Well Number	Filtered	Units	Minimum	Maximum	Average	# Samples
Vanadium	399-1-8	N	ug/L	0.00	8.00	0.62	75
Vanadium	399-1-8	Y	ug/L	0.00	5.00	0.45	51
Vinyl chloride	399-1-10A	N	ug/L	0.00	0.60	0.01	162
Vinyl chloride	399-1-10B	N	ug/L	0.00	0.30	0.01	123
Vinyl chloride	399-1-16A	N	ug/L	0.00	0.30	0.01	171
Vinyl chloride	399-1-16B	N	ug/L	0.00	0.30	0.01	180
Vinyl chloride	399-1-17A	N	ug/L	0.00	0.30	0.00	534
Vinyl chloride	399-1-17B	N	ug/L	0.00	0.40	0.01	171
Vinyl chloride	399-1-18A	N	ug/L	0.00	0.40	0.01	186
Vinyl chloride	399-1-18B	N	ug/L	0.00	0.40	0.01	123
Xylenes (total)	399-1-11	N	ug/L	0.00	0.26	0.00	225
Xylenes (total)	399-1-16A	N	ug/L	0.00	10.00	0.15	195
Xylenes (total)	399-1-16B	N	ug/L	0.00	0.06	0.00	219
Zinc	399-1-10A	N	ug/L	0.00	24.00	3.63	182
Zinc	399-1-10A	Y	ug/L	0.00	23.20	3.20	203
Zinc	399-1-10B	N	ug/L	0.00	13.40	3.35	28
Zinc	399-1-10B	Y	ug/L	0.00	20.40	4.14	84
Zinc	399-1-11	N	ug/L	0.00	25.00	6.20	140
Zinc	399-1-11	Y	ug/L	0.00	25.00	5.10	203
Zinc	399-1-16A	N	ug/L	0.00	232.00	20.69	175
Zinc	399-1-16A	Y	ug/L	0.00	49.00	11.64	231
Zinc	399-1-16B	N	ug/L	0.00	40.00	9.37	182
Zinc	399-1-16B	Y	ug/L	0.00	136.00	13.56	231
Zinc	399-1-17A	N	ug/L	0.00	24.00	4.60	182
Zinc	399-1-17A	Y	ug/L	0.00	17.00	3.01	273
Zinc	399-1-17B	N	ug/L	0.00	53.00	6.91	161
Zinc	399-1-17B	Y	ug/L	0.00	16.10	3.21	189
Zinc	399-1-18A	N	ug/L	0.00	100.00	7.68	168
Zinc	399-1-18A	Y	ug/L	0.00	20.00	2.38	182
Zinc	399-1-18B	N	ug/L	0.00	16.00	6.78	91
Zinc	399-1-18B	Y	ug/L	0.00	27.00	6.04	119
Zinc	399-1-21A	N	ug/L	0.00	11.40	2.28	35
Zinc	399-1-21B	N	ug/L	0.00	11.90	4.53	28
Zinc	399-1-7	N	ug/L	0.00	808.00	48.17	196
Zinc	399-1-7	Y	ug/L	0.00	7.00	2.06	126
Zinc	399-1-8	N	ug/L	0.00	32.00	4.51	126
Zinc	399-1-8	Y	ug/L	0.00	18.00	1.71	119
Zirconium/Niobium-95	399-1-17A	N	pCi/L	0.00	108.00	12.39	16

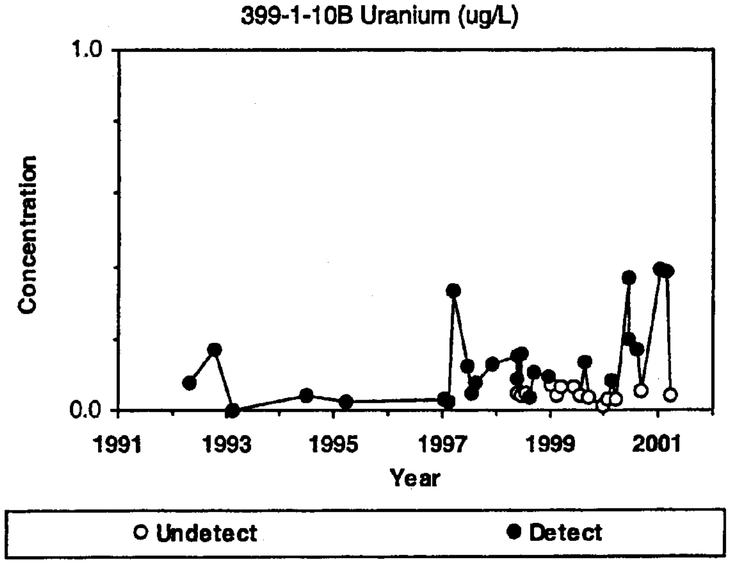
Appendix B

Trend Plots (Constituent vs. Time) for Uranium, Cis-1,2-Dichloroethene, Trichloroethene, and Perchloroethene at Wells in the Proposed Monitoring Network

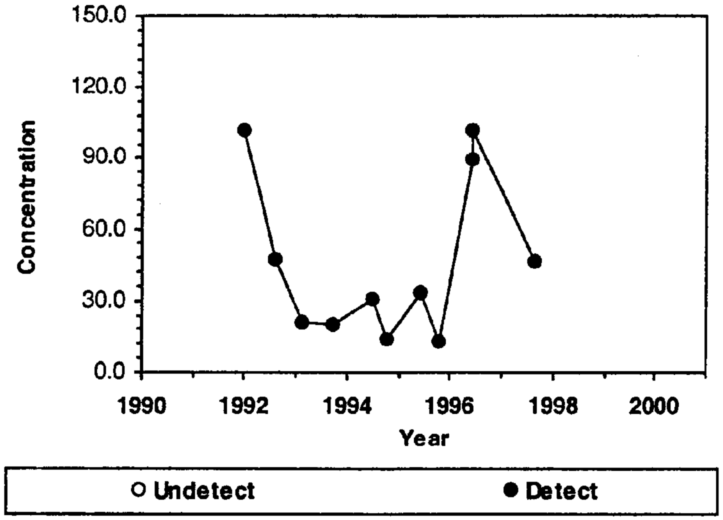

399-1-7 Uranium (ug/L)


399-1-8 Uranium (ug/L)

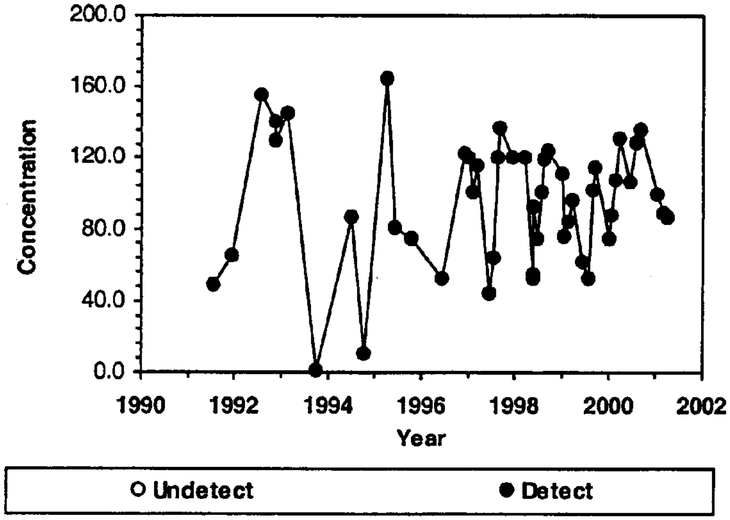

399-1-10A Uranium (ug/L)


399-1-10B Uranium (ug/L)

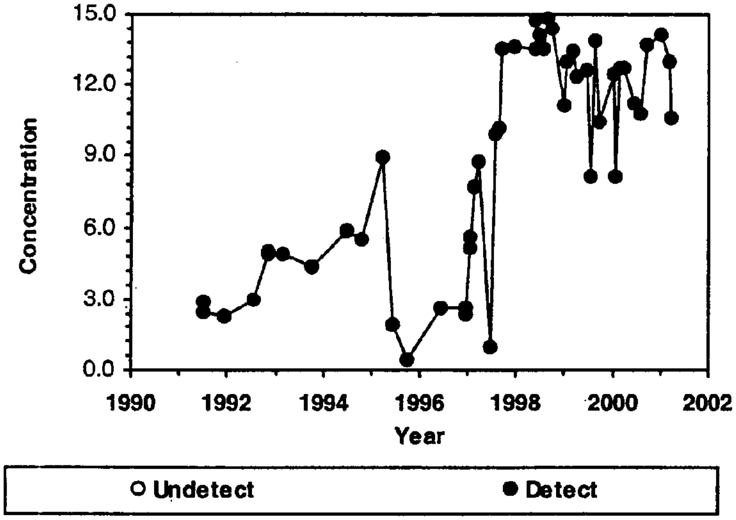
399-1-11 Uranium (ug/L)



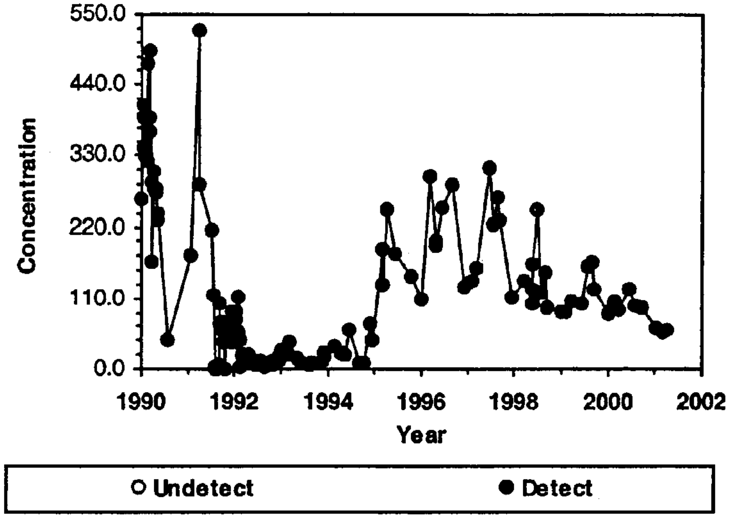
399-1-16A Uranium (ug/L)

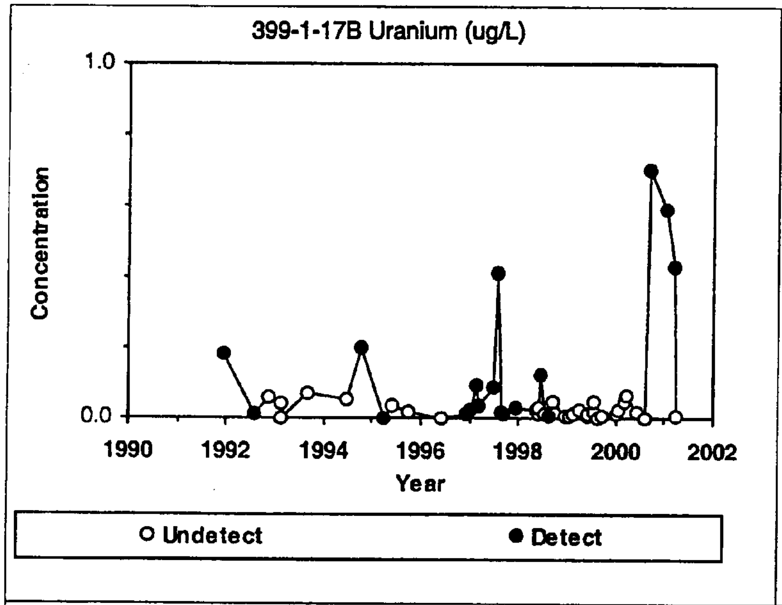


399-1-16B Uranium (ug/L)

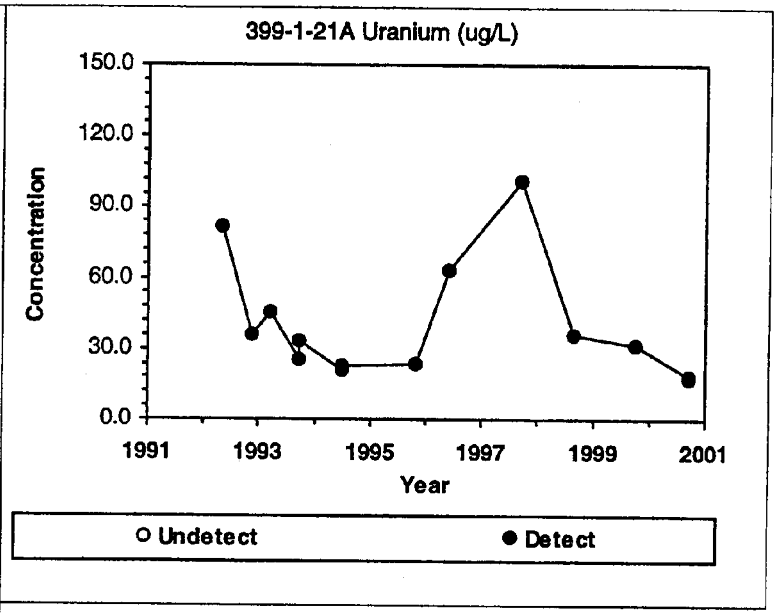


399-1-17A Uranium (ug/L)

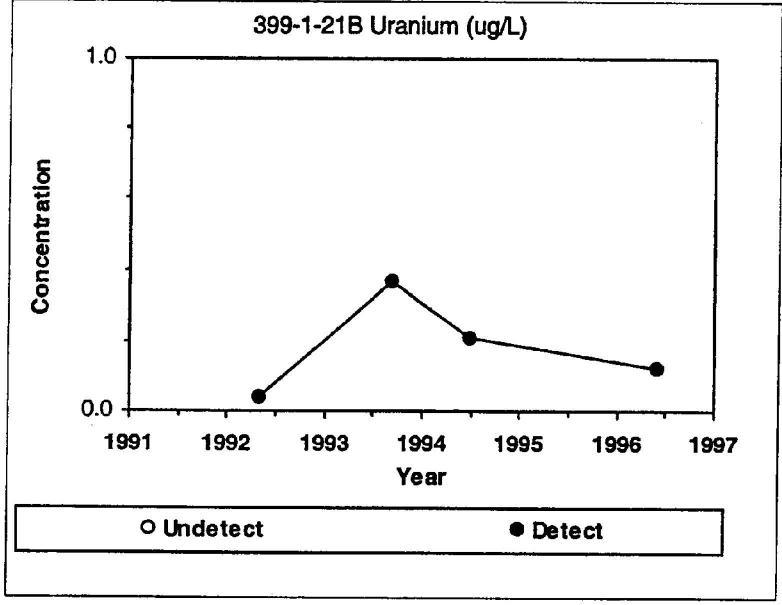




399-1-17B Uranium (ug/L)

