

# 1.0 Introduction

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The U.S. Department of Energy (DOE) has committed to a mission to protect the Columbia River from contaminated groundwater resulting from past, present, and future operations and to protect and remediate groundwater. *Hanford Site Groundwater Strategy* (DOE/RL-2002-59) focuses on three key areas: groundwater protection, groundwater monitoring, and remediation of contaminated groundwater.

One of the implementing documents for the groundwater strategy is *Hanford's Groundwater Management Plan: Accelerated Cleanup and Protection* (DOE/RL-2002-68). DOE established the Groundwater Remediation Project, managed by Fluor Hanford Inc., to implement the accelerated plan. Protection of Hanford's groundwater requires an aggressive plan to limit and control the continued migration of contaminants already in the soil and the groundwater. To do this, the Groundwater Remediation Project performs the following tasks:

- Prevent degradation of groundwater by (a) remediating high-risk waste sites, (b) shrinking the contaminated area, and (c) reducing natural and artificial recharge.
- Remediate groundwater.
- Monitor groundwater.

DOE monitors groundwater at the Hanford Site to fulfill a variety of state and federal regulations, including the *Atomic Energy Act of 1954* (AEA), the *Resource Conservation and Recovery Act* (RCRA), the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), and Washington Administrative Code. DOE manages these activities through the Groundwater Performance Assessment Project (groundwater project), which is conducted by Pacific Northwest National Laboratory. The groundwater project is under the umbrella of the Groundwater Remediation Project.

## 1.1 Purpose and Scope

This document presents results of groundwater monitoring to meet the requirements of AEA and RCRA sites and those CERCLA groundwater operable units where cleanup decisions have not yet been made (Table 1.1-1). This report also summarizes groundwater remediation, vadose zone monitoring and characterization, groundwater modeling, and well installation activities. Monitoring results primarily rely on data from samples collected in fiscal year (FY) 2004, i.e., October 1, 2003 through September 30, 2004.

*This report is designed to meet the following objectives:*

- *Provide a comprehensive report of groundwater conditions on the Hanford Site.*
- *Fulfill the reporting requirements of RCRA, CERCLA (for operable units where cleanup decisions have not yet been made), DOE Orders, and Washington Administrative Code.*
- *Summarize the results of groundwater monitoring conducted to assess the effects of interim remedial actions conducted under CERCLA.*
- *Describe the results of vadose zone monitoring, characterization, and studies.*
- *Summarize groundwater modeling activities.*
- *Summarize the installation, maintenance, and decommissioning of Hanford Site monitoring wells.*

*CERCLA regulates waste sites that were active before RCRA took effect. It covers sites where radioactive or hazardous waste was disposed or leaked and also requires groundwater monitoring where appropriate.*

**RCRA regulates facilities used to treat, store, or dispose of hazardous, non-radioactive waste. At Hanford, the law applies to sites that contained hazardous or mixed (hazardous and radioactive) waste. RCRA stipulates requirements for monitoring the groundwater beneath these sites.**

Groundwater remediation and associated monitoring is the responsibility of Fluor Hanford, Inc. Vadose zone monitoring and characterization are conducted by Bechtel Hanford, Inc.; CH2M HILL Hanford Group, Inc.; Fluor Hanford, Inc.; and Pacific Northwest National Laboratory.

Background information, including descriptions of regulatory requirements, waste sites, analytical methods, regional geology, and statistics is included in a separately published companion volume, *Hanford Site Groundwater: Setting, Sources and Methods* (PNNL-13080), and in the most recent update, which was provided in PNNL-13788, Appendix C. Those changes have been incorporated into the electronic version of PNNL-13080, provided with this groundwater monitoring report.

As in previous reports, this report includes a set of electronic files that contain groundwater data for the fiscal year and previous years.

## 1.2 Related Reports

Other reports and databases relating to Hanford Site groundwater include the following:

- Hanford Environmental Information System (HEIS) — This is the main environmental database for the Hanford Site that stores groundwater chemistry data, as well as other environmental data (e.g., soil chemistry, survey data).
- Quarterly data transmittals — DOE transmits informal reports quarterly to the Washington State Department of Ecology after groundwater data collected for the RCRA program have been verified and evaluated. These reports describe changes or highlights of the quarter with reference to HEIS for the analytical results.
- *Calendar Year 2003 Annual Summary Report for the 100-HR-3, 100-KR-4, and 100-NR-2 Operable Unit Pump-and-Treat Operations* (DOE/RL-2004-21) — This report evaluates the performance of groundwater remediation systems in the 100-K, 100-N, 100-D, and 100-H Areas.
- *Fiscal Year 2003 Annual Summary Report for the In Situ Redox Manipulation Operations* (DOE/RL-2004-06) — This report describes activities related to the remediation system in the southwest 100-D Area.
- *Fiscal Year 2003 Annual Summary Report for the 200-UP-1 and 200-ZP-1 Pump-and-Treat Operations* (DOE/RL-2003-58) — This report evaluates the performance of groundwater remediation systems in the 200 West Area.
- *Performance Evaluation Report for Soil Vapor Extraction Operations at the 200-PW-1 Carbon Tetrachloride Site, Fiscal Year 2003* (WMP-21327) — This report describes activities related to vadose zone remediation in the 200 West Area.
- *Hanford Site Environmental Report for Calendar Year 2003* (PNNL-14687) — This annual report summarizes environmental data, including riverbank springs and river water. It also describes environmental management performance and reports the status of compliance with environmental regulations.
- *Hanford Site Climatological Data Summary 2003 with Historical Data* (PNNL-14616) — This annual report summarizes data on temperature, precipitation, and other weather conditions that may impact groundwater recharge.

### Units of Measure

µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
M	molar
mg/L	milligrams per liter
mm/yr	millimeters per year
mrem/yr	millirem per year
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/mg	picocuries per milligram
ppb	parts per billion
ppm	parts per million
ppmv	parts per million volume

## 1.3 Conventions Used in This Report

Contaminant plume maps in this report, unless specified otherwise, are based on average FY 2004 data for each well, excluding data that appear erroneous. The maps

are hand-contoured by project staff based on current and historical data, source knowledge, and flow directions. The maps use data from FY 2002 and 2003 if there were no new data for a well in FY 2004. These older data, and data from aquifer tubes along the Columbia River, are given less “weight” than the current well data when the maps are contoured. The maps show data from wells completed at or near the top of the aquifer. Concentrations of most contaminants decrease with depth, but carbon tetrachloride distribution at depth may be significantly different from distribution at the top of the aquifer, as discussed in Section 2.8 of this report.

Trend plots generally include analytical results that appear to be erroneous if they do not distort the scale or obscure the data trends. If the outlying data distort the figure, they are not plotted. All of the data, with appropriate data quality flags, are included in the data files that accompany this report and are available in the HEIS database. Trend plots in this report use open symbols to show values so low the laboratory could not detect them. These results are typically reported and plotted as values that represent the detection limit.

This report uses the following conventions for chemical results:

- Text, figures, and tables express nitrate and nitrite as the NO<sub>3</sub> and NO<sub>2</sub> ions, respectively.
- Figures showing chromium include total chromium in filtered samples and hexavalent chromium in filtered or unfiltered samples. Dissolved chromium in Hanford Site groundwater is virtually all hexavalent (WHC-SD-EN-TI-302), so filtered total chromium represents hexavalent chromium.
- Contaminant concentrations are compared with state or federally enforceable drinking water standards (Table 1.1-2). Although Hanford Site groundwater is not generally used for drinking, these levels provide perspective on contaminant concentrations. Radionuclide concentrations also are compared with DOE derived concentration guides (Table 1.1-3).

Conversion Table		
The primary units of measurement in this report are metric. To convert metric units to English units, use the information provided in this table.		
Multiply	By	To Obtain
centimeters	0.394	inches
meters	3.28	feet
kilometers	0.621	miles
kilograms	2.205	pounds
liters	0.2642	gallons
square meters	10.76	square feet
hectares	2.47	acres
square kilometers	0.386	square miles
cubic meters	1.308	cubic yards
curie	$3.7 \times 10^{10}$	becquerel
picocurie	0.03704	becquerel
rem	0.01	sievert
°C	$(^{\circ}\text{C} \times 9/5) + 32$	°F

Common Abbreviations	
AEA	<i>Atomic Energy Act of 1954</i>
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act</i>
DOE	U.S. Department of Energy
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FY	fiscal year
NAVD88	North American Vertical Datum of 1988
RCRA	<i>Resource Conservation and Recovery Act</i>

