PNNL-13326

Groundwater Sampling and Analysis Plan for the 100-BC-5 Operable Unit

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1.0 Introduction

The purpose of this plan is to describe groundwater sampling and analysis for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in the 100-BC-5 Operable Unit. The plan describes the well network, constituents analyzed, sampling protocol, and reporting and quality assurance requirements. Sampling and analysis requirements for this Operable Unit are specified in the change control form to the Federal Facility Agreement and Consent Order (Appendix A). The 100-BC-5 Operable Unit is the groundwater/surface water operable unit associated with past nuclear reactor operations in the 100-B,C Area of the U.S. Department of Energy's (DOE's) Hanford Site. The operable unit includes the groundwater below the source operable units (100-BC-1 through -4) plus the adjacent groundwater, surface water, sediments and aquatic biota impacted by 100-B,C Area operations (DOE/RL-90-08).

The 100-B,C Area (Figure 1) is the reactor area farthest upstream along the Columbia River. B Reactor was placed into service in 1944 and operated until 1968. C Reactor operated from 1952 to 1969. The B and C Reactors used a single-pass system for cooling water (i.e., cooling water passed through the reactor and was discharged to the Columbia River). Groundwater contaminants include strontium-90 and tritium. Chromium and nitrate are elevated locally.

2.0 Hydrogeology

The geology of the 100-B,C Area is described in detail in *Conceptual Site Models for Groundwater Contamination at 100-BC-5, 100-KR-4, 100-HR-03, and 100-FR-3 Operable Units* (BHI-00917). In general, the stratigraphy beneath the 100-B,C Area consists of the Hanford and Ringold Formations. The thickness of the Hanford formation is uncertain because the contact between it and the underlying Ringold Formation is not well defined. The Hanford formation, a gravel-dominated sequence with sandy and silty intervals, was reported to range from ~14 m near the Columbia River to over 30 m thick in the southern part of the 100-B,C Area (Newcomb et al. 1972, WHC-SD-EN-TI-133). The Ringold Formation in the 100-B,C Area includes Unit E and the underlying paleosols and overbank deposits (BHI-00917, WHC-SD-EN-TI-133). Unit E, which varies in thickness across the 100-B,C Area is dominated by silty, sandy gravel with subordinate sand- and silt-dominated interbeds.

The unconfined aquifer beneath the 100-B,C Area lies within the silt, sand, and gravels belonging primarily to the Ringold Formation and is ~34 m thick. The upper portion of the unconfined aquifer lies locally within the lowermost Hanford formation. The top of the paleosols and overbank deposits of the Ringold Formation form the bottom of the unconfined aquifer. The depth to the water table varies from <1 m near the Columbia River to <30 m farther inland. Local confined aquifers lie within the Ringold Formation between the paleosol/overbank deposits and the top of the basalt.