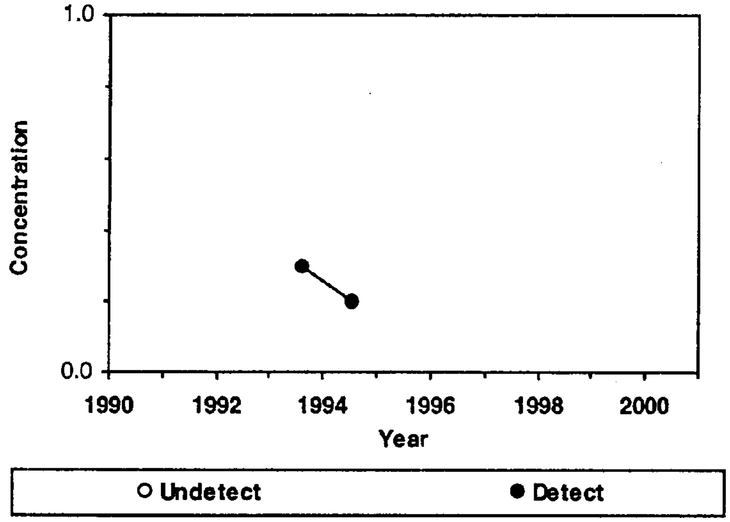


399-1-21A Uranium (ug/L)

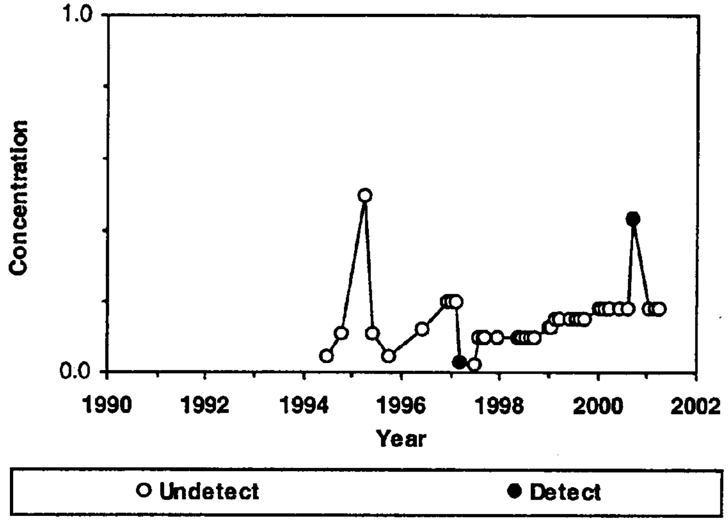


399-1-21B Uranium (ug/L)

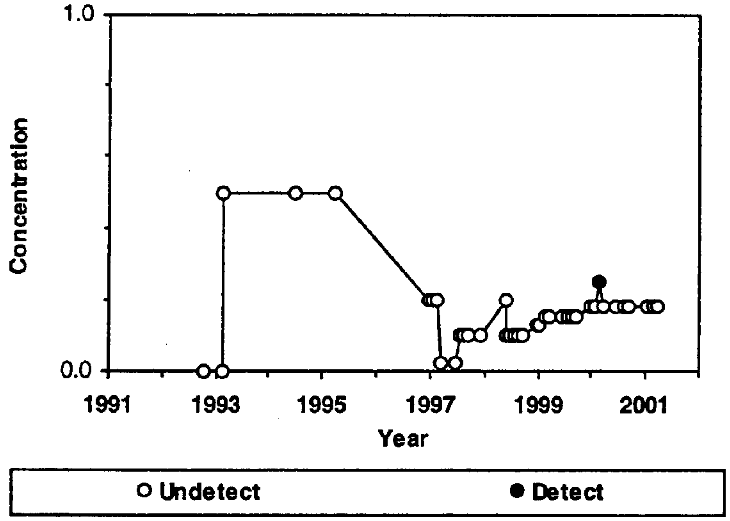
399-1-8 cis-1,2-Dichloroethylene (ug/L)



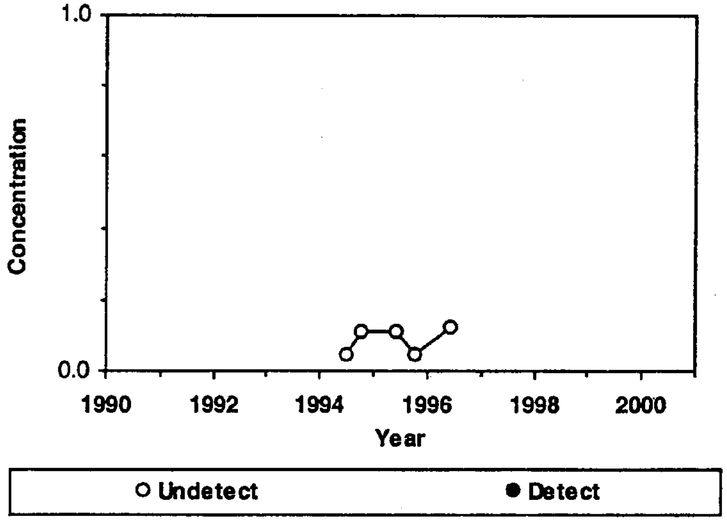
399-1-10A cis-1,2-Dichloroethylene (ug/L)

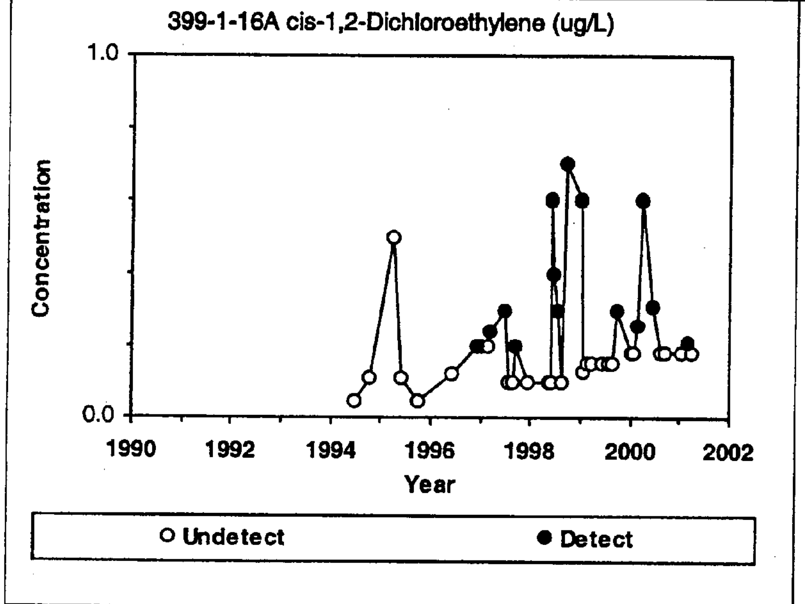


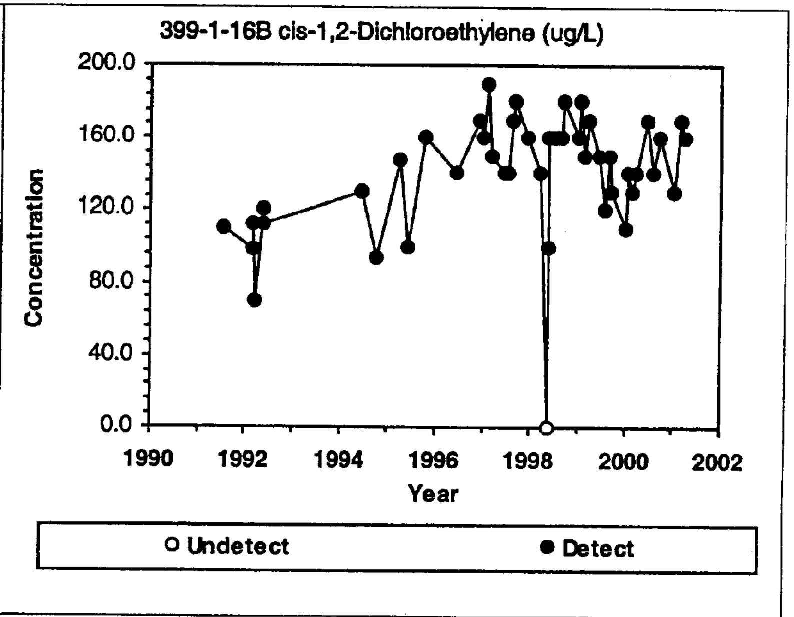
399-1-10B cis-1,2-Dichloroethylene (ug/L)

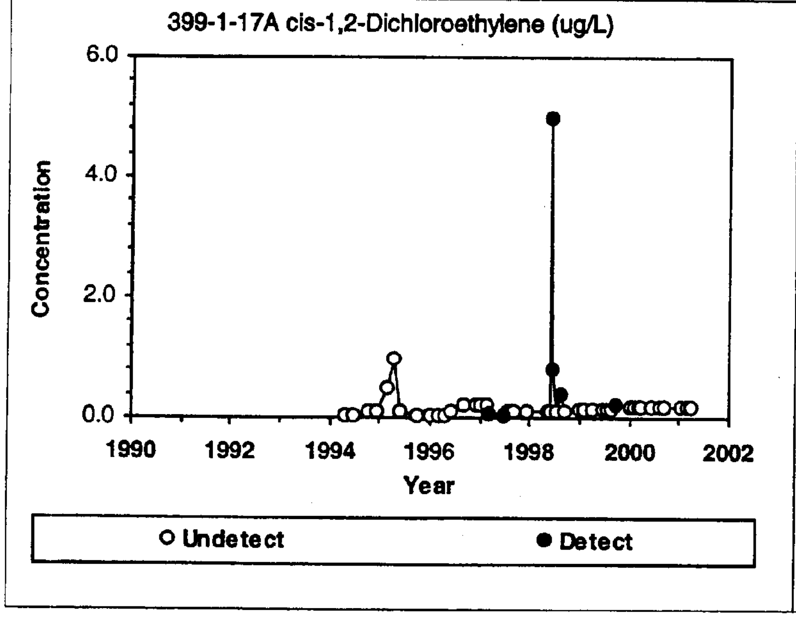


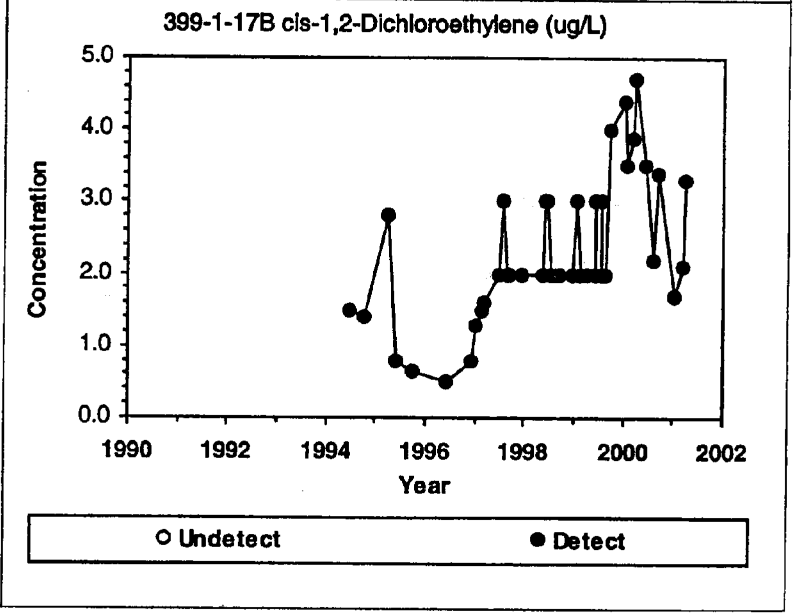
399-1-11 cis-1,2-Dichloroethylene (ug/L)

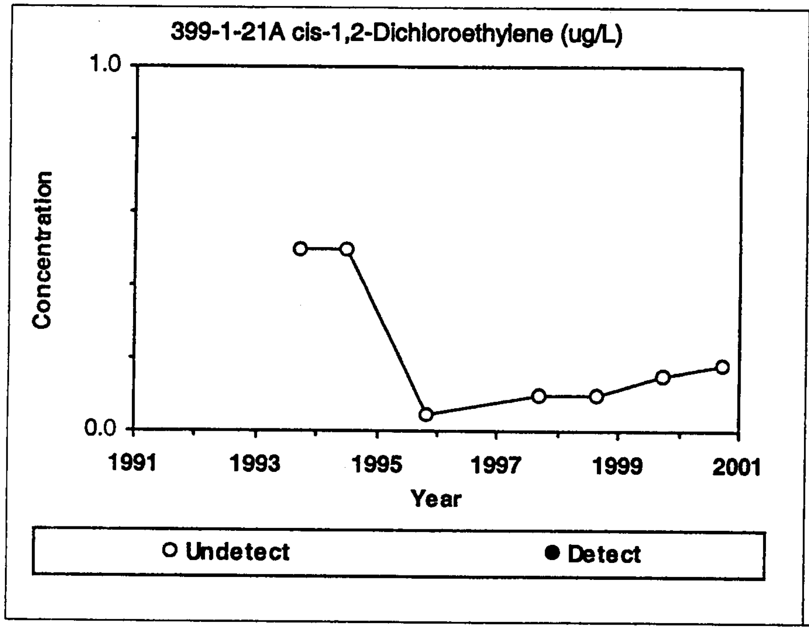


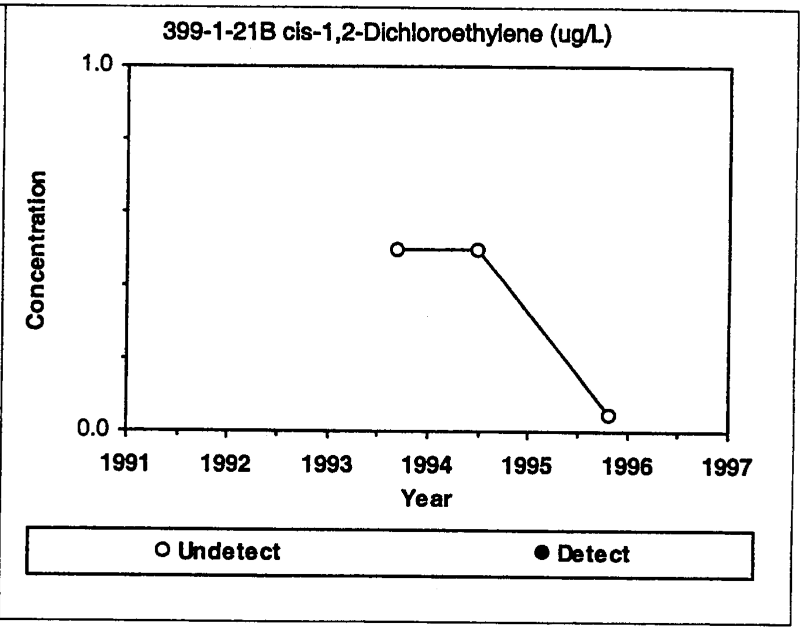

399-1-16A cis-1,2-Dichloroethylene (ug/L)