**Table 1.1-1.** Reporting Requirements for Groundwater Monitoring

Operable Unit or Facility	Formal Report	Supplemental Reports or Summaries
<b>CERCLA</b>		
Operable units without RODs (100-BC-5, 100-FR-3, 200-BP-5, 200-PO-1)	This report	Unit manager's meeting presentations
Operable units with interim RODs managed by FH (100-KR-4, 100-NR-2, 100-HR-3, 200-UP-1, 200-ZP-1)	Interim action annual reports (summarized in this report)	Unit manager's meeting presentations; this report
Operable unit with interim ROD managed by PNNL (300-FF-5)	Separate annual reports beginning FY 2005 (summarized in this report)	Unit manager's meeting presentations; this report
Operable unit with final ROD managed by PNNL (1100-EM-1)	This report	None
ERDF	Separate annual report covers groundwater and leachate (summarized in this report)	This report
<b>RCRA Units</b>		
Detection sites (116-N-1 and -3, 120-N-1 and -2, 216-A-29, 216-B-63, 216-S-10, B Pond, IDF, LERF, LLBG, NRDWL, WMA A-AX, WMA C)	This report	Informal quarterly reports to Ecology
Assessment sites (216-U-12; PUREX cribs; WMAs B-BX-BY, S-SX, T, TX-TY, and U)	This report; also occasional assessment reports	Informal quarterly reports to Ecology
Corrective action sites (116-H-6, 316-5)	Semiannual letter reports to Ecology; this report	Informal quarterly reports to Ecology
<b>Other Facilities</b>		
AEA sites (K Basins, 400 Area water supply wells)	This report	Quarterly reports to facility operators and DOE
SALDS (WAC 173-216)	Separate annual report	This report
TEDF (WAC 173-216)	This report	None
WAC 173-304 site (SWL)	This report for groundwater; separate report for leachate and soil gas	None

- AEA = Atomic Energy Act of 1954.
- CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
- DOE = U.S. Department of Energy.
- Ecology = Washington State Department of Ecology.
- ERDF = Environmental Restoration Disposal Facility.
- FH = Fluor Hanford, Inc.
- FY = Fiscal year.
- IDF = Integrated Disposal Facility (planned).
- LERF = Liquid Effluent Retention Facility.
- LLBG = Low-level burial grounds.
- NRDWL = Nonradioactive Dangerous Waste Landfill.
- PNNL = Pacific Northwest National Laboratory.
- PUREX = Plutonium-Uranium Extraction (Plant).
- RCRA = Resource Conservation and Recovery Act.
- ROD = Record of decision.
- SALDS = State-Approved Land Disposal Site.
- SWL = Solid Waste Landfill.
- TEDF = Treated Effluent Disposal Facility.
- WAC = Washington Administrative Code.
- WMA = Waste management area.

**Table 1.1-2.** Drinking Water Standards

Constituent	DWS	Agency <sup>(a)</sup>
Aluminum <sup>(b)</sup>	50 to 200 µg/L	EPA, DOH
Antimony	6 µg/L	EPA, DOH
Arsenic	10 µg/L <sup>(c)</sup>	EPA, DOH
Barium	2,000 µg/L	EPA, DOH
Cadmium	5 µg/L	EPA
Carbon tetrachloride	5 µg/L	EPA, DOH
Chloride	250 mg/L <sup>(b)</sup>	EPA, DOH
Chloroform (THM) <sup>(d)</sup>	80 µg/L	EPA
Chromium	100 µg/L	EPA, DOH
cis-1,2-Dichloroethene	70 µg/L	EPA, DOH
Copper	1,000 µg/L <sup>(b)</sup>	EPA, DOH
Cyanide	200 µg/L	EPA, DOH
1,4-Dichlorobenzene	75 µg/L	EPA
Fluoride	4,000 µg/L	EPA, DOH
	2,000 µg/L <sup>(b)</sup>	EPA, DOH
Iron	300 µg/L <sup>(b)</sup>	EPA, DOH
Lead	15 µg/L <sup>(e)</sup>	EPA
Manganese	50 µg/L <sup>(b)</sup>	EPA, DOH
Mercury (inorganic)	2 µg/L	EPA, DOH
Methylene chloride	5 µg/L	EPA, DOH
Nitrate, as NO <sub>3</sub> <sup>-</sup>	45 mg/L	EPA, DOH
Nitrite, as NO <sub>2</sub> <sup>-</sup>	3.3 mg/L	EPA, DOH
Pentachlorophenol	1 µg/L	EPA, DOH
pH	6.5 to 8.5 <sup>(b)</sup>	EPA
Selenium	50 µg/L	EPA, DOH
Silver	100 µg/L <sup>(b)</sup>	EPA, DOH
Sulfate	250 mg/L <sup>(b)</sup>	EPA, DOH
Tetrachloroethene	5 µg/L	EPA, DOH
Thallium	2 µg/L	EPA, DOH
Total dissolved solids	500 mg/L <sup>(b)</sup>	EPA
1,1,1-Trichloroethane	200 µg/L	EPA, DOH
Trichloroethene	5 µg/L	EPA, DOH
Zinc	5,000 µg/L <sup>(b)</sup>	EPA, DOH
Antimony-125	300 pCi/L <sup>(f)</sup>	EPA
Beta particle and photon activity	4 mrem/yr <sup>(g)</sup>	EPA, DOH
Carbon-14	2,000 pCi/L <sup>(f)</sup>	EPA
Cesium-137	200 pCi/L <sup>(f)</sup>	EPA
Cobalt-60	100 pCi/L <sup>(f)</sup>	EPA
Iodine-129	1 pCi/L <sup>(f)</sup>	EPA
Ruthenium-106	30 pCi/L <sup>(f)</sup>	EPA
Strontium-90	8 pCi/L <sup>(f)</sup>	EPA, DOH
Technetium-99	900 pCi/L <sup>(f)</sup>	EPA
Total alpha (excluding uranium)	15 pCi/L <sup>(f)</sup>	EPA, DOH
Tritium	20,000 pCi/L <sup>(f)</sup>	EPA, DOH
Uranium	30 µg/L	EPA, DOH

