PNNL-14444

Pacific Northwest National Laboratory
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Aquifer Sampling Tube Results for Fiscal Year 2003

M. J. Hartman
R. E. Peterson

October 2003

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;
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Available to the public from the National Technical Information Service,
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Summary

This report presents and discusses results of the fiscal year 2003 sampling event associated with aquifer tubes along the Columbia River in the northern Hanford Site. Aquifer tube data help define the extent of groundwater contamination near the Columbia River, determine vertical variations in contamination, monitor the performance of interim remedial actions near the river, and support impact studies.

Seventy-nine tubes at 40 locations were sampled in November 2002 through January 2003. Table 1 lists the maximum concentration of the contaminants of concern in fiscal year 2003 aquifer tube samples.

Table 1. Results of Fiscal Year 2003 Aquifer Tube Samples

Groundwater Constituent of Concern and Standard	100-B	100-K	100-D	100-H	100-F
Chromium: DWS 100 μg/L, AWQC 11 μg/L	**38 μg/L**	**52 μg/L**	**295 μg/L**	**43 μg/L**	**14 μg/L**
Nitrate: DWS and AWQC 45 mg/L	Not a COC	3.6 mg/L	NA	NA	NA
Strontium-90: DWS and AWQC 8 pCi/L	**15 pCi/L**	ND	NA	ND	1.9 pCi/L
Tritium: DWS and AWQC 20,000 pCi/L	**32,200 pCi/L**	ND	**29,700 pCi/L**	NA	NA
Other		Carbon-14: 67.2 pCi/L		Technetium-99: ND; fluoride, uranium: NA	Alpha, beta, TCE: NA

Bold values exceed aquatic or drinking water standards.
AWQC = Ambient water quality criteria.
COC = Constituent of concern.
DWS = Drinking water standard.
NA = Not analyzed.
ND = Not detected.
TCE = Trichloroethene.

Aquifer tube data help identify contaminant distributions along the Columbia River where there are few or no monitoring wells. For example, aquifer tube data reveal the following areas where contamination appears to be moving parallel to the river farther than could be interpreted from monitoring well data alone:

- chromium and tritium from 100-K Area
- tritium from 100-N Area
- chromium from 100-H Area

In many contaminated areas, two or three sampling tubes completed at different depths were sampled. Data from these samples help define the vertical distribution of contaminants near the Columbia River.

Lowest contaminant concentrations occur in the shallowest tubes, which are most affected by dilution with river water.

Aquifer tube data supplement data from wells for monitoring the performance of interim remedial measures at the 100-K, 100-D, and 100-H Areas. Aquifer tube data show declining trends in chromium concentrations near the following interim remediation action sites:

- 100-K Area (pump-and-treat)
- northern 100-D Area plume (pump-and-treat)
- southwest 100-D Area plume (redox site)
- 100-H Area (pump-and-treat)

However, it is premature to conclude that the concentration declines were caused solely by the interim remedial actions. Natural processes (e.g., dilution, dispersion) also are reducing the level of contamination in the nearshore areas. There are too few data points in the aquifer tube trend plots to attribute trends conclusively to a specific cause.

Installation of new and replacement aquifer sampling tubes is planned for fall 2003. The new installations will serve *Comprehensive Environmental Response, Compensation, and Liability Act* long-term monitoring needs in the 100-BC-5, 100-KR-4, 100-FR-3, and 300-FF-5 Operable Units.

An expansion of the sampling and analysis schedule for aquifer tubes is proposed for fiscal year 2004. First, at least one tube site in each area containing a contaminant plume undergoing active remediation could be sampled several times during the year to detect water quality changes caused by seasonal changes in river flow. Second, where a tube site contains at least three tubes at various depths in the aquifer, analyses for specific conductance and one contaminant could be made to develop a zone of interaction mixing curve for the plume.

Acknowledgments

The fiscal year 2003 aquifer tube sampling event was the first since the work scope shifted from Fluor Hanford, Inc. to Pacific Northwest National Laboratory. A principal change in operations included use of the laboratory's boat to conduct the field work. Special thanks go to Bob Fulton for extra effort expended in preparing the field equipment and supplies, for operating the boat in an exemplary manner, and for helping collect samples. Greg Patton directed the field activities, provided global positioning system coordinates, and collected samples. Janet Julya and Paula Henry provided very capable support in preparing the complex sample labeling and data tracking paperwork. Mike Baechler and Rich Mahood shared their previous tube sampling experience with the new field team during the reconnaissance and maintenance phase of the project. John McDonald provided a helpful peer review of this document.

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1.0 Introduction

Aquifer sampling tubes (aquifer tubes) are small diameter polyethylene tubes that have been installed in the unconfined aquifer along the Hanford Reach shoreline. Each site typically contains one to three tubes, with screened sampling ports at various depths in the aquifer. The tube sites cover the Hanford Site shoreline from just upstream of the 100-B Area downstream to the Hanford town site at intervals of ~600 meters (~2,000 feet) (Figure 1). Sites are more closely spaced along some segments where additional spatial resolution of contaminant plumes is needed. Appendix Table A.1 lists the aquifer tubes and their geographic coordinates.

1.1 Purpose of the Project

The aquifer tube installation project was conceived during the mid-1990s to provide additional sampling facilities for monitoring groundwater characteristics near the Columbia River. A goal of the project was to enhance existing descriptions of groundwater contamination near the river to support environmental restoration decisions. The problem statement used to guide the Data Quality Objectives process for the installation project was included in Peterson et al. (1997):

> *"Groundwater contamination is known or suspected at numerous locations along the 100 Area river shoreline. Contamination is presumed absent along the intervening segments. Data gaps should be filled to provide a firm technical basis for assessing risk and selecting remediation alternatives in groundwater operable units that include segments of the river shoreline."*

Several specific objectives were identified during the Data Quality Objectives process. The objectives are paraphrased below and remain valid for re-sampling events:

- Describe the nature, concentration, and extent of chemical and radiological indicator contaminants in groundwater at locations adjacent to the river.
- Verify the presence or absence of groundwater contamination at other locations along the Hanford Site shoreline.
- Describe the vertical distribution of contaminants with depth in the aquifer near the river.
- Monitor the performance of interim remedial actions that address groundwater contamination.

1.2 Project History

The method for installing aquifer tubes was initially developed during a project to obtain pore water samples from riverbed sediment at the 100-D and 100-H Areas in 1995 (Hope and Peterson 1996a, 1996b). Field teams experimented with using a GeoProbe™ hydraulic push equipment and a hand-held air hammer to drive a temporary steel casing into the cobble beach sediment.

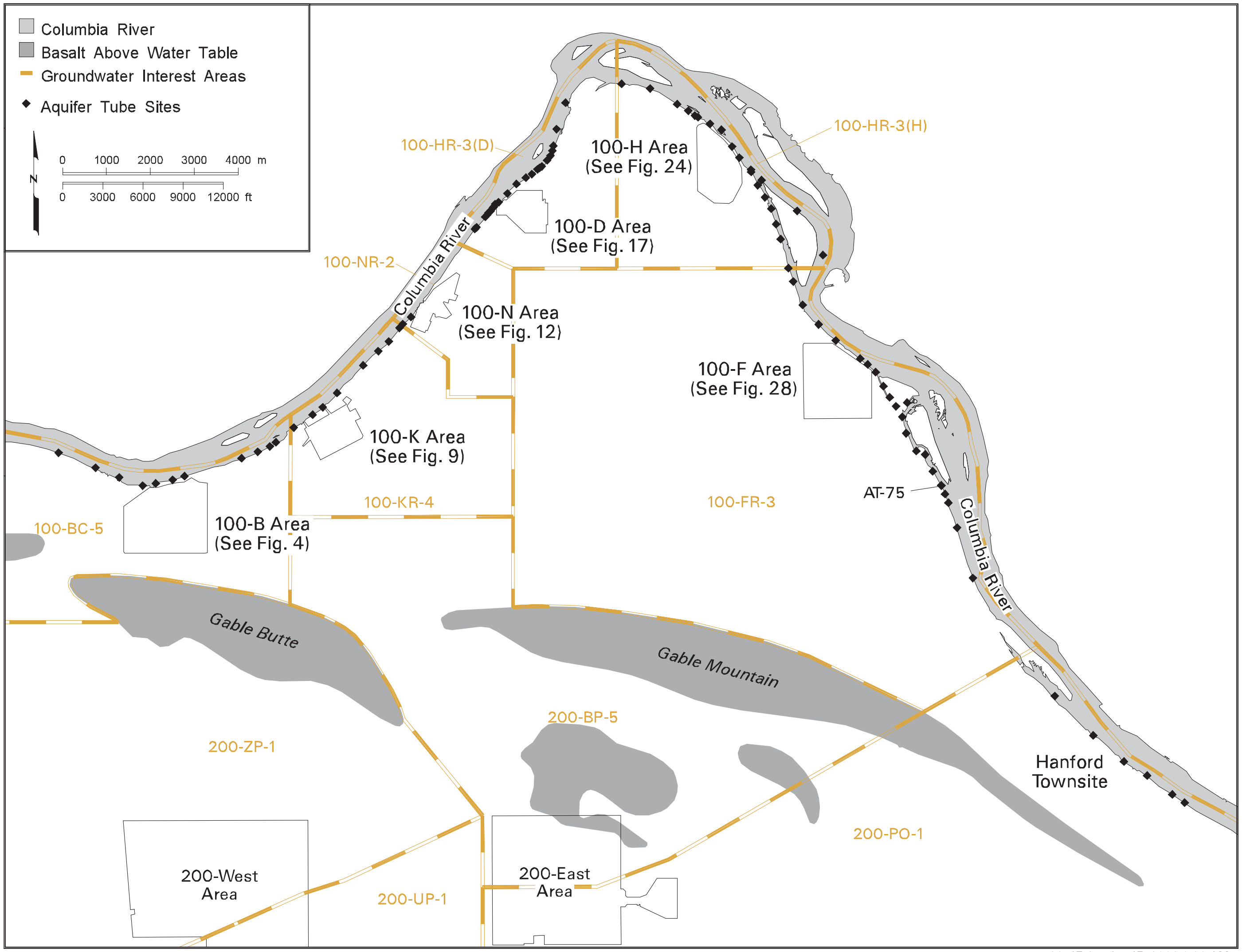

Figure 1. Northern Portion of the Hanford Site and Aquifer Tube Locations

The objective at each location was to install aquifer tubes with ports near the bottom of the unconfined aquifer (i.e., above a low-permeability sediment layer), at aquifer mid-depth, and within approximately 1.5 meters (5 feet) of the water table. However, there were numerous sites where aquifer thickness was unknown or installing tubes at the planned depths was not successful. Hard sediment layers or large boulders sometimes prevented completion of the ideal three-tube arrangement. To complete the tubes, polyethylene tubing with a screened sample port was lowered into the temporary casing, and the casing backpulled, thus allowing the formation to collapse against the tubing (Figure 2). Based on the success of these experiments, a larger project was conceived that would provide aquifer tube coverage for the entire 100 Area shoreline.

The Data Quality Objectives process (EPA 1994) was followed during the planning of the comprehensive installation project, and discussions included representatives from the U.S. Department of Energy (DOE), Washington State Department of Ecology (Ecology), the U.S. Environmental Protection Agency (EPA), and the Environmental Restoration Contractor Team (ERC). The meeting minutes of those discussions are included as Appendix C in the description of work that was subsequently prepared (Peterson et al. 1997). The description of work provides details for the installation of aquifer tubes and a discussion of the logistical constraints associated with field conditions (e.g., cultural, ecological, and radiological access restrictions). The description of work also established protocols for sampling and analyzing samples from the aquifer tubes.

During the planning process, 87 locations were identified for installations, with each location being equipped with tubes at three different depths in the aquifer (see Table A.1). Field work was conducted between September 5 and November 26, 1997, and resulted in 70 locations being equipped with a total of 178 individual sampling tubes (Peterson et al. 1998). A photograph showing a typical aquifer tube site is shown in Figure 3. Samples were collected as part of the installation activities and analyzed for hexavalent chromium, nitrate, gross beta, tritium, carbon-14, and strontium-90; however, not all samples were analyzed for the entire constituent list. The specific conductance and temperature of each sample were recorded in the field. The analytical results are included in the installation report (Peterson et al. 1998). Data from analyses conducted by offsite laboratories (some hexavalent chromium results, gross beta, tritium, carbon-14, and strontium-90) are contained in the Hanford Environmental Information System (HEIS 1994), while the field parameters, hexavalent chromium, and nitrate results are currently available in the published report. Efforts are underway to get those results into the HEIS database.

Many of the aquifer tubes have been re-sampled each year. The published reports containing the analytical results for each year of sampling are contained in the following documents:

- October–November 1995 (100-D Area only): Hope and Peterson (1996c)
- September–December 1997: Peterson et al. (1998)
- October–November 1998: No report produced
- October–November 1999: Lee and Raidl (2000)[1]

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[1] Lee, T.A. and R.F. Raidl. 2000. *Fall 1999 Aquifer Sampling Tube Results at the 100 Area and Hanford Townsite Shoreline*. Environmental Restoration Contractor InterOffice Memorandum No. 078404, dated May 2000. Prepared by CH2M HILL Hanford Inc. for Bechtel Hanford, Inc., Richland, Washington.

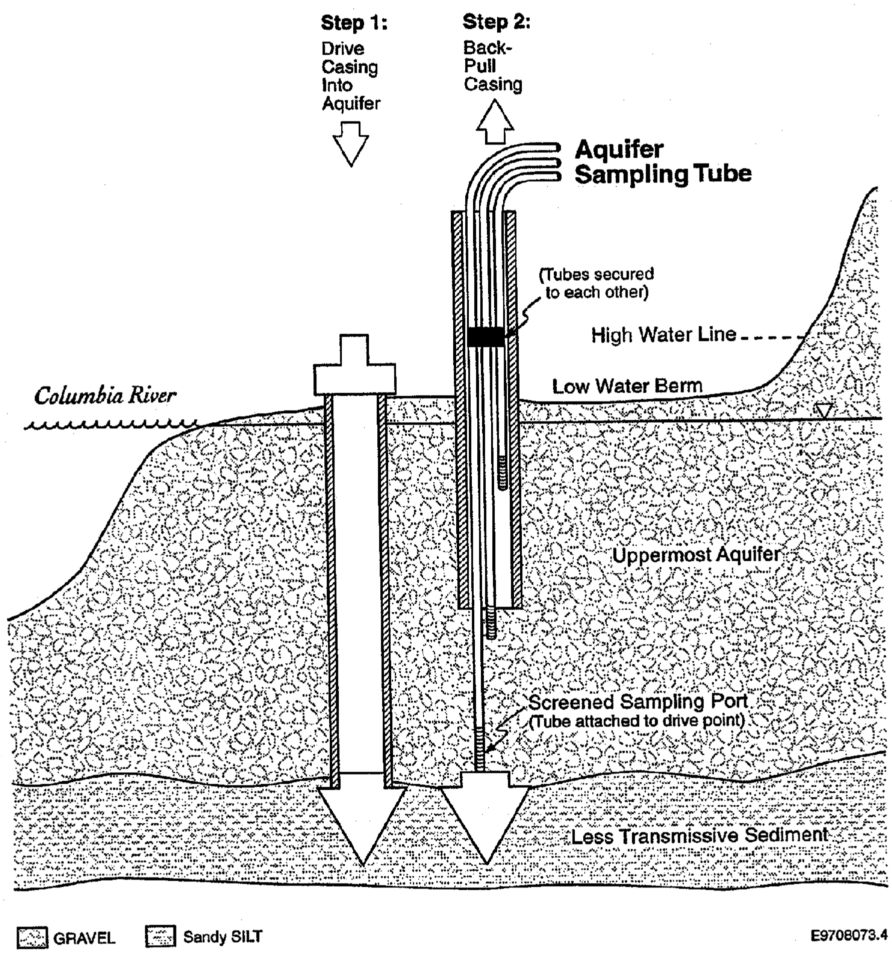

Figure 2. Main Components of Aquifer Tube Installation

- October–November 2000: Raidl (2001)
- November 2001: Raidl (2002)
- November 2002–January 2003: this report

The responsibility for scheduling the sampling, field logistics, arranging laboratory analyses, entering data into HEIS, and summarizing the results for the aquifer tube project shifted from Fluor Hanford, Inc. to Pacific Northwest National Laboratory (PNNL) on October 1, 2002. Prior to re-sampling the tubes during fall 2002, DOE met several times with EPA, Ecology, Fluor Hanford, Inc., and PNNL to agree on which sites to re-sample and the list of analyses for each site. The final meeting was held on October 24, 2002, and field work started shortly thereafter.

Planning is in progress to equip ~32 new or replacement sites with aquifer tubes during fall 2003. The new or replacement tubes will support new long-term monitoring objectives within the 100-BC-5, 100-FR-3, and 300-FF-5 Operable Units (a PNNL responsibility), and additional performance evaluation

Figure 3. Sampling an Aquifer Tube Site

monitoring requirements associated with the interim remedial actions that address chromium contamination in the 100-KR-4 and 100-HR-3 Operable Units (a Fluor Hanford, Inc. responsibility).

1.3 Status of Aquifer Tube Sites

The fiscal year 2003 campaign to re-sample aquifer tubes was conducted in two phases: a field reconnaissance of sites to find the tubes and ascertain their condition for sampling, followed by a second visit to actually collect samples for analysis. Nearly all of the field work was conducted via river access, which simplified logistics as compared to land access. Where needed, minor maintenance was performed to provide protection of the tubes from sunlight and animals. Coordinates for each site were checked using a sub-meter Trimble™ global positioning system (GPS) unit. If labels were missing from a tube, efforts were made to determine the tube's length using a "fish wire," although not all efforts were successful because full insertion of a wire to measure tube length was hampered by friction. The field notes and layout sketches from the installation logbooks also proved helpful to identify individual aquifer tubes. Of the sites visited in fiscal year 2003, most of the aquifer tubes that had been protected with polyvinyl chloride (PVC) pipe remained in good condition. The most common problem was loss of labels from the individual tubes, followed by limited or no water yield when pumped. Label replacement and maintenance of the PVC pipe was accomplished wherever possible during the reconnaissance and sampling phases of the project, although not all maintenance was completed. A summary of the condition of each aquifer tube site, as of fall 2002, is provided in Appendix Table A.2.

2.0 Sampling Procedures

The procedures and methods used for the annual sampling events have changed little from those initially developed as part of the installation project. A sampling and analysis plan was prepared in October 2000 that includes a quality assurance project plan, field sampling plan, and health and safety plan (DOE/RL 2000a). That plan is still in effect, although minor modifications to the list of sites and analysis lists are made for each annual event, based on discussions among DOE, EPA, Ecology, and contractor representatives.

2.1 Methods for Fiscal Year 2003 Sampling Event

At each tube site, the identity of individual tubes was confirmed by attached labels and/or comparison to installation notes from field logbooks. If individual tube labels were not present, attempts were made to re-identify them as described in Section 1.3, followed by re-labeling. At several sites, ambiguity still existed at the time of sampling, the sampling port depth was assumed based on the specific conductance of the sample, and specific conductance was assumed to increase with depth.

Water was withdrawn from each aquifer tube using a peristaltic pump. During the initial purge, periodic measurements of specific conductance were made as a guide to determine when a sufficient purge was obtained. Additional subjective criteria used to ensure an acceptable purge of the lines included the turbidity of the water produced and a constant rate of production. On completion of the purge, the tube most representative of groundwater, as judged by having the highest specific conductance, was sampled for contaminant indicator analyses. In addition to specific conductance, temperature, pH, and oxidation reduction potential were measured in the field, as was the specific conductance of nearshore river water.

A Groundwater Sample Report (GSR) form was prepared in advance for each tube site to be sampled. The GSR lists the samples to be collected, container type, preservative information, filtering requirements, and HEIS sample numbers. It also contains space for recording field parameters measured at the time of sampling, and any other information relative to the sample (i.e., sample comments). The GSR is the official record of the sample collection and field parameter measurement activities. It is accompanied by a chain-of-custody form if samples are to be taken from the sampling site to a laboratory for analysis.

Minor modifications were made to the sampling protocol during the fiscal year 2003 sampling event, compared to the protocol for previous years. First, if the specific conductance of water collected from all of the aquifer tubes at a particular site was less than ~160 μS/cm, no samples were collected for offsite laboratory analysis (for previous events, ~200 μS/cm was the threshold value). Second, at some sites located within the boundaries of chromium plumes, samples were collected from aquifer tubes at all depths, to help characterize the diluting effect of river water infiltration on chromium concentrations.

2.2 Sample Analysis and Data Management

Samples for hexavalent chromium were sent to either the Fluor Hanford, Inc. mobile laboratory or PNNL's Sigma V laboratory for analysis. Samples for nitrate and sulfate were sent to the Fluor Hanford, Inc. mobile laboratory. Samples for radionuclides were sent to Severn-Trent Laboratory in Richland. Sampling-derived waste (i.e., peristaltic pump tubing, gloves, filters, and purgewater) were delivered to a Fluor Hanford, Inc. waste management representative for subsequent disposal. Analytical results were subsequently loaded into HEIS including field parameter measurement results recorded on the GSR. Additional information on analytical methods and detection limits is available in the HEIS record and is included on the CD included with this report.

3.0 Aquifer Tube Results

This section summarizes the analytical results of aquifer tubes for fiscal year 2003 and compares results to historical trends and contaminant distribution in the aquifer. The section is organized by operable unit, upstream to downstream.

Aquifer tubes with sampling ports at multiple depths were sampled at most sites. The figures accompanying the following sections generally show the maximum concentration at any site, regardless of port depth. For example, the maximum chromium value at site 5 may have been in the deep tube in 2001 and in the mid-level tube in 2002. Not all depths are sampled at every location each year, so pooling the maximum values for a site allows a more complete comparison with historical trends. The discussion and data tables specify individual tubes.

Samples were analyzed for site-specific constituents and routine field parameters, which included oxidation-reduction potential, pH, specific conductance, and temperature. Table 2 lists the key fiscal year 2003 chemical and radiological results. The CD that accompanies this report includes the complete data set as well as historical data. These data also are in HEIS.

Water quality at depths monitored by some of the aquifer tubes is affected by infiltration of river water into the aquifer beneath the shoreline region. If the shallow tubes are sampled after a period of high river stage, samples represent primarily river water. Samples collected after a period of low river stage are predominantly groundwater. The aquifer tubes are sampled in fall and early winter when river stage tends to be low, but this does not guarantee unmixed samples. Because the specific conductance of river water is much lower than that of groundwater, this parameter can be used to qualify the composition of the samples. Specific conductance less than ~160 μS/cm indicates the sample is primarily river water, and contaminant concentrations are likely to be lower than they would be in less diluted samples. Specific conductance greater than ~350 μS/cm indicates the sample is primarily groundwater. A specific conductance between 160 and 350 μS/cm suggests a mixture of groundwater and river water.