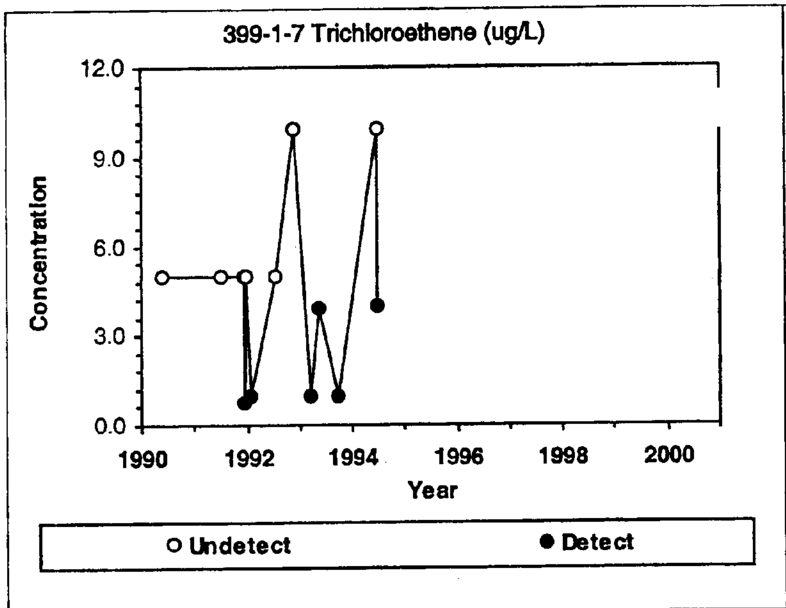

399-1-16B cis-1,2-Dichloroethylene (ug/L)

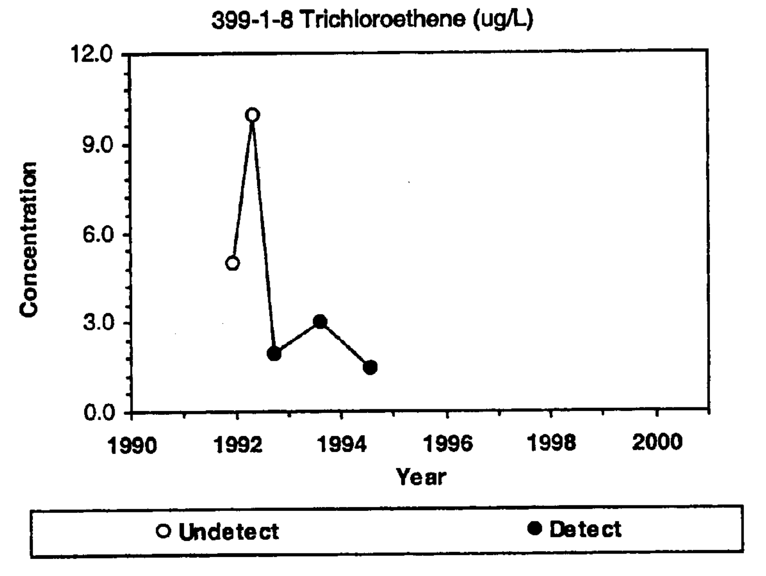

399-1-17A cis-1,2-Dichloroethylene (ug/L)

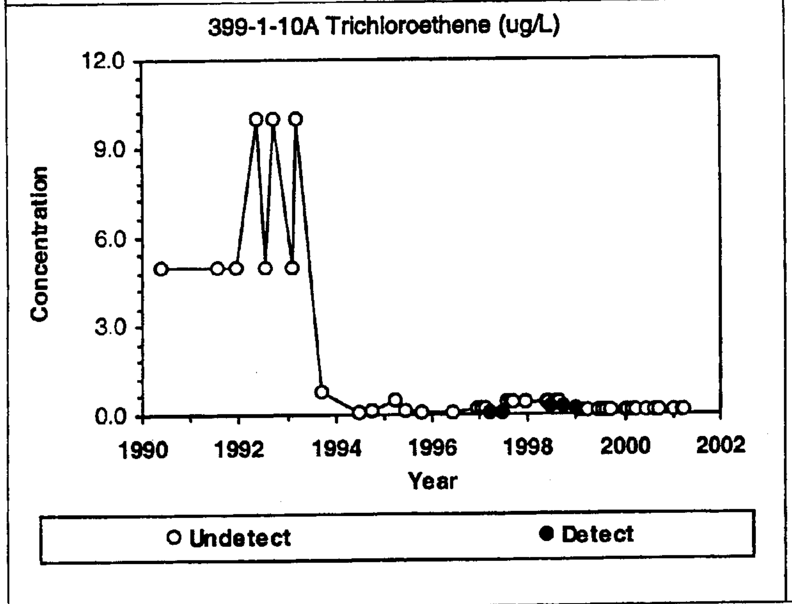

399-1-17B cis-1,2-Dichloroethylene (ug/L)

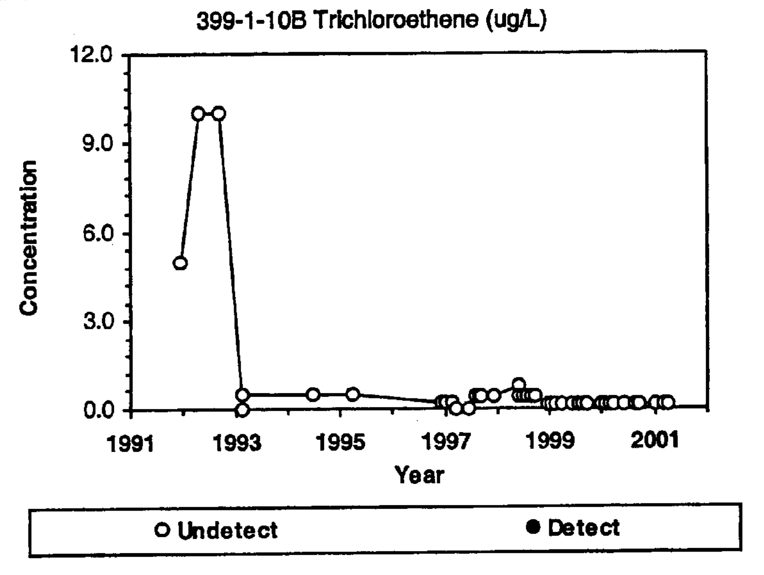

399-1-21A cis-1,2-Dichloroethylene (ug/L)
1.0
0.0
Concentration
1991
1993
1995
1997
1999
2001
Year
○ Undetect
● Detect

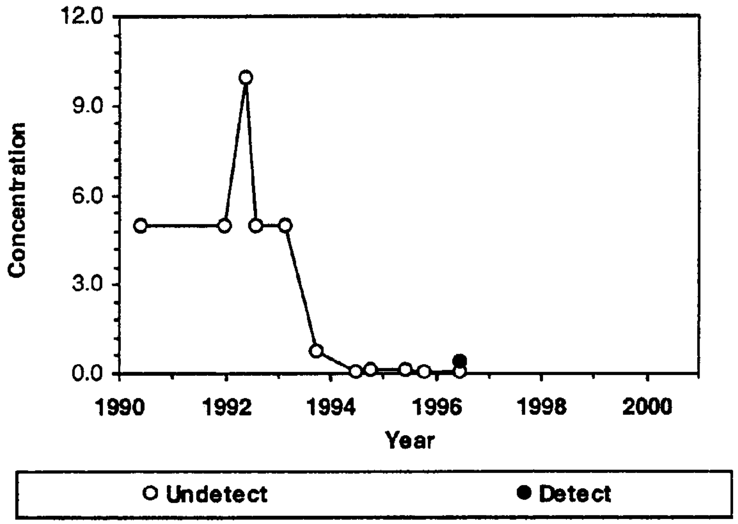

399-1-21B cis-1,2-Dichloroethylene (ug/L)
1.0
0.0
Concentration
1991
1992
1993
1994
1995
1996
1997
Year
○ Undetect
● Detect

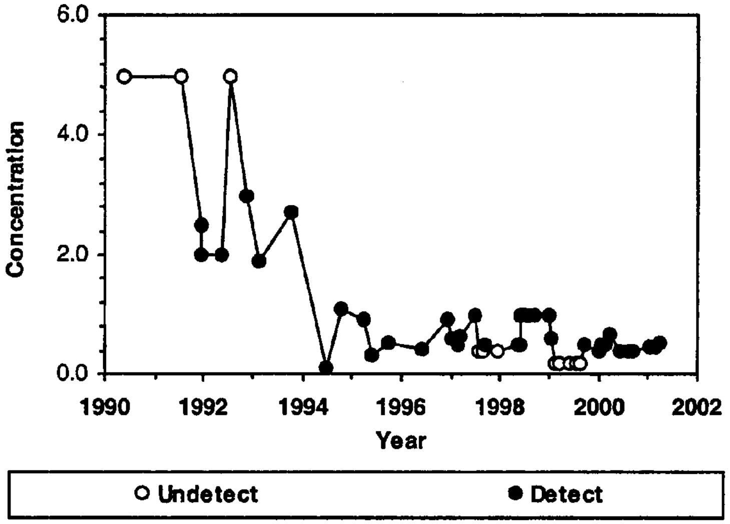

399-1-7 Trichloroethene (ug/L)

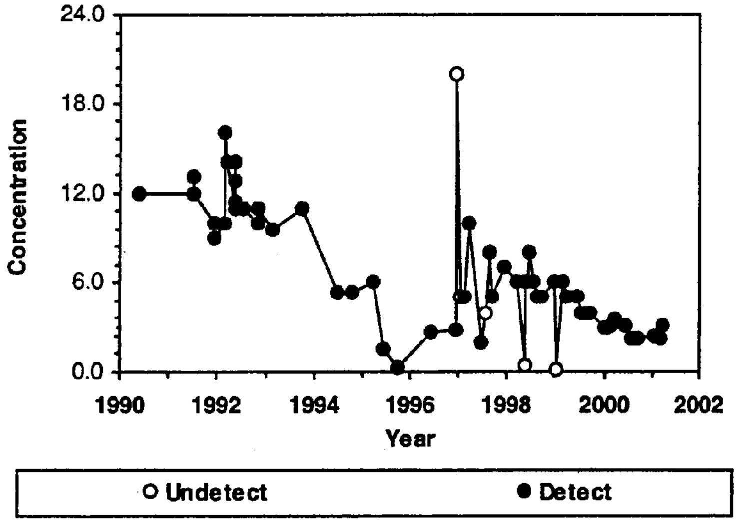

399-1-8 Trichloroethene (ug/L)

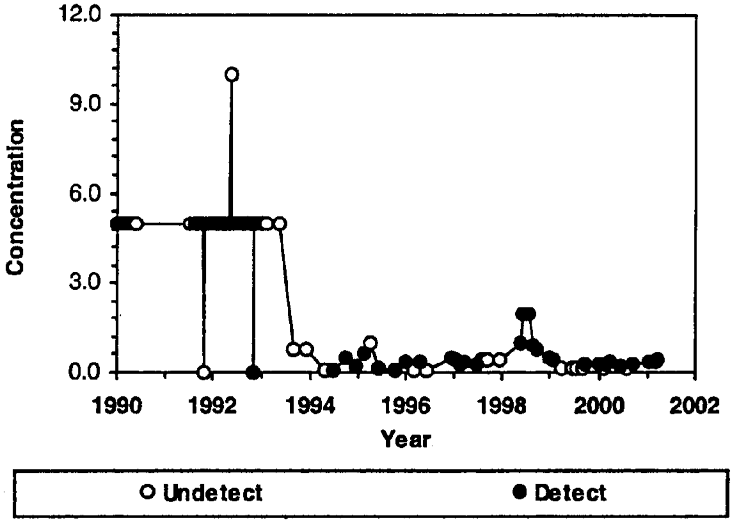

399-1-10A Trichloroethene (ug/L)

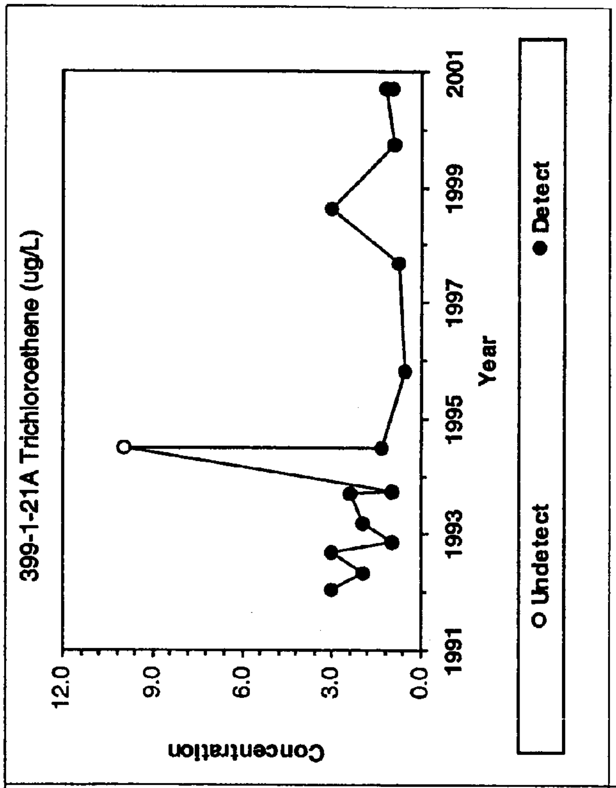

399-1-10B Trichloroethene (ug/L)

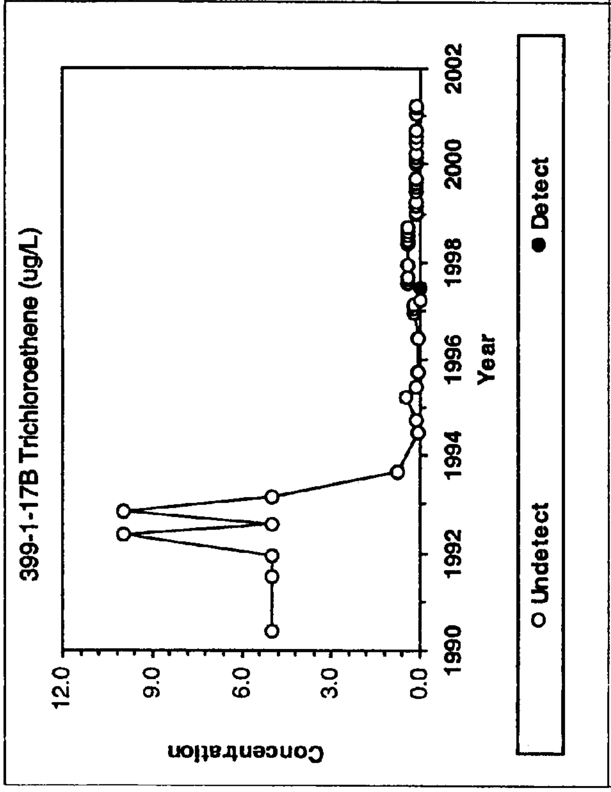

399-1-11 Trichloroethene (ug/L)