(a) DOH = Washington State Department of Health at WAC 246-290; EPA = U.S. Environmental Protection Agency at 40 CFR 141, 40 CFR 143, and EPA 822-R-96-001.

(b) Secondary drinking water standard.

(c) Becomes effective January 23, 2006.

(d) Standard is for total trihalomethanes (THM).

(e) Action level.

(f) Concentration assumed to yield an annual dose equivalent of 4 mrem/yr.

(g) Beta and gamma radioactivity from anthropogenic radionuclides. Annual average concentration shall not produce an annual dose from anthropogenic radionuclides equivalent to the total body or any internal organ dose >4 mrem/yr. If two or more radionuclides are present, the sum of their annual dose equivalents shall not exceed 4 mrem/yr. Compliance may be assumed if annual average concentrations of total beta, tritium, and strontium-90 are <50, 20,000, and 8 pCi/L, respectively.

DWS = Drinking water standard.

**Table 1.1-3.** Derived Concentration Guides<sup>(a,b,c)</sup> and 4-mrem Effective Dose Equivalent Concentrations for Drinking Water<sup>(d)</sup>

Radionuclide	Derived Concentration Guide, pCi/L	4-mrem Effective Dose Equivalent, pCi/L
Tritium	2,000,000	80,000
Carbon-14	70,000	2,800
Cobalt-60	5,000	200
Strontium-90	1,000	40
Technetium-99	100,000	4,000
Ruthenium-103	50,000	2,000
Ruthenium-106	6,000	240
Antimony-125	60,000	2,400
Iodine-129	500	20
Iodine-131	3,000	120
Cesium-134	2,000	80
Cesium-137	3,000	120
Uranium-234	500	20
Uranium-235	600	24
Uranium-238	600	24
Plutonium-238	40	1.6
Plutonium-239	30	1.2
Plutonium-240	30	1.2
Americium-241	30	1.2

(a) Concentration of a specific radionuclide in water that could be continuously consumed at average annual rates and not exceed an effective dose equivalent of 100 mrem/yr.

(b) Values in this table represent the lowest, most conservative derived concentration guides considered potentially applicable to Hanford Site operations, and may be adjusted upward (larger) if accurate solubility information is available.

(c) From DOE Order 5400.5.

(d) Concentration of a specific radionuclide in water that would produce an effective dose equivalent of 4 mrem/yr if consumed at average annual rates. EPA drinking water standards for radionuclides listed in Table 1.1-2 were derived based on a 4-mrem/yr dose standard using maximum permissible concentrations in water specified in *National Bureau of Standards Handbook 69* (U.S. Department of Commerce, as amended August 1963). The 4-mrem/yr dose standard listed in this table was calculated using a more recent dosimetry system adopted by DOE and other regulatory agencies (as implemented in DOE Order 5400.5 in 1993).

DOE = U.S. Department of Energy.

EPA = U.S. Environmental Protection Agency.

*For additional information on contaminants that are found at the Hanford Site, see “Summary Fact Sheets for Selected Environmental Contaminants to Support Health Risk Analysis” (Peterson et al. 2002), available on the website of Environmental Assessment Division, Argonne National Laboratory (<http://www.ead.anl.gov>). Click on “publications” and search for the title.*