3.1 100-BC-5 Operable Unit (100-B Area)

Contaminants of concern in the 100-B Area are hexavalent chromium, strontium-90, and tritium (DOE/RL 2000a). Figure 4 shows the locations of aquifer tubes, monitoring wells, landmarks in the 100-B Area, and fiscal year 2002 strontium-90 distribution in the aquifer. The aquifer tubes were

Table 2. Summary of Fiscal Year 2003 Aquifer Tube Results

Aquifer Tube[a]	Sample Date	Specific Conductance (µS/cm)	Hexavalent Chromium (µg/L)		C-14 (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)		Nitrate (mg/L)		Sr-90 (pCi/L)		Sulfate (mg/L)		Tc-99 (pCi/L)		Tritium (pCi/L)	
04-S	12/16/2002	337	6.7																	
04-M	12/16/2002	337	10.6																	
04-D	12/16/2002	336	8.4										0.124	U					3,980	
05-S	12/16/2002	205	3.9																	
05-M	12/16/2002	345	38.4										14.5						9,870	
05-D	12/16/2002	313	27.3																	
06-S	12/16/2002	239																		
06-M	12/16/2002	351	36.8										14.7						32,200	
06-D	12/16/2002	397	35.7																	
07-D	12/16/2002	284	8.9										0	U					4,130	
14-D	11/20/2002	371	2.7				1.21	U	42.2		24.3		0	U	43.8		46.7		7,790	
17-M	11/20/2002	302	2.2		67.2		2.76		5.93		3.59				15.1				74	U
17-D	11/20/2002	339	2.2																	
19-D	11/19/2002	226	5.0	U	3.57	U								U			-1.76	U	180	U
21-S	11/19/2002	126	2.3																	
21-M	11/19/2002	172	5.0	U																
22-M	11/19/2002	142	7.8																	
22-D	11/19/2002	244	52.0																	
DK-04-2	11/19/2002	244	30.1																1,960	
DK-04-3	11/19/2002	241	24.0																	
25-D	11/19/2002	121	5.0	U																
26-S	11/20/2002	112	1.5	U																

Table 2. (contd)

Aquifer Tube[a]	Sample Date	Specific Conductance (µS/cm)	Hexavalent Chromium (µg/L)		C-14 (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)		Nitrate (mg/L)		Sr-90 (pCi/L)		Sulfate (mg/L)		Tc-99 (pCi/L)		Tritium (pCi/L)	
26-M	11/20/2002	144	1.5	U																
26-D	11/20/2002	340	17.1																1,610	
DD-50-1	12/18/2002	192	14.4																	
DD-50-2	12/18/2002	245	24.5																	
DD-50-3	12/18/2002	244	28.0												30.0				9,540	
DD-49-1	12/18/2002	184	10.0																	
DD-49-3	12/18/2002	252	20.0																	
DD-49-4	12/18/2002	263	16.7																	
DD-49-4	12/18/2002	256	25.0												31.0					
DD-44-3	12/18/2002	202	46.2																	
DD-44-4	12/18/2002	533	247.0												100.0	D			29,700	
DD-43-3	12/18/2002	281	144.0												44.0					
DD-42-4	12/18/2002	354	295.0												58.0					
DD-41-1	12/18/2002	124	1.5	U																
DD-41-2	12/18/2002	295	176.0												59.0					
DD-41-3	12/18/2002	260	142.6																	
166-D-3	12/18/2002	611	172.1																	
166-D-3B	12/18/2002	585	166.0												160.0	D				
DD-39-1	12/18/2002	182	12.8																	
DD-39-1	12/18/2002	182	11.6																	
DD-39-2	12/18/2002	532	104.0												145.0	D				
166-D-2	12/18/2002	227	41.2																	

Table 2. (contd)

Aquifer Tube[(a)]	Sample Date	Specific Conductance (µS/cm)	Hexavalent Chromium (µg/L)		C-14 (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)		Nitrate (mg/L)		Sr-90 (pCi/L)		Sulfate (mg/L)		Tc-99 (pCi/L)		Tritium (pCi/L)	
166-D-2B	12/18/2002	297	30.0												55.0					
DD-17-2	1/9/2003	166	34.0																	
DD-15-3	1/9/2003	182	21.0																	
TDP-15 C	1/9/2003	201	29.0																	
DD-12-4	1/9/2003	149	14.0																	
DD-10-4	1/9/2003	182	8.0																	
DD-06-3	1/9/2003	197	9.0																	
46-D	1/14/2003	183	8.0														0.726	U		
47-D	1/14/2003	143	8.0																	
48-S	1/14/2003	466	15.5																	
48-M	1/14/2003	476	17.7										0.05	U						
48-M	1/14/2003	476	21.0																	
49-S	1/14/2003	163	10.0																	
49-M	1/14/2003	350	12.2																	
49-D	1/14/2003	381	20.0																	
50-S	1/14/2003	409	16.6																	
50-M	1/14/2003	522	37.0																	
51-S	1/14/2003	367	22.6																	
51-M	1/14/2003	443	32.0																	
51-D	1/14/2003	455	43.0																	
52-S	1/14/2003	203	9.4																	
52-M	1/14/2003	256	2.3																	
52-D	1/14/2003	310	5.0	U																

Table 2. (contd)

Aquifer Tube[(a)]	Sample Date	Specific Conductance (µS/cm)	Hexavalent Chromium (µg/L)		C-14 (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)		Nitrate (mg/L)		Sr-90 (pCi/L)		Sulfate (mg/L)		Tc-99 (pCi/L)		Tritium (pCi/L)	
54-S	1/15/2003	178	1.5	U																
54-M	1/15/2003	286	6.6																	
54-D	1/15/2003	232	1.1																	
62-S	1/16/2003	145	1.5																	
62-M	1/16/2003	444	4.2										0.041	U						
63-S	1/16/2003	142	2.6																	
63-M	1/16/2003	193	13.6																	
64-M	1/16/2003	133	1.5																	
64-D	1/16/2003	219	3.1										1.91							
65-S	1/16/2003	153	7.0																	
65-M	1/16/2003	146																		
66-S	1/16/2003	176	1.4	U																
66-M	1/16/2003	209	2.6																	
66-D	1/16/2003	204	3.7										0.212	U						
67-S	1/16/2003	179	1.5																	
67-M	1/16/2003	181	2.0										0.348	U						

(a) Listed in order of distance downstream.
D = Sample diluted for analysis.
U = Undetected.

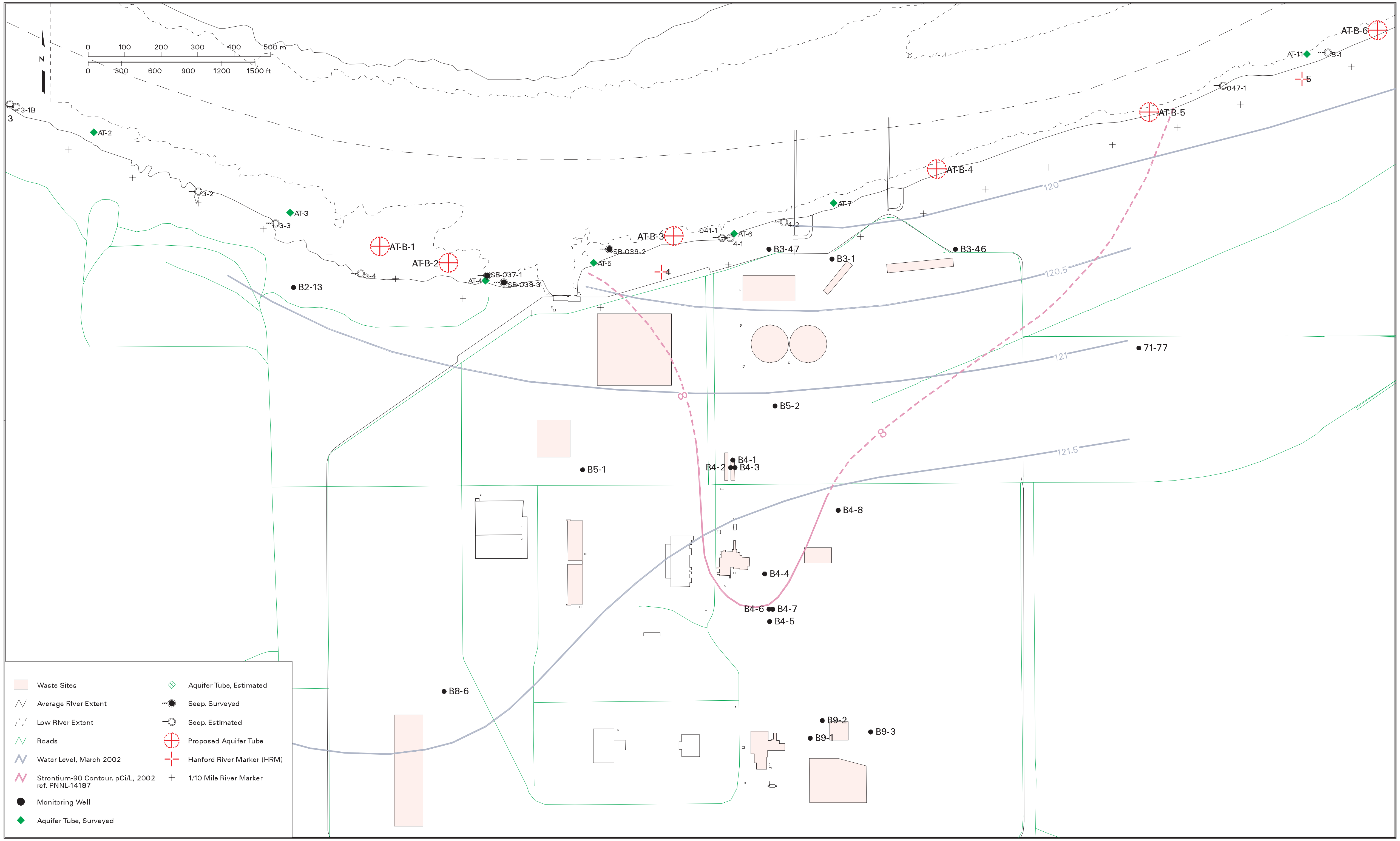

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Figure 4. Locations of Aquifer Tubes, Monitoring Wells, and Fiscal Year 2002 Strontium-90 Plume in the 100-B Area

100-B Area, and fiscal year 2002 strontium-90 distribution in the aquifer. The aquifer tubes were sampled December 16, 2002. Samples were analyzed for hexavalent chromium (10 samples), tritium (5 samples), and strontium-90 (5 samples), plus routine field parameters. One sample was also analyzed for anions, gross alpha, gross beta, metals, and technetium-99.

Specific conductance ranged from 205 µS/cm (primarily river water) to 397 µS/cm (primarily groundwater).

Hexavalent chromium was detected at 100-B Area. The highest concentrations in the 100-B Area in fiscal year 2003 were 38 and 37 µg/L at tubes 5-M and 6-M, respectively. The specific conductance of these samples (~350 µS/cm) indicates they were primarily groundwater. Chromium concentrations remained fairly constant from 1998 to 2001 and are consistent with concentrations in nearby monitoring wells (Figure 5).

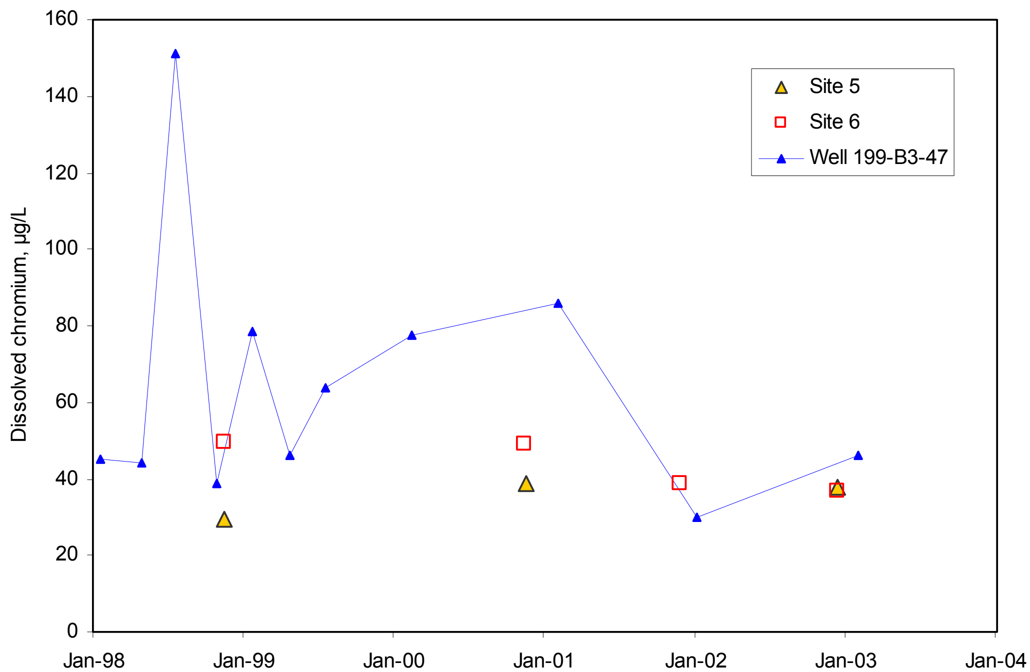

Figure 5. Annual Maximum Dissolved Chromium Concentrations in Aquifer Tube Sites 5 and 6 and Monitoring Well 199-B3-47

Four chromium results exceeded 20 µg/L, the interim remedial action objective associated with pump-and-treat systems at the 100-K, 100-D, and 100-H Areas. Five chromium results exceeded 10 µg/L, Washington State's ambient water quality criterion for protection of freshwater aquatic organisms.

Chromium concentrations were lowest in the shallowest tubes and higher in the mid-depth and deeper tubes, as expected (Figure 6). Specific conductance of the samples follows the same vertical profile as chromium and indicates dilution with river water in the shallowest tubes.

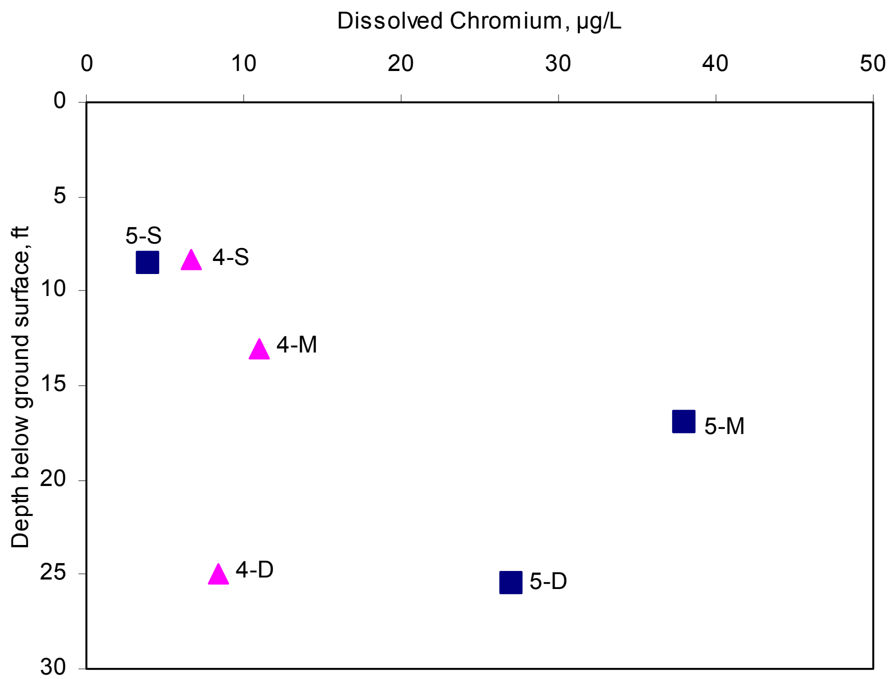

Figure 6. Chromium Concentration with Depth in Two Aquifer Tube Sites in the 100-B Area

Strontium-90 was detected in two of the five samples analyzed for this constituent, and both results exceeded the 8 pCi/L drinking water standard. Aquifer tube 5-M contained 14.5 pCi/L, and tube 6-M contained 14.7 pCi/L. These values are part of flat trends and are consistent with (and lower than) concentrations in nearby monitoring wells (Figure 7).

Tritium was detected in 100-B Area aquifer tubes; the maximum concentration in fiscal year 2003 was 32,200 pCi/L in tube 6-M, which is within the historical range for this tube. This result was higher than the February 2003 result from nearby monitoring well 199-B3-47 (Figure 8). This was the only aquifer tube result from the 100-B Area that exceeded the 20,000 pCi/L tritium drinking water standard in fiscal year 2003. Other results ranged from 3,980 in tube 4-D to 9,870 pCi/L in tube 5-M, which agree with the general distribution of tritium in the aquifer.

Additional radionuclides were found in some samples. Aquifer tube 14-D, located between 100-B and 100-K Area (Figure 1), was sampled for gross alpha, gross beta, technetium-99, strontium-90, and tritium to look for the influence of contaminant plumes migrating from the 200 Areas. Tritium, at 7,790 pCi/L, is believed to represent the influence of the 200 Areas plume. Technetium-99 was detected at 46.7 pCi/L, and also may represent the 200 Areas plume. Gross alpha and strontium-90 were undetected.

The concentration of gross beta in tube 14-D was 42.2 pCi/L in fiscal year 2003; the cause of the elevated gross beta is not known. The concentration is higher than can be accounted for by the technetium-99 alone, and no strontium-90 was detected. In fiscal year 2002, a sample was analyzed for gamma-emitting radionuclides, but none were detected. The recent gross beta value was lower than the previously measured range in this cluster (63 to 82 pCi/L).

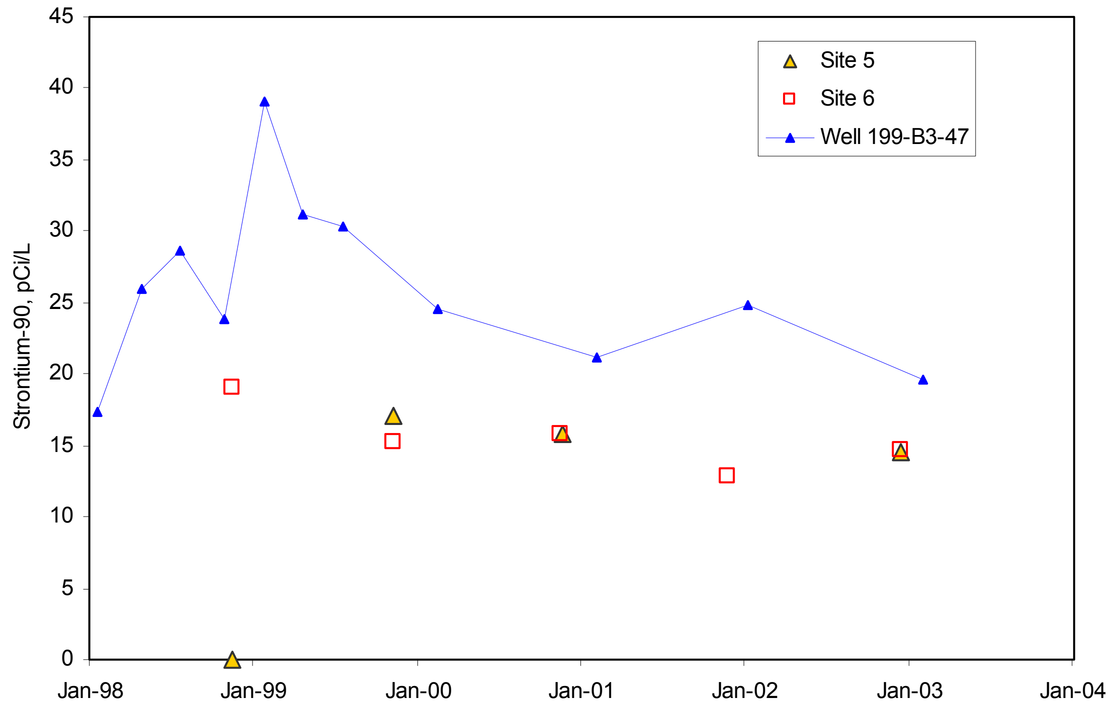

Figure 7. Annual Maximum Strontium-90 Concentrations in Aquifer Tube Sites 5 and 6 and Monitoring Well 199-B3-47

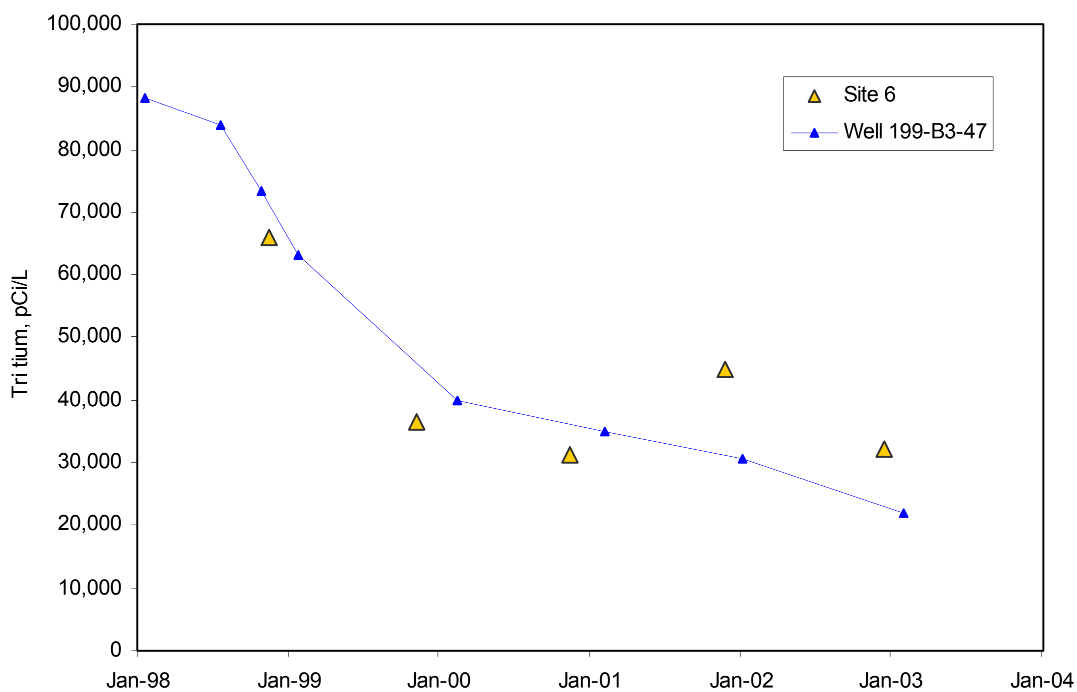

Figure 8. Annual Maximum Tritium Concentrations in Aquifer Tube Site 6 and Monitoring Well 199-B3-47

3.2 100-KR-4 Operable Unit (100-K Area)

Contaminants of concern in the 100-K Area are hexavalent chromium, carbon-14, strontium-90, tritium, and nitrate (DOE/RL 2000a). Figure 9 shows the locations of aquifer tubes, monitoring wells, landmarks in the 100-K Area, and the fiscal year 2002 distribution of chromium in the aquifer. Tube site 26 is located near the 100-N Area, and its location is shown on Figure 9. The aquifer tubes were sampled November 19 and 20, 2002. Samples were analyzed for hexavalent chromium (13 samples), tritium (5 samples), and carbon-14 (2 samples). Anions, gross alpha, gross beta, strontium-90, and technetium-99 were analyzed in one sample each.

Specific conductance of the aquifer tube samples ranged from 112 to 340 μS/cm indicating some samples were infiltrated river water and others were primarily groundwater.

Hexavalent chromium concentrations were low (<5 μg/L) in most 100-K Area aquifer tubes in November 2002. Some of these (e.g., tubes 19-D and 21-M) were lower than expected based on plume distribution. These samples had relatively low specific conductance values (226 and 172 μS/cm, respectively), which probably accounts for the low chromium concentrations.

The highest fiscal year 2003 chromium value in the 100-K Area was 52 μg/L in tube 22-D, located near the 100-K trench (waste site 116-K-2) and associated pump-and-treat extraction wells. Chromium concentrations at site 22 show a declining trend since 1998 (Figure 10). The most recent value was associated with fairly low specific conductance (244 μS/cm), but it appears the overall decline is persistent and may be related to remediation efforts.

Tube site DK-04 is located downstream of the 100-K trench between 100-K and 100-N Areas. Chromium was measured at 30 μg/L in a sample from tube DK-04-2 (Figure 10). The appearance of elevated chromium concentrations downstream of its source suggests that some of the chromium from the 100-K trench may have migrated along the shoreline. Previous tritium measurements at this site also provide evidence for a trench source for these contaminants.