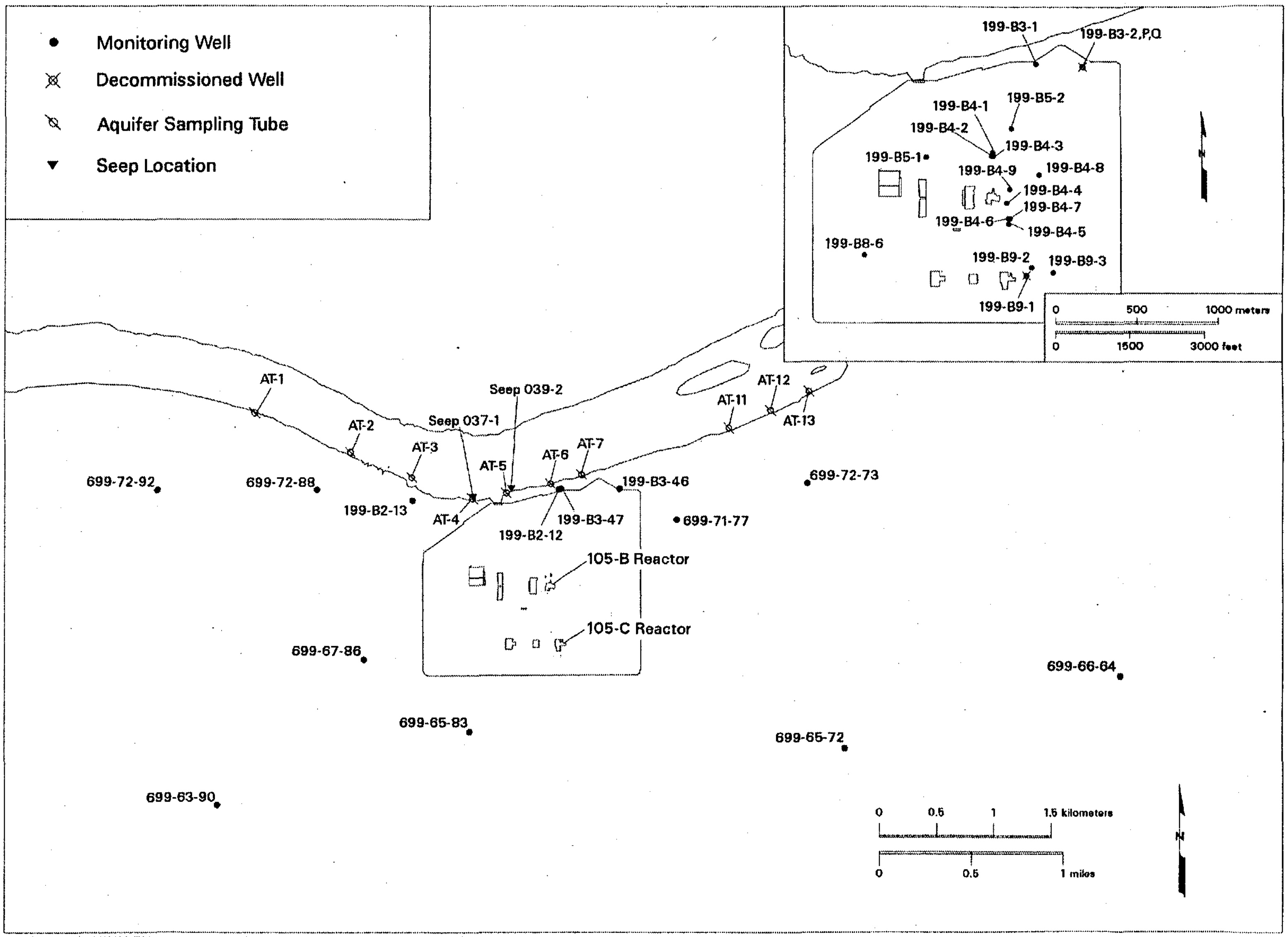

Figure 1. 100-B,C Groundwater Monitoring Network

River-stage fluctuations dominate groundwater flow beneath the 100-B,C Area. The direction of groundwater flow within the unconfined aquifer is generally north toward the Columbia River. However, the flow direction periodically shifts to the southeast when river stage is high.

During the high-river stages, the groundwater gradient has been estimated to be 0.0009 with a gradient to the northeast. The low-river gradient for the 100-B,C Area is estimated to be 0.001. Hydraulic conductivity of the Hanford formation in the 100-B,C Area ranges from 4.3 to 17 m/d (BHI-00917). Using this range for hydraulic conductivity, a 0.0009 summer gradient, a 0.001 winter gradient, and an estimated effective porosity of 0.2, the groundwater-flow velocity ranges from 0.02 to 0.08 m/d in the summer and 0.02 to 0.09 m/d in the winter.

3.0 Monitoring Network

The 100-BC-5 groundwater-monitoring network wells are shown in Figure 1 and are listed in Appendix A. The form in Appendix A also lists the specific constituents monitored at each well and the frequency of sampling. Additional constituents may be sampled at these wells for the requirements of the *Atomic Energy Act of 1954* ("surveillance monitoring"), or for the requirements of the Integrated Monitoring Program (PNNL-11989, or the most recent edition).