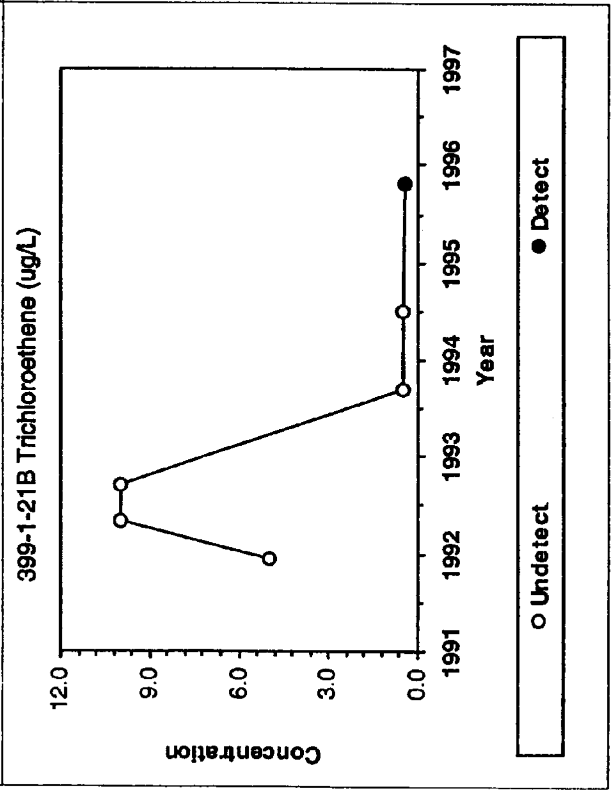

399-1-16A Trichloroethene (ug/L)

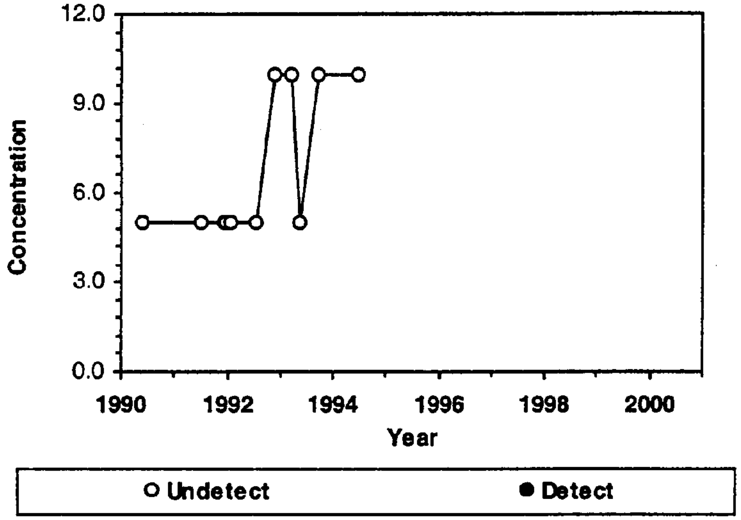

399-1-16B Trichloroethene (ug/L)

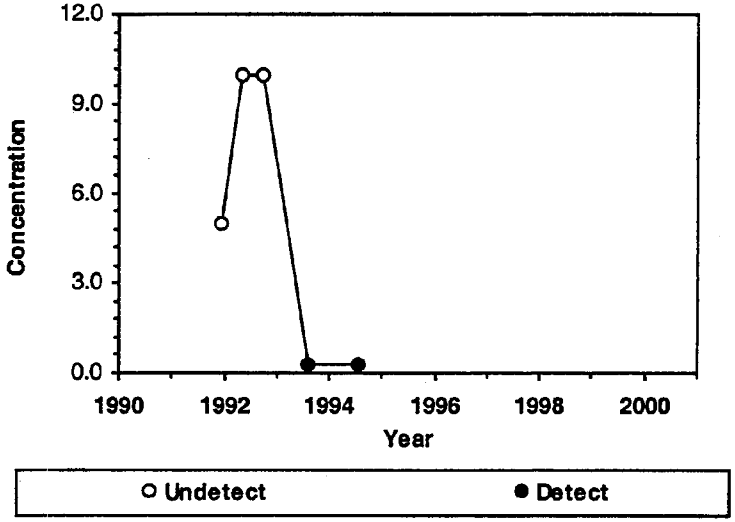

399-1-17A Trichloroethene (ug/L)

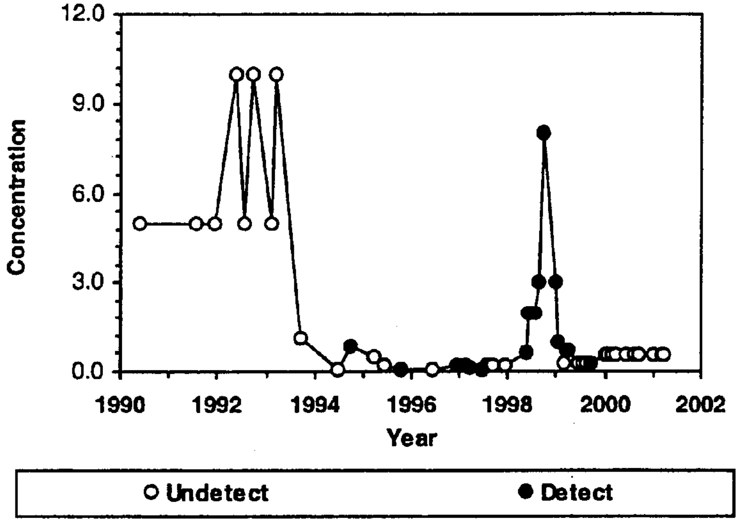

399-1-21A Trichloroethene (ug/L)
Concentration
12.0
9.0
6.0
3.0
0.0
1991
1993
1995
1997
1999
2001
Year
○ Undetect
● Detect

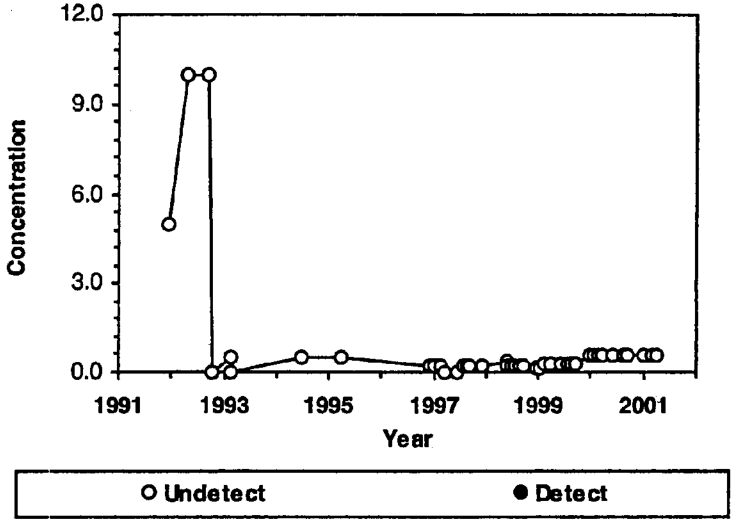

399-1-17B Trichloroethene (ug/L)
Concentration
12.0
9.0
6.0
3.0
0.0
1990
1992
1994
1996
1998
2000
2002
Year
○ Undetect
● Detect

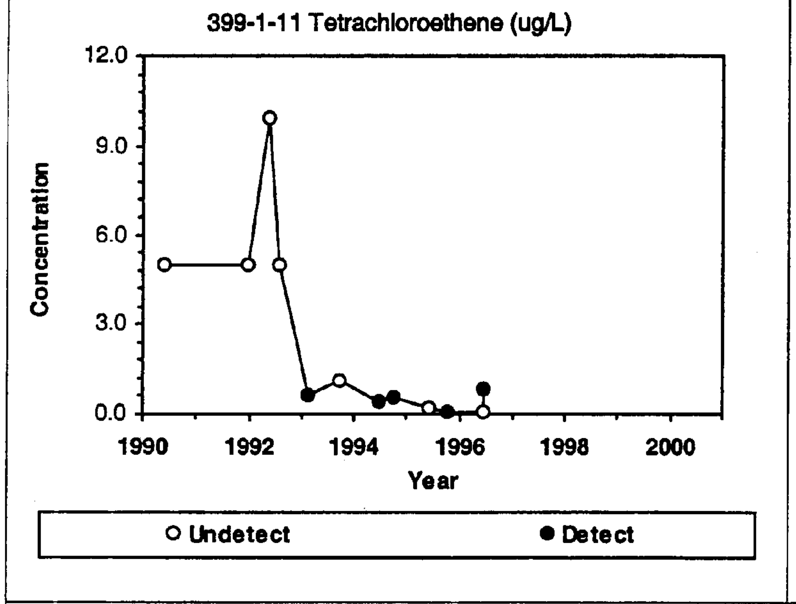

399-1-21B Trichloroethene (ug/L)
Concentration
12.0
9.0
6.0
3.0
0.0
1991
1992
1993
1994
1995
1996
1997
Year
○ Undetect
● Detect

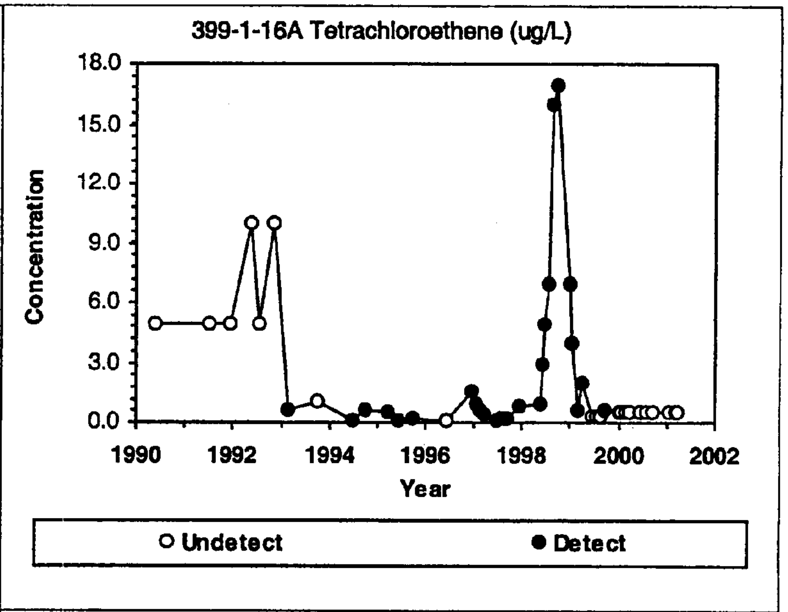

399-1-7 Tetrachloroethene (ug/L)

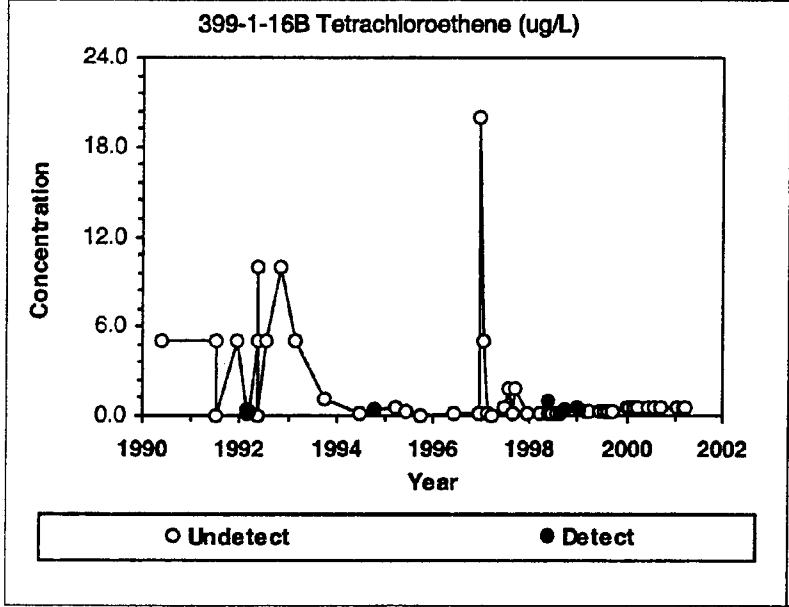

399-1-8 Tetrachloroethene (ug/L)

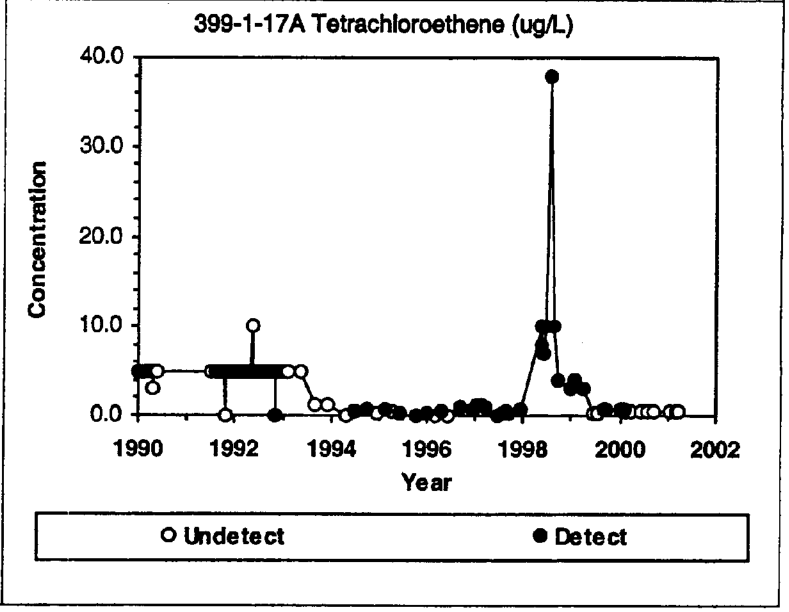

399-1-10A Tetrachloroethene (ug/L)