Three chromium results exceeded 20 μg/L, the interim remedial action objective associated with the pump-and-treat operations at the 100-K Area. Four chromium results exceeded 10 μg/L, the Washington State ambient water quality criterion for protection of aquatic organisms. All of the exceedances were in tube sites at the northeast end of the trench or farther downstream.

The vertical distribution of chromium is not clearly defined from the fiscal year 2003 data because no shallow aquifer tubes were sampled for chromium in tube locations with significant detections at depth. Differences in chromium concentration between mid-depth and deeper tubes are variable (Figure 11). It is likely that shallow chromium concentrations are lowest, as they are in the other reactor areas.

Carbon-14 was detected at 67.2 pCi/L in tube 17-M, downgradient of the KW Reactor building and associated waste sites. Although tube 17-M had not been sampled for carbon-14 before, the deeper tube

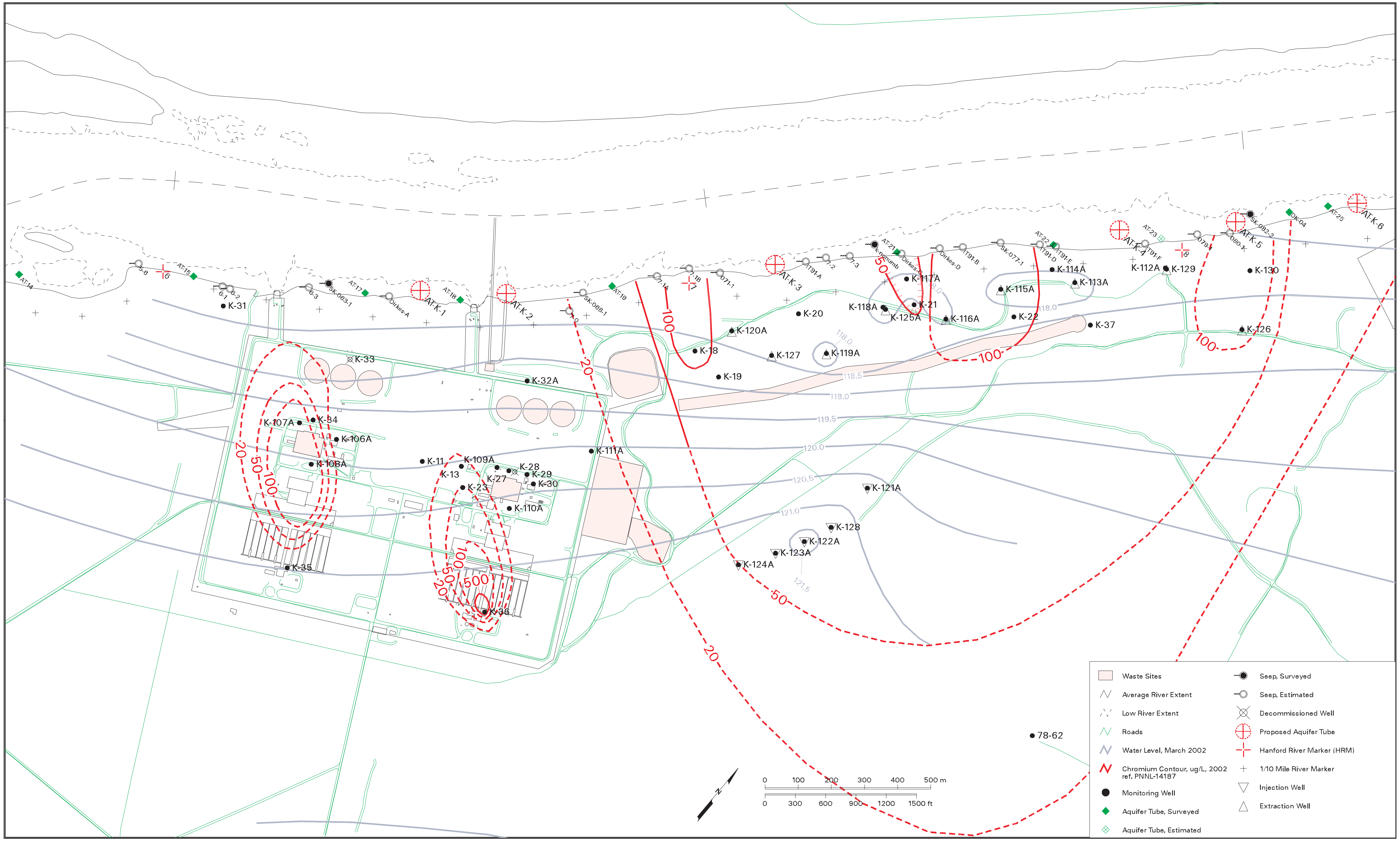

Figure 9. Locations of Aquifer Tubes, Monitoring Wells, and Fiscal Year 2002 Chromium Plume in the 100-K Area

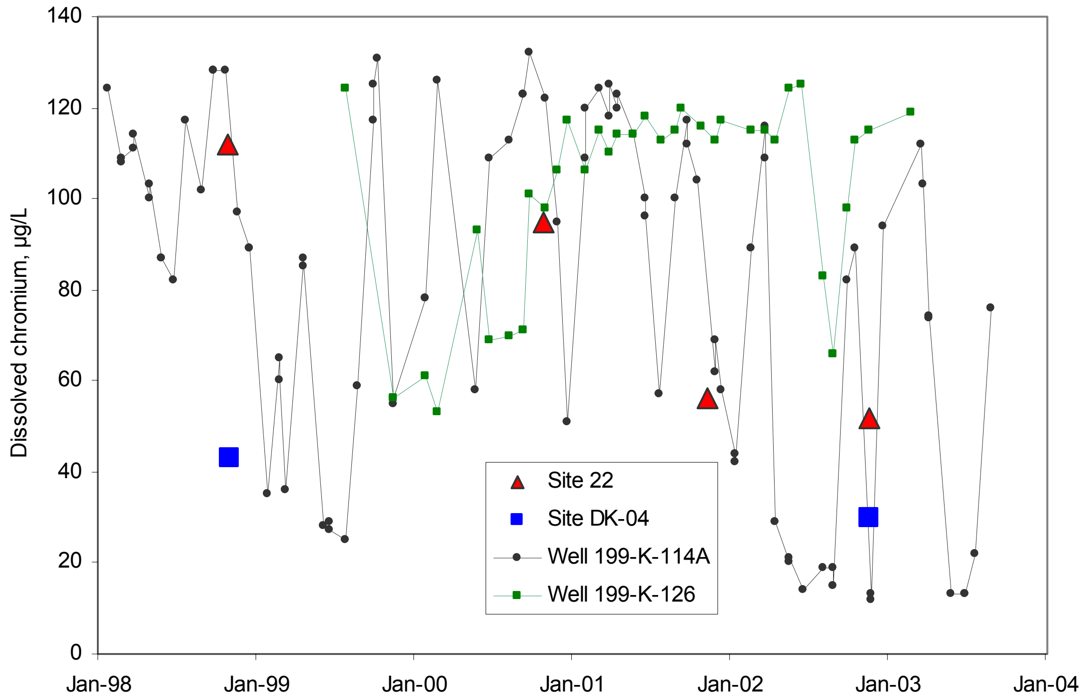

Figure 10. Annual Maximum Dissolved Chromium Concentrations in Aquifer Tube Sites 22 and DK-04 and Monitoring Wells 199-K-114A and 199-K-126

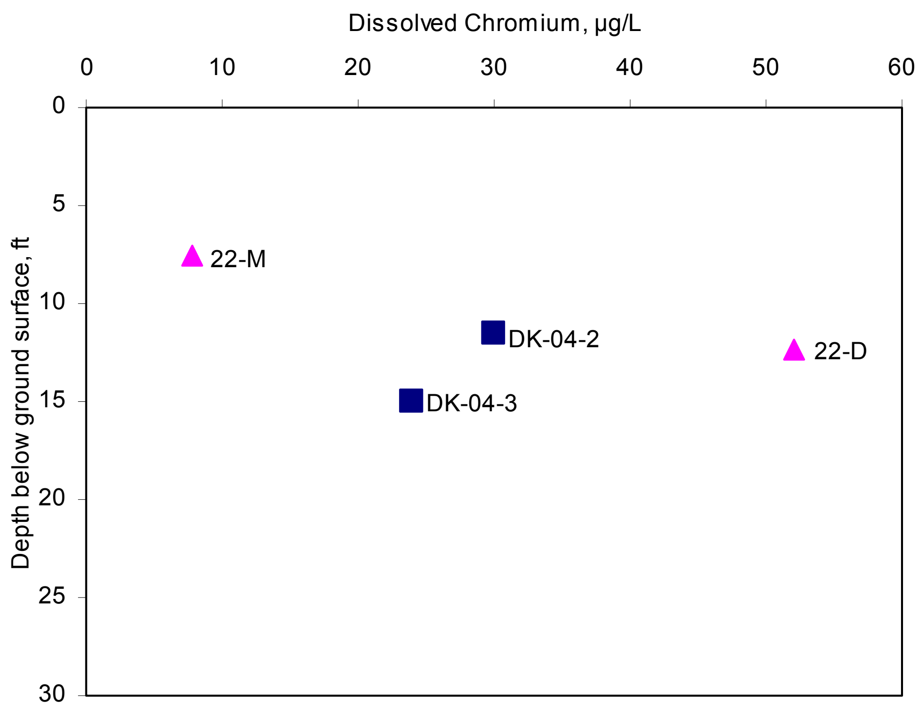

Figure 11. Chromium Concentrations with Depth in Two Aquifer Tube Sites in the 100-K Area

(17-D) detected carbon-14 at concentrations above 600 pCi/L in previous years. The deeper tube was not sampled for carbon-14 in fiscal year 2003. This tube site is downgradient of a carbon-14 plume in groundwater with concentrations >10,000 pCi/L. Carbon-14 was undetected in tube 19-D, as it was in 2000 and 2001. Nearby well 199-K-32A revealed a carbon-14 concentration of 213 pCi/L in fall 2002.

Strontium-90 was undetected in tube 19-D, which is consistent with previous measurements. Nearby well 199-K-32A has shown low, but detectable, concentrations (~2 pCi/L) in previous years. This well and tube site 19 are downgradient of a strontium-90 source near the KE Reactor building. Strontium-90 also is elevated in a few wells monitoring the 100-K trench, but aquifer tubes in that area were not sampled for strontium-90 in fall 2002. Historical data from those tubes are mostly non-detects. The drinking water standard for strontium-90 is 8 pCi/L.

Tritium was undetected at tube sites 17 and 19, downgradient of the KW and KE Reactor complexes, which include multiple past-practices waste site sources for tritium. Tritium has been detected in those tubes before at levels up to ~2,000 pCi/L. These results contrast with high tritium concentrations at nearby well 199-K-32A (>60,000 pCi/L).

Tritium was detected at 1,960 pCi/L in tube DK-04-2, downstream of the 100-K trench and upstream of 100-N Area. This value was an order of magnitude lower than the only previous result for this tube (11,000 pCi/L in 1998) and was higher than the concentration in nearby well 199-K-112A (69 to 323 pCi/L between 1998 and 2002). It is possible that the relatively elevated tritium at this tube site represents passage of a higher concentration core of the contaminant plume from past disposal to the 100-K trench. The drinking water standard for tritium is 20,000 pCi/L.

Nitrate was analyzed in one aquifer tube in the 100-K Area in fiscal year 2003. Tube 17-M, located downgradient of the KW Reactor building, contained 3.6 mg/L nitrate. In nearby monitoring wells, nitrate concentrations range from ~20 mg/L in well 199-K-31 to ~60 mg/L in well 199-K-33. Historical aquifer tube data are limited to October 1998, when nitrate concentrations ranged from 1.7 mg/L in tube 21-M to 60 mg/L (a questionable result) in tube 26-S (near 100-N Area).

Technetium-99 was undetected in tube 19-D, the only tube sample analyzed for this constituent in the 100-K Area. Technetium-99 was included in the constituent list because it is believed to be a unique indicator for fuel storage basin shielding water. It has been detected at concentrations up to ~60 pCi/L in a well downgradient of the KE Basin, which reflects the plume created by shielding water leakage in 1993. The drinking water standard for technetium-99 is 900 pCi/L.

3.3 100-NR-2 Operable Unit (100-N Area)

Groundwater contaminants of concern monitored for the 100-NR-2 Operable Unit are strontium-90, tritium, chromium, manganese, nitrate, sulfate, and petroleum hydrocarbons (DOE/RL 2000a). No aquifer tubes were installed along the 100-N Area shoreline because of the basalt rip-rap covering the shoreline. Figure 12 shows locations of aquifer tubes just upstream and downstream of the 100-N Area. Pertinent results for those tubes are discussed in the sections on 100-K and 100-D Areas. Thirteen "seep wells," which are carbon-steel casings installed in the rip-rap as part of an earlier N Springs

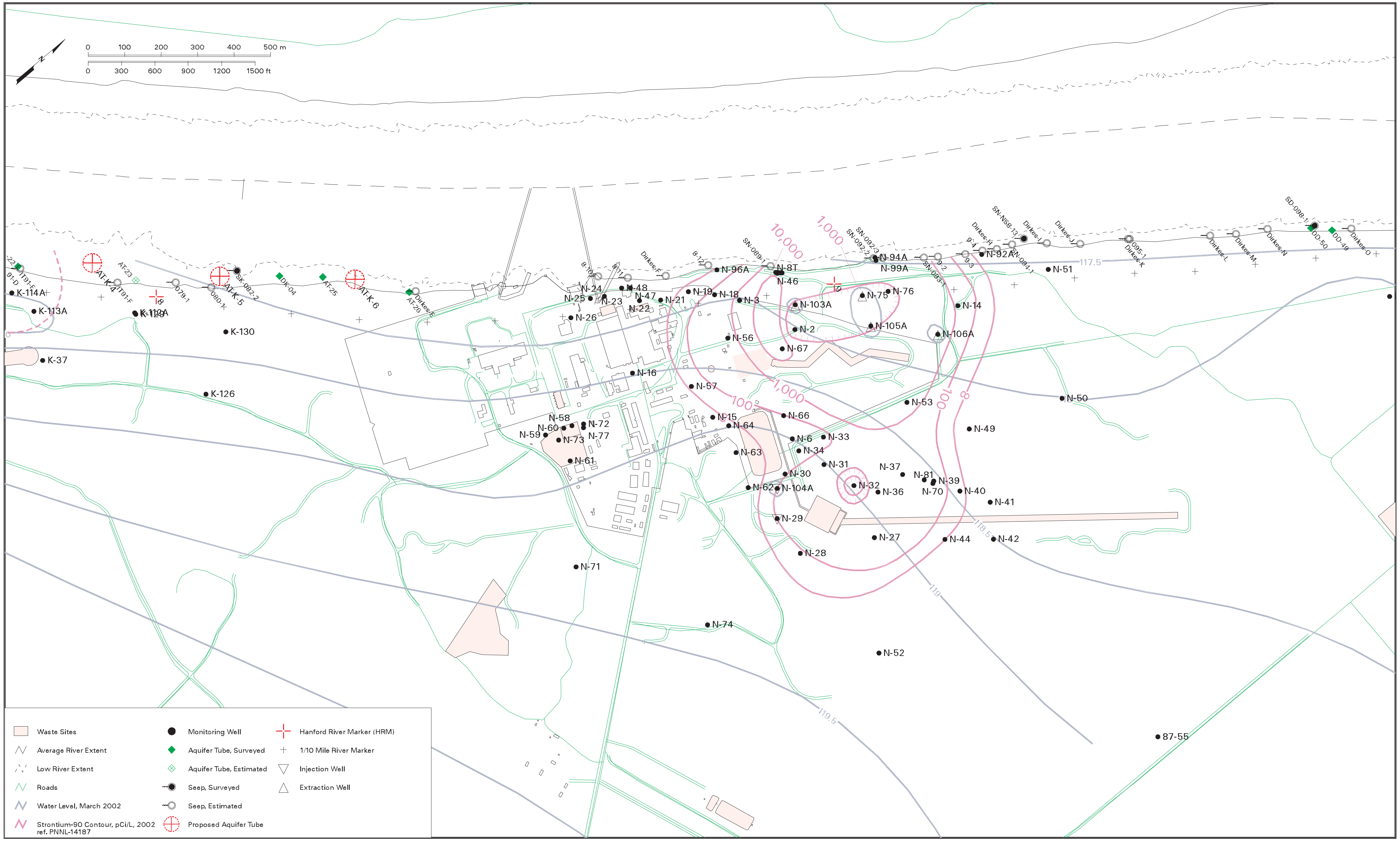

Figure 12. Locations of Aquifer Tubes, Monitoring Wells, and Fiscal Year 2002 Strontium-90 Plume in the 100-N Area

environmental monitoring project, are sampled annually to support the near-field monitoring program (Figure 13). Samples from the seep wells are analyzed for strontium-90, tritium, and additional radionuclides. Specific conductance of the samples is not recorded. Strontium-90 and tritium data from the seep wells are included in this discussion because they are somewhat representative of groundwater near locations of discharge to the river. Investigation of potential additional use of seep wells as monitoring sites for the strontium-90 plume is underway during fall 2003.

Strontium-90 concentrations generally have been declining in the seep wells (Figure 14). The segment of shoreline represented by seep wells NS-3 and NS-4 consistently shows the highest strontium-90 concentrations. This area is downgradient of the 1301-N crib, where strontium-90 concentrations in groundwater also are highest. The maximum concentration of strontium-90 in a 100-N Area seep well in fall 2002 was 82 pCi/L in NS-3 (Figure 15). Strontium-90 concentrations decreased by 2 orders of magnitude between 1987 and 2002.

The variability in strontium-90 concentrations in seep wells relates to operational status of disposal facilities and water levels in the aquifer. Until 1991, strontium-90 concentrations were high because the 116-N-3 facility was still in operation for disposal of liquid effluent containing strontium-90. Since 1991, variations in strontium-90 concentrations correlate with water table elevations, which are determined by river stage (see Figure 15). When the water table is high, it rises into sediment that was formerly saturated by the groundwater mound beneath the 116-N-1 facility. The water mobilizes some of the sorbed strontium from this horizon and concentrations increase in monitoring wells and the seep wells. Conversely, when river stage is low (e.g., 1992 to 1995), the aquifer lies entirely within the deeper, less-contaminated part of the aquifer. Average river stage was low in 2000, 2001, and 2002, and strontium-90 concentrations were correspondingly low in seep wells.

Tritium concentrations have declined by orders of magnitude since the 1980s as a consequence of cessation of effluent disposal and radioactive decay (Figure 16). A peak in tritium concentrations in seep well NS-3 occurred at the same time as the strontium-90 increase (1996). It is unclear why tritium, a highly mobile constituent that does not adsorb to aquifer sediments, would increase due to high water levels. All seep well samples from fall 2002 were below detection limits for tritium. The non-detect results for 2002 may be caused, in part, by dilution with river water. In 2001, the highest tritium concentration was in seep well NS-9, which is consistent with the tritium distribution in the aquifer.

3.4 100-HR-3 Operable Unit (100-D Area)

The 100-HR-3 Operable unit includes the 100-D Area and the 100-H Area. This section discusses aquifer tube results for the 100-D Area shoreline, while Section 3.5 discusses 100-H Area tube results.

Contaminants of concern in the 100-D Area are hexavalent chromium, strontium-90, nitrate, and tritium (DOE/RL 2000a). Some tubes also were sampled for sulfate as part of the redox compliance monitoring program (DOE/RL 2000b). Figure 17 shows the locations of aquifer tubes, monitoring wells, landmarks in the 100-D Area, and the chromium distribution in the aquifer. The aquifer tubes were sampled December 18, 2002 (fenced 100-D Area) and January 9, 2003 (area immediately north of