Groundwater near the Columbia River is sampled annually in the late fall via aquifer sampling tubes and riverbank seeps. The sampling tubes are polyethylene tubes that were driven into the aquifer at locations near the low-water shoreline. Seeps are locations where groundwater discharges above the river level.

4.0 Sampling and Analysis Protocol

Monitoring for the 100-BC-5 Operable Unit is part of the Hanford Groundwater Monitoring Project. Procedures for groundwater sampling, documentation, sample preservation, shipment, and chain-of-custody requirements are described in Pacific Northwest National Laboratory (PNNL) or subcontractor manuals (currently a Waste Management Northwest procedure manual) and in the quality assurance plan (a PNNL internal document). Samples generally are collected after three casing volumes of water have been purged from the well or after field parameters (pH, temperature, specific conductance, and turbidity) have stabilized. For routine groundwater samples, preservatives are added to the collection bottles before their use in the field. Samples to be analyzed for metals are usually filtered in the field so that results represent dissolved metals.

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

5.0 Quality Assurance and Quality Control

The groundwater monitoring project's quality assurance/quality control (QA/QC) program is designed to assess and enhance the reliability and validity of groundwater data. The primary quantitative measures or parameters used to assess data quality are accuracy, precision, completeness, and the method detection limit. Qualitative measures include representativeness and comparability. Goals for data representativeness for groundwater monitoring projects are addressed qualitatively by the specification of well locations, well construction, sampling intervals, and sampling and analysis techniques in the groundwater monitoring plan for each Resource Conservation and Recovery Act (RCRA) facility. Comparability is the confidence with which one data set can be compared to another. The QC parameters are evaluated through laboratory checks (e.g., matrix spikes, laboratory blanks), replicate sampling and analysis, analysis of blind standards and blanks, and interlaboratory comparisons. Acceptance criteria have been established for each of these parameters, based on guidance from the U.S. Environmental Protection Agency (OSWER-9950.1), and are specified in the project's quality assurance manual. When a parameter is outside the criteria, corrective actions are taken to prevent a future occurrence and affected data are flagged in the database.

6.0 Data Management, Evaluation, and Reporting

This chapter describes how groundwater data are stored, retrieved, evaluated, interpreted, and reported.

6.1 Data Management

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

The data undergo a validation/verification process according to a documented procedure, as described in the project QA plan. QC data are evaluated against the criteria listed in the project QA plan and data flags are assigned when appropriate. In addition, data are screened by scientists familiar with the hydrogeology of the unit, compared to historical trends or spatial patterns, and flagged if they are not representative. Other checks on data may include comparison of general parameters to their specific counterparts (e.g., conductivity to ions; gross alpha to uranium), calculation of charge balances, and comparison of calculated versus measured conductivity. If necessary, the laboratory may be asked to check calculations or reanalyze the sample, or the well may be resampled.

6.2 Interpretation

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

- Hydrographs: graph water levels versus time to determine decreases, increases, seasonal, or man-made fluctuations in groundwater levels.

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

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

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

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

6.3 Reporting

Interpretations of data for the 100-BC-5 Operable Unit are reported annually along with the rest of the Groundwater Project (e.g., PNNL-13116).

7.0 References

Atomic Energy Act of 1954, as amended, Ch. 1073, 68 Stat. 919, 42 USC 2011 et seq.

BHI-00917. 1996. *Conceptual Site Models for Groundwater Contamination at 100-BC-5, 100-KR-4, 100-HR-03, and 100-FR-3 Operable Units*. R. E. Peterson, R. F. Raidel, and C. W. Denslow, Bechtel Hanford, Inc., Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act. 1980. Public Law 96-150, as amended, 94 Stat. 2767, USC 9601 et seq.

DOE/RL-90-08. 1992. *Remedial Investigation/Feasibility Study Work Plan for the 100-BC-5 Operable Unit, Hanford Site, Richland, Washington*. U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Gillespie, B. M. 1999. "Appendix C, Analytical Methods." In PNNL-12086, *Hanford Site Groundwater Monitoring for 1998*, Pacific Northwest National Laboratory, Richland, Washington.