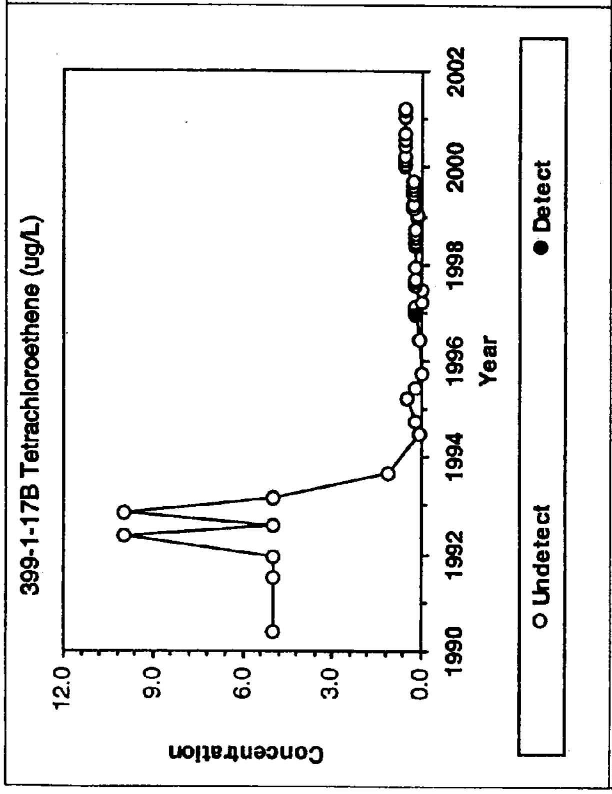

399-1-10B Tetrachloroethene (ug/L)

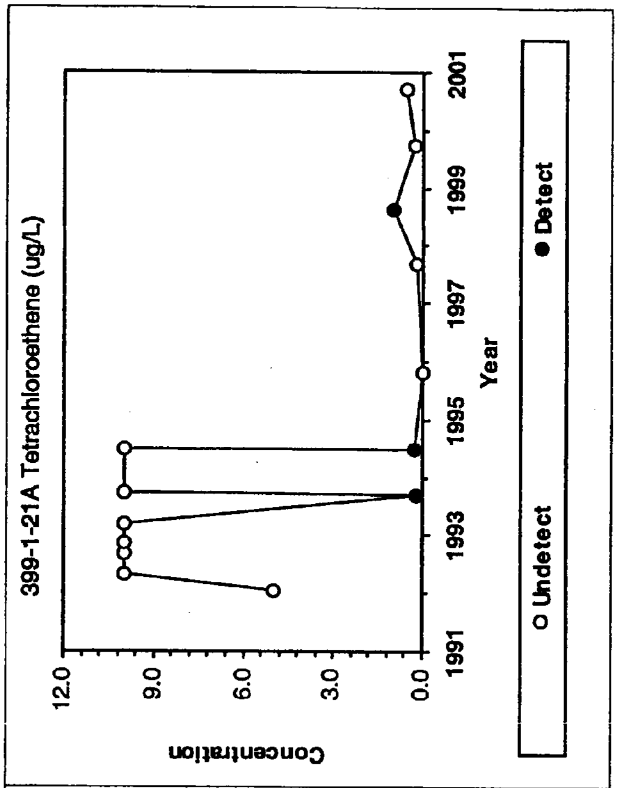

399-1-11 Tetrachloroethene (ug/L)

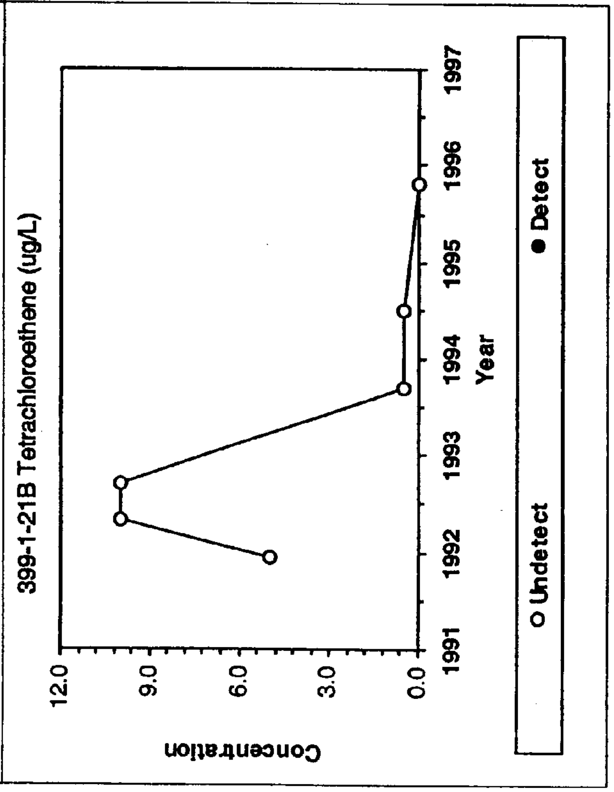

399-1-16A Tetrachloroethene (ug/L)


399-1-16B Tetrachloroethene (ug/L)


399-1-17A Tetrachloroethene (ug/L)


399-1-17B Tetrachloroethene (ug/L)


399-1-21A Tetrachloroethene (ug/L)


399-1-21B Tetrachloroethene (ug/L)

Appendix C

Well Construction Diagrams for Wells in the Proposed Monitoring Network

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Bigham
Drilling Company: Onwego Drilling
Date Started: 04Feb85

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: 0036
Company Location: Kennewick, WA
Date Complete: 25Feb85

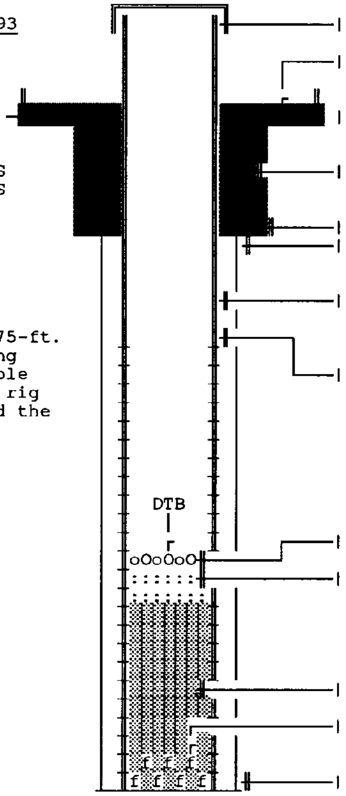
WELL NUMBER: 399-1-7
TEMPORARY WELL NO: 399-T-1
Hanford Coordinates: N/S S 23,597 E/W E 14,111
State RN 55,779.9 RE 15,716.5
State Coordinates: N Not documented E Not doc
Start Card #: Not documented T____ R____ S______
Elevation Ground surface: 382.8-ft Estimated

Depth to water: 37.0-ft Feb85
(Ground surface) 40.7-ft 17Dec93

GENERALIZED STRATIGRAPHY	Geologist's Log

0-5: BACKFILL (SAND, COBBLES, and BOULDERS
5-15: SAND, COBBLES and BOULDERS
15-20: SAND, PEBBLES and COBBLES
20-75: Sandy GRAVEL

Original hole was drilled to 75-ft. The screen was destroyed during installation. The original hole could not be reentered so the rig was moved 6-ft to the west and the hole redrilled to 75-ft. No documentation of grouting the original hole.



Elevation of reference point: [385.63-ft] (top of casing)

Height of reference point above ground surface [2.8-ft]

Depth of surface seal [15-ft]

Type of surface seal: 3-ft x 3-ft concrete pad

Cement grout to 15-ft

Hole diameter, 0-15-ft, 13-in nominal

15-75-ft, 9-in nominal

6-in ID 316 stainless steel casing, +2.8-25.0-ft

6-in T316 stainless steel screen, 25-75-ft, #15-slot

DTB=Depth to bottom, 54.4-ft, 17Jan92

Gravel, 54.4-57.5-ft

Bentonite pellets, 57.5-62.2-ft

Silica sand, 62.2-71.9-ft

Fill, 71.9-75.0-ft

Borehole drilled depth: [75-ft]

Drawing By: RKL/3-01-07.ASB
Date : 12Jan94
Reference : HANFORD WELLS
WHC-SD-EN-DP-071

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-7

WELL DESIGNATION : 399-1-7
RCRA FACILITY : 300 Area Process Trenches
CERCLA UNIT : 300-FF-5
HANFORD COORDINATES : S 23,597 E 14,111 [Hanford Wells]
Richland RN 55,779.9 RE 15,716.5 [24Apr87-300 Area]
LAMBERT COORDINATES : Not documented
DATE DRILLED : Feb85
DEPTH DRILLED (GS) : 75-ft
MEASURED DEPTH (GS : 54.4-ft, 17Jan92
DEPTH TO WATER (GS) : 37-ft, Feb85;
40.7-ft, 17Dec93
CASING DIAMETER : 6-in, stainless steel, +2.8-25-ft.
ELEV TOP CASING : 385.63-ft, [24Apr87-NGS]
ELEV GROUND SURFACE : 382.8-ft Estimated
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 25-75-ft, #15-slot, stainless steel
COMMENTS : FIELD INSPECTION, 19Oct90;
Stainless steel casing.
3-ft x 3-ft concrete pad,
2 posts (not removable),
capped and locked,
brass cap in pad with well ID.
Not in radiation zone.
OTHER: Original hole was drilled to 75-ft.
The screen was destroyed during installation.
The original hole could not be re-entered so the rig was moved 6 ft to the west and hole redrilled to 75-ft. No documentation of grouting the original hole. Surface seal to 12-ft. No documentation of annular seal.
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Depths referenced to ground surface:
11Dec90; DTB=72-ft, silty. DTW=39.3-ft, clean. Vadose/submerged casing clean. Screen 25.2-72-ft. Continous wrap with a small amount of algae buildup. Water clear. The well does not need cleaning.
DATE EVALUATED : Feb91
EVAL RECOMMENDATION : 1) Reduce monitored interval to 15-20 ft.
2) Survey to water level measurement standards.
LISTED USE : 300 Area monthly water level measurement 23Aug85-22Nov93;
CURRENT USER : WHC ES&M RCRA sampling and w/l monitoring, ER CERCLA sampling and W/l monitoring; PNL sitewide sampling and w/l monitoring 93
PUMP TYPE : Hydrostar,
MAINTENANCE : Maintenance activities documented in the Hanford Wells Database System
REHABILITATION : 22Jul91; Reduced monitored interval: (Depths TOC).
15-gal silica sand, 65.0-74.7-ft;
5-gals bentonite pellets, 60.3-65.0-ft;
5-gal gravel, 57.2-60.3-ft.
02Aug91; Developed to <5 NTU.

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: L. Bultena
Drilling Company: Onwego Drilling
Date Started: 22Jul85

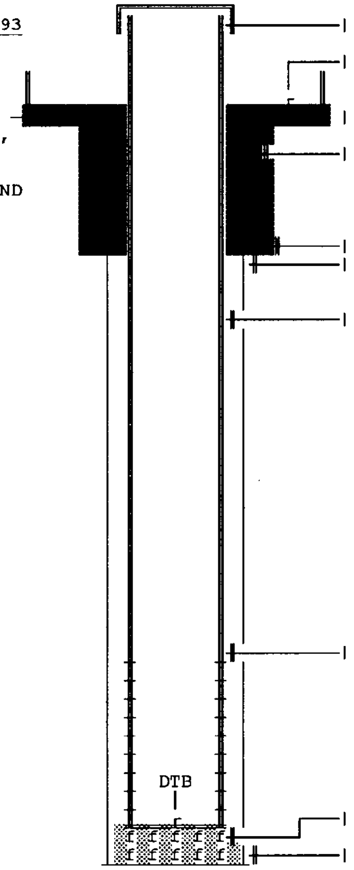
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Kennewick, WA
Date Complete: 08Aug85

WELL NUMBER: 399-1-8
TEMPORARY WELL NO: 399-T-2
Hanford Coordinates: N/S S 23,615 E/W E 14,103
State Coordinates: N Not documented RN 55,762.1 E Not doc RE 15,708.5
Start Card #: Not documented T____ R____ S_______
Elevation Ground surface: 383.3-ft Estimated

Depth to water: ~40.0-ft Aug85
(Ground surface) 41.2-ft 17Dec93

GENERALIZED STRATIGRAPHY Geologist's Log

0-5: BACKFILL (COBBLES and SAND, some small BOULDERS)
5-15: COBBLES and SAND
15-20: BOULDERS, COBBLES and SAND
20-21: COBBLES and SAND
21-23: Gravelly SAND
23-25: SILT lenses mixed with broken GRAVEL
25-75: Sandy GRAVEL
75-85: SAND, coarse
85-90: SAND, granular
90-105: Sandy GRAVEL
105-106: Silty SAND with GRAVEL
106-108: Clayey SAND



Elevation of reference point: [384.91-ft]
(top of casing)

Height of reference point above ground surface [1.6-ft]

Depth of surface seal [18-ft]

Type of surface seal:
Cement/5% bentonite grout to 18-ft with 4-ft x 4-ft concrete pad

Hole diameter,
0-18-ft, 13-in nominal
18-107-ft, 9-in nominal

6-in ID stainless steel casing, +1.6-85.0-ft

DTB=Depth to bottom, 105.3-ft, 14Dec90

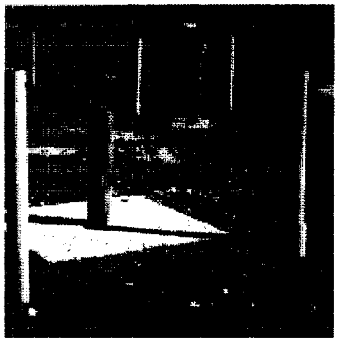
6-in stainless steel screen, 85-105-ft, #25-slot

Fill, 105-107-ft

Borehole drilled depth: [107-ft]

Drawing By: RKL/3-01-08.ASB
Date : 12Jan94
Reference : HANFORD WELLS WHC-SD-EN-DP-071

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-8



WELL DESIGNATION : 399-1-8
RCRA FACILITY : 300 Area Process Trenches
CERCLA UNIT : 300-FF-5
HANFORD COORDINATES : S 23,615 E 14,103 [Hanford Wells]
Richland RN 55,762.1 RE 15,708.5 [24Apr87-300
Area]
LAMBERT COORDINATES : Not documented
DATE DRILLED : Aug85
DEPTH DRILLED (GS) : 107-ft
MEASURED DEPTH (GS) : 105.3-ft, 14Dec90
DEPTH TO WATER (GS) : ~40-ft, Aug85;
41.2-ft, 17Dec93
CASING DIAMETER : 6-in, stainless steel, +1.6-85-ft.
ELEV TOP CASING : 384.91-ft, [24Apr87-NGS]
ELEV GROUND SURFACE : 383.3-ft, Estimated
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 85-105-ft, #25-slot, stainless steel
COMMENTS : FIELD INSPECTION, 19Oct90;
Stainless steel casing.
4-ft by 4-ft concrete pad,
2 posts (fixed), capped and locked,
brass cap in pad with well ID.
Not in radiation zone.
OTHER;
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Depths referenced to ground surface;
11Dec90; DTB=105-ft, silty. DTW=39.7-ft, appearance good.
Vadose/submerged casing clean. Screen 85-105-ft, continous wrap. Small amount of algae near bottom of screen. Water clear. The well doesn't need to be cleaned.
DATE EVALUATED : Feb91
EVAL RECOMMENDATION : 1) Survey to water level measurement standards.
LISTED USE : 300 Area monthly water level measurement 29Oct85-22Nov93;
CURRENT USER : WHC ES&M and ER w/l monitoring,
PNL sitewide sampling and w/l monitoring 93
PUMP TYPE : Hydrostar
MAINTENANCE : Maintenance activities documented in the Hanford Wells Database System