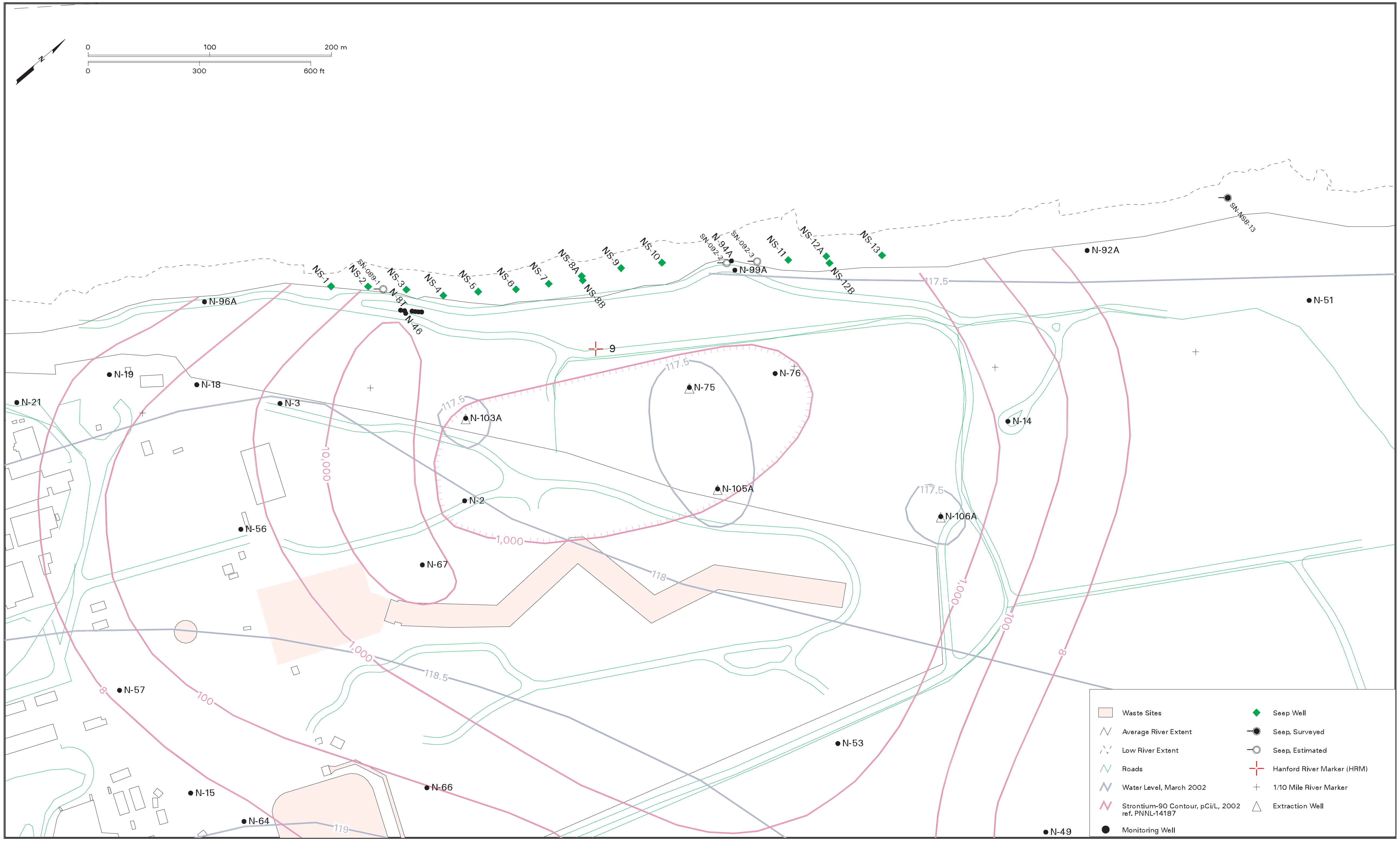

Figure 13. Locations of Seep Wells in the 100-N Area

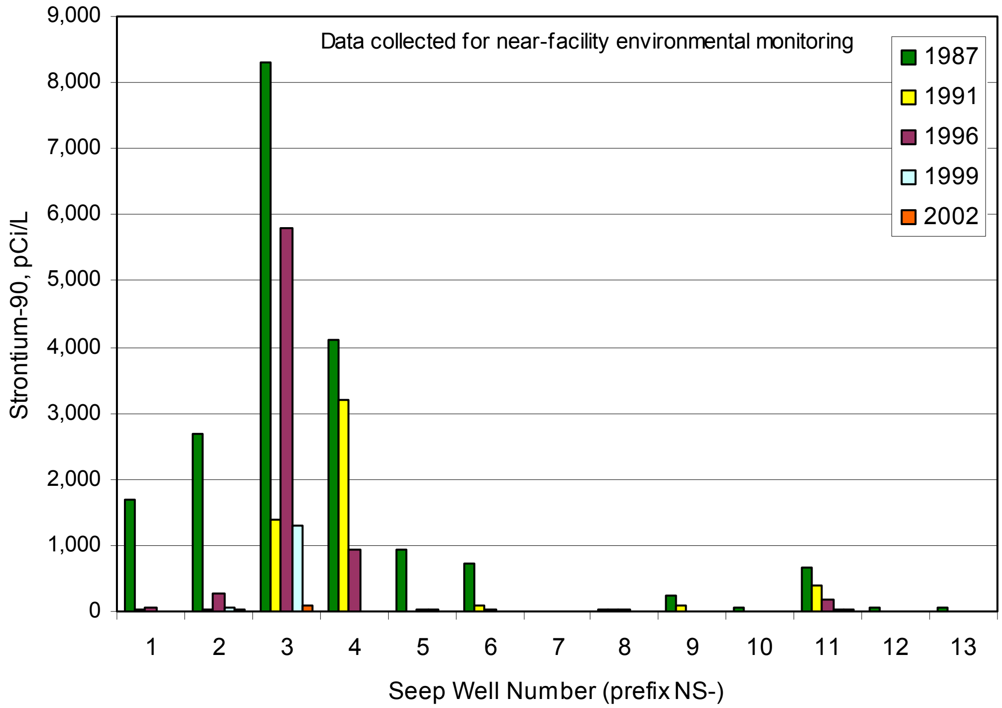

Figure 14. Strontium-90 Concentrations in 100-N Seep Wells for Selected Years

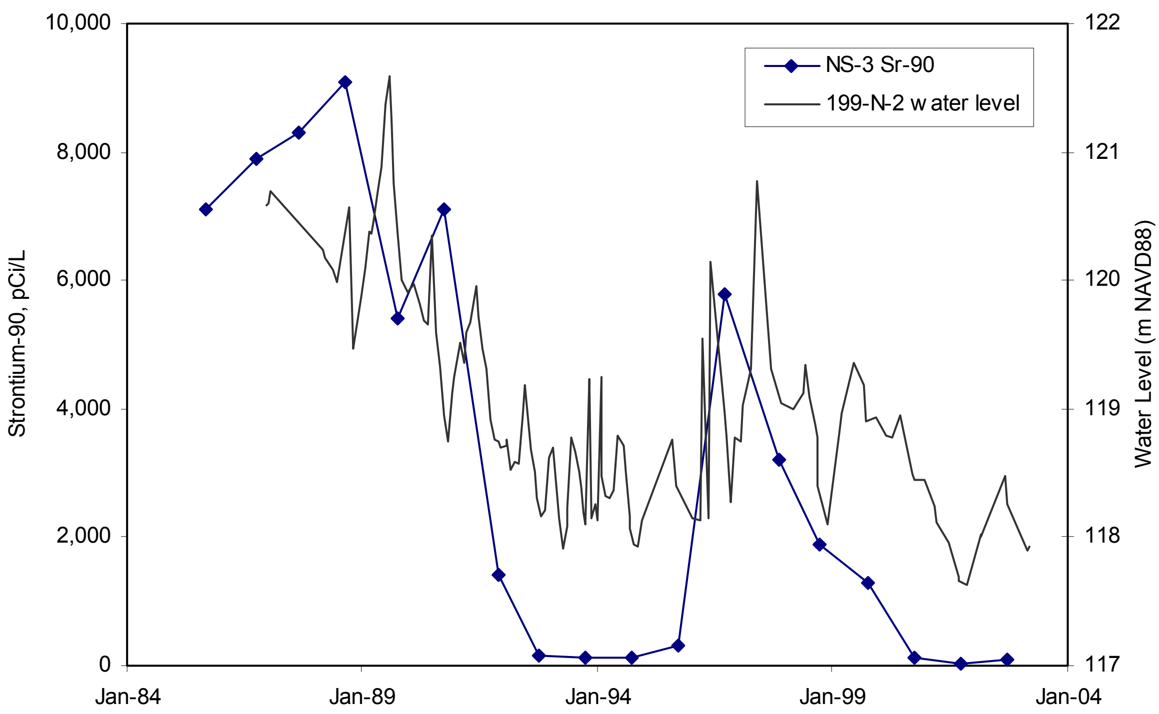

Figure 15. Strontium-90 in Seep Well NS-3 and Water Level in Monitoring Well 199-N-2

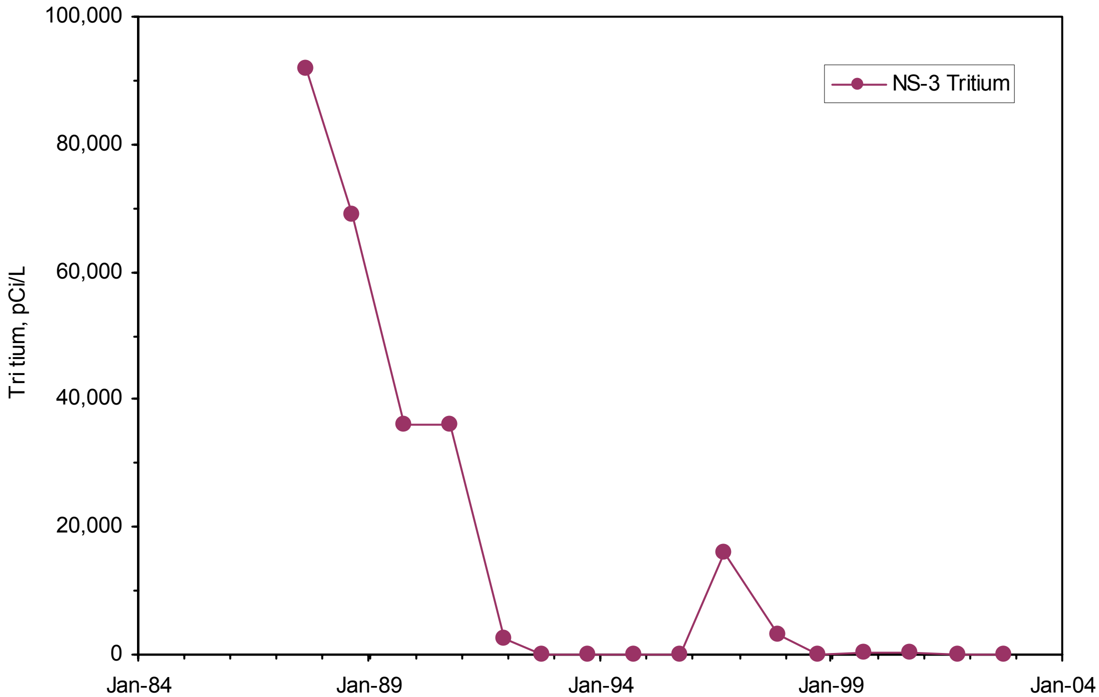

Figure 16. Tritium in Seep Well NS-3

100-D Area). Samples were analyzed for hexavalent chromium (33 samples), sulfate (12 samples), and tritium (2 samples). Most of the tubes are downgradient of the redox site in the southern 100-D Area.

Specific conductance in aquifer tube samples ranged from 124 (river water) to 611 (groundwater influenced by plumes and/or redox treatment).

Hexavalent chromium concentrations are highest in the aquifer tubes within the southwestern 100-D Area chromium plume (Figure 18). The highest value in fiscal year 2003 samples was in tube DD-42-4 at 295 µg/L, a decline from fall 2001. Figure 19 shows trend plots for tube site DD-44 and nearby well 199-D4-19. The sharp 2002 decrease in chromium concentration in well 199-D4-19 was caused by redox treatment in adjacent wells. Chromium concentrations at tube site DD-44 have decreased slightly since fall 1998.

Tube sites 166-D-1, 166-D-2, 166-D-3, and 166-D-4 (also known as redox-1, -2, -3, and -4) monitor pore water (river substrate) at shallower depths below ground surface than do the aquifer tube ports along the shoreline. Tube sites 166-D-2 and 166-D-3 were sampled in fiscal year 2003. The chromium concentration at tube sites 166-D-3 and DD-39 have varied in the past 3 years (Figure 20). The sharp decreases in chromium concentrations may have been caused by effects of the redox remediation system. Simultaneous increases in sulfate concentrations, presumably residual from redox injections, supports this conclusion (see DOE 2003b).

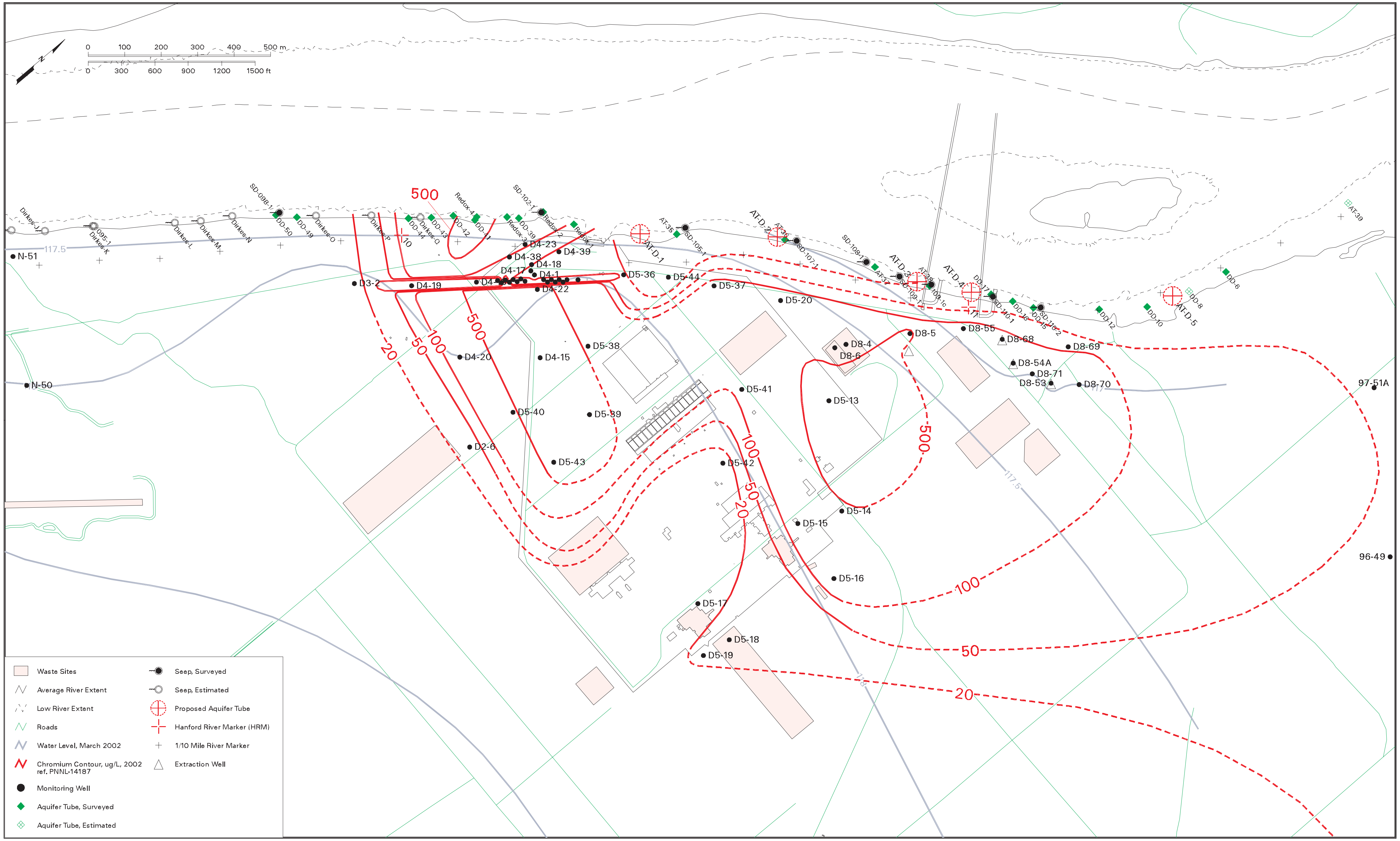

Figure 17. Locations of Aquifer Tubes, Monitoring Wells, and Fiscal Year 2002 Chromium Plume in the 100-D Area

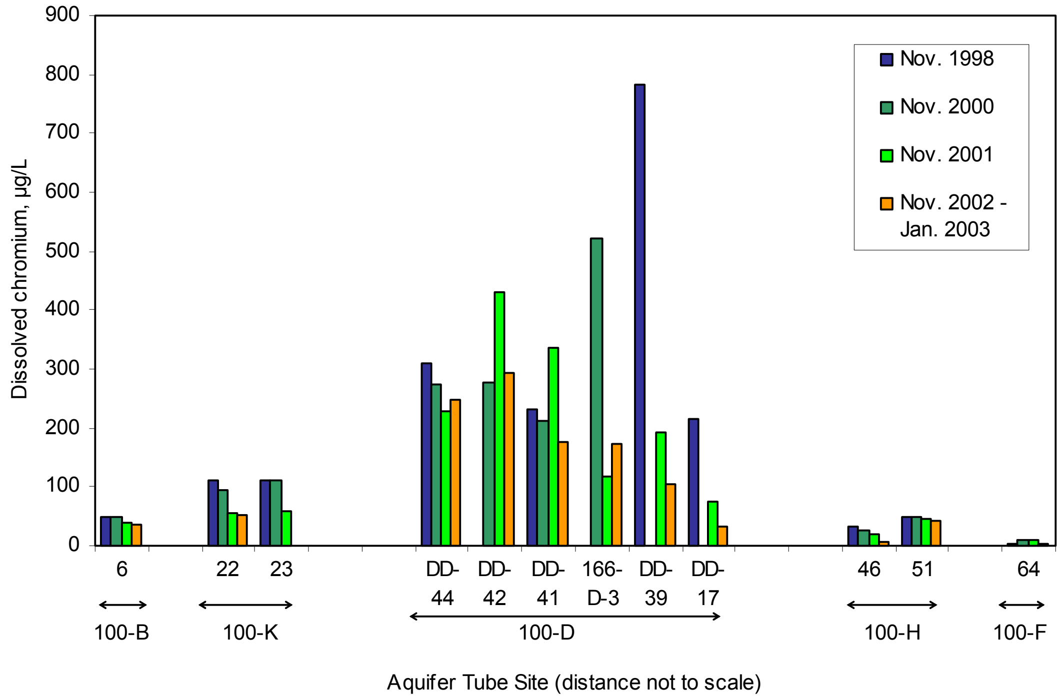

Figure 18. Dissolved Chromium at Selected Aquifer Tube Sites for Selected Years, 100 Areas

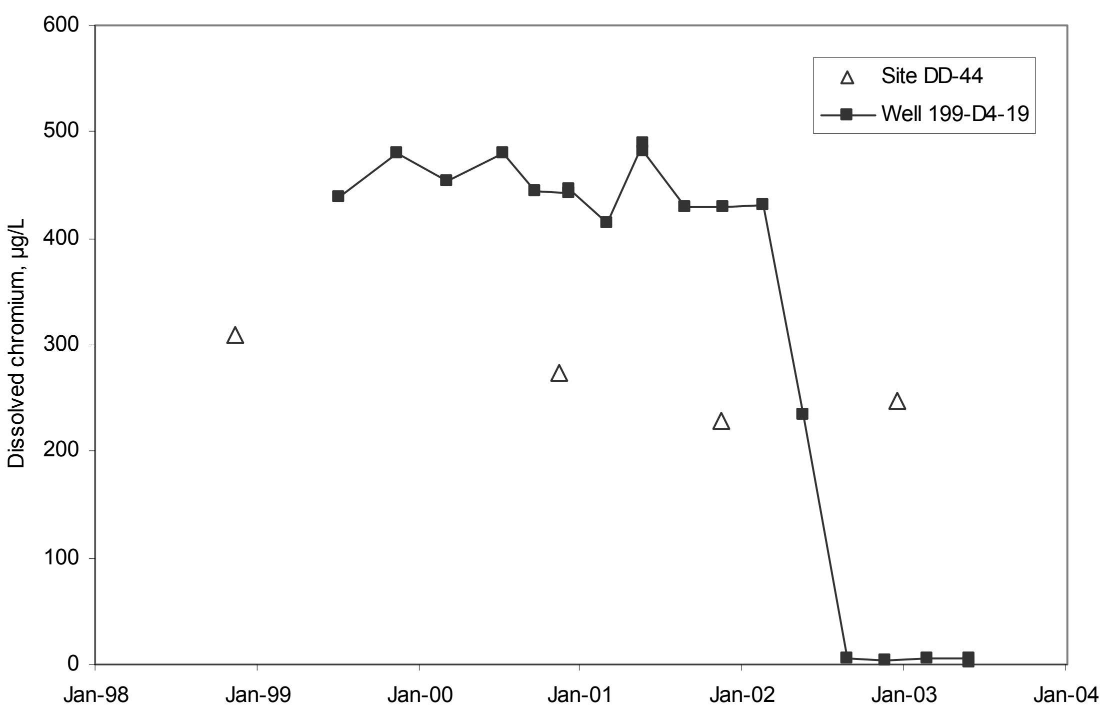

Figure 19. Annual Maximum Dissolved Chromium Concentrations in Aquifer Tube Site DD-44 and Monitoring Well 199-D4-19 Near Redox Site

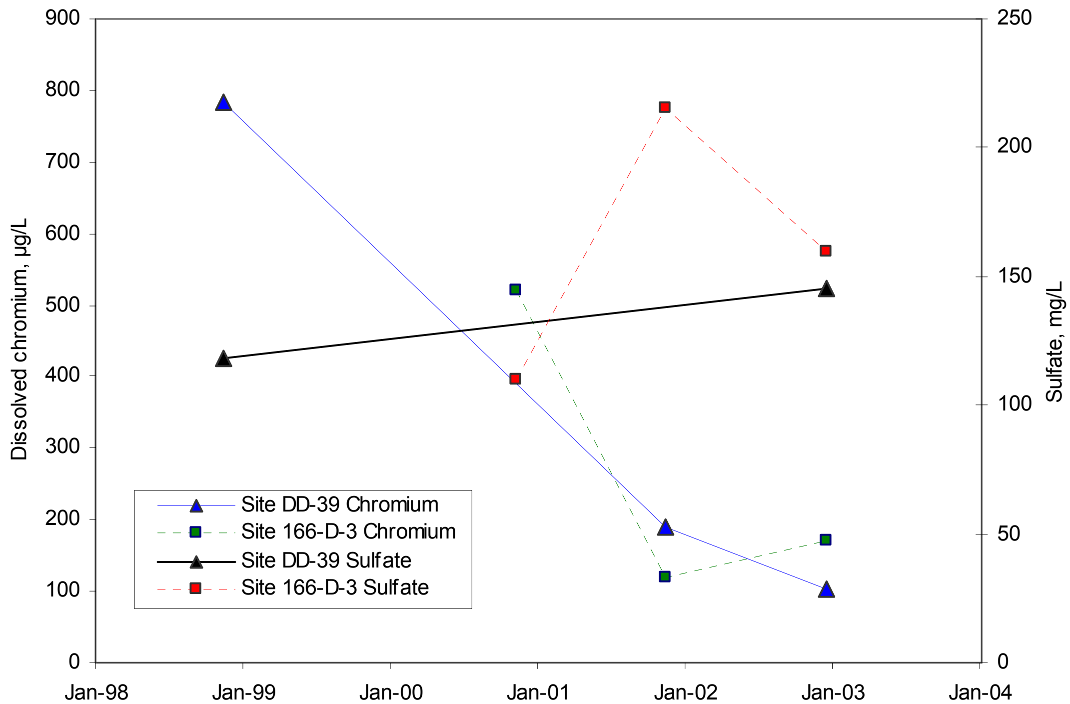

Figure 20. Annual Maximum Dissolved Chromium and Sulfate Concentrations in Aquifer Tube Sites 166-D-3 and DD-39 Near Redox Site

Chromium concentrations in aquifer tubes at sites DD-6 to DD-17, in the northern 100-D Area near the pump-and-treat extraction wells, were 8 to 34 µg/L and lower than values in previous years. The fiscal year 2003 samples from this area were diluted with river water (specific conductance <200 µS/cm), which contributed to the low chromium concentrations. Figure 21 compares chromium concentrations at site DD-17 to concentrations at nearby compliance well 199-D8-68. The trend in specific conductance of the aquifer tube samples parallels the decline in chromium. The declines could indicate actual decreases in contaminant levels (chromium, nitrate, other ions), but dilution by river water is also a factor, especially in the most recent sample, which had a specific conductance of just 166 µS/cm.

Chromium concentrations were lowest in the shallowest tubes and higher in the mid-depth and deeper tubes (Figure 22). Specific conductance of the samples follows the same vertical profile as chromium and indicates dilution with river water in the shallowest tubes.

Nineteen of the aquifer tube samples were above the 20 µg/L interim remedial action objective associated with remediation in the 100-D Area. Twenty-eight chromium results exceeded 10 µg/L, the Washington State ambient water quality criterion for protection of aquatic organisms.

Strontium-90 data were not collected from 100-D Area aquifer tubes in fiscal year 2003. Only one strontium-90 result is available from prior sampling in this area: concentrations at tube DD-17-3 were 4.8 pCi/L strontium-90 in November 1999. This detection was consistent with levels in nearby monitoring wells. The drinking water standard for strontium-90 is 8 pCi/L.