Newcomb, R. C., J. R. Strand, and F. J. Frank. 1972. *Geology and Ground-Water Characteristics of the Hanford Reservation of the U.S. Atomic Energy Commission, Washington*. Professional Paper 717, U.S. Geological Survey, Washington, D.C.

OSWER-9950.1. 1986. *Resource Conservation and Recovery Act (RCRA) Groundwater Monitoring Technical Enforcement Guidance Document (TEGD)*. U.S. Environmental Protection Agency, Washington, D.C.

PNNL-11989, Rev. 1. 1999. *Integrated Monitoring Plan for the Hanford Groundwater Monitoring Project*. M. J. Hartman, P. E. Dresel, D. R. Newcomer, and E. C. Thornton, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13116. 2000. *Hanford Site Groundwater Monitoring for Fiscal Year 1999*. M. J. Hartman, L. F. Morasch, and W. D. Webber (eds.), Pacific Northwest National Laboratory, Richland, Washington.

Resource Conservation and Recovery Act. 1976. Public Law 94-580, as amended, 90 Stat. 2795, 42 USC 6901 et seq.

SW-846. 1986. *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, 3rd ed.* Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy. 1998. *Hanford Federal Facility Agreement and Consent Order*. Document No. 89-10, Rev. 5 (The Tri-Party Agreement), Olympia, Washington.

WHC-SD-EN-TI-133. 1993. *Geology of the 100-B/C Area, Hanford Site, South-Central Washington*. J. W. Lindberg, Westinghouse Hanford Company, Richland, Washington.

Appendix A

Federal Facility Agreement and Consent Order
Change Control Form M-15-99-03

Change Number	Federal Facility Agreement and Consent Order	Date
M-15-99-03	Change Control Form Do not use blue ink. Type or print using black ink.	7/14/99

Originator
M. J. Furman

Phone
373-9630

Class of Change

[ ] I - Signatories [ ] II - Executive Manager [X] III - Project Manager

Change Title
Modifications to the Groundwater Sampling and Analysis for the 100-BC-5 Operable Unit Groundwater Sampling Project

Description/Justification of Change

The following encapsulates changes to the 100-BC-5 Operable Unit Monitoring as of 07/31/96

1) Four wells were deleted from the original Change Control Form (Change Number M-15-96-07). Technetium-99 and carbon-14 were also removed from the annual sampling schedule. These changes were noted in the correspondence appended to the Change Control Form without justification. The current revision of the Change Control Form reflects these previous deletions.

2) Wells 199-B3-2(p,q) and 199-B9-1 were deleted as part of remediation efforts in the 100-B,C Area. The 100-BC-5 Operable Unit continues to have adequate coverage from remaining groundwater monitoring wells. Changes in groundwater conditions or elevation of constituent levels could require new well installations. Well placements are selected on the basis of proximity to the Columbia River, historical trends in each well, and contaminant plume locations.

3) Integration of groundwater programs within the Hanford Site has eliminated overlap in sampling schedules and constituents. Surveillance and 100-BC-5 Operable Unit monitoring were added to the Integrated Monitoring Plan for the Hanford Groundwater Monitoring Project (PNNL-11989) in September 1998. Future changes to surveillance monitoring and the 100-BC-5 Change Control Form will be reflected in revisions to the Integrated Monitoring Plan.

4) Data validation will follow requirements outlined in the Integrated Monitoring Plan (PNNL-11989).

The attached Tables 1 and 2 summarize the changes to 100-BC-5 sampling. Minor modifications to the list of specific wells used and constituents analyzed may occur to meet the changing field conditions and the results of data evaluation.

Impact of Change
The changes continue the trend established in Change Control Form M-15-96-07 to produce a more integrated and cost-effective system. Changes to the monitoring network as a result of excavation in support of remediation are also included. Sample collection efforts will be integrated further under the consolidated program (PNNL-11989). Where reductions in number of samples, analytes, and frequency of sampling occur, a minimal or negligible loss of relevant information is expected.