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 300 Area Water Supply
Driller's Name: Cordon
Drilling Company: Associated Drillers
Date Started: 13Nov86

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: 0079
Company Location:
Date Complete: 22Nov86

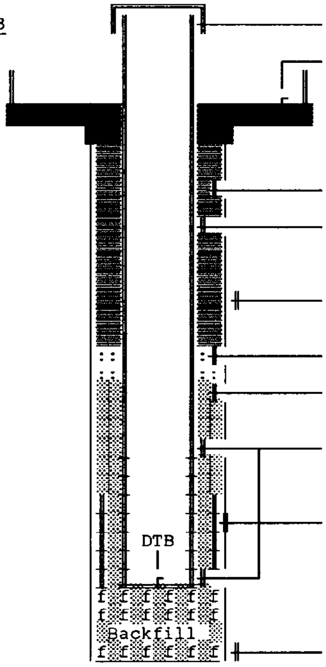
WELL NUMBER: 399-1-10A
TEMPORARY WELL NO: S-3
Hanford Coordinates: N/S S 22,293 E/W E 14,413
State Coordinates: N Not documented RN 57,083.8 E Not doc RE 16,018.6
Start Card #: Not documented T____ R____ S____
Elevation Ground surface: 371.94-ft Brass cap

Depth to water: 29.0-ft Nov86
(Ground surface) 29.4-ft 17Dec93

GENERALIZED STRATIGRAPHY

Geologist's Log

0-10: Coarse to medium SAND
10-20: Sandy GRAVEL
20-30: Silty, sandy GRAVEL
30-35: Silty, sandy PEBBLES



Elevation of reference point: [373.65-ft]
(top of casing)

Height of reference point above [1.71-ft]
ground surface

Depth of surface seal [0-13.5-ft]
Type of surface seal:
Portland cement 4-ft x 4-ft x 6-in(nom)
extending 3-ft into annulus.

Bentonite crumbles to 13.5-ft

6-in ID stainless steel casing,
+1.7-24.5-ft

Hole diameter,
0-45.0-ft, 11-in nominal

Volclay bentonite pellets,
13.5-18.5-ft

Silica sand pack,
18.5--39.5-ft, 8-12-mesh

6-in stainless steel screen
24.5-39.5-ft, #40-slot

10-in telescoping screen,
29.5-39.5-ft

DTB=Depth to bottom,
39.1-ft, 12Feb92

Borehole drilled depth: [45.0-ft]

Drawing By: RKL/3-01-10A.ASB
Date : 12Jan94
Reference : HANFORD WELLS
WHC-SD-EN-DP-071

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-10A

```
WELL DESIGNATION     :    399-1-10A
RCRA FACILITY        :    300 Area Process Trenches
CERCLA UNIT          :    300-FF-5
HANFORD COORDINATES :     S  22,293   E  14,413    [Hanford
Wells]
         Richland         RN 57,083.8 RE 16,018.6 [24Apr87-300
Area]
LAMBERT COORDINATES :     Not documented
DATE DRILLED         :    Nov86
DEPTH DRILLED (GS)   :    45-ft
MEASURED DEPTH (GS) :     39.1-ft, 12Feb92
DEPTH TO WATER (GS) :     29.0-ft, Nov86;
                          29.4-ft, 17Dec93
CASING DIAMETER      :    6-in, stainless steel, +1.71-24.5-
ft.
ELEV TOP CASING      :    373.65-ft,           [24Apr87-NGS]
ELEV GROUND SURFACE :     371.94-ft, Brass cap [24Apr87-NGS]
PERFORATED INTERVAL :     Not applicable
SCREENED INTERVAL    :    24.5-39.5-ft
COMMENTS             :    FIELD INSPECTION, 31Oct89;
                          Stainless steel casing.
                          4-ft by 4-ft concrete pad,
                          4 posts, 1 removable capped and locked,
                          brass cap in pad with well ID. Not in radiation zone.
                          OTHER;
AVAILABLE LOGS       :    Geologist
TV SCAN COMMENTS     :    Depths referenced to ground surface;
                          12Feb92; DTB=38.7-ft, gravelly. DTW=30.2-ft, clear.
                          Vadose casing no corrosion/scale/rust. Submerged casing not applicable.
                          Screen 23.6-ft-not determined.  Slots open. Well does not need to be cleaned.
DATE EVALUATED       :    Not applicable
EVAL RECOMMENDATION :     Not applicable
LISTED USE           :    300 Area monthly water level measurement 29Dec86-22Nov93;
CURRENT USER         :    WHC ES&M w/l monitoring and RCRA sampling, ER w/l monitoring and sampling
                          PNL sitewide sampling and w/l monitoring 93
PUMP TYPE            :    Hydrostar
MAINTENANCE          :    Maintenance activities documented in the Hanford Wells Database System
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WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Raw water
Driller's Name: D Rossman
Drilling Company: Kaiser Engineers
Date Started: 06Sep91

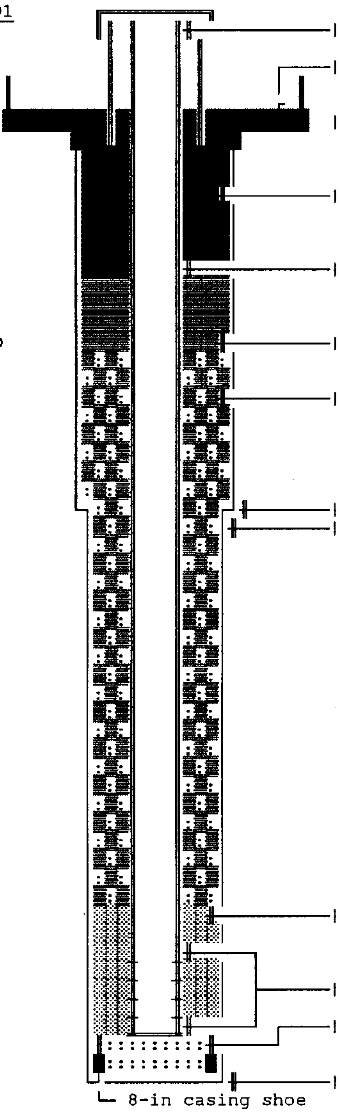
Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 08Oct91

WELL NUMBER: 399-1-10B
TEMPORARY WELL NO: 1-10B
Hanford Coordinates: N/S Not documented E/W Not doc
State NAD83 RN 57,067.3 RE 16,033.3
Coordinates: N 116,729.06m E 594,351.09m
Start Card #: Not documented T____ R____ S____
Elevation Ground surface: 372.47-ft Brass cap

Depth to water: 37.7-ft 08Oct91
(Ground surface)

GENERALIZED STRATIGRAPHY | Geologist's Log

0-8: SAND
8-10: Silty SAND
10-35: Gravelly silty SAND
35-39.4: Sandy GRAVEL
39.4-49.6: Gravelly SAND
49.6-54.7: Sandy GRAVEL
54.7-72: Gravelly SAND
72-73: SILT
73-79.8: Gravelly SAND
79.8-80.1: Gravelly SILT
80.1-98: Gravelly SAND
98-109.8: Slightly gravelly SAND
109.8-113: Gravelly SAND
113-119: SILT



Elevation of reference point: [375.58-ft]
(top of inner casing)

Height of reference point above [3.11-ft]
ground surface

Depth of surface seal [0-20.3-ft]
Type of surface seal:
4-ft x 4-ft concrete surface pad
extends 2.5-ft into annulus
Portland cement grout
to 20.3-ft

4-in ID T304 stainless steel casing,
+1.5-104.5-ft

Bentonite crumbles,
20.3-28.2-ft

Bentonite slurry,
28.2-99.0-ft

Hole diameter,
0-53.0-ft, 10.95-in
53.0-119.0-ft, 8.8-in

Silica sand pack,
99.0-100.8-ft, 40-100-mesh
100.8-114.4-ft, 20-40-mesh

4-in T304 stainless steel screen,
104.5-114.5-ft, #10-slot

Bentonite hole plug,
115.3-119.0-ft

Borehole drilled depth: [119.0-ft]

8-in casing shoe
cut off and left in hole, ~117.0-119.0-ft

Drawing By: RKL/3-01-10B.ASB
Date : 31Jan94
Reference : HANFORD WELLS
WHC-SD-EN-TI-052

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-10B

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WELL DESIGNATION     :   399-1-10B
RCRA FACILITY        :   Not applicable
CERCLA UNIT          :   300-FF-5
HANFORD COORDINATES  :   Not documented
                         RN 57,067.3    RE 16,033.0   [08Jan92-300A]
LAMBERT COORDINATES  :   N 116,729.06m  E 594,351.09M [08Jan92-NAD83]
DATE DRILLED         :   Oct91
DEPTH DRILLED (GS)   :   119.0-ft
MEASURED DEPTH (GS)  :   Not documented
DEPTH TO WATER (GS)  :   37.7-ft, 08Oct91
CASING DIAMETER      :   4-in, stainless steel, +3.11-104.5-ft;
                         6-in, stainless stee, ~3.1-0.5-ft
ELEV TOP CASING      :   375.58-ft,           [08Jan92-NGVD'29]
ELEV GROUND SURFACE  :   372.47-ft, Brass cap [08Jan92-NGVD'29]
PERFORATED INTERVAL  :   Not applicable
SCREENED INTERVAL    :   104.5-114.5-ft, #10-slot, T304 stainless steel
COMMENTS             :   FIELD INSPECTION, 07Aug92
                         6-in stainless steel casing.
                         4-ft square concrete pad,
                         4 posts, capped, locked and labeled.
                         Not in radiation zone.
                         OTHER:
AVAILABLE LOGS       :   Geologist
TV SCAN COMMENTS     :   Not documented
DATE EVALUATED       :   Not applicable
EVAL RECOMMENDATION  :   1) Survey to water level measurement standards.
LISTED USE           :   Not documented
CURRENT USER         :   WHC ER w/l monitoring,
                         PNL sitewide sampling
PUMP TYPE            :   Hydrostar
MAINTENANCE          :   Maintenance activities documented in the Hanford Wells Database System
```

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 300 Area Water Supply
Driller's Name: Cordon
Drilling Company: Associated Drillers
Date Started: 17Nov86

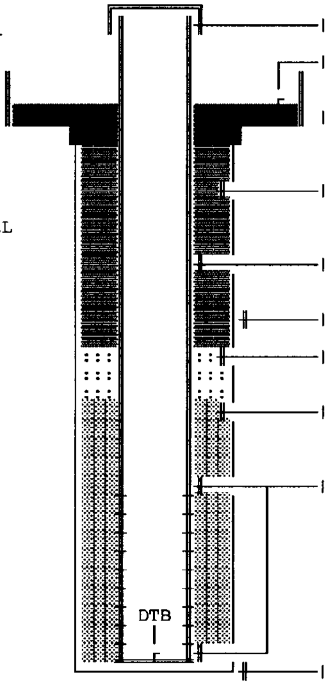
Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: 0079
Company Location:
Date Complete: 20Nov86

WELL NUMBER: 399-1-11
TEMPORARY WELL NO: S-4
Hanford Coordinates: N/S S 22,523 E/W E 13,635
State RN 56,853.7 RE 15,240.6
Coordinates: N Not documented E Not doc
Start Card #: Not documented T____ R____ S______
Elevation Ground surface: 376.18-ft Brass cap

Depth to water: 32.3-ft Nov86
(Ground surface) 33.8-ft 17Dec93

GENERALIZED STRATIGRAPHY
Geologist's Log

0-5: Sandy GRAVEL
5-10: SAND
10-30: Sandy GRAVEL
30-40: SAND
40-45: Silty, sandy GRAVEL
45-TD: Silty, clayey, sandy GRAVEL



Elevation of reference point: [377.79-ft]
(top of casing)
Height of reference point above ground surface [1.61-ft]

Depth of surface seal [0-15.0-ft]
Type of surface seal:
4.3-ft x 4.3-ft Portland cement pad extending 3.0-ft into annulus

Bentonite crumbles,
3.0-15.0-ft

6-in ID stainless steel casing,
+1.6-25.6-ft

Hole diameter,
0-47.3-ft, 11-in nominal

Volclay bentonite pellets,
15.0-19.5-ft

Silica sand pack,
19.5-33.0-ft, 10-20-mesh
33.0-47.0-ft, 8-12-mesh

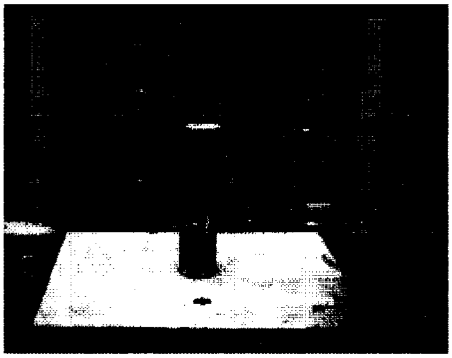
6-in stainless steel screen,
25.6-36.4-ft, #20-slot
36.4-46.8-ft, #40-slot

DTB=Depth to bottom,
47.8-ft, 22May92

Borehole drilled depth: [47.3-ft]

Drawing By: RKL/3-01-11.ASB
Date : 12Jan94
Reference : HANFORD WELLS
WHC-SD-EN-DP-071

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-11



WELL DESIGNATION : 399-1-11
RCRA FACILITY : 300 Area Process Trenches
CERCLA UNIT : 300-FF-5
HANFORD COORDINATES : S 22,523 E 13,635 [Hanford Wells]
Richland RN 56,853.7 RE 15,240.6 [24Apr87-300A]
LAMBERT COORDINATES : Not documented
DATE DRILLED : Nov86
DEPTH DRILLED (GS) : 47.3-ft
MEASURED DEPTH (GS) : 47.8-ft, 22May92
DEPTH TO WATER (GS) : 32.3-ft, Nov86;
33.8-ft, 17Dec93
CASING DIAMETER : 6-in, stainless steel, +1.61-25.6-ft.
ELEV TOP CASING : 377.79-ft, [24Apr87-NGS]
ELEV GROUND SURFACE : 376.18-ft, Brass cap [24Apr87-NGS]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 25.6-46.8-ft
COMMENTS : FIELD INSPECTION, 03Nov89;
Stainless steel casing.
4-ft by 4-ft concrete pad,
4 posts, 1 removable
capped and locked, brass cap in pad with well ID.
Located in surface radiation zone.
OTHER;
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Depths referenced to ground surface
21May92; DTB=47.6-ft. DTW=31.8-ft, surface good.
Vadose and submerged casing clean. Water clear.
Screen 26.6-47.6-ft. Well casing and screen look good.
DATE EVALUATED : Not applicable
EVAL RECOMMENDATION : Not applicable
LISTED USE : 300 Area monthly water level measurement Feb87-22Nov93,
CURRENT USER : WHC ER and ES&M w/l monitoring and RCRA sampling,
PNL sitewide sampling and w/l monitoring 93
PUMP TYPE : Hydrostar
MAINTENANCE : Maintenance activities documented in the Hanford Wells Database System