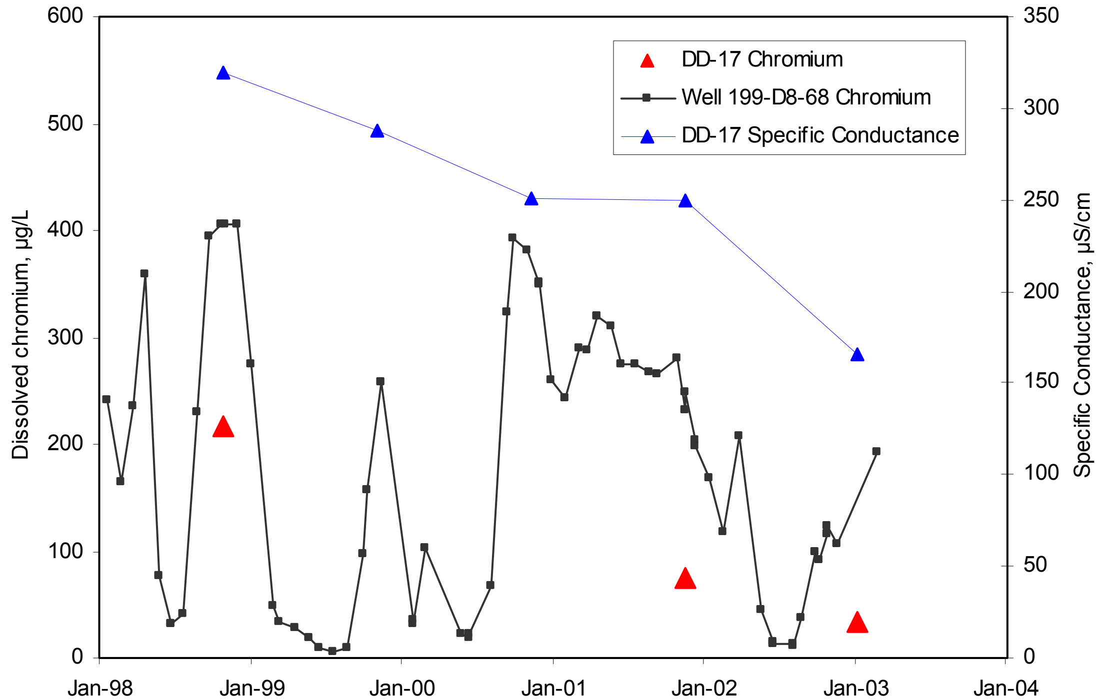

Figure 21. Annual Maximum Dissolved Chromium Concentrations in Aquifer Tube Site DD-17 and Monitoring Well 199-D8-68 Near Extraction Wells

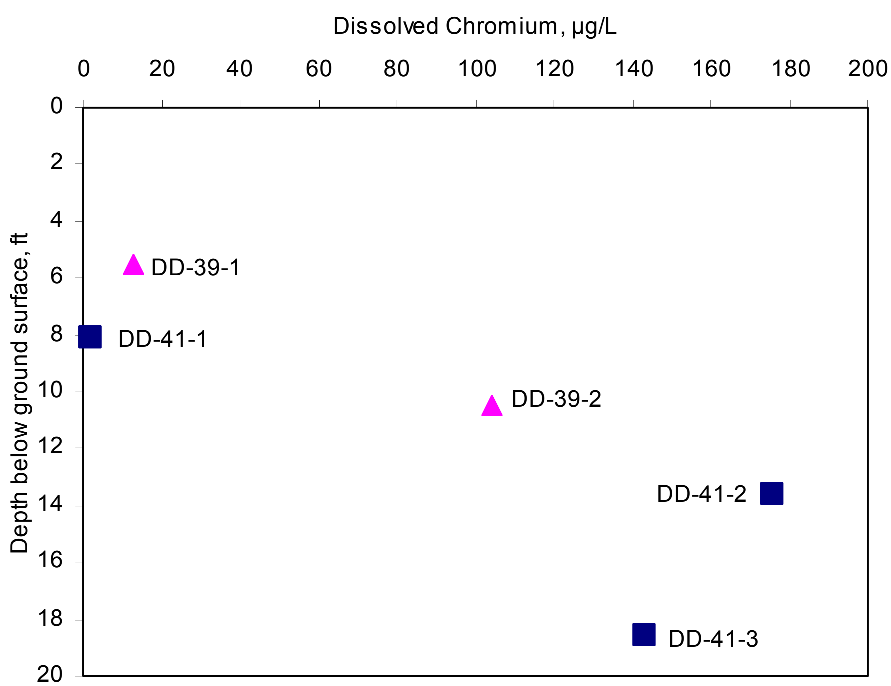

Figure 22. Chromium Concentration with Depth in Two Aquifer Tube Sites in the 100-D Area

Nitrate was not analyzed in aquifer tube samples for fiscal year 2003. Historical results are limited to samples from October 1998, which ranged from 2 to 41 mg/L. The highest concentrations were detected in aquifer tubes in the southwestern 100-D Area. Nitrate concentrations are elevated but are currently below the 45 mg/L drinking water standard beneath most of the 100-D Area.

Tritium was analyzed in samples from two aquifer tubes in the 100-D Area. Aquifer tube DD-50-3 (south of the redox site) contained 9,540 pCi/L and tube DD-44-4 (at the redox site) contained 29,700 pCi/L, which is greater than the 20,000 pCi/L drinking water standard. Figure 23 shows that concentrations have increased since fall 1998 at site DD-44 and the well upgradient of it (199-D4-19). A short distance to the south, concentrations at site DD-50 and nearby well 199-D3-2 have decreased since 1998. This pattern could be caused by northward movement of the tritium contamination. The source of this tritium presumably is the 100-N Area tritium plume.

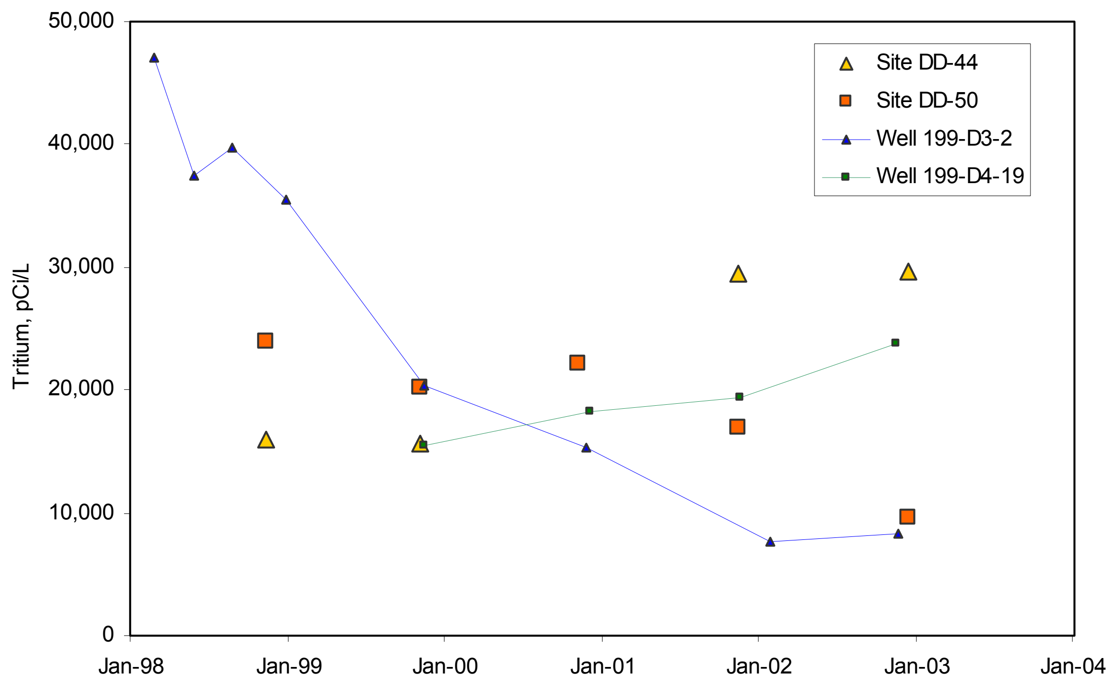

Figure 23. Annual Maximum Tritium Concentrations in Aquifer Tube Sites DD-44 and DD-50 and Monitoring Wells 199-D3-2 and 199-D4-19

Sulfate concentrations are elevated in 100-D Area groundwater from waste disposal and from aquifer treatment at the redox site. Sulfate concentrations in groundwater upgradient of the redox influence range up to 160 mg/L, as did samples from the aquifer tubes downgradient of the redox site. The data indicate that residual chemicals from redox injections may cause elevated sulfate concentrations in some aquifer tubes (see discussion under ***hexavalent chromium*** above). However, the effect is not far-reaching and levels are below the 250 mg/L secondary drinking water standard.

Oxidation-reduction potential was measured for the first time in fiscal year 2003; dissolved oxygen data were not collected. These parameters are of interest because an influx of low-oxygen water to the river could harm aquatic life near the point of discharge. Oxidation-reduction potential ranged from 161 to 216 mV near the redox site. Aquifer tubes outside the redox area (south and north) revealed values in the same range.

3.5 100-HR-3 Operable Unit (100-H Area)

Contaminants of concern in the 100-H Area are hexavalent chromium, strontium-90, fluoride, nitrate, technetium-99, tritium, and uranium (DOE/RL 2000a). Figure 24 shows the locations of aquifer tubes, monitoring wells, landmarks in the 100-H Area, and the areal extent of chromium contamination in the aquifer. The aquifer tubes were sampled January 14 and 15, 2003. Samples were analyzed for hexavalent chromium (19 samples). Strontium-90 and technetium-99 were analyzed in one sample.

Specific conductance ranged from 143 μS/cm (primarily river water) to 522 μS/cm (groundwater influenced by contamination).

Hexavalent chromium concentrations continued to decline in aquifer tube 46-D, located near extraction wells 199-H4-12A and 199-H4-15A (Figure 25). The decline is consistent with decreasing chromium concentrations in many 100-H Area monitoring wells, and may be partially caused by the removal of chromium via the pump-and-treat system. The fiscal year 2003 sample from tube 46-D was diluted by river water (specific conductance 183 μS/cm), but the data do not indicate that the entire 4-year decline is related to sample dilution.

The highest 2003 chromium concentration in the 100-H Area was 43 μg/L in tube 51-D (south of the main 100-H Area), which was consistent with a gradually declining trend (Figure 26). Chromium concentrations at site 48, slightly north of site 51, and in nearby well 199-H6-1, show a more prominent, decreasing trend (Figure 26). The chromium plume appears to be migrating along the river at concentrations below the drinking water standard of 100 μg/L.

Chromium concentrations were lowest in the shallowest tubes and higher in the mid-depth and deeper tubes (Figure 27). Specific conductance of the samples follows the same vertical profile as chromium and indicates dilution with river water in the shallowest tubes.

Strontium-90 was undetected in tube 48-M, the only site where it was analyzed in fiscal year 2003. This result is consistent with historical data (undetected at sites 48, 49, and 50). There is a strontium-90 plume in groundwater to the north and inland from these tubes; source is likely past disposal to the 107-H retention basins and nearby 100-H liquid waste disposal trench. The aquifer tube results are used to interpret the southern edge of the strontium-90 plume in the aquifer.

Fluoride was not analyzed in aquifer tube samples for fiscal year 2003. Historical data are limited to 10 non-detect values in tubes sampled in 1998. Fluoride concentrations currently are not elevated in 100-H Area groundwater.

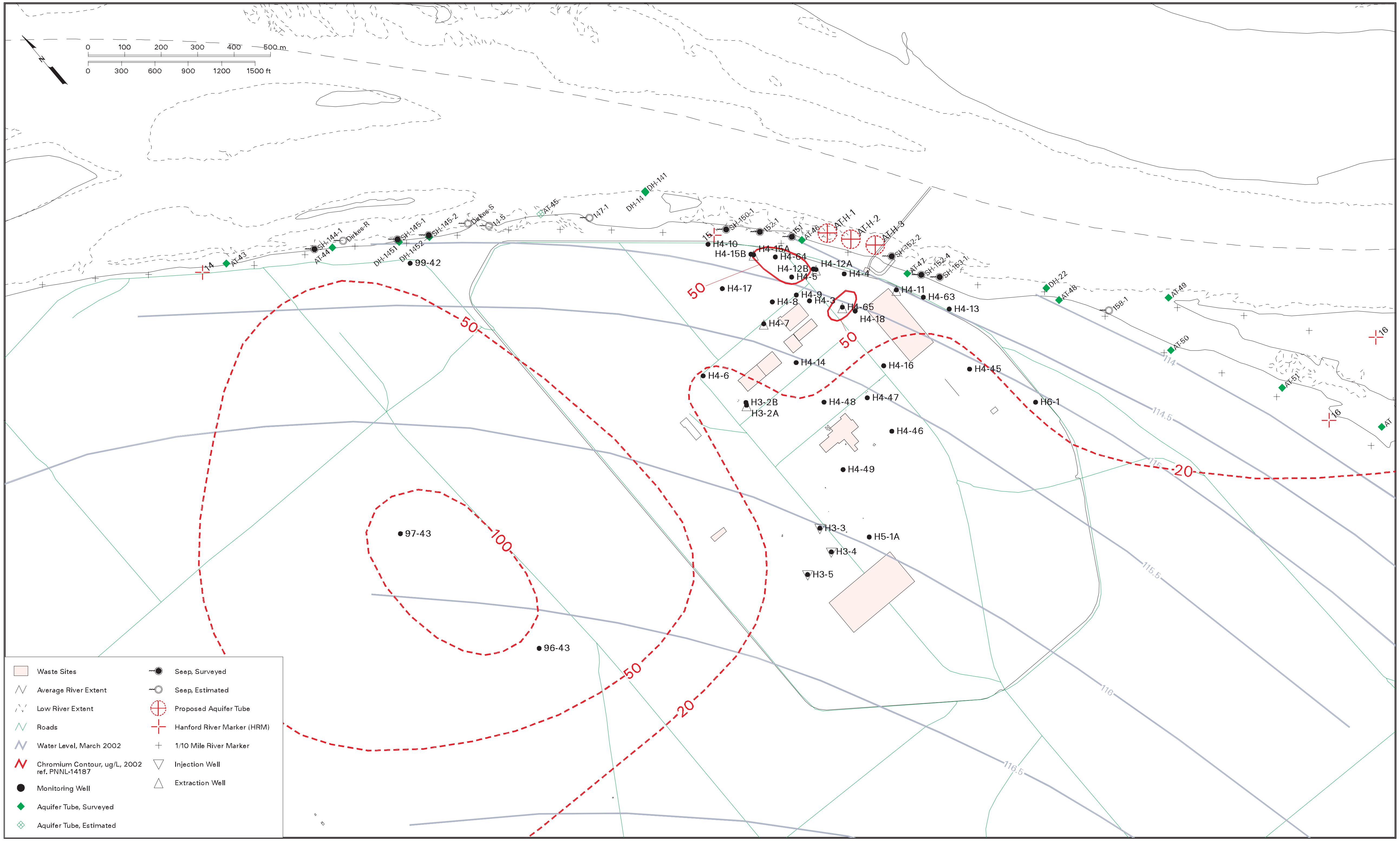

Figure 24. Locations of Aquifer Tubes, Monitoring Wells, and Fiscal Year 2002 Chromium Plume in the 100-H Area

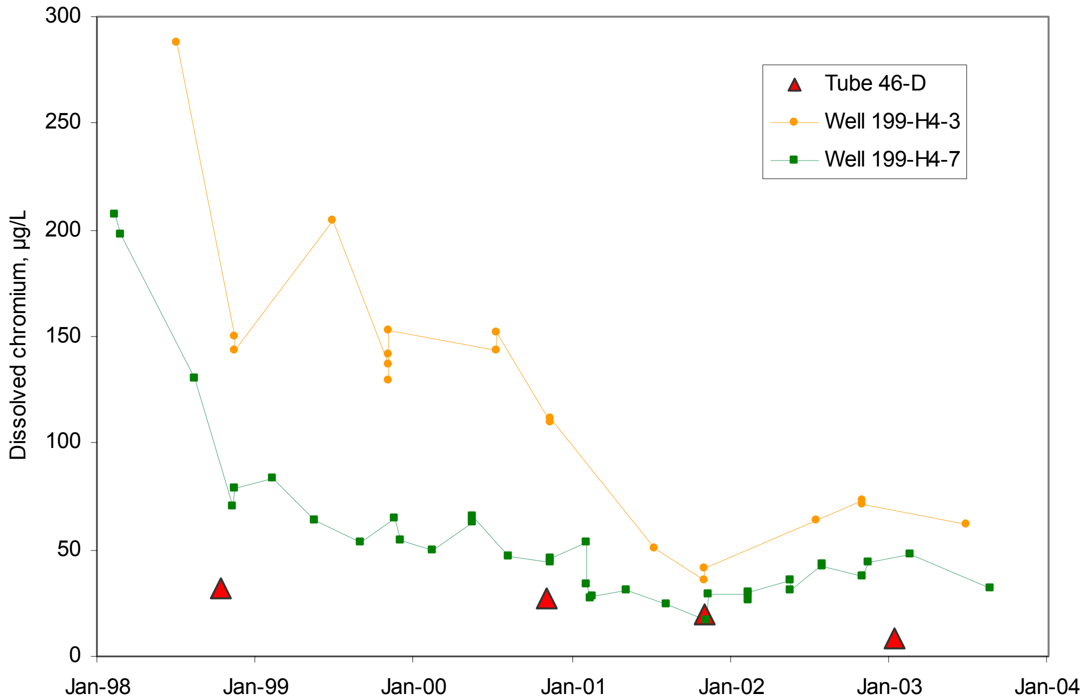

Figure 25. Dissolved Chromium Concentrations in Aquifer Tube 46-D and Monitoring Wells 199-H4-3 and 199-H4-7, Central 100-H Area

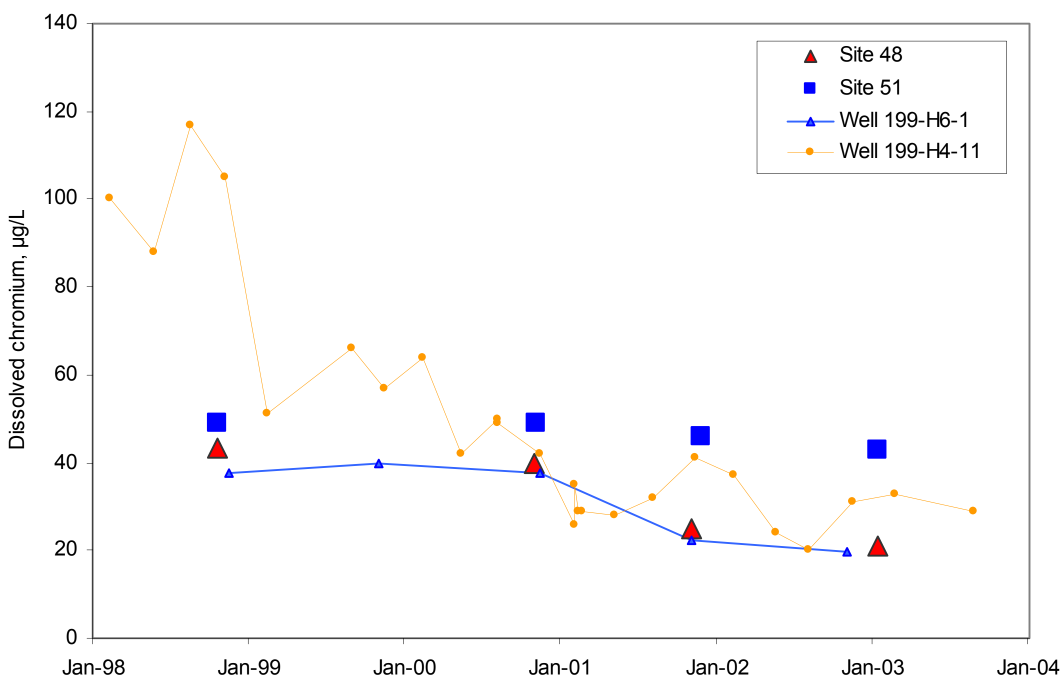

Figure 26. Annual Maximum Dissolved Chromium Concentrations in Aquifer Tube Sites 48 and 51 and Monitoring Wells 199-H4-11 and 199-H6-1, Southern 100-H Area

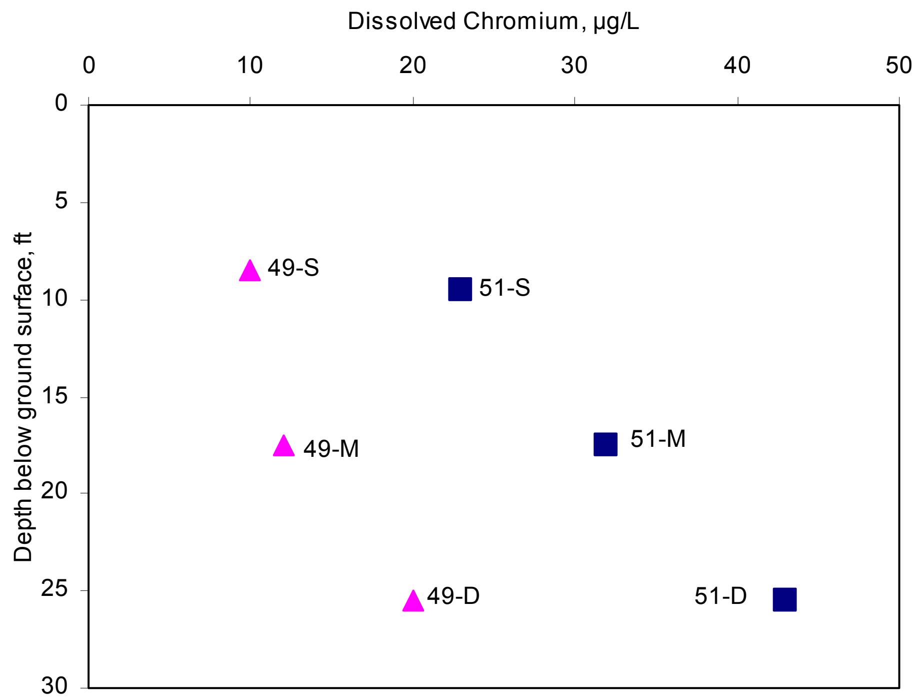

Figure 27. Chromium Concentrations with Depth in Two Aquifer Tube Sites in the 100-H Area

Nitrate was not analyzed in aquifer tube samples for fiscal year 2003. Historical results are limited to seven samples for October 1998, which ranged from 12 to 50 mg/L. The highest concentration in groundwater in November 2002 was 255 mg/L in well 199-H4-3. The drinking water standard for nitrate is 45 mg/L.

Technetium-99 was undetected in tube 46-D, the only site where it was measured in fiscal year 2003. The recent value is consistent with an undetected result from 1998. Technetium-99 concentrations in nearby monitoring wells range from undetected (well 199-H4-15A) to 177 pCi/L (June 2003, well 199-H4-12A). Technetium-99 concentrations in 100-H Area groundwater are declining; the only documented source is liquid effluent stored in the former 183-H Solar Evaporation Basins. The drinking water standard is 900 pCi/L.

Tritium was not analyzed in aquifer tube samples from the 100-H Area for fiscal year 2003. Historical data are limited to seven tubes sampled in 1998, when concentrations ranged from <200 to 4,300 pCi/L. Those values are consistent with concentrations in the aquifer. The drinking water standard for tritium is 20,000 pCi/L.

Uranium was not analyzed in aquifer tube samples for fiscal year 2003. Historical data are limited to two detections at very low levels in October 1999 (1.3 µg/L in tube 47-D and 6.9 µg/L in tube 48-M). As with technetium-99, the only documented source is liquid effluent stored in the former 183-H Solar Evaporation Basins. Uranium concentrations in the aquifer have declined below the 30 µg/L drinking water standard in recent years.

3.6 100-FR-3 Operable Unit (100-F Area)

Contaminants of concern in the 100-F Area are hexavalent chromium, gross alpha, gross beta, nitrate, strontium-90, trichloroethene, and tritium (DOE/RL 2000a). Figure 28 shows the locations of aquifer tubes, monitoring wells, landmarks in the 100-F Area, and nitrate distribution in the aquifer. The aquifer tubes were sampled January 16, 2003. Samples were analyzed for hexavalent chromium (12 samples) and strontium-90 (4 samples).

Specific conductance ranged from 133 μS/cm to 444 μS/cm. Most were <200 μS/cm, indicating that the samples were diluted with river water.

Hexavalent chromium is not a major contaminant in 100-F Area groundwater. Concentrations in aquifer tube samples for fiscal year 2003 ranged from undetected to 14 μg/L. The latter was in tube 63-M, where chromium has not been measured before.

Figure 29 shows chromium trends in aquifer tube sites 64 and 66 and monitoring well 199-F5-44, located near the shore between those tube sites. Historical chromium concentrations in tube sites 64 and 66 range from 3 to 10 μg/L, typical values for 100-F Area aquifer tubes. Chromium concentrations in monitoring well 199-F5-44 are higher and variable. As in the other 100 Areas, aquifer tube concentrations tend to increase with depth (Figure 30).

Nitrate is a constituent of interest in 100-F Area groundwater but was not analyzed in aquifer tube samples in fiscal year 2003. Historical data are limited to six results from November 1998. These ranged from 8 to 16 mg/L in the 100-F Area itself, and up to 49 mg/L in tube 75-M, downgradient (southeast) of the 100-F Area (Figure 1). Concentrations in groundwater exceed the 45 mg/L drinking water standard beneath a large portion of the 100-F Area and the region downgradient. The plume is oriented parallel to the river.