Affected Documents
1) Remedial Investigation/Feasibility Study Work Plan for the 100-BC-5 Operable Unit, Hanford Site, Richland, WA; DOE/RL-90-08, July 1992. 2) 100 NPL Agreement/Change Control Form #14, "100-BC-5 Operable Unit Groundwater Monitoring Network," EPA approval July 1992; 3) Federal Facility Agreement and Consent Order Change Control Form, Change Number M-15-96-07.

Approvals

M. J. Furman — DOE	Date 6/22/99	✓ Approved	___ Disapproved
EPA	Date 7-14-99	✓ Approved	___ Disapproved
N/A — Ecology	Date	___ Approved	___ Disapproved

Table 1. Sampling and Analysis Schedule for 100-BC-5 Groundwater Project

Well Number	Facility Monitored/Purpose	Schedule	Program	Change
199-B2-12	116-B-11 Retention Basin	A	BCLFI	None
199-B3-1	116-B-11 Retention Basin	A	BCLFI	None
199-B3-2(p,q)	116-B-11 Trench	N/A	N/A	Decommissioned
199-B3-46	116-C-1 Trench	A	BCLFI	None
199-B3-47	116-B-11 Retention Basin	A	BCLFI	None
199-B4-1	116-B-5 Crib	2-O	BCLFI	None
199-B4-2	116-B-5 Crib	A	S	None
199-B4-3	116-B-5 Crib	N/A	BCLFI	Reserve
199-B4-4	B Reactor Building Effluent Disposal	2-E	BCLFI	None
199-B4-5	In Situ Vitrification Test/116-B-6A	2-E	BCLFI	None
199-B4-6	In Situ Vitrification Test/116-B-6A	N/A	BCLFI	Reserve
199-B4-7	In Situ Vitrification Test/116-B-6A	2-E	BCLFI	None
199-B5-1	183-B Water Treatment Plant	A	BCLFI	None
199-B5-2	Liquid Effluent Disposal Crib	A	BCLFI	None
199-B8-6	105-B Burial Ground	2-E	BCLFI	None
199-B9-1	Reactor "pluto" crib	N/A	N/A	Decommissioned
199-B9-2	Reactor "pluto" crib	2-E	BCLFI/S	None
199-B9-3	Reactor "pluto" crib	2-O	BCLFI	None
699-63-90	Background	A	S	None
699-65-72	Background	2-O	BCLFI/S	None
699-65-83	Background	2-E	BCLFI	None
699-66-64	Background	2-O	BCLFI/S	None
699-67-86	Background	2-E	BCLFI	None
699-72-73	Background	A	BCLFI/S	None
699-72-88	Background	A	S	None
699-72-92	Background	2-E	BCLFI	None
Seep 037-1	Area/shoreline exposure	A	BCLFI	None
Seep 039-2	Area/shoreline exposure	A	BCLFI	None

Notes: 2-E = biennial sampling, even years (starting 1998), A = annual sampling, 2-O = biennial sampling, odd years (starting 1997), S = Surveillance Monitoring, BCLFI = 100-BC-5 Limited Field Investigation, N/A = not applicable/decommissioned well

Table 2. Analysis Suite Codes for the 100-BC-5 Groundwater Project

Analysis/Parameter	Constituent	
Metals by routine ICP (EPA 6010A-Target Analyte List) Note: Filtered samples only for all metal analysis	Aluminum Antimony Barium Beryllium Cadmium Calcium Chromium Cobalt Copper	Iron Magnesium Manganese Nickel Potassium Silver Sodium Vanadium Zinc
Anions by IC (EPA 300.0)	Chloride Fluoride	Nitrate Sulfate
Radionuclide screening	Gross alpha Gross beta Activity scan*	
Specific radionuclides	Strontium-90 Tritium	
Field parameters	pH Specific conductance Temperature Turbidity Hexavalent chromium**	
Note: * = Selected wells only, ** = Annually in wells 199-B3-47 and 199-B5-1, ICP= Inductively coupled plasma, IC = Ion chromotography. Constituent selection based on TPA Change Control Form M-15-96-07, August 1996.		

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