WELL CONSTRUCTION AND COMPLETION SUMMARY

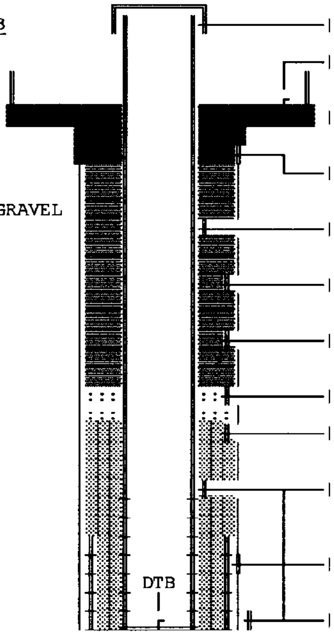
Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 399-1-16A / TEMPORARY WELL NO: C-1A
Drilling Fluid Used: 300 Area Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S S 23,341 E/W E 14,304
Driller's Name: Amos	WA State Lic Nr: 1224	State Coordinates: N RN 56,035.6 E RE 15,910.1
Drilling Company: Associated Drillers	Company Location:	Start Card #: Not documented T____ R____ S______ Coordinates: N Not documented E Not documented
Date Started: 01Dec86	Date Complete: 04Dec86	Elevation Ground surface: 380.21-ft Brass cap

Depth to water: 40.0-ft Dec86
(Ground surface) 38.1-ft 17Dec93

GENERALIZED STRATIGRAPHY

Geologist's Log

0-15: Silty, sandy GRAVEL
15-20: Clayey, sandy GRAVEL
20-30: Silty, sandy GRAVEL
30-35: Silty, gravelly SAND
35-45: Silty SAND with CLAY and GRAVEL
45-TD: Silty, gravelly SAND



Elevation of reference point: [381.51-ft]
(top of casing)

Height of reference point above [1.30-ft]
ground surface

Depth of surface seal [0-5.0-ft]

Type of surface seal:
4-ft x 4-ft concrete surface pad
Cement to 5.0-ft

6-in ID stainless steel casing,
+1.3-32.5-ft

Bentonite crumbles,
5.0-21.0-ft

Hole diameter,
0-47.5-ft. 11-in nominal

Bentonite pellets,
21.0-24.8-ft

Silica sand pack,
24.8-47.5-ft, 10-20-mesh

6-in stainless steel screen,
32.5-47.5-ft, #20-slot

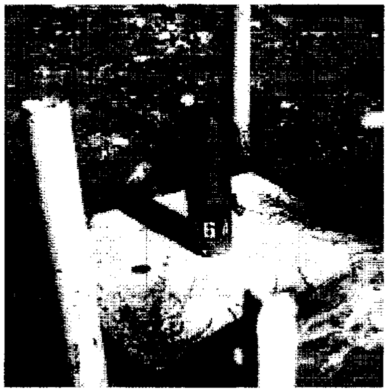
10-in telescoping screen,
37.5-47.5-ft, #40-slot

Borehole drilled depth: [47.5-ft]

DTB=Depth to bottom,
47.8-ft, 04Dec90

Drawing By: RKL/3-01-16A.ASB
Date : 12Jan94
Reference : HANFORD WELLS
WHC-SD-EN-DP-071

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-16A



WELL DESIGNATION : 399-1-16A
RCRA FACILITY : 300 Area Process Trenches
CERCLA UNIT : 300-FF-5
HANFORD COORDINATES : S 23,341 E 14,304 [Hanford Wells]
RN 56,035.6 RE 15,910.1 [24Apr87-300 A]
LAMBERT COORDINATES : Not documented
DATE DRILLED : Dec86
DEPTH DRILLED (GS) : 47.5-ft
MEASURED DEPTH (GS) : 47.8-ft, 04Dec90
DEPTH TO WATER (GS) : 40-ft, Dec86;
38.1-ft, 17Dec93
CASING DIAMETER : 6-in, stainless steel, +1.30-32.5-ft.
ELEV TOP CASING : 381.51-ft, [24Apr87-NGS]
ELEV GROUND SURFACE : 380.21-ft, Brass cap [24Apr87-NGS]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 32.5-47.5-ft, #40-slot, stainless steel
COMMENTS : FIELD INSPECTION, 19Oct90;
Stainless steel casing.
4-ft square concrete pad,
4 posts, capped, locked and labeled.
Not in radiation zone.
OTHER;
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Depths referenced to ground surface;
16Nov90; DTB=47.2-ft, silty looking. DTW=36.4-ft, clean, no floating debris.
Vadose casing clean. Screen 31.5-47.25-ft, continous wrap, looks real good. Water clear.
DATE EVALUATED : Feb91
EVAL RECOMMENDATION : 1) Survey to water level measurement standards.
LISTED USE : 300 Area monthly water level measurement Feb87-22Nov93,
CURRENT USER : WHC ES&M RCRA sampling and w/l monitoring, ER CERCLA sampling and w/l monitoring, PNL sitewide sampling and w/l monitoring 93
PUMP TYPE : Hydrostar
MAINTENANCE : Maintenance activities documented in the Hanford Wells Database System

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 300 Area Water Supply
Driller's Name: Cordon/Amos
Drilling Company: Associated Drillers
Date Started: 29Jan87

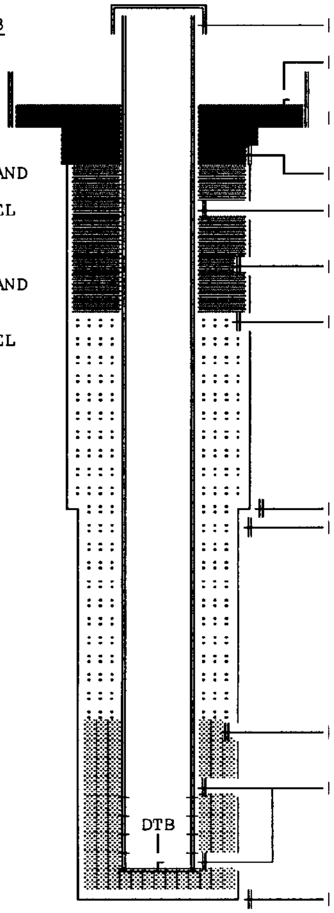
Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: 1517/1224
Company Location: ________
Date Complete: 10Feb87

WELL NUMBER: 399-1-16B
TEMPORARY WELL NO: C-1D
Hanford Coordinates: N/S S 23,350 E/W E 14,326
RN 56,026.9 RE 15,931.6
State Coordinates: N Not documented E Not doc
Start Card #: Not documented T____ R____ S______
Elevation Ground surface: 380.03-ft Brass cap

Depth to water: 37.5-ft Feb87
(Ground surface) 37.8-ft 17Dec93

GENERALIZED Geologist's
STRATIGRAPHY Log

0-10: Sandy GRAVEL
10-35: Silty, sandy GRAVEL
35-45: Gravelly, silty, clayey SAND
45-60: Silty, sandy GRAVEL
60-65: Clayey, silty, sandy GRAVEL
65-75: Silty, gravelly SAND
75-80: Silty, sandy GRAVEL
80-85: Clayey, sandy GRAVEL
85-90: Gravelly, silty, clayey SAND
90-95: Sandy GRAVEL
95-110: Silty, sandy GRAVEL
110-TD: Clayey, silty sandy GRAVEL



Elevation of reference point: [381.14-ft]
(top of casing)
Height of reference point above [1.11-ft]
ground surface

Depth of surface seal [0-5.0-ft]
Type of surface seal:
4-ft x 4-ft surface pad
Cement to 5.0-ft

6-in ID stainless steel casing,
+1.1-105.0-ft

Bentonite crumbles,
5.0-26.0-ft

Volclay tablets,
26.0-99.7-ft

Hole diameter,
0-60.0-ft, 13-in nominal
60.0-118.0-ft, 11-in nominal

Silica sand pack,
99.7-118.0-ft, 8-12-mesh

6-in stainless steel screen,
105.0-115.0-ft, #20-slot

Borehole drilled depth: [118.0-ft]

DTB=Depth to bottom,
115.5-ft, 03Dec90

Drawing By: RKL/3-01-16B.ASB
Date : 12Jan94
Reference : HANFORD WELLS
WHC-SD-EN-DP-071

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-16B

WELL DESIGNATION : 399-1-16B
RCRA FACILITY : 300 Area Process Trenches
CERCLA UNIT : 300-FF-5
HANFORD COORDINATES : S 23,350 E 14,326 [Hanford Wells]
Richland RN 56,026.9 RE 15,931.6 [24Apr87-300 A]
LAMBERT COORDINATES : Not documented
DATE DRILLED : Feb87
DEPTH DRILLED (GS) : 118-ft
MEASURED DEPTH (GS) : 115.5-ft, 03Dec90
DEPTH TO WATER (GS) : 37.5-ft, Feb87;
37.8-ft, 17Dec93
CASING DIAMETER : 6-in, stainless steel, +1.11-105 ft.
ELEV TOP CASING : 381.14-ft, [24Apr87-NGS]
ELEV GROUND SURFACE : 380.03-ft, Brass cap [24Apr87-NGS]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 105-115-ft, #20-slot, stainless steel
COMMENTS : FIELD INSPECTION, 19Oct90;
Stainless steel casing.
4-ft square concrete pad,
4 posts, capped, locked and labeled.
Not in radiation zone.
OTHER;
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Depths referenced to ground surface:
16Nov90; DTB=114.5-ft, silty and looked like a small weed on bottom. DTW=36.4-ft, clean, no floating debris. Vadose/submerged casing clean. Screen 104-114.5-ft, continous wrap, clean except for spot near the bottom. Water clear.
DATE EVALUATED : Feb91
EVAL RECOMMENDATION : 1) Survey to water level measurement standards.
LISTED USE : 300 Area monthly water level measurement Feb87-22Nov93,
CURRENT USER : WHC ES&M RCRA sampling and w/l monitoring, ER CERCLA sampling and w/l monitoring
PNL sitewide sampling 93
PUMP TYPE : Hydrostar
MAINTENANCE : Maintenance activities documented in the Hanford Wells Database System

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 300 Area Water Supply
Driller's Name: Cordon
Drilling Company: Associated Drillers
Date Started: 08Nov86

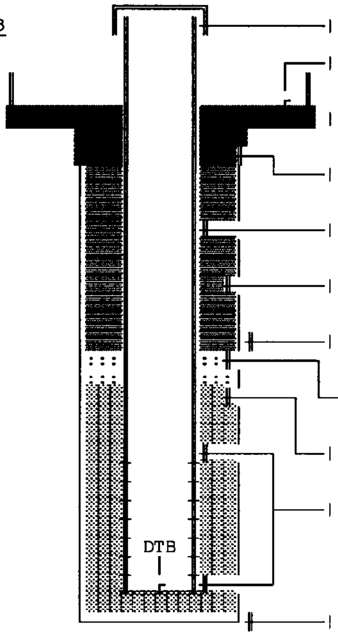
Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: 0079
Company Location:
Date Complete: 13Nov86

WELL NUMBER: 399-1-17A
TEMPORARY WELL NO: C-2A
Hanford Coordinates: N/S S 23,331 E/W E 13,630
State RN 56,045.7 RE 15,236.2
Coordinates: N Not documented E Not doc
Start Card #: Not documented T R S
Elevation Ground surface: 375.13-ft Brass cap

Depth to water: 32.3-ft Nov86
(Ground surface) 33.2-ft 17Dec93

GENERALIZED STRATIGRAPHY
Geologist's Log

0-10: Sandy GRAVEL
10-25: Silty, sandy GRAVEL
25-35: Silty, gravelly SAND
35-40: Silty SAND



Elevation of reference point: (top of casing) [377.47-ft]

Height of reference point above ground surface [2.3-ft]

Depth of surface seal [0-5.0-ft]

Type of surface seal:
4-ft x 4-ft concrete pad.
Cement to 5.0-ft

6-in ID stainless steel casing,
5.0-25.0-ft

Bentonite crumbles,
5.0-19.4-ft

Hole diameter,
0-41.0-ft, 11-in nominal

Volclay bentonite pellets,
19.4-21.6-ft

Silica sand pack,
21.6-41.0-ft

6-in stainless steel screen,
25.0-40.0-ft, #40-slot

Borehole drilled depth: [41.0-ft]

DTB=Depth to bottom,
41.5-ft, 03Dec90

Drawing By: RKL/3-01-17A.ASB
Date : 12Jan94
Reference : HANFORD WELLS
WHC-SD-EN-DP-071

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-17A

WELL DESIGNATION : 399-1-17A
RCRA FACILITY : 300 Area Process Trenches
CERCLA UNIT : 300-FF-5
HANFORD COORDINATES : S 23,331 E 13,630 [Hanford Wells]
Richland RN 56,045.7 RE 15,236.2 [24Apr87-300 A]
LAMBERT COORDINATES : Not documented
DATE DRILLED : Nov86
DEPTH DRILLED (GS) : 41-ft
MEASURED DEPTH (GS) : 41.5-ft, 03Dec90
DEPTH TO WATER (GS) : 32-ft, Nov86;
33.2-ft, 22Nov93
CASING DIAMETER : 6-in, stainless steel, +2.34-25-ft.
ELEV TOP CASING : 377.47-ft, [24Apr87-NGS]
ELEV GROUND SURFACE : 375.13-ft, Brass cap [24Apr87-NGS]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 25-40-ft, #40-slot, stainless steel
COMMENTS : FIELD INSPECTION, 19Oct90;
Stainless steel casing.
4-ft square concrete pad,
4 posts, capped, locked and labeled.
Not in radiation zone.
OTHER;
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Depths referenced to ground surface;
16Nov90; DTB=42.3-ft, silty. There was a small rock on the bottom.
DTW=33.1-ft, clean, no floating debris. Vadose/submerged casing clean.
Screen 26.9-42.3-ft, continous wrap, good shape and clean.
Water clear, some suspended debris.
DATE EVALUATED : Feb91
EVAL RECOMMENDATION : 1) Survey to water level measurement standards.
LISTED USE : 300 Area monthly water level measurement Dec86-22Nov93,
CURRENT USER : WHC ES&M RCRA sampling and w/l monitoring, ER w/l monitoring
PNL sitewide sampling and w/l monitoring 93
PUMP TYPE : Hydrostar, intake at 39.4-ft (TOC)
MAINTENANCE : Maintenance activities documented in the Hanford Wells Database System

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 300 Area Water Supply
Driller's Name: Cordon
Drilling Company: Associated Drillers
Date Started: 01Dec86

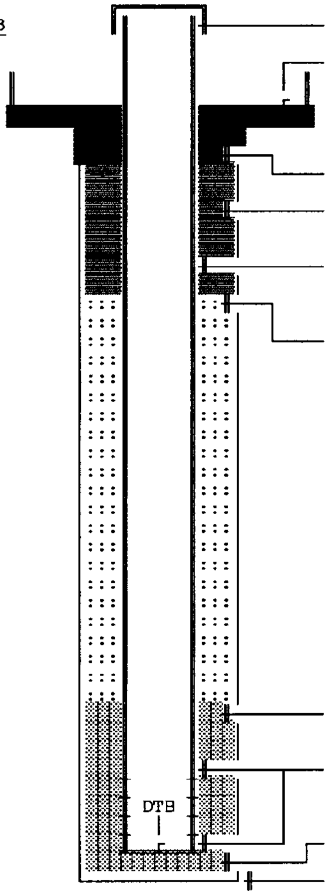
Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: 1517
Company Location: ______
Date Complete: 19Dec86

WELL NUMBER: 399-1-17B
TEMPORARY WELL NO: C-2B
Hanford Coordinates: N/S S 23,317 E/W E 13,604
State Coordinates: N Not documented E Not doc
RN 56,059.5 RE 15,210.3
Start Card #: Not documented T____ R____ S______
Elevation Ground surface: 375.48-ft Brass cap

Depth to water: 32.9-ft Dec86
(Ground surface) 33.3-ft 17Dec93

GENERALIZED STRATIGRAPHY Geologist's Log

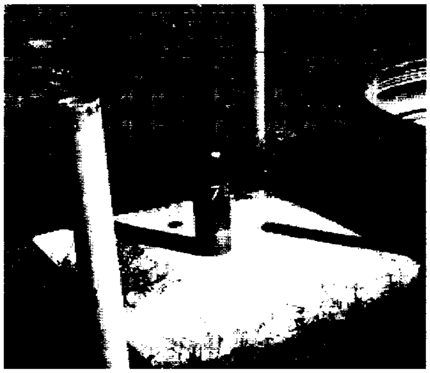
0-5: Silty SAND
5-15: Silty, sandy PEBBLES
15-25: Sandy PEBBLES
25-30: Gravelly SAND
30-35: Sandy GRAVEL
35-40: Sandy PEBBLES
40-55: Sandy GRAVEL
55-70: Silty, sandy GRAVEL
70-85: Sandy GRAVEL
85-90: Silty, sandy GRAVEL
90-95: Sandy GRAVEL
95-105: Silty, sandy GRAVEL
105-110: Silty, gravelly SAND
110-115: Sandy, gravelly CLAY



Elevation of reference point: (top of casing) [377.87-ft]
Height of reference point above ground surface [2.39-ft]
Depth of surface seal [0-4.0-ft]
Type of surface seal:
4-ft x 4-ft concrete surface pad
Cement to 4.0-ft
Bentonite crumbles, 4.0-28.0-ft
6-in ID stainless steel casing, +2.4-100.0-ft
Volclay tablets, 20.8-95.0-ft
Silica sand pack, 95.0-113.5-ft, 8-12-mesh
6-in stainless steel screen, 100-110-ft, #40-slot [100.0-ft]
Fill, 113.5-115.0-ft
Borehole drilled depth: [115.0-ft]
DTB=Depth to bottom, 110.2-ft, 03Dec90

Drawing By: RKL/3-01-17B.ASB
Date : 12Jan94
Reference : HANFORD WELLS
WHC-SD-EN-DP-071

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-17B



WELL DESIGNATION	:	399-1-17B
RCRA FACILITY	:	300 Area Process Trenches
CERCLA UNIT	:	300-FF-5
HANFORD COORDINATES	:	S 23,317 E 13,604 [Hanford Wells] RN 56,059.5 RE 15,210.3 [24Apr87-NGS]
LAMBERT COORDINATES	:	N 382,020 E 2,308,989
DATE DRILLED	:	Dec86
DEPTH DRILLED (GS)	:	115-ft
MEASURED DEPTH (GS)	:	110.2-ft, 03Dec90
DEPTH TO WATER (GS)	:	33-ft, Dec86; 33.3-ft, 17Dec93
CASING DIAMETER	:	6-in, stainless steel, +2.39-100-ft
ELEV TOP CASING	:	377.87-ft, [24Apr87-NGS]
ELEV GROUND SURFACE	:	375.48-ft, Brass cap [24Apr87-NGS]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	100-110-ft, #40-slot, stainless steel
COMMENTS	:	FIELD INSPECTION, 19Oct90; Stainless steel casing. 4-ft square concrete pad, 4 posts, capped, locked and labeled. Not in radiation zone. OTHER; Documented surface seal to 4-ft.
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Depths referenced to ground surface; 16Nov90; DTB=109-ft, silty. DTW=31.2-ft, clean, no floating debris. Vadose/submerged casing clean. Screen 99-109-ft, continous wrap, clean except for one small spot near the bottom. Water clear, some suspended debris.
DATE EVALUATED	:	Feb91
EVAL RECOMMENDATION	:	1) Survey to water level measurement standards.
LISTED USE	:	300 Area monthly water level measurementFeb87-22Nov93;
CURRENT USER	:	WHC ES&M RCRA sampling and w/l monitoring, ER CERCLA sampling and w/l monitoring
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	Maintenance activities documented in the Hanford Wells Database System

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Raw water
Driller's Name: G Thomas
Drilling Company: Kaiser Engineers
Date Started: 18Sep91

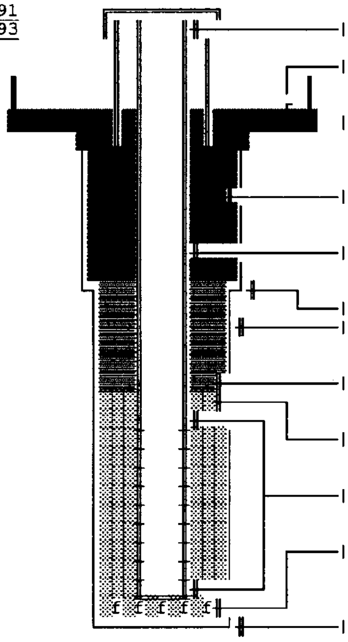
Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 25Sep91

WELL NUMBER: 399-1-21A
TEMPORARY WELL NO: 6A
Hanford Coordinates: N/S Not documented E/W Not doc
State NAD83 Coordinates: N 116,184.18m E 594,161.02m
Start Card #: Not documented T____ R____ S______
Elevation Ground surface: 379.87-ft Brass cap

Depth to water: 36.9-ft 23Sep91
(Ground surface) 37.8-ft 17Dec93

GENERALIZED STRATIGRAPHY
Geologist's Log

0-9: Gravelly SAND
9-20: Sandy GRAVEL
20-24.5: Gravelly SAND
24.5-54.6: Sandy GRAVEL



Elevation of reference point: (top of inner casing) [382.39-ft]
Height of reference point above ground surface [2.52-ft]
Depth of surface seal [0-19.0-ft]
Type of surface seal:
4-ft x 4-ft concrete surface pad extending 1-ft into annulus
Cement grout to 19.0-ft
4-in ID T304 stainless steel casing, +2.5-31.4-ft
Hole diameter, 0-19.9-ft, 10.95-ft
19.9-54.6-ft, 8.8-in
Bentonite crumbles, 19.0-29.1-ft
Silica sand pack, 29.1-52:4-ft, 20-40-mesh
4-in T304 stainless steel screen, 31.4-52.2-ft, #10-slot
Fill, 52.4-54.6-ft
Borehole drilled depth: [54.6-ft]

Drawing By: RKL/3-01-21A.ASB
Date : 31Jan94
Reference : HANFORD WELLS
WHC-SD-EN-TI-052

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 399-1-21A

WELL DESIGNATION : 399-1-21A
RCRA FACILITY : Not applicable
CERCLA UNIT : 300-FF-5
HANFORD COORDINATES : Not documented
LAMBERT COORDINATES : N 116,184.18m E 594,161.02M [08Jan92-NAD83]
DATE DRILLED : Sep91
DEPTH DRILLED (GS) : 54.6-ft
MEASURED DEPTH (GS) : Not documented
DEPTH TO WATER (GS) : 36.9-ft, 23Sep91;
37.8-ft, 17Dec91
CASING DIAMETER : 4-in, stainless steel, +2.52-31.4-ft;
6-in, stainless stee, ~2.5-0.5-ft
ELEV TOP CASING : 382.39-ft, [08Jan92-NGVD'29]
ELEV GROUND SURFACE : 379.87-ft, Brass cap [08Jan92-NGVD'29]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 31.4-52.2-ft, #10-slot, T304 stainless steel
COMMENTS : FIELD INSPECTION, 20Oct93;
6-in stainless steel casing.
4-ft by 4-ft concrete pad, 4 posts, 1 removable.
Capped and locked, brass cap in pad with well ID.
Not in radiation zone.
OTHER:
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Not documented
DATE EVALUATED : Not applicable
EVAL RECOMMENDATION : Not documented
LISTED USE : 300 Area monthly water level measurements, 28Apr93-17Dec93;
CURRENT USER : WHC ES&M w/l monitoring, ER sampling and w/l monitoring,
PNL w/l sitewide sampling
PUMP TYPE : Hydrostar
MAINTENANCE : Maintenance activities documented in the Hanford Wells Database System

Appendix D

Letter from Ecology to DOE Regarding the *Statistical Assessment for the 300 Area RCRA Groundwater Monitoring Plan*

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
1315 W. 4th Avenue • Kennewick, Washington 99336-6018 • (509) 735-7581

May 7, 2001

Mr. Marvin Furman
U.S. Department of Energy
Richland Operations Office
P.O. Box 550, MSIN A5-13
Richland, Washington 99352

Dear Mr. Furman:

Re: Statistical Assessment for the 300 Area Resource Conservation and Recovery Act of 1976 (RCRA) Ground Water Monitoring Plan

The Washington State Department of Ecology (Ecology) has evaluated the proposal presented by the United States Department of Energy (USDOE) requesting "variance" from applying interim status regulations at B-Pond and other Treatment, Storage, and Disposal (TSD) units, and their request to apply the Shewhart-CUSUM control limits for the 300 Area Process Trenches (APT). The purpose of this letter is to present regulatory guidance regarding the proposed "variance" from applying interim status regulations and to denote the requirements for achieving acceptable control limits for the 300 APT. This letter does not negate the current status of the site, but allows for variance.

B-Pond - "Variance" from applying interim status regulations. The following guidance is provided to the USDOE regarding the request for "variance" from applying interim status regulations for the RCRA monitoring network at B Pond monitored under interim indicator evaluation status. The appropriate indicators of ground-water contamination and statistical evaluation methods will be proposed by Pacific Northwest National Laboratory (PNNL) and submitted for approval by Ecology on a case-by-case basis.

The following criteria must be met prior to receiving approval of a variance from applying interim status regulations.

1. Identification of appropriate indicators of ground-water contamination and suitable statistical evaluation methods will be achieved by utilizing best professional judgement (i.e., waste source terms, conceptual models), expertise, and site-specific knowledge to: (a) determine the best technical approach based on hydrogeology and (b) tailor statistical approach to each individual site as necessary (i.e., consider type of monitoring, the nature of the data, the proportions of non-detects, spatial and temporal variations in the selection of appropriate statistical methods). A list of the appropriate indicators will be provided to Ecology for approval prior to implementation of the proposed plan.

2. The selection of quality background data and data sets for identification of an appropriate baseline period. Once baseline data has been obtained, outliers will be properly addressed to avoid substantial bias in the statistical analysis.

3. American Society for Testing and Materials (ASTM) guidance will be utilized for circumstances regarding non-detects and outliers.

4. The utilization of probability plots in order to maintain normal distribution of data.

5. Input parameter values (e.g., k, h, and SCL) will be proposed and submitted to Ecology for approval prior to implementation of this plan.

6. Variance from applying interim status requirements for the RCRA monitoring network at B Pond and other TSD units currently monitored under interim indicator evaluation status will be allowed for a period to cover four sampling events. Upon completion of the four sampling events and statistical evaluation of the data, the submitted proposal shall be reevaluated by Ecology for subsequent approval.

300 Area Process Trenches (300-APT) – Calculation of control limits. The following table depicts the control limits and special conditions to be applied for each constituent of concern at the 300-APT as proposed in the USDOE/Ecology meeting held December 11, 2000.

Table 1. Summary of Various Control Limits at the 300 APT

Constituent of Concern	Shewhart CUSUM Parameter Value	Control Limit (μg/L)
	Well # 3-1-16A	
cis-DCE (μg/L)	4.5	0.803
TCE (μg/L)	4.5	1.72
	Well # 3-1-16B	
cis-DCE (μg/L)	4.5	[39, 262][b]
TCE (μg/L)	NA	5
	Well # 3-1-17A	
Uranium (μg/L)	4[a]	[7, 218]
	Well # 3-1-17B	
Uranium (μg/L)	4.5	0.67

[a] Use 4 sigma because there are 16 data points in the baseline period (ASTM 1996).
[b] Numbers in brackets indicate upper and lower limits.

Specific procedures to be used are as follows:

1. For wells where the Maximum Contamination Level (MCL) has been and still is exceeded, quarterly monitoring will be conducted. One sample will be collected from each well during each sampling event and compared to the agreed upon control limits for each identified constituent of concern (i.e., cis-DCE, TCE, and uranium). If a control limit is exceeded (proof by verification sampling), a notification process will be followed.

2. For wells where the MCL has not been exceeded, semiannual monitoring will be conducted. One sample will be collected from each well during each sampling event and compared to the agreed upon control limits for each identified constituent of concern (i.e., cis-DCE, TCE, and uranium). A notification process will be followed after a confirmed exceedance (by verification sampling).

3. Currently tetrachloroethene (PCE) is not detected in the 300 APT wells. However, it has been detected in the past. PNNL will continue to monitor PCE and report detected results.

The proposed statistical approach shall be in effect for a period of two years or four sampling events. Based on the results of this trial application, Ecology would decide whether to continue, modify, or abandon the proposed approach in these facilities or to apply the approach to other facilities. The USDOE is therefore requested not to apply this variance or similar procedures/methods at other facilities with out Ecology's prior approval.

If further discussion is necessary, please contact Deborah Singleton at (509) 736-5722 or me at (509) 736-3015.

Sincerely,

Dib Goswami, PhD
Nuclear Waste Program

DG:lkd

cc: Doug Hildebrand, USDOE
John Morse, USDOE
Charissa Chou, PNL
Stuart Luttrell, PNL

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