Strontium-90 was detected in one of the four tubes analyzed in fiscal year 2003, tube 64-D (1.91 pCi/L). Historical data are limited to two results collected in November 2000 (1.7 pCi/L in tube 64-D and undetected in tube 66-M). The highest strontium-90 concentration in nearby well 199-F6-1 was 6.6 pCi/L in fall 2002. The drinking water standard is 8 pCi/L.

Gross alpha, gross beta, trichloroethene, and tritium were not analyzed in 100-F Area aquifer tube samples in fiscal year 2003. Historical data are limited, but show undetectable to near-background levels of gross alpha and gross beta. Tritium concentrations ranged from undetected to 1,100 pCi/L. Trichloroethene and other volatile organic compounds have not been included for samples from aquifer tubes (Table 1-2 in DOE/RL 2000a).

3.7 Hanford Town Site

The former Hanford town site is located near the Columbia River in the east-central Hanford Site and is part of the 200-PO-1 Operable Unit. Contaminants of concern for aquifer tube sampling are

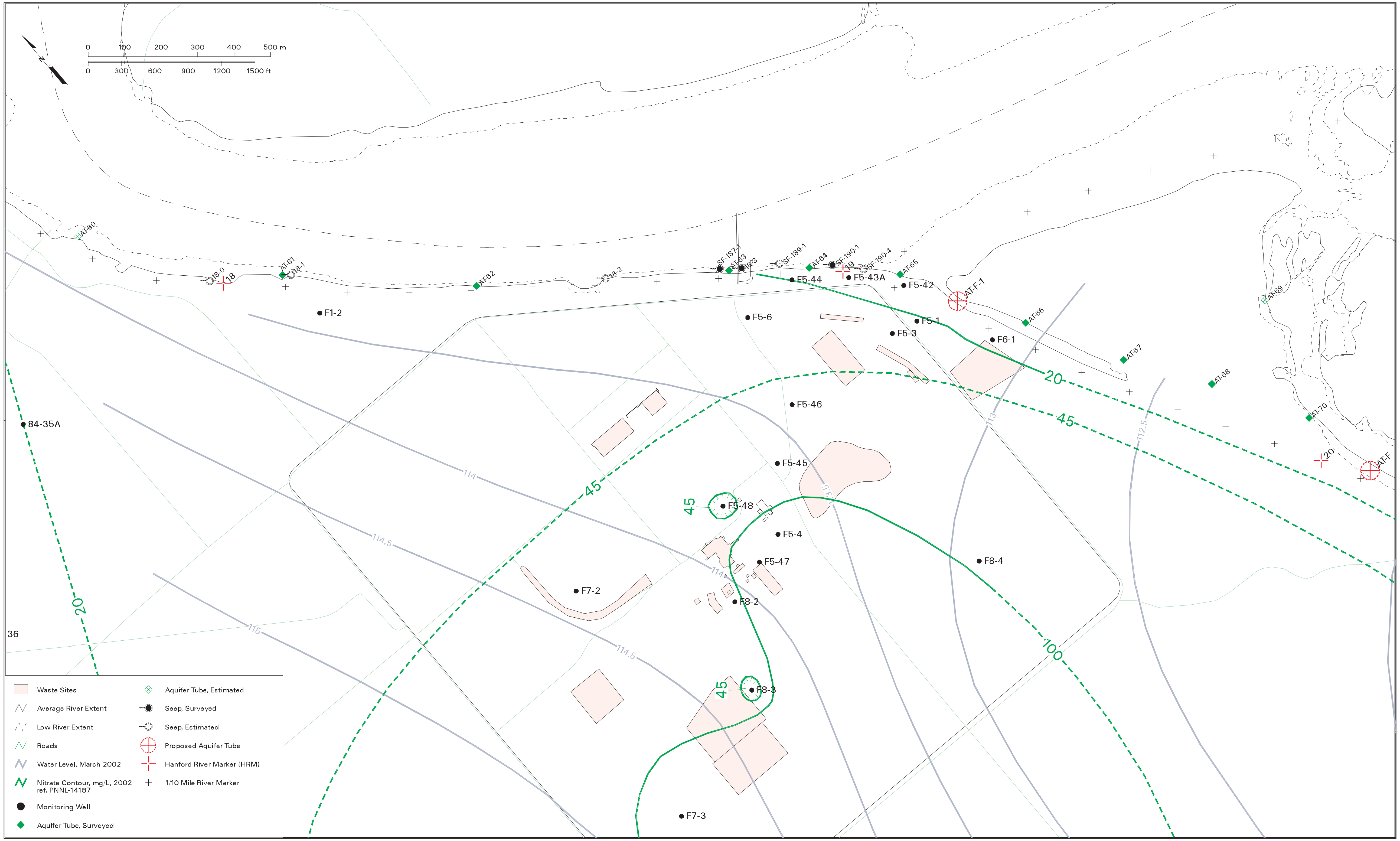

Figure 28. Locations of Aquifer Tubes, Monitoring Wells, and Fiscal Year 2003 Nitrate Plume in the 100-F Area

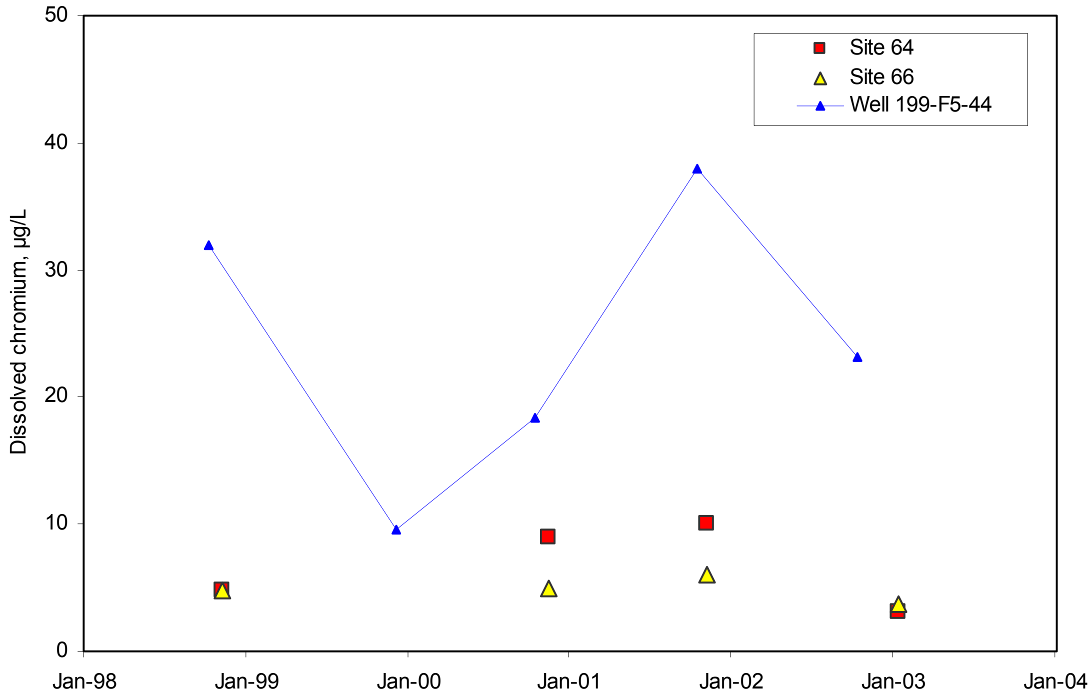

Figure 29. Dissolved Chromium Concentrations at Aquifer Tube Sites 64 and 66 and Monitoring Well 199-F-5-44

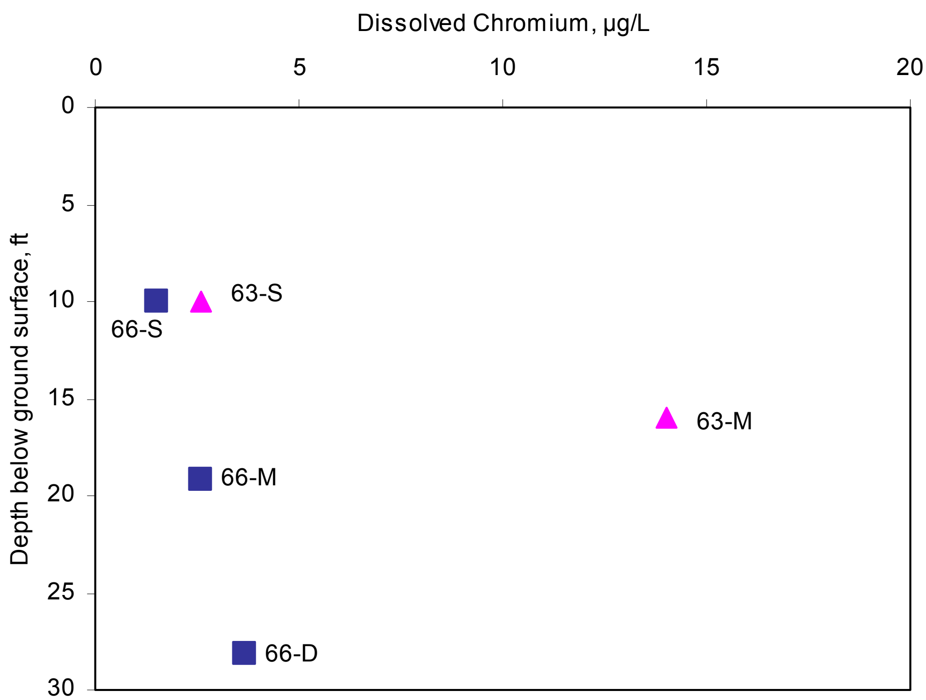

Figure 30. Chromium Concentrations with Depth in Two Aquifer Tube Sites in the 100-F Area

hexavalent chromium, nitrate, gross alpha, gross beta, and tritium (DOE/RL 2000a). Groundwater in this area is contaminated with tritium at levels exceeding the 20,000 pCi/L drinking water standard (see Figure 1 for locations of sampling tubes near the Hanford town site).

The aquifer tubes in this area were not sampled in fiscal year 2003, and historical data are limited. The highest tritium concentration in historical data was 12,600 pCi/L in tube 84-D in November 1997. This compares to values of 80,000 to 180,000 pCi/L for groundwater at nearby monitoring wells.

3.8 300-FF-5 Operable Unit (300 Area)

The 300-FF-5 Operable Unit includes the 300 Area and the 618-10 and 618-11 burial grounds, which are located farther north and inland. There are currently no aquifer tubes installed along the 300 Area shoreline, although installations are planned for fiscal year 2004.

4.0 Conclusions

This section presents conclusions based on fiscal year 2003 aquifer tube results, historical data, and data from near-shore monitoring wells. This section lists the objectives of the sampling tube program as described in Section 1.1 of this report, and describes how well the program supported these objectives in fiscal year 2003.

Describe the nature, concentration, and extent of chemical and radiological indicators in groundwater at locations adjacent to the river: The aquifer tube results meet this objective for the major contaminants of concern in near-shore groundwater. The objective is not met as well for lower priority contaminants of concern.

The table on the next page lists the maximum concentration of the contaminants of concern in fiscal year 2003 aquifer tube samples. Bold values exceed aquatic or drinking water standards.

Verify the presence or absence of groundwater contamination at other locations along the Hanford Site shoreline: Seventy-nine aquifer tubes at 40 locations were sampled in fiscal year 2003, supplementing data from near-river wells and seeps. These data helped identify contaminant distribution along the river where there are few or no monitoring wells. For example, aquifer tube data reveal the following areas where contamination appears to be moving parallel to the river farther than could be interpreted from monitoring well data alone:

- chromium and tritium from 100-K Area
- tritium from 100-N Area
- chromium from 100-H Area
- tritium and technetium-99 from 200-East Area detected between 100-B and 100-K Areas

Groundwater Constituent of Concern and Standard	100-B	100-K	100-D	100-H	100-F
Chromium: DWS 100 μg/L, AWQC 11 μg/L	**38 μg/L**	**52 μg/L**	**295 μg/L**	**43 μg/L**	**14 μg/L**
Nitrate: DWS and AWQC 45 mg/L	Not a COC	3.6 mg/L	NA	NA	NA
Strontium-90: DWS and AWQC 8 pCi/L	**15 pCi/L**	ND	NA	ND	1.9 pCi/L
Tritium: DWS and AWQC 20,000 pCi/L	**32,200 pCi/L**	ND	**29,700 pCi/L**	NA	NA
Other		Carbon-14: 67.2 pCi/L TCE: NA		Technetium-99: ND; fluoride, uranium: NA	Alpha, beta, TCE: NA
AWQC = Ambient water quality criteria. COC = Constituent of concern. DWS = Drinking water standard. NA = Not analyzed. ND = Not detected. TCE = Trichloroethene.					

Describe the vertical distribution of contaminants with depth in the aquifer near the Columbia River: Most aquifer tube sites include two or three tubes, which monitor different depths in the aquifer. Specific conductance and contaminant concentrations vary with aquifer tube depth. Lowest specific conductance and contaminant concentrations occur in the shallowest tubes, which are most affected by dilution with river water. This discussion focuses on chromium distribution because it was the most widely measured contaminant in fiscal year 2003. In virtually all cases, the shallow tubes, monitoring near the top of the saturated zone, contained the lowest levels of chromium and specific conductance. In many cases, the difference between shallow and deeper concentrations was large (e.g., shallow tube DD-39-1 at 13 μg/L and deeper tube DD-39-2 at 104 μg/L).

The highest chromium concentration in a shallow tube (excluding pore water tubes) was 23 μg/L in tube 51-S, south of the 100-H Area. Five shallow tubes exceeded the 10 μg/L aquatic standard. All of these were located either south of the 100-H Area or in the southwestern 100-D Area.

There is no obvious relationship between depth and chromium concentrations in the tubes completed at mid-level and bottom of the aquifer. Specific conductance reflected which tubes have the highest chromium concentrations.

There is insufficient data to determine vertical distribution for other contaminants of concern. Radionuclides and nitrate were analyzed only in samples from mid-level or deep tubes, and only in one tube per site.

Monitor the performance of interim remedial actions that are underway at the 100-H, 100-K, and 100-D Areas: Aquifer tube data supplement data from performance monitoring wells when evaluating the performance of interim remedial measures (DOE/RL 2000b; DOE/RL 2003). The success or limitations of the interim measures will be considered in developing final remediation strategies. Aquifer tube data show declining trends in chromium concentrations near the following interim remediation action sites:

- 100-K Area (pump-and-treat)
- northern 100-D Area plume (pump-and-treat)
- southwest 100-D Area plume (redox site)
- 100-H Area (pump-and-treat)

However, it is premature to conclude that the concentration declines were caused solely by the interim remedial actions. Natural processes (e.g., dilution, dispersion) are also reducing the level of contamination in the nearshore areas. There are too few data points in the aquifer tube trend plots to attribute trends conclusively to a specific cause.

The *Sampling and Analysis Plan for Aquifer Sampling Tubes* (DOE/RL 2000a) states the following additional objectives.

Supplying data for risk assessments: Monitoring contaminant concentrations in pore water in the river bed provides a baseline for assessing the potential for impacts on early life stages of salmon and other shoreline biota. The southwestern shoreline in the 100-D Area is the only location where pore water tubes are installed that were re-sampled during fiscal year 2003 (re-sampleable pore water tubes were also installed at the 100-K and 100-H Areas in 1996, though their current condition and viability for sampling are unknown). Data from these and similar pore water sampling tubes, along with aquifer tubes, will support impact studies.

Supporting monitoring efforts for other Hanford Site projects: Analytical data from aquifer tubes are stored in the HEIS database, where they are available for use by other Hanford Site projects, regulators, and the public. Examples of projects that use these data include the Groundwater Project and the Surface Environmental Surveillance Project.

5.0 Path Forward

Installation of new and replacement aquifer tubes is planned for fall 2003. The new installations will serve *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) long-term monitoring needs in the 100-BC-5, 100-KR-4, 100-FR-3, and 300-FF-5 Operable Units, and will supplement interim remedial action performance assessment monitoring at the 100-KR-4 and 100-HR-3 Operable Units. Design and installation methods will be very similar to those used for the existing installations (see Peterson et al. 1997 for a description of methods).

Several sample collection and analytical procedural issues should be revisited for future sampling events, to promote consistency among the various projects that collect water quality data from the river environment. The issues include

- Need for field filtration of water samples: Currently followed procedures call for filtration of samples that are analyzed for hexavalent chromium, which may add unnecessary cost and generate unnecessary waste. Samples collected for total metals analysis by offsite labs are typically filtered. Samples collected for radionuclide and anions analyses at offsite labs are not currently filtered.

- Methods for preserving samples

- Disposal of the small volume of purgewater generated at each tube (typically less than 1 liter per tube sampled

The sampling and analysis schedule for aquifer tubes proposed for FY 2004 is being expanded somewhat to address two additional objectives. First, at least one tube site in each area containing a contaminant plume undergoing active remediation will be sampled several times during the year. This will provide data to describe the water quality changes caused by the seasonal river discharge cycle. Second, where a tube site contains at least three tubes at various depths in the aquifer, analyses for specific conductance and one contaminant will be made at all depths to develop a zone of interaction mixing curve for the plume. Each of these two sampling objectives will contribute information for future risk assessments that require contaminant concentration data from locations close to sensitive aquatic habitat.

6.0 References

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Appendix

Aquifer Tube Locations and Status in Fall 2002

Table A.1. Aquifer Tube Well Identifiers, Location Names, and Geographic Coordinates

Well ID (HEIS)[a]	AQST: Tube Name (HEIS)[a]	Port Depth (ft bgs)[b]	Hanford River Marker (HRM2k)	AQT: Site Name	Shore Segment[c]	EASTING (m-NAD83)	NORTHING (m-NAD83)	Coordinate Quality[d]	Comment
B8115	01-S	7.0	2.600	AT-01	VB	562,697.662	146,033.078	SURV	
B8114	01-M	16.0	2.600	AT-01	VB	562,697.662	146,033.078	SURV	
B8113	01-D	24.0	2.600	AT-01	VB	562,697.662	146,033.078	SURV	
B8118	02-S	6.0	3.130	AT-02	VB	563,539.581	145,689.247	SURV	
B8117	02-M	14.9	3.130	AT-02	VB	563,539.581	145,689.247	SURV	
B8120	03-M	7.0	3.450	AT-03	BC5	564,077.431	145,469.247	SURV	
B8119	03-D	13.0	3.450	AT-03	BC5	564,077.431	145,469.247	SURV	
B8124	04-S	8.3	3.730	AT-04	BC5	564,612.459	145,283.419	SURV	
B8123	04-M	13.0	3.730	AT-04	BC5	564,612.066	145,283.047	SURV	
B8122	04-D	25.0	3.730	AT-04	BC5	564,612.184	145,283.275	SURV	
B8127	05-S	8.5	3.890	AT-05	BC5	564,908.310	145,332.290	SURV	
B8126	05-M	17.0	3.890	AT-05	BC5	564,908.310	145,332.290	SURV	
B8125	05-D	25.5	3.890	AT-05	BC5	564,908.310	145,332.290	SURV	
B8130	06-S	8.8	4.120	AT-06	BC5	565,293.927	145,412.052	SURV	
B8129	06-M	15.5	4.120	AT-06	BC5	565,293.927	145,412.052	SURV	
B8128	06-D	23.0	4.120	AT-06	BC5	565,293.927	145,412.052	SURV	
B8132	07-M	8.0	4.270	AT-07	BC5	565,566.011	145,495.641	SURV	
B8131	07-D	20.0	4.270	AT-07	BC5	565,564.591	145,493.904	SURV	
B8143	11-D	10.5	5.070	AT-11	BC5	566,862.628	145,903.913	SURV	
B8146	12-D	10.0	5.330	AT-12	BC5	567,231.722	146,055.169	SURV	
B8151	13-S	8.3	5.610	AT-13	BC5	567,507.297	146,172.598	SURV	
B8149	13-D	22.9	5.610	AT-13	BC5	567,507.297	146,172.598	SURV	
B8154	14-S	7.5	5.880	AT-14	BC5	567,645.588	146,268.095	SURV	
B8153	14-M	14.5	5.880	AT-14	BC5	567,645.588	146,268.095	SURV	
B8152	14-D	21.5	5.880	AT-14	BC5	567,645.588	146,268.095	SURV	
B8156	15-M	13.7	6.080	AT-15	KR4	568,082.000	146,642.000	EST	
B8162	17-M	11.0	6.470	AT-17	KR4	568,480.003	146,895.929	SURV	
B8161	17-D	19.5	6.470	AT-17	KR4	568,480.003	146,895.929	SURV	
B8204	18-S	8.5	6.710	AT-18	KR4	568,678.000	147,059.000	EST	
B8206	19-M	10.0	6.850	AT-19	KR4	569,036.700	147,389.952	SURV	
B8205	19-D	22.0	6.850	AT-19	KR4	569,036.700	147,389.952	SURV	

Table A.1. (contd)

Well ID (HEIS)[a]	AQT: Tube Name (HEIS)[a]	Port Depth (ft bgs)[b]	Hanford River Marker (HRM2k)	AQT: Site Name	Shore Segment[c]	EASTING (m-NAD83)	NORTHING (m-NAD83)	Coordinate Quality[d]	Comment
B8213	21-S	11.0	7.420	AT-21	KR4	569,628.862	148,020.334	SURV	
B8212	21-M	15.0	7.420	AT-21	KR4	569,628.862	148,020.334	SURV	
B8215	22-M	7.5	7.730	AT-22	KR4	569,975.776	148,340.349	SURV	
B8214	22-D	12.3	7.730	AT-22	KR4	569,975.776	148,340.349	SURV	
B8218	23-M	7.0	7.900	AT-23	KR4	569,820.000	148,308.000	EST	
B8217	23-D	12.0	7.900	AT-23	KR4	569,820.000	148,308.000	EST	
B8526	DK-04-2	11.5	8.140	DK-04	KR4	570,456.600	148,872.300	SURV	
B8527	DK-04-3	15.0	8.140	DK-04	KR4	570,456.600	148,872.300	SURV	
B8223	25-D	7.5	8.260	AT-25	KR4	570,534.770	148,960.980	SURV	
B8228	26-S	6.0	8.390	AT-26	KR4	570,718.626	149,115.832	SURV	
B8227	26-M	14.0	8.390	AT-26	KR4	570,718.626	149,115.832	SURV	
B8226	26-D	23.0	8.390	AT-26	KR4	570,718.626	149,115.832	SURV	
B8515	DD-50-1	15.0	9.800	DD-50	NR2	572,172.189	151,121.164	SURV	
B8516	DD-50-2	20.0	9.800	DD-50	NR2	572,172.633	151,121.569	SURV	
B8517	DD-50-3	24.7	9.800	DD-50	NR2	572,172.166	151,120.007	SURV	
B8518	DD-50-4	31.0	9.800	DD-50	NR2	572,173.030	151,121.180	SURV	
B8511	DD-49-1	12.0	9.830	DD-49	NR2	572,213.696	151,161.553	SURV	
B8512	DD-49-2	21.8	9.830	DD-49	NR2	572,213.968	151,162.781	SURV	
B8513	DD-49-3	25.0	9.830	DD-49	NR2	572,210.802	151,163.304	SURV	
B8514	DD-49-4	31.0	9.830	DD-49	NR2	572,211.150	151,163.981	SURV	
B8509	DD-44-3	12.0	10.010	DD-44	HR3D	572,412.676	151,394.279	SURV	
B8510	DD-44-4	18.0	10.010	DD-44	HR3D	572,411.362	151,396.947	SURV	
B8507	DD-43-2	10.0	10.050	DD-43	HR3D	572,450.906	151,443.222	SURV	
B8508	DD-43-3	13.9	10.050	DD-43	HR3D	572,450.504	151,443.236	SURV	
B8504	DD-42-2	10.2	10.090	DD-42	HR3D	572,485.766	151,492.564	SURV	
B8505	DD-42-3	15.2	10.090	DD-42	HR3D	572,486.189	151,492.480	SURV	
B8506	DD-42-4	18.2	10.090	DD-42	HR3D	572,485.319	151,492.503	SURV	
B8503	DD-41-1	8.1	10.124	DD-41	HR3D	572,532.894	151,530.892	SURV	Orig DD-41-4 in HEIS; msg to JA 081503
B8483	DD-41-2	13.6	10.124	DD-41	HR3D	572,532.688	151,530.738	SURV	
B8484	DD-41-3	18.6	10.124	DD-41	HR3D	572,532.209	151,530.033	SURV	
C3383	166-D-4	3.0	10.125	Redox-4	HR3D	572,529.706	151,540.006	SURV	Redox-4-3.0; riverbed pore water tubes

