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Pacific Northwest
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Groundwater Monitoring Plan for the 1301-N, 1324-N/NA, and 1325-N RCRA Facilities

M. J. Hartman

May 2002

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

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Summary

The 1301-N and 1325-N Liquid Waste Disposal Facilities, the 1324-N Surface Impoundment, and the 1324-NA Percolation Pond, located in the 100 N Area of the Hanford Site, are regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA). The closure plans for these facilities stipulate that groundwater is monitored according to the *100-N Pilot Project: Proposed Consolidated Groundwater Monitoring Program* (BHI-00725). This document supplements the consolidated plan by providing information on sampling and analysis protocols, quality assurance, data management, and a conceptual model for the RCRA sites. Monitoring well networks, constituents, and sampling frequency remain the same as in the consolidated plan or the previous groundwater monitoring plan (Hartman 1996).

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1.0 Introduction

Four hazardous waste units in the Hanford Site's 100 N Area are regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA): the 1301-N and 1325-N Liquid Waste Disposal Facilities, the 1324-N Surface Impoundment, and the 1324-NA Percolation Pond (Figure 1). The facilities are no longer used and will be closed under the RCRA regulations and in conjunction with clean-up activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). The 1324-N and 1324-NA facilities are monitored as a single waste management area because they are adjacent to one another and received the same type of waste.

The 1301-N, 1325-N, and 1324-N/NA sites are incorporated into the Hanford Site RCRA Permit (Ecology 1994) and are subject to final status monitoring requirements under WAC 173-303-645. The closure plans for the facilities (Appendices A and B of DOE 1998) state that during the closure period "monitoring will be done in accordance with the existing groundwater monitoring program (Borghese et al. 1996)." Borghese et al. (1996) is the *100-N Pilot Project: Proposed Consolidated Groundwater Monitoring Program*, and includes wells, constituents, and sampling frequencies for the 100 N Area RCRA sites. It is supplemented by Hartman (1996) which also includes descriptions of site hydrogeology, sampling and analysis protocols, quality assurance, and data management.

This monitoring plan briefly describes the conceptual model, monitoring well networks, and sampling frequency for the 100 N Area RCRA sites. These basic elements are unchanged from those presented in Borghese et al. (1996) or the previous monitoring plan (Hartman 1996). This plan updates the previous monitoring plan with new descriptions of sampling and analysis protocols, quality assurance, data management, and conceptual models. Descriptions of statistical techniques, history of monitoring, and hydrogeology of the site are included in Hartman (1996).

2.0 Conceptual Model

A conceptual model is an evolving hypothesis that identifies the important features, events, and processes that control our understanding of consequences for a particular problem. Conceptual models form the basis for investigation of field observations and laboratory data. The characteristics of the conceptual models for the facilities are described in Sections 2.1 and 2.2.

