

Environmental Solutions

A Summary of Contributions for CY04

PNNL-15093



**PNNL Contributions to
U.S. Department of Energy**



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Executive Summary

Partnership Helps Protect the Public and the Environment

The U.S. Department of Energy's mission is to protect the Columbia River and the public living in communities surrounding the Hanford Site while cleaning up and shrinking the Site. Pacific Northwest National Laboratory is contributing to the cleanup mission and protection of the Columbia River and public. This booklet summarizes work PNNL performed directly for DOE. Work done for Hanford contractors and the Waste Treatment Plant is summarized in the other booklets in this series.

Protecting Public Safety

The Hanford Site is governed by a complex system of environmental regulations designed to protect the public, workers, and the environment. Each year, DOE publishes a report that demonstrates the status of the Site's compliance with these regulations through environmental monitoring and surveillance. For DOE, PNNL coordinated input, authored major sections, edited, and designed the 2003 edition of this report, which totaled more than 500 pages. Fluor Hanford, Inc.; Bechtel Hanford, Inc.; Bechtel National, Inc.; CH2M Hill Hanford Group; S.M. Stoller Corporation, and other Hanford subcontractors also wrote major portions of the report.

In addition, PNNL completed the annual report summarizing the climatological data for the Site and surrounding areas. The report provides reliable, consistent data that can be used to perform environmental calculations. For example, wind speeds and direction may be used to help determine radiation exposures.



From October 2003 through September 2004, 139 shoreline aquifer tube samples were collected along the Columbia River, to gather data on contamination that has seeped into the Columbia River.

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To help DOE protect Hanford's cultural resources, PNNL reviewed ~170 projects that could potentially result in adverse impacts.

Protecting Public Resources

Because the cultural and environmental resources on the Hanford Site are an important part of our nation's heritage, DOE is dedicated to preserving them for generations to come. To ensure protection of these cultural and environmental resources, PNNL completed a management plan and performed about 170 reviews for projects that could potentially result in adverse impacts.

DOE is evaluating the potential for residual radioactive contamination on the Hanford Reach National Monument, which includes the last free-flowing stretch of the Columbia River, before releasing this historic land from DOE control. To assist DOE, PNNL determined the radiological release criteria, which were then approved by DOE, and PNNL collected and analyzed soil samples that showed that the radiation was below the criteria.

Protecting Groundwater

DOE is evaluating contamination from Hanford sources that have seeped into the Site's groundwater and the Columbia River. To gather data for this work, PNNL made more than 1,600 sample trips from October 2003 through September 2004. These trips included sampling to 730 wells and 139 shoreline aquifer tubes and increased groundwater sampling at the Site's spent nuclear fuel storage basins. The results of these sampling and analysis efforts helped ensure that actions taken by DOE are protective. PNNL is continuing to develop new ways of efficiently evaluating groundwater data.

Closing the Hanford Site

Each DOE site is required to prepare a report on its vision of what the site will look like when cleanup is completed. At Hanford, PNNL assisted DOE's Richland Operations Office in developing this document, conducting public and stakeholder meetings, and addressing comments.

When remediation is completed, residual waste will remain at Hanford. To determine the impact of this waste for DOE, PNNL is updating a Site-wide assessment called the Composite Analysis. This analysis estimates the cumulative impact of all radioactive waste that will remain on the Site after closure and is required for continued waste management operations. In addition, PNNL maintains the groundwater model that is used to evaluate Site-wide and Site-specific groundwater flow and contaminant transport assessments.

An important part of the Site's closure is the Waste Treatment Plant, which will vitrify nuclear waste from Hanford's tanks. In 2002, concerns were raised about the seismic study used to design the plant. At the request of DOE's Office of River Protection, PNNL resolved tectonic issues related to the plant's seismic design.

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Protecting Public Resources and Public Safety

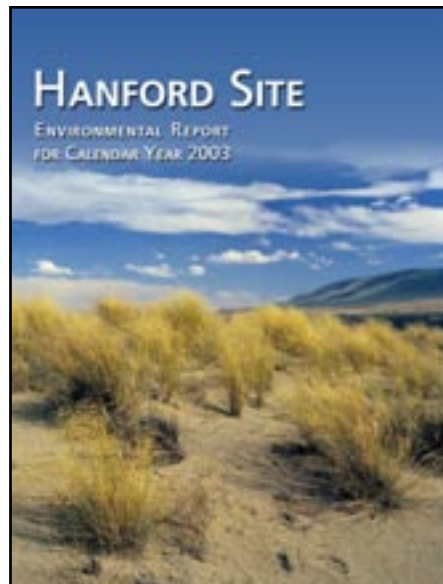
Providing Baseline Environmental Data

Pacific Northwest National Laboratory (PNNL) provides the U.S. Department of Energy (DOE) Richland Operations Office with Hanford Site-wide baseline environmental data. These data are used to assure public and worker safety, environmental compliance, and ecological and cultural resource protection.

In 2004, PNNL completed the *Hanford Site Environmental Report for Calendar Year 2003*, PNNL-14687, fulfilling a major DOE Richland Operations milestone and a DOE Headquarters reporting requirement. Personnel from Fluor Hanford, Inc.; Bechtel Hanford, Inc.; Bechtel National, Inc.; CH2M HILL Hanford Group, Inc.; S.M. Stoller Corporation, and other subcontractors also prepared or provided significant input to selected sections.

The report documents the status of the Site's compliance with federal, state, and local environmental laws and regulations, executive orders, and DOE policies and directives. In addition, the report summarizes environmental data that is used in managing environmental risk at Hanford and protecting the public and environment, assessing the adequacy of Site clean-up actions, and assuring the ecological and cultural security of the Site.

PNNL also completed the annual climatological data summary, *Hanford Site Climatological Data Summary 2003 With Historical Data*, PNNL-14616. This report presents the current year's climatological data along with updated historical information, providing a single, reliable reference that provides consistent data sets for multiple Site uses, such as offsite radiological dose assessment, in a cost-efficient manner.



In 2004, PNNL completed the Site Environmental Report for Calendar Year 2003, which summarizes environmental data used in managing environmental risk at Hanford.

Across the Hanford Site, environmental data was gathered to assure public and worker safety, environmental compliance, and ecological and cultural resource protection.

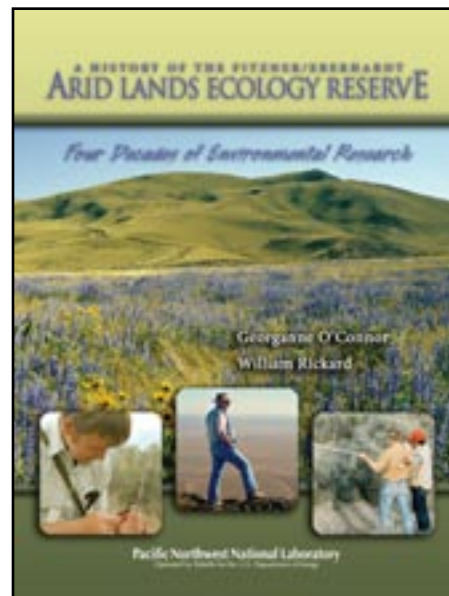
Monitoring and Protecting Ecological and Cultural Resources

PNNL completed the *Hanford Cultural Resources Management Plan*, which was approved by DOE Richland Operations. The document describes the Hanford Cultural and Historic Resources Program, including roles, responsibilities, and applicable regulations. It also defines DOE Richland Operations' strategy and planned activities to assure agency compliance.

The Hanford Cultural Resources Management Plan was completed.

Two PNNL authors summarized the environmental research conducted on the Fitzner/Eberhardt Arid Lands Ecology Reserve over the past 40 years in *A History of the Fitzner/Eberhardt Arid Lands Ecology Reserve: Four Decades of Environmental Research*. The award-winning document captures the extensive research activities, educational opportunities, and successful stewardship practices that occurred on the reserve while it was owned and managed by DOE.

In addition, PNNL performed approximately 170 ecological and cultural reviews, required by the *National Environmental Policy Act*, for those projects having the potential to adversely impact Hanford's biological or cultural resources. Ecological compliance activities associated with the *Endangered Species Act* were also completed during fiscal year 2004.



In this book, two PNNL authors summarized the environmental research conducted on the Fitzner/Eberhardt Arid Lands Ecology Reserve over the past 40 years.

Radiological Release of Hanford Reach National Monument Lands

DOE is required to evaluate the potential for residual radioactive contamination in the Hanford Reach National Monument, which contains the last free-flowing stretch of the Columbia River, before the land can be released from the Department's control. PNNL made significant progress towards the radiological release of selected monument lands during fiscal year 2004. Specifically, PNNL

- Developed authorized limits, or radiological release criteria, that are required per DOE Order 5400.5. The limits were subsequently approved by DOE-Headquarters.
- Published the *Technical Basis for the Derivation of Authorized Limits for Units of the Hanford Reach National Monument*, PNNL-14531, which provides the radiation dose modeling analysis supporting the technical derivation of the authorized limits.
- Prepared a soil sampling and analysis plan. It was subsequently approved by DOE's Richland Operations Office.
- Collected soil samples, based on the approved plan.
- Determined that radionuclide concentrations were in the range observed routinely in the past, similar to "reference" concentrations, and far below the authorized limits.

Radionuclide concentrations on selected parts of the Hanford Reach National Monument were examined, in preparation for releasing the land from DOE control.



Protecting the Groundwater

Groundwater Monitoring and Sampling

Contamination from sources on the Hanford Site has seeped into the groundwater and the Columbia River. To understand the contamination and its migration, PNNL made more than 1,600 sample trips to 730 wells and 139 shoreline aquifer tubes in fiscal year 2004. These samples were reviewed, evaluated, interpreted, and summarized in reports.

At the K-Basins, PNNL responded to increased tritium and technetium-99 in groundwater samples by increasing sample frequency. The source has not yet been conclusively identified. PNNL performed a soil-gas survey north of the 100-K Burial Ground to look for tritium in this area. Elevated helium-3 was detected in some of the samples, suggesting a possible vadose zone source for tritium and/or a groundwater plume.

In addition, PNNL completed a variety of groundwater monitoring plans for DOE. Before groundwater can be sampled or monitored, a detailed plan analyzing the situation has to be written. In fiscal year 2004, PNNL-