Table A.1. (contd)

Well ID (HEIS)[a]	AQT: Tube Name (HEIS)[a]	Port Depth (ft bgs)[b]	Hanford River Marker (HRM2k)	AQT: Site Name	Shore Segment[c]	EASTING (m-NAD83)	NORTHING (m-NAD83)	Coordinate Quality[d]	Comment
C3515	166-D-4B	6.0	10.125	Redox-4	HR3D	572,529.706	151,540.006	SURV	Redox-4-6.0; riverbed pore water tubes
C3384	166-D-3	3.3	10.180	Redox-3	HR3D	572,583.206	151,603.027	SURV	Redox-3-3.3; riverbed pore water tubes
C3514	166-D-3B	4.6	10.180	Redox-3	HR3D	572,583.206	151,603.027	SURV	Redox-3-4.6; riverbed pore water tubes
B8479	DD-39-1	5.5	10.210	DD-39	HR3D	572,606.547	151,625.856	SURV	
B8480	DD-39-2	10.5	10.210	DD-39	HR3D	572,606.894	151,626.189	SURV	
B8481	DD-39-3	15.0	10.210	DD-39	HR3D	572,606.548	151,626.197	SURV	
B8482	DD-39-4	21.0	10.210	DD-39	HR3D	572,606.888	151,625.527	SURV	
C3385	166-D-2	3.0	10.240	Redox-2	HR3D	572,636.662	151,687.803	SURV	Redox-2-3.0; riverbed pore water tubes
C3513	166-D-2B	6.0	10.240	Redox-2	HR3D	572,636.662	151,687.803	SURV	Redox-2-6.0; riverbed pore water tubes
C3382	166-D-1	3.3	10.295	Redox-1	HR3D	572,716.336	151,730.810	SURV	Redox-1-3.3; riverbed pore water tubes
C3512	166-D-1B	6.0	10.295	Redox-1	HR3D	572,716.336	151,730.810	SURV	Redox-1-6.0; riverbed pore water tubes
B8255	35-S	8.0	10.390	AT-35	HR3D	572,806.000	151,832.000	EST	
B8254	35-M	14.0	10.390	AT-35	HR3D	572,806.000	151,832.000	EST	
B8253	35-D	21.0	10.390	AT-35	HR3D	572,806.000	151,832.000	EST	
B8258	36-S	8.0	10.580	AT-36	HR3D	572,992.000	152,060.000	EST	
B8257	36-M	14.0	10.580	AT-36	HR3D	572,992.000	152,060.000	EST	
B8256	36-D	21.0	10.580	AT-36	HR3D	572,992.000	152,060.000	EST	
B8261	37-S	6.5	10.700	AT-37	HR3D	573,168.000	152,198.000	EST	
B8260	37-M	13.5	10.700	AT-37	HR3D	573,168.000	152,198.000	EST	
B8259	37-D	19.5	10.700	AT-37	HR3D	573,168.000	152,198.000	EST	
B8263	38-M	10.0	10.840	AT-38	HR3D	573,361.000	152,301.000	EST	
B8262	38-D	16.5	10.840	AT-38	HR3D	573,361.000	152,301.000	EST	
B8477	DD-17-2	10.5	11.030	DD-17	HR3D	573,597.984	152,482.772	SURV	
B8478	DD-17-3	15.0	11.030	DD-17	HR3D	573,597.162	152,483.304	SURV	
B8475	DD-16-3	17.5	11.060	DD-16	HR3D	573,650.431	152,516.128	SURV	
B8476	DD-16-4	25.5	11.060	DD-16	HR3D	573,651.165	152,516.993	SURV	
B8472	DD-15-2	15.0	11.100	DD-15	HR3D	573,700.609	152,547.828	SURV	
B8473	DD-15-3	21.0	11.100	DD-15	HR3D	573,700.609	152,547.828	SURV	
B8474	DD-15-4	25.5	11.100	DD-15	HR3D	573,700.609	152,547.828	SURV	
B8469	DD-12-2	10.0	11.200	DD-12	HR3D	573,819.657	152,683.584	SURV	
B8470	DD-12-3	15.0	11.200	DD-12	HR3D	573,818.681	152,683.696	SURV	

Table A.1. (contd)

Well ID (HEIS)[a]	AQT: Tube Name (HEIS)[a]	Port Depth (ft bgs)[b]	Hanford River Marker (HRM2k)	AQT: Site Name	Shore Segment[c]	EASTING (m-NAD83)	NORTHING (m-NAD83)	Coordinate Quality[d]	Comment
B8471	DD-12-4	21.0	11.200	DD-12	HR3D	573,820.559	152,683.591	SURV	
B8819	DD-10-2	12.0	11.270	DD-10	HR3D	573,899.056	152,788.072	SURV	
B8820	DD-10-3	17.0	11.270	DD-10	HR3D	573,899.056	152,788.072	SURV	
B8468	DD-10-4	22.0	11.270	DD-10	HR3D	573,899.056	152,788.072	SURV	
B8821	DD-08-2	11.2	11.340	DD-08	HR3D	573,940.057	152,903.527	EST	
B8466	DD-08-3	17.2	11.340	DD-08	HR3D	573,940.057	152,903.527	SURV	
B8467	DD-08-4	22.3	11.340	DD-08	HR3D	573,940.057	152,903.527	EST	
B8464	DD-06-2	12.0	11.400	DD-06	HR3D	573,964.576	153,015.374	SURV	
B8465	DD-06-3	16.0	11.400	DD-06	HR3D	573,964.576	153,015.374	SURV	
B8267	39-S	8.0	11.620	AT-39	HR3D	574,035.000	153,393.000	EST	
B8266	39-M	18.0	11.620	AT-39	HR3D	574,035.000	153,393.000	EST	
B8265	39-D	28.0	11.620	AT-39	HR3D	574,035.000	153,393.000	EST	
B8270	40-S	8.0	11.980	AT-40	HR3D	574,238.000	153,997.000	EST	
B8269	40-M	15.5	11.980	AT-40	HR3D	574,238.000	153,997.000	EST	
B8273	41-S	10.0	13.100	AT-41	HR3D	575,515.614	154,424.185	SURV	
B8272	41-M	15.0	13.100	AT-41	HR3D	575,511.260	154,423.723	SURV	
B8271	41-D	25.0	13.100	AT-41	HR3D	575,512.511	154,424.668	SURV	
B8276	42-S	10.0	13.550	AT-42	HR3D	576,165.935	154,320.154	SURV	
B8275	42-M	15.0	13.550	AT-42	HR3D	576,166.225	154,320.454	SURV	
B8274	42-D	24.0	13.550	AT-42	HR3D	576,167.589	154,320.018	SURV	
B8278	43-M	7.5	14.040	AT-43	HR3H	576,782.564	153,963.570	SURV	
B8277	43-D	9.7	14.040	AT-43	HR3H	576,779.961	153,965.240	SURV	
B8281	44-M	8.5	14.260	AT-44	HR3H	577,033.113	153,810.532	SURV	
B8280	44-D	12.7	14.260	AT-44	HR3H	577,031.509	153,811.744	SURV	
B8521	DH-1451-1		14.390	DH-14	HR3H	577,182.865	153,704.528	SURV	
B8522	DH-1452-1		14.450	DH-14	HR3H	577,255.023	153,661.681	SURV	
B8285	45-S	8.0	14.660	AT-45	HR3H	577,529.000	153,514.000	EST	
B8284	45-M	15.0	14.660	AT-45	HR3H	577,529.000	153,514.000	EST	
B8283	45-D	23.0	14.660	AT-45	HR3H	577,529.000	153,514.000	EST	
B8519	DH-14-1	32.0	14.860	DH-14	HR3H	577,787.186	153,374.820	SURV	
B8520	DH-14-11		14.860	DH-14	HR3H	577,788.415	153,377.955	SURV	

Table A.1. (contd)

Well ID (HEIS)[a]	AQT: Tube Name (HEIS)[a]	Port Depth (ft bgs)[b]	Hanford River Marker (HRM2k)	AQT: Site Name	Shore Segment[c]	EASTING (m-NAD83)	NORTHING (m-NAD83)	Coordinate Quality[d]	Comment
B8286	46-D	10.5	15.120	AT-46	HR3H	578,031.495	152,999.261	SURV	
B8290	47-M	8.0	15.300	AT-47	HR3H	578,193.919	152,743.533	SURV	
B8289	47-D	14.5	15.300	AT-47	HR3H	578,193.394	152,744.421	SURV	
B8523	DH-22-1	4.0	15.500	DH-22	HR3H	578,460.331	152,468.304	SURV	
B8524	DH-22-2	8.0	15.500	DH-22	HR3H	578,460.331	152,468.304	SURV	
B8525	DH-22-3	13.5	15.500	DH-22	HR3H	578,460.331	152,468.304	SURV	
B8294	48-S	9.0	15.520	AT-48	HR3H	578,465.520	152,420.795	SURV	
B8293	48-M	17.0	15.520	AT-48	HR3H	578,465.520	152,420.795	SURV	
B8292	48-D	25.0	15.520	AT-48	HR3H	578,465.520	152,420.795	SURV	
B8297	49-S	8.5	15.680	AT-49	HR3H	578,699.729	152,232.848	SURV	
B8296	49-M	17.5	15.680	AT-49	HR3H	578,699.729	152,232.848	SURV	
B8295	49-D	25.5	15.680	AT-49	HR3H	578,699.729	152,232.848	SURV	
B8300	50-S	8.5	15.710	AT-50	HR3H	578,611.792	152,118.154	SURV	
B8299	50-M	17.5	15.710	AT-50	HR3H	578,611.792	152,118.154	SURV	
B8298	50-D	26.5	15.710	AT-50	HR3H	578,611.792	152,118.154	SURV	
B8303	51-S	9.5	15.890	AT-51	HR3H	578,779.254	151,843.755	SURV	
B8302	51-M	17.5	15.890	AT-51	HR3H	578,779.254	151,843.755	SURV	
B8301	51-D	25.5	15.890	AT-51	HR3H	578,779.254	151,843.755	SURV	
B8306	52-S	7.0	16.100	AT-52	HR3H	578,919.484	151,586.176	SURV	
B8305	52-M	15.0	16.100	AT-52	HR3H	578,919.484	151,586.176	SURV	
B8304	52-D	24.0	16.100	AT-52	HR3H	578,919.484	151,586.176	SURV	
B8309	53-S	8.0	16.370	AT-53	HR3H	579,510.574	151,531.727	SURV	
B8308	53-M	17.0	16.370	AT-53	HR3H	579,510.574	151,531.727	SURV	
B8307	53-D	26.0	16.370	AT-53	HR3H	579,510.188	151,531.413	SURV	
B8312	54-S	7.5	16.400	AT-54	HR3H	579,033.518	151,231.944	SURV	
B8311	54-M	17.0	16.400	AT-54	HR3H	579,033.518	151,231.944	SURV	
B8310	54-D	26.0	16.400	AT-54	HR3H	579,033.518	151,231.944	SURV	
B8315	55-S	10.0	16.670	AT-55	HR3H	579,134.582	150,891.146	SURV	
B8314	55-M	18.0	16.670	AT-55	HR3H	579,134.582	150,891.146	SURV	
B8313	55-D	26.0	16.670	AT-55	HR3H	579,135.286	150,891.368	SURV	
B8321	57-S	7.0	17.100	AT-57	HR3H	580,101.000	150,525.000	EST	

Table A.1. (contd)

Well ID (HEIS)[a]	AQT: Tube Name (HEIS)[a]	Port Depth (ft bgs)[b]	Hanford River Marker (HRM2k)	AQT: Site Name	Shore Segment[c]	EASTING (m-NAD83)	NORTHING (m-NAD83)	Coordinate Quality[d]	Comment
B8320	57-M	18.0	17.100	AT-57	HR3H	580,101.000	150,525.000	EST	
B8319	57-D	29.0	17.100	AT-57	HR3H	580,101.000	150,525.000	EST	
B8324	58-S	11.0	17.160	AT-58	HR3H	579,310.627	150,232.255	SURV	
B8323	58-M	19.5	17.160	AT-58	HR3H	579,311.429	150,230.317	SURV	
B8322	58-D	26.5	17.160	AT-58	HR3H	579,310.118	150,233.170	SURV	
B8327	59-S	11.0	17.380	AT-59	HR3H	579,420.404	149,928.523	SURV	
B8326	59-M	16.5	17.380	AT-59	HR3H	579,420.300	149,930.907	SURV	
B8325	59-D	23.0	17.380	AT-59	HR3H	579,420.305	149,930.079	SURV	
B8330	60-S	8.5	17.740	AT-60	HR3H	579,638.000	149,392.000	EST	
B8329	60-M	17.5	17.740	AT-60	HR3H	579,638.000	149,392.000	EST	
B8328	60-D	26.5	17.740	AT-60	HR3H	579,638.000	149,392.000	EST	
B8333	61-S	8.5	18.100	AT-61	FR3	580,000.071	148,950.427	SURV	
B8332	61-M	15.5	18.100	AT-61	FR3	580,001.323	148,949.889	SURV	
B8331	61-D	24.0	18.100	AT-61	FR3	580,002.501	148,949.718	SURV	
B8336	62-S	8.0	18.400	AT-62	FR3	580,388.292	148,585.876	SURV	
B8335	62-M	18.0	18.400	AT-62	FR3	580,387.648	148,586.349	SURV	
B8334	62-D	28.0	18.400	AT-62	FR3	580,389.375	148,585.095	SURV	
B8339	63-S	10.0	18.810	AT-63	FR3	580,945.002	148,174.193	SURV	
B8338	63-M	16.0	18.810	AT-63	FR3	580,944.736	148,174.517	SURV	
B8337	63-D	23.0	18.810	AT-63	FR3	580,943.236	148,175.400	SURV	
B8342	64-S	7.5	18.940	AT-64	FR3	581,118.756	148,037.975	SURV	
B8341	64-M	17.0	18.940	AT-64	FR3	580,945.002	148,174.193	SURV	
B8340	64-D	27.0	18.940	AT-64	FR3	580,945.002	148,174.193	SURV	
B8345	65-S	8.5	19.100	AT-65	FR3	581,297.412	147,864.503	SURV	
B8344	65-M	16.0	19.100	AT-65	FR3	581,295.747	147,866.273	SURV	
B8343	65-D	27.0	19.100	AT-65	FR3	581,295.747	147,866.273	SURV	
B8348	66-S	10.0	19.370	AT-66	FR3	581,475.927	147,541.818	SURV	
B8347	66-M	19.2	19.370	AT-66	FR3	581,475.927	147,541.818	SURV	
B8346	66-D	28.1	19.370	AT-66	FR3	581,475.927	147,541.818	SURV	
B8351	67-S	10.0	19.580	AT-67	FR3	581,616.352	147,291.431	SURV	
B8350	67-M	20.0	19.580	AT-67	FR3	581,616.352	147,291.431	SURV	

Table A.1. (contd)

Well ID (HEIS)[a]	AQT: Tube Name (HEIS)[a]	Port Depth (ft bgs)[b]	Hanford River Marker (HRM2k)	AQT: Site Name	Shore Segment[c]	EASTING (m-NAD83)	NORTHING (m-NAD83)	Coordinate Quality[d]	Comment
B8349	67-D	30.0	19.580	AT-67	FR3	581,616.352	147,291.431	SURV	
B8354	68-S	10.5	19.760	AT-68	FR3	581,758.431	147,085.176	SURV	
B8353	68-M	18.3	19.760	AT-68	FR3	581,758.431	147,085.176	SURV	
B8352	68-D	25.0	19.760	AT-68	FR3	581,758.431	147,085.176	SURV	
B8356	69-M	15.0	19.800	AT-69	FR3	582,017.000	147,168.000	EST	
B8355	69-D	31.0	19.800	AT-69	FR3	582,017.000	147,168.000	EST	
B8360	70-S	17.0	19.950	AT-70	FR3	581,902.543	146,843.106	SURV	
B8359	70-M	24.0	19.950	AT-70	FR3	581,902.543	146,843.106	SURV	
B8358	70-D	31.0	19.950	AT-70	FR3	581,902.543	146,843.106	SURV	
B8361	71-D	7.5	20.260	AT-71	FR3	581,992.000	146,474.000	EST	
B8366	72-S	9.5	20.670	AT-72	FR3	582,223.666	146,067.007	SURV	72-smd-S; uncertain, missing labels
B8365	72-M	18.0	20.670	AT-72	FR3	582,224.292	146,067.252	SURV	72-smd-M; uncertain, missing labels
B8364	72-D	28.0	20.670	AT-72	FR3	582,224.473	146,066.634	SURV	72-smd-D; uncertain, missing labels
B8369	73-S	10.5	20.810	AT-73	FR3	582,424.818	145,989.728	SURV	73-smd-S; uncertain, missing labels
B8368	73-M	19.0	20.810	AT-73	FR3	582,424.473	145,989.251	SURV	73-smd-M; uncertain, missing labels
B8367	73-D	27.0	20.810	AT-73	FR3	582,424.378	145,988.225	SURV	73-smd-D; uncertain, missing labels
B8372	74-S	11.0	21.160	AT-74	FR3	582,599.498	145,609.940	SURV	74-smd-S; uncertain, missing labels
B8371	74-M	17.0	21.160	AT-74	FR3	582,599.881	145,609.471	SURV	74-smd-M; uncertain, missing labels
B8370	74-D	29.0	21.160	AT-74	FR3	582,600.480	145,608.435	SURV	74-smd-D; uncertain, missing labels
B8375	75-S	11.0	21.490	AT-75	FR3	582,790.915	145,287.068	SURV	75-smd-S; uncertain, missing labels
B8374	75-M	19.0	21.490	AT-75	FR3	582,792.893	145,285.862	SURV	75-smd-M; uncertain, missing labels
B8373	75-D	27.0	21.490	AT-75	FR3	582,793.490	145,283.988	SURV	75-smd-D; uncertain, missing labels
B8378	76-S	11.0	21.680	AT-76	FR3	582,877.989	145,089.114	SURV	76-smd-S; uncertain, missing labels
B8377	76-M	19.0	21.680	AT-76	FR3	582,878.733	145,088.849	SURV	76-smd-M; uncertain, missing labels
B8376	76-D	25.0	21.680	AT-76	FR3	582,878.748	145,087.325	SURV	76-smd-D; uncertain, missing labels
B8381	77-S	8.5	21.860	AT-77	FR3	582,957.215	144,889.256	SURV	
B8380	77-M	16.5	21.860	AT-77	FR3	582,957.215	144,889.256	SURV	
B8379	77-D	24.5	21.860	AT-77	FR3	582,957.215	144,889.256	SURV	
B8384	78-S	8.0	22.300	AT-78	FR3	583,152.559	144,325.675	SURV	
B8383	78-M	16.0	22.300	AT-78	FR3	583,152.559	144,325.675	SURV	
B8382	78-D	24.0	22.300	AT-78	FR3	583,152.559	144,325.675	SURV	

Table A.1. (contd)

Well ID (HEIS)[a]	AQT: Tube Name (HEIS)[a]	Port Depth (ft bgs)[b]	Hanford River Marker (HRM2k)	AQT: Site Name	Shore Segment[c]	EASTING (m-NAD83)	NORTHING (m-NAD83)	Coordinate Quality[d]	Comment
B8390	80-S	5.0	23.100	AT-80	HTS	583,509.431	143,178.792	SURV	Destroyed by animals
B8389	80-M	15.5	23.100	AT-80	HTS	583,510.578	143,175.382	SURV	80-md-M; uncertain, missing labels
B8388	80-D	25.5	23.100	AT-80	HTS	583,510.578	143,175.382	SURV	80-md-D; uncertain, missing labels
B8393	81-S	8.5	25.120	AT-81	HTS	585,375.000	140,494.000	EST	
B8392	81-M	16.5	25.120	AT-81	HTS	585,375.000	140,494.000	EST	
B8391	81-D	24.5	25.120	AT-81	HTS	585,375.000	140,494.000	EST	
B8396	82-S	8.5	25.720	AT-82	HTS	586,252.470	139,595.836	SURV	
B8395	82-M	14.5	25.720	AT-82	HTS	586,252.470	139,595.836	SURV	
B8397	83-D	20.0	26.230	AT-83	HTS	586,949.357	139,005.466	SURV	
B8402	84-S	8.0	26.640	AT-84	HTS	587,477.148	138,683.000	SURV	
B8401	84-M	14.0	26.640	AT-84	HTS	587,476.025	138,683.515	SURV	
B8400	84-D	22.0	26.640	AT-84	HTS	587,476.487	138,683.945	SURV	
B8405	85-S	8.0	27.130	AT-85	HTS	588,052.700	138,256.786	SURV	
B8404	85-M	17.0	27.130	AT-85	HTS	588,052.700	138,256.786	SURV	
B8403	85-D	26.0	27.130	AT-85	HTS	588,052.700	138,256.786	SURV	
B8408	86-S	7.0	27.390	AT-86	HTS	588,332.623	138,068.820	SURV	
B8407	86-M	10.0	27.390	AT-86	HTS	588,333.214	138,068.172	SURV	
B8406	86-D	26.0	27.390	AT-86	HTS	588,333.555	138,067.727	SURV	

(a) Well identifiers and aquifer tube (AQT) names as they appear in the Hanford Environmental Information System.
(b) Depth below ground surface (bgs) at which sampling port was installed.
(c) Vernita Bridge (VB); 100-B (BC5); 100-K (KR4); 100-N (NR2); 100-D (HR3D); 100-H (HR3H); 100-F (FR3); and Hanford town site (HTS).
(d) SURV indicates Global Positioning System coordinates; EST indicates estimated from maps.