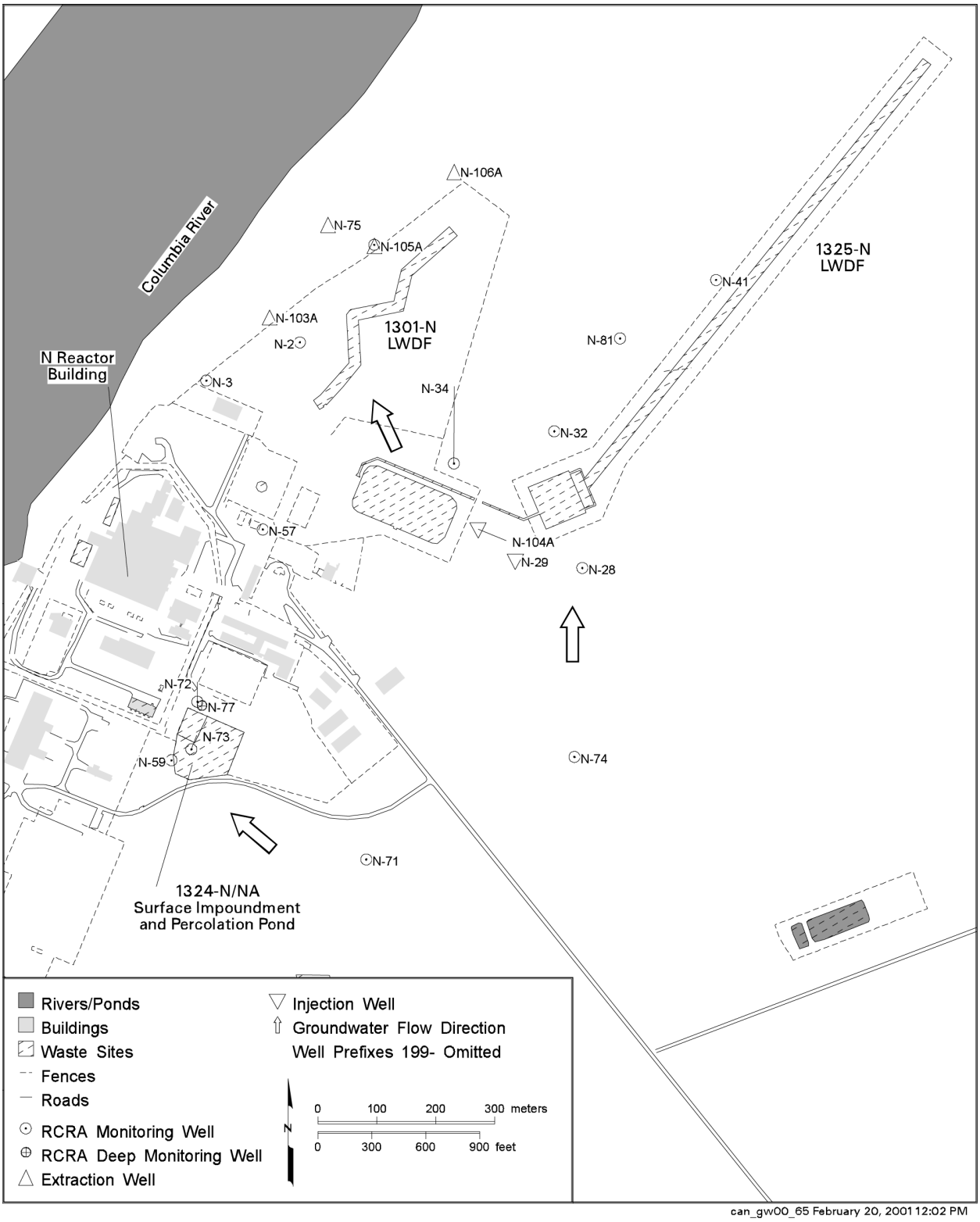

Figure 1. Groundwater Monitoring Wells for 100 N Area RCRA Units

2.1 1301-N and 1325-N Liquid Waste Disposal Facilities

The following characteristics describe the conceptual model for the 1301-N and 1325-N facilities:

- Most of the contamination from these facilities is radioactive (e.g., strontium-90, cesium-137, cobalt-60, tritium). Most of the radionuclides remain in the vadose zone or have decayed with time. Only strontium-90 and tritium are detected in the groundwater. These contaminants are regulated under CERCLA.

- The contaminated effluent infiltrated along the entire length of the 1301-N crib and trench. Infiltration at the 1325-N crib occurred only beneath the crib and the southern quarter of the trench.

- Strontium-90 has sorbed to sediments in the vadose zone and in the aquifer. The vadose zone is a continuing source of contamination to groundwater. It is mobilized by infiltrating precipitation and by a rising and falling water table. There is no evident declining trend in strontium-90 concentrations in groundwater.

- Tritium is mobile in groundwater, but the continuing presence of the tritium plume indicates that there is still tritium-contaminated water draining out of the vadose zone. Tritium concentrations are declining with plume movement and radioactive decay.

- Small quantities of dangerous waste were present in waste discharged to the facilities, but they were not detected at the point of discharge. Groundwater monitoring indicates these constituents are not significant contaminants.

- No organic constituents were discharged to the facility. Thus, any exceedances of critical mean values for total organic carbon or total organic halides did not originate at the site.

- Nitrate is elevated in several wells downgradient of the sites, but the distribution pattern and trends do not indicate that the 1301-N and 1325-N facilities are the source of contamination.

- Groundwater flows to the north and northwest beneath the 1325-N facility, and to the northwest beneath the 1301-N facility. Some groundwater discharges to the Columbia River through springs above the river level, but most discharges beneath the surface of the river. Contaminants mix with river water and concentrations in the river are below drinking water standards.

- Extraction of groundwater downgradient of the 1301-N facility is reducing groundwater flow into the Columbia River, thereby reducing the flux of strontium-90 while pumping continues. However, concentrations in near-river wells remain high, and the system is not removing a significant amount of strontium-90 from the groundwater.

- Injection of treated groundwater in wells near the 1325-N crib influences flow directions locally, creating radial flow near the injection wells. The water contains residual strontium-90.

- Strontium-90 is mobilized by ion exchange processes as high-conductivity groundwater from the 1324-N/NA site flows through the strontium-90 plume.

2.2 1324-N/NA Surface Impoundment and Percolation Pond

The conceptual model for the 1324-N/NA facility includes the following elements:

- The 1324-N surface impoundment did not leak and, thus, did not contaminate the vadose zone or groundwater.

- The 1324-NA percolation pond introduced non-hazardous contaminants, primarily sulfate and sodium, to groundwater. The pH of the effluent ranged from 1 to 14, causing it to be classified as hazardous, but mixing in the pond and neutralization in the sediment prevented the high-pH or low-pH water from reaching groundwater.

- Sulfate and sodium move readily with groundwater toward the northwest to the Columbia River. There appears to be continuing drainage of water from the vadose zone, since concentrations are remaining high many years after disposal ceased. These constituents cause the groundwater to have a high specific conductance.

- No organic constituents were discharged to the facilities. Thus any total organic carbon or total organic halides exceedances did not originate at the site.

3.0 Groundwater Monitoring Program

This section describes the RCRA monitoring programs for the 1301-N, 1325-N, and 1324-N/NA facilities, designed to detect possible groundwater contamination from these facilities. It includes well networks, constituent lists, and sampling frequency.

Although the sites are part of the Hanford Site RCRA permit and are, therefore, subject to final status requirements for groundwater monitoring, the closure plans stipulate that the existing, interim status programs will be continued during the closure periods. Therefore, this document describes interim status monitoring. Cleanup of the RCRA units is integrated with CERCLA operable unit remediation, so cleanup decisions await implementation of a final record of decision.

3.1 Monitoring Well Network

The monitoring network will remain the same as listed in Hartman (1996) and Borghese et al. (1996). There are three separate well networks for the 1301-N, 1325-N, and 1324-N/NA sites (Tables 1 through 3). All but one of the wells monitor the top of the unconfined aquifer where contamination from the

facilities is most likely to be detected. Most of the wells for RCRA monitoring are constructed to the standards of WAC 173-160. A few older wells are included because they are adequate for the objectives of monitoring and are approved parts of the networks. As-built diagrams are included in Hartman (1996).

The network of monitoring wells for 1301-N Liquid Waste Disposal Facility includes two upgradient wells and three downgradient wells. One of the downgradient wells (199-N-105A) is an extraction well for the pump-and-treat system.

The 1325-N well network includes one upgradient well, three downgradient wells that are used for statistical evaluations, and an additional upgradient well (199-N-28) used for supplemental information (i.e., to look for possible influences from injected water). Only the southern quarter of the trench was used, so there is no need to monitor the northern portion.

The 1324-N/NA site includes one upgradient well, three shallow downgradient wells, and one deeper well. Well 199-N-77 monitors the bottom of the unconfined aquifer; it was included in the monitoring well network at the request of Washington State Department of Ecology (Ecology).

Well 199-N-59 was installed when there was a groundwater mound beneath the 1324-NA percolation pond, and it is shallower than the other wells in the network. When the water table is lower than average (i.e., after lengthy periods of low river stage), the well contains too little water to sample.

3.2 Constituent List and Sampling Frequency

Samples will continue to be analyzed semiannually for contamination indicator parameters (specific conductance, pH, total organic carbon, and total organic halides) and annually for additional constituents as listed in Tables 1 through 3. Quadruplicate measurements for the contamination indicator parameters are required for wells used in statistical evaluations (i.e., all wells except 199-N-28 and 199-N-77). Gross alpha is analyzed in wells 199-N-59 and 199-N-77 as requested by Ecology.

Total organic carbon and total organic halides are not good indicators for any of the 100 N Area RCRA sites because organic constituents were not discharged to them and there are other sources of organic contamination nearby. These indicator parameters are retained because they are required by the regulations.

Radionuclides are outside the scope of RCRA monitoring at the 100 N Area sites, but strontium-90, tritium, and selected other radionuclides are analyzed at many 100 N Area wells for the objectives of CERCLA or the *Atomic Energy Act* (i.e., surveillance monitoring).

3.3 Sampling and Analysis Protocol

Monitoring for the 100 N Area RCRA sites is part of the Hanford Groundwater Monitoring Project. Procedures for groundwater sampling, documentation, sample preservation, shipment, and chain-of- custody

Table 1. Monitoring Wells and Constituents for 1301-N Liquid Waste Disposal Facility

Well	Year Installed (well standard)	Comments
199-N-2	1964 (PRE)	
199-N-3	1964 (PRE)	
199-N-34	1983 (PRE)	Upgradient
199-N-57	1987 (WAC)	Upgradient
199-N-105A	1995 (WAC)	Extraction well; screened over entire thickness of aquifer.
Constituents		
Constituent Group (regulatory requirement)	Constituent	Sampling Frequency and Comments
Contamination indicator parameters (40 CFR 265.92[3])	pH (field)	Semiannual; quadruplicate samples
	Specific conductance (field)	
	Total organic carbon	
	Total organic halides	
Groundwater quality parameters (40 CFR 265.92[2])(a)	Chloride	Annual
	Iron	
	Manganese	
	Sodium	
	Sulfate	
Supporting parameters	Alkalinity	Annual
	Turbidity	Semiannual

(a) Samples analyzed for anions and dissolved metals (inductively coupled plasma emission spectroscopy method). Phenols required under 40 CFR 265.92(2) but waived for 100 N Area RCRA sites as in previous monitoring plans.
PRE = Well not constructed to Washington Administrative Code standards.
WAC = Well constructed to Washington Administrative Code standards (WAC 173-160).

requirements are included in subcontractor manuals[1]. 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.

[1] Currently *Sampling Services Procedure Manual*. DFSNW-SSPM-001, Duratek Federal Services Northwest, Richland, Washington.

Table 2. Monitoring Wells and Constituents for 1325-N Liquid Waste Disposal Facility

Well	Year Installed (well standard)	Comments
199-N-28	1983 (PRE)	Monitors potential effects of injection wells 199-N-104A and 199-N-29. Not used for statistical evaluations.
199-N-32	1983 (PRE)	
199-N-41	1984 (PRE)	
199-N-74	1991 (WAC)	Upgradient
199-N-81	1993 (WAC)	
Constituents		
Constituent Group (regulatory requirement)	Constituent	Sampling Frequency and Comments
Contamination indicator parameters (40 CFR 265.92[3])	pH (field)	Semiannual; quadruplicate samples except single sample in well 199-N-28
	Specific conductance (field)	
	Total organic carbon	
	Total organic halides	
Groundwater quality parameters (40 CFR 265.92[2])[(a)]	Chloride	Annual (199-N-32 semiannual)
	Iron	
	Manganese	
	Sodium	
	Sulfate	
Supporting parameters	Alkalinity	Annual (199-N-32 semiannual)
	Turbidity	Semiannual

(a) Samples analyzed for anions and dissolved metals (inductively coupled plasma emission spectroscopy method). Phenols required under 40 CFR 265.92(2) but waived for 100 N Area RCRA sites as in previous monitoring plans.
PRE = Well not constructed to Washington Administrative Code standards.
WAC = Well constructed to Washington Administrative Code standards (WAC 173-160).

Procedures for field measurements are specified in the subcontractor's or manufacturer's manuals. Analytical methods are specified in contracts with laboratories, and most are standard methods from *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* (EPA 1986a). Alternative procedures meet the guidelines of SW-846, Chapter 10. Analytical methods are described in Section 8 of Hartman (2000).

Table 3. Monitoring Wells and Constituents for 1324-N/NA Facilities

Well	Year Installed (well standard)	Comments
199-N-59	1987 (WAC)	Little water; dry when water table is low.
199-N-71	1991 (WAC)	Upgradient
199-N-72	1991 (WAC)	
199-N-73	1991 (WAC)	
199-N-77	1992 (WAC)	Completed at bottom of aquifer. Not used for statistical evaluations.
Constituents		
Constituent Group (regulatory requirement)	Constituent	Sampling Frequency and Comments
Contamination indicator parameters (40 CFR 265.92[3])	pH (field)	Semiannual; quadruplicate samples except single sample in well 199-N-77
	Specific conductance (field)	
	Total organic carbon	
	Total organic halides	
Groundwater quality parameters[(a)] (40 CFR 265.92[2])	Chloride	Annual
	Iron (filtered)	
	Manganese (filtered)	
	Sodium (filtered)	
	Sulfate	
Supporting parameters	Alkalinity	Annual
	Turbidity	Semiannual
Radionuclides	Gross alpha	Semiannual; analyzed in199-N-59 and 199-N-77 only

(a) Samples analyzed for anions and dissolved metals (inductively coupled plasma emission spectroscopy method). Phenols required under 40 CFR 265.92(2) but waived for 100 N Area RCRA sites as in previous monitoring plans.
WAC = Well constructed to Washington Administrative Code standards (WAC 173-160).

4.0 Quality Assurance and Quality Control

The Groundwater Monitoring Project's quality assurance/quality control 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 RCRA facility. Comparability is the confidence with which one data set can be compared to another. The quality control 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 in the project quality assurance plan,[1] based on guidance from the U.S. Environmental Protection Agency (EPA 1986a; 1986b). When a parameter is outside the criteria, corrective actions are taken to prevent a future occurrence and affected data are flagged in the database.

5.0 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.

Verification of analytical data provided by the subcontracted laboratory will be performed in accordance with a documented procedure[1]. This procedure includes checks for: 1) completeness of hardcopy deliverable, 2) condition of samples upon receipt by the laboratory, 3) problems that arose during the analysis of the samples, and 4) correct reporting of results. The procedure also describes the actions to be taken associated with incomplete or deficient data.

Quality control data are evaluated against criteria listed in the project QA plan[2] and data flags are assigned when the data do not meet these criteria. The data undergo a validation/verification process according to a documented procedure.[3] Under this procedure, data are screened by scientists familiar with the site hydrogeology, 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., specific conductance to ions), calculation of charge balances, and comparisons of calculated versus measured values. If data appear anomalous, the project scientist submits a Request for Data Review.[4] If necessary, the laboratory may be requested to check calculations or reanalyze the sample, or the well may be resampled. Results of a review may be used to flag or correct data in HEIS.

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[1] Procedure DM-3, *Verification of Analytical Data (Hardcopy)*, in PNL-MA-567.
[2] *The Hanford Ground-Water Monitoring Project Quality Assurance Project Plan*. QA Plan ETD-012, Rev. 2. December 2000.
[3] Procedure QC-5, *Groundwater Data Validation Process* in PNL-MA-567.
[4] Procedure DA-3, *Data Review Procedure* in PNL-MA-567.

6.0 Reporting

Chemistry and water-level data are reviewed at least quarterly and are available in HEIS. Interpretive reports are issued annually in March (e.g., Hartman et al. 2002).

7.0 References

40 CFR 265.92(2). U.S. Environmental Protection Agency. "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities – Sampling and Analysis." *U.S. Code of Federal Regulations.*

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

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

WAC 173-160. *Minimum Standards for Construction and Maintenance of Wells.* Washington Administrative Code, Olympia, Washington.

WAC 173-303-645. *Releases from Regulated Units.* Washington Administrative Code, Olympia, Washington.

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