Table A.2. Status of Aquifer Tubes as Determined During Fall 2002 Sampling Event

AQT: Tube Name (HEIS)[a]	Installation Type[b]	Install Status 1997[c] BHI-01153	Eagle Nesting Area?[c] BHI-01153	Culturally Sensitive Location?[c] BHI-01153	Field Reconnais-sance 2002	Location Status[d] 2002	Yield Status 2002	Maint. Required? 2002	On 10/24/02 List[e]	Fall 2002 Sample Date	Fall 2002 Sample No.	Fall 2002 Comment
01-S	GeoProbe				9/24/2002	ok			x		Not sampled	Assigned lowest priority
01-M	GeoProbe				9/24/2002	ok			x		Not sampled	Assigned lowest priority
01-D	GeoProbe	No yield			9/24/2002	ok			x		Not sampled	Assigned lowest priority
02-S	GeoProbe				9/24/2002	ok			x		Not sampled	Assigned lowest priority
02-M	GeoProbe	No yield			9/24/2002	ok			x		Not sampled	Assigned lowest priority
03-M	GeoProbe				9/24/2002	ok						
03-D	GeoProbe				9/24/2002	ok						
04-S	GeoProbe				9/24/2002	ok			x	12/16/2002	B15YY8	
04-M	GeoProbe				9/24/2002	ok			x	12/16/2002	B15YY6	
04-D	GeoProbe				9/24/2002	ok			x	12/16/2002	B15YY4	
04-D	GeoProbe				9/24/2002	ok			x	12/16/2002	B15YY5	
05-S	GeoProbe				9/24/2002	ok			x	12/16/2002	B16004	
05-M	GeoProbe				9/24/2002	ok			x	12/16/2002	B16000	
05-M	GeoProbe				9/24/2002	ok			x	12/16/2002	B16001	
05-D	GeoProbe				9/24/2002	ok			x	12/16/2002	B16002	
06-S	GeoProbe				9/24/2002	ok	murky		x	12/16/2002	B16012	Sample opaque-could not analyze; nonsettleable
06-M	GeoProbe				9/24/2002	ok			x	12/16/2002	B16006	
06-M	GeoProbe				9/24/2002	ok			x	12/16/2002	B16007	
06-D	GeoProbe				9/24/2002	ok			x	12/16/2002	B16008	
07-M	Rhino				9/24/2002	ok	no yield	yes	x	12/16/2002		Needs PVC protection; no yield
07-D	Rhino				9/24/2002	ok		yes	x	12/16/2002	B16014	Needs PVC protection
07-D	Rhino				9/24/2002	ok		yes	x	12/16/2002	B16015	Needs PVC protection
11-D	Rhino								x		Not sampled	Assigned lowest priority
12-D	Rhino								x		Not sampled	Assigned lowest priority
13-S	GeoProbe			yes	9/24/2002	ok			x		Not sampled	Assigned lowest priority
13-D	GeoProbe	No yield		yes	9/24/2002	ok			x		Not sampled	Assigned lowest priority
14-S	GeoProbe		yes	yes	9/24/2002	ok			x	11/20/2002	Not sampled	Lower spec conduct
14-M	GeoProbe		yes	yes	9/24/2002	ok			x	11/20/2002	Not sampled	Lower spec conduct
14-D	GeoProbe		yes	yes	9/24/2002	ok			x	11/20/2002	B16028	Substitute for 15-M
14-D	GeoProbe		yes	yes	9/24/2002	ok			x	11/20/2002	B15YT9	Substitute for 15-M
14-D	GeoProbe		yes	yes	9/24/2002	ok			x	11/20/2002	B15YV0	Substitute for 15-M
14-D	GeoProbe		yes	yes	9/24/2002	ok			x	11/20/2002	B15YV1	Substitute for 15-M
15-M	GeoProbe		yes	yes	9/24/2002	can't find			x	9/24/2002	Not sampled	Can't locate 9/24/02 (looked wrong area); go farther downstream
17-M	Rhino			yes	9/24/2002	ok			x	11/20/2002	B16032	
17-M	Rhino			yes	9/24/2002	ok			x	11/20/2002	B15YV4	

Table A.2. (contd)

AQT: Tube Name (HEIS)[a]	Installation Type[b]	Install Status 1997[c] BHI-01153	Eagle Nesting Area?[c] BHI-01153	Culturally Sensitive Location?[c] BHI-01153	Field Reconnaissance 2002	Location Status[d] 2002	Yield Status 2002	Maint. Required? 2002	On 10/24/02 List[e]	Fall 2002 Sample Date	Fall 2002 Sample No.	Fall 2002 Comment
17-M	Rhino			yes	9/24/2002	ok			x	11/20/2002	B15YV5	
17-D	Rhino			yes	9/24/2002	ok			x	11/20/2002	B16030	Did not collect for Sr-90 analysis
18-S	GeoProbe			yes	9/24/2002	can't find			x	9/24/2002	Not sampled	Can't locate 9/24/02 (looked wrong area); it's between pump houses
19-M	Rhino			yes	9/24/2002	ok			x	11/19/2002	Not sampled	Lower spec conduct
19-D	Rhino			yes	9/24/2002	ok			x	11/19/2002	B16037	
19-D	Rhino			yes	9/24/2002	ok			x	11/19/2002	B15YV9	
19-D	Rhino			yes	9/24/2002	ok			x	11/19/2002	B16036	
21-S	Rhino			yes	9/24/2002	ok			x	11/19/2002	B160L1	
21-M	Rhino			yes	9/24/2002	ok			x	11/19/2002	B16040	
22-M	Rhino			yes	9/24/2002	ok			x	11/19/2002	B16043	
22-D	Rhino			yes	9/24/2002	ok			x	11/19/2002	B16042	
23-M	Rhino			yes	9/24/2002	can't find			x	9/24/2002	Not sampled	Could not locate
23-D	Rhino			yes	9/24/2002	can't find			x	9/24/2002	Not sampled	Could not locate
DK-04-2	GeoProbe			yes				yes	x	11/19/2002	B160K0	Temporary protection installed
DK-04-2	GeoProbe			yes					x	11/19/2002	B161P9	
DK-04-3	GeoProbe			yes				yes	x	11/19/2002	B160K1	Temporary protection installed
25-D	Rhino			yes					x	11/19/2002	B16046	Regrouped with KR4
26-S	Rhino			yes					x	11/20/2002	B16049	Regrouped with KR4
26-M	Rhino			yes					x	11/20/2002	B16048	Regrouped with KR4
26-D	Rhino			yes					x	11/20/2002	B16047	Regrouped with KR4
26-D	Rhino			yes					x	11/20/2002	B15YW2	
DD-50-1	Rhino				11/26/2002	ok			x	12/18/2002	B160J7	
DD-50-2	Rhino				11/26/2002	ok			x	12/18/2002	B160J8	
DD-50-3	Rhino				11/26/2002	ok			x	12/18/2002	B16005	
DD-50-3	Rhino				11/26/2002	ok			x	12/18/2002	B160J9	
DD-50-4	Rhino				11/26/2002	ok			x	12/18/2002	Not sampled	Try again to sample; tube closer to river than others
DD-49-1	Rhino				11/26/2002	ok			x	12/18/2002	B160J4	Dupl result is 9.971; confusion over 12 or 16 ft (both installed)
DD-49-2	Rhino				11/26/2002	ok		yes	x	12/18/2002	Not sampled	Confusion over 12 or 16 ft tube
DD-49-3	Rhino				11/26/2002	ok			x	12/18/2002	B160J2	
DD-49-4	Rhino				11/26/2002	ok			x	12/18/2002	B160J3	
DD-49-4	Rhino				11/26/2002	ok			x	12/18/2002	B160J5	
DD-44-3	Rhino				11/26/2002	ok			x	12/18/2002	B160J0	
DD-44-4	Rhino				11/26/2002	ok			x	12/18/2002	B15YY9	
DD-44-4	Rhino				11/26/2002	ok			x	12/18/2002	B160J1	

Table A.2. (contd)

AQT: Tube Name (HEIS)[a]	Installation Type[b]	Install Status 1997[c] BHI-01153	Eagle Nesting Area?[c] BHI-01153	Culturally Sensitive Location?[c] BHI-01153	Field Reconnais-sance 2002	Location Status[d] 2002	Yield Status 2002	Maint. Required? 2002	On 10/24/02 List[e]	Fall 2002 Sample Date	Fall 2002 Sample No.	Fall 2002 Comment
DD-43-2	Rhino				11/26/2002	ok	no yield		x	12/18/2002		No yield
DD-43-3	Rhino				11/26/2002	ok			x	12/18/2002	B160M8	
DD-42-2	Rhino				11/26/2002	ok	no yield		x	12/18/2002		No yield
DD-42-3	Rhino				11/26/2002	ok	no yield		x	12/18/2002		No yield
DD-42-4	Rhino				11/26/2002	ok			x	12/18/2002	B160H7	
DD-41-1	Rhino				11/26/2002	ok			x	12/18/2002	B160H4	Probably shallow tube at 8.1 ft (i.e., DD-41-1, not -4)
DD-41-2	Rhino				11/26/2002	ok			x	12/18/2002	B160H2	
DD-41-3	Rhino				11/26/2002	ok			x	12/18/2002	B160H3	
166-D-4	Air hammer				11/26/2002	ok	no yield	yes	x	12/18/2002		Riverbed pore water tubes; no yield; Redox-4-3.0; 15M 0.25 3.0
166-D-4B	Air hammer				11/26/2002	ok	no yield	yes	x	12/18/2002		Riverbed pore water tubes; no yield; Redox-4-6.0; 15M 0.25 6.0
166-D-3	Air hammer				11/26/2002	ok		yes	x	12/18/2002	B160K6	Riverbed pore water tubes; Redox-3-3.3; 14M 0.25 3.3
166-D-3B	Air hammer				11/26/2002	ok		yes	x	12/18/2002	B160K7	Riverbed pore water tubes; Redox-3-4.6; 14M 0.25 4.6
DD-39-1	GeoProbe				11/26/2002	ok			x	12/18/2002	B15YW9	Black PVC
DD-39-1	GeoProbe				11/26/2002	ok			x	12/18/2002	B160F8	Black PVC
DD-39-2	GeoProbe				11/26/2002	ok			x	12/18/2002	B160F9	Black PVC
DD-39-3	GeoProbe				11/26/2002	ok	no yield		x	12/18/2002		Black PVC; no yield
DD-39-4	GeoProbe	No yield			11/26/2002	ok	no yield		x	12/18/2002		Black PVC; no yield
TDP-39	Diver				11/26/2002	ok				12/18/2002	Not sampled	Diver-installed riverbed pore water tubes
166-D-2	Air hammer				11/26/2002	ok		yes	x	12/18/2002	B160K4	Riverbed pore water tubes; Redox-2-3.0; 13M 0.25 3.0
166-D-2B	Air hammer				11/26/2002	ok		yes	x	12/18/2002	B160K5	Riverbed pore water tubes; Redox-2-6.0; 13M 0.25 6.0
166-D-1	Air hammer				11/26/2002	ok	no yield	yes	x	12/18/2002		Riverbed pore water tubes; no yield; Redox-1-3.3; 12M 0.25 3.3
166-D-1B	Air hammer				11/26/2002	ok	no yield	yes	x	12/18/2002		Riverbed pore water tubes; no yield; Redox-1-6.0; 12M 0.25 6.0
35-S	Rhino											
35-M	Rhino	No yield										
35-D	Rhino	No yield										
36-S	Rhino											
36-M	Rhino											
36-D	Rhino											
37-S	Rhino											
37-M	Rhino	No yield										
37-D	Rhino	No yield										
38-M	Rhino											

Table A.2. (contd)

AQT: Tube Name (HEIS)[a]	Installation Type[b]	Install Status 1997[c] BHI-01153	Eagle Nesting Area?[c] BHI-01153	Culturally Sensitive Location?[c] BHI-01153	Field Reconnais-sance 2002	Location Status[d] 2002	Yield Status 2002	Maint. Required? 2002	On 10/24/02 List[e]	Fall 2002 Sample Date	Fall 2002 Sample No.	Fall 2002 Comment
38-D	Rhino											
DD-17-2	GeoProbe				1/9/2003	ok			x	1/9/2003	B160F6	INLAND ( ); No flow from OFFSHORE ( ); tube identify uncertain
DD-17-3	GeoProbe				1/9/2003	ok	no yield		x	1/9/2003		?OFFSHORE? ( ); tube identify uncertain; no yield
DD-16-3	GeoProbe				1/9/2003	can't find			x	1/9/2003	Not sampled	Could not locate
DD-16-4	Rhino?				1/9/2003	can't find			x	1/9/2003	Not sampled	Could not locate
DD-15-2	GeoProbe				1/9/2003	ok			x	1/9/2003	Not sampled	?A?, murky, sc = 127; no sample
DD-15-3	GeoProbe				1/9/2003	ok			x	1/9/2003	B160F3	
DD-15-4	GeoProbe				1/9/2003	ok	no yield		x	1/9/2003		?B?, no yield
TDP-15 C	Diver				1/9/2003	ok			x	1/9/2003	B160F2	One of three diver-installed riverbed pore water tubes
DD-12-2	GeoProbe				1/9/2003	ok			x	1/9/2003	Not sampled	Low spec conduct (either 12-2 or 12-3)
DD-12-3	GeoProbe				1/9/2003	ok			x	1/9/2003	Not sampled	Missing tube, stake only (either 12-2 or 12-3)
DD-12-4	GeoProbe				1/9/2003	ok			x	1/9/2003	B160D9	INLAND ( ); OFFSHORE ( ) sc = 127
DD-10-2	GeoProbe				1/9/2003	ok			x	1/9/2003	Not sampled	?SHORT?
DD-10-3	GeoProbe				1/9/2003	ok			x	1/9/2003	Not sampled	?MEDIUM?
DD-10-4	GeoProbe				1/9/2003	ok			x	1/9/2003	B160D7	TALL of three tubes; SHORT sc = 126; MEDIUM sc = 139
DD-08-2	GeoProbe				1/9/2003	can't find			x	1/9/2003	Not sampled	Could not locate
DD-08-3	GeoProbe				1/9/2003	can't find			x	1/9/2003	Not sampled	Could not locate
DD-08-4	GeoProbe				1/9/2003	can't find			x	1/9/2003	Not sampled	Could not locate
DD-06-2	GeoProbe				1/9/2003	ok	no yield		x	1/9/2003		"C" spec conduct = 117 rising; "A" no yield
DD-06-3	GeoProbe				1/9/2003	ok			x	1/9/2003	B160D1	"B" of three tubes
39-S	GeoProbe											
39-M	GeoProbe											
39-D	GeoProbe	No yield										
40-S	GeoProbe											
40-M	GeoProbe											
41-S	Rhino	No yield	yes									
41-M	Rhino		yes									
41-D	Rhino		yes									
42-S	Rhino		yes	yes					x		Not sampled	Not accessed--eagles in the area
42-M	Rhino		yes						x		Not sampled	Not accessed--eagles in the area
42-D	Rhino	No yield	yes						x		Not sampled	Not accessed--eagles in the area
43-M	Rhino		yes									
43-D	Rhino		yes									
44-M	Rhino		yes						x		Not sampled	Not accessed--eagles in the area

Table A.2. (contd)

AQT: Tube Name (HEIS)[a]	Installation Type[b]	Install Status 1997[c] BHI-01153	Eagle Nesting Area?[c] BHI-01153	Culturally Sensitive Location?[c] BHI-01153	Field Reconnais-sance 2002	Location Status[d] 2002	Yield Status 2002	Maint. Required? 2002	On 10/24/02 List[e]	Fall 2002 Sample Date	Fall 2002 Sample No.	Fall 2002 Comment
44-D	Rhino		yes						x		Not sampled	Not accessed--eagles in the area
DH-1451-1	Uncertain		yes									
DH-1452-1	Uncertain		yes									
45-S	GeoProbe											
45-M	GeoProbe											
45-D	GeoProbe											
DH-14-1	Uncertain											
DH-14-11	Uncertain											
46-D	Rhino				1/10/2003	ok			x	1/14/2003	B15YT6	
46-D	Rhino				1/10/2003	ok			x	1/14/2003	B16056	
47-M	Rhino				1/10/2003	ok				1/14/2003	Not sampled	DOWNSTREAM sc = 128
47-D	Rhino				1/10/2003	ok				1/14/2003	B15YW5	UPSTREAM; River sc = 140
DH-22-1	Uncertain											
DH-22-2	Uncertain											
DH-22-3	Uncertain											
48-S	GeoProbe			yes	1/10/2003	ok			x	1/14/2003	B16059	
48-M	GeoProbe			yes	1/10/2003	ok			x	1/14/2003	B160L6	QC lab split
48-M	GeoProbe			yes	1/10/2003	ok			x	1/14/2003	B15YX5	
48-M	GeoProbe			yes	1/10/2003	ok			x	1/14/2003	B16058	
48-D	GeoProbe	No yield		yes	1/10/2003	ok	no yield		x	1/14/2003		No yield
49-S	GeoProbe				1/10/2003	ok			x	1/14/2003	B16060	
49-M	GeoProbe				1/10/2003	ok			x	1/14/2003	B16061	
49-D	GeoProbe				1/10/2003	ok			x	1/14/2003	B16062	
50-S	GeoProbe				1/10/2003	ok			x	1/14/2003	B16065	
50-S	GeoProbe				1/10/2003	ok			x	1/14/2003	B16065	QC analysis duplicate
50-M	GeoProbe				1/10/2003	ok			x	1/14/2003	B16064	
50-D	GeoProbe	No yield			1/10/2003	ok	no yield		x	1/14/2003		No yield
51-S	GeoProbe				1/10/2003	ok			x	1/14/2003	B16068	
51-M	GeoProbe				1/10/2003	ok			x	1/14/2003	B16067	
51-D	GeoProbe				1/10/2003	ok			x	1/14/2003	B16066	
52-S	GeoProbe		yes		1/10/2003	ok			x	1/14/2003	B16071	
52-M	GeoProbe		yes		1/10/2003	ok			x	1/14/2003	B16070	
52-D	GeoProbe		yes		1/10/2003	ok			x	1/14/2003	B16069	
53-S	GeoProbe		yes						x	1/14/2003	Not sampled	Assigned lowest priority
53-M	GeoProbe		yes						x	1/14/2003	Not sampled	Assigned lowest priority

Table A.2. (contd)

AQT: Tube Name (HEIS)[a]	Installation Type[b]	Install Status 1997[c] BHI-01153	Eagle Nesting Area?[c] BHI-01153	Culturally Sensitive Location?[c] BHI-01153	Field Reconnais-sance 2002	Location Status[d] 2002	Yield Status 2002	Maint. Required? 2002	On 10/24/02 List[e]	Fall 2002 Sample Date	Fall 2002 Sample No.	Fall 2002 Comment
53-D	GeoProbe	No yield	yes						x	1/14/2003	Not sampled	Assigned lowest priority
54-S	GeoProbe		yes		1/10/2003	ok			x	1/15/2003	B16077	
54-M	GeoProbe		yes		1/10/2003	ok			x	1/15/2003	B16076	
54-D	GeoProbe		yes		1/10/2003	ok			x	1/15/2003	B16075	
55-S	GeoProbe		yes									
55-M	GeoProbe	No yield	yes									
55-D	GeoProbe	No yield	yes									
57-S	GeoProbe		yes									
57-M	GeoProbe		yes									
57-D	GeoProbe	No yield	yes									
58-S	Rhino		yes									
58-M	Rhino		yes									
58-D	Rhino		yes									
59-S	Rhino		yes									
59-M	Rhino		yes									
59-D	Rhino		yes									
60-S	Rhino		yes									
60-M	Rhino		yes									
60-D	Rhino	No yield	yes									
61-S	Rhino		yes									
61-M	Rhino		yes									
61-D	Rhino		yes									
62-S	Rhino								x	1/16/2003	B16082	
62-M	Rhino								x	1/16/2003	B16080	
62-M	Rhino								x	1/16/2003	B16079	
62-D	Rhino	No yield					no yield		x	1/16/2003		No yield
63-S	Rhino				1/10/2003	ok			x	1/16/2003	B16088	DOWNRIVER
63-M	Rhino				1/10/2003	ok			x	1/16/2003	B16086	MIDDLE; no Sr-90 due very low yield; river sc = 129
63-D	Rhino	No yield			1/10/2003	ok	no yield		x	1/16/2003		No yield
64-S	Rhino				1/10/2003	ok	no yield		x	1/16/2003		UPRIVER; no yield
64-M	Rhino				1/10/2003	ok			x	1/16/2003	B16092	DOWNRIVER
64-D	Rhino				1/10/2003	ok			x	1/16/2003	B16090	MIDDLE
64-D	Rhino				1/10/2003	ok			x	1/16/2003	B16091	MIDDLE; river sc = 132
65-S	Rhino				1/10/2003	ok			x	1/16/2003	B160B0	River sc = 130.2
65-S	Rhino				1/10/2003	ok			x	1/16/2003	B160B0	QC analysis duplicate

Table A.2. (contd)

AQT: Tube Name (HEIS)[a]	Installation Type[b]	Install Status 1997[c] BHI-01153	Eagle Nesting Area?[c] BHI-01153	Culturally Sensitive Location?[c] BHI-01153	Field Reconnais-sance 2002	Location Status[d] 2002	Yield Status 2002	Maint. Required? 2002	On 10/24/02 List[e]	Fall 2002 Sample Date	Fall 2002 Sample No.	Fall 2002 Comment
65-M	Rhino				1/10/2003	ok			x	1/16/2003	Not sampled	Spec conduct too low for Sr-90
65-D	Rhino	No yield			1/10/2003	ok	no yield		x	1/16/2003		No yield
66-S	GeoProbe								x	1/16/2003	B160B6	
66-M	GeoProbe								x	1/16/2003	B160B4	
66-D	GeoProbe								x	1/16/2003	B160B2	
66-D	GeoProbe								x	1/16/2003	B160B3	
67-S	GeoProbe								x	1/16/2003	B160C2	
67-M	GeoProbe								x	1/16/2003	B160C0	
67-M	GeoProbe								x	1/16/2003	B160B9	
67-D	GeoProbe	No yield					no yield		x	1/16/2003		No yield
68-S	GeoProbe								x	1/16/2003	Not sampled	Not accessed--eagles in the area
68-M	GeoProbe								x	1/16/2003	Not sampled	Not accessed--eagles in the area
68-D	GeoProbe								x	1/16/2003	Not sampled	Not accessed--eagles in the area
69-M	GeoProbe											
69-D	GeoProbe	No yield										
70-S	GeoProbe											
70-M	GeoProbe											
70-D	GeoProbe											
71-D	Rhino											
72-S	Rhino		yes									
72-M	Rhino		yes									
72-D	Rhino		yes									
73-S	Rhino		yes									
73-M	Rhino		yes									
73-D	Rhino		yes									
74-S	Rhino		yes									
74-M	Rhino		yes									
74-D	Rhino		yes									
75-S	Rhino		yes									
75-M	Rhino		yes									
75-D	Rhino		yes									
76-S	Rhino		yes									
76-M	Rhino		yes									
76-D	Rhino		yes									
77-S	GeoProbe		yes									

Table A.2. (contd)

AQT: Tube Name (HEIS)[a]	Installation Type[b]	Install Status 1997[c] BHI-01153	Eagle Nesting Area?[c] BHI-01153	Culturally Sensitive Location?[c] BHI-01153	Field Reconnais-sance 2002	Location Status[d] 2002	Yield Status 2002	Maint. Required? 2002	On 10/24/02 List[e]	Fall 2002 Sample Date	Fall 2002 Sample No.	Fall 2002 Comment
77-M	GeoProbe		yes									
77-D	GeoProbe		yes									
78-S	GeoProbe		yes									
78-M	GeoProbe		yes									
78-D	GeoProbe	No yield	yes	yes								
80-S	Rhino	Destroyed										
80-M	Rhino											
80-D	Rhino											
81-S	GeoProbe											
81-M	GeoProbe											
81-D	GeoProbe	No yield										
82-S	GeoProbe		yes									
82-M	GeoProbe	No yield	yes									
83-D	Rhino	No yield	yes									
84-S	Rhino			yes								
84-M	Rhino			yes								
84-D	Rhino			yes								
85-S	GeoProbe											
85-M	GeoProbe											
85-D	GeoProbe											
86-S	Rhino			yes								
86-M	Rhino			yes								
86-D	Rhino			yes								

(a) Aquifer tube (AQT) name as it appears in the Hanford Environmental Information System.
(b) GeoProbe™ (GeoProbe Systems, Salinas, Kansas); "Rhino" indicates large capacity air hammer; "Air hammer" indicates small capacity air hammer.
(c) Water yield status and logistical constraints encountered during installation project in 1997 (Peterson et al. 1998).
(d) Coordinates were checked or re-established using Trimble™ sub-meter Global Positioning System equipment.
(e) List of sites to sample and analyses to performed as agreed upon by DOE, EPA, and Ecology on October 24, 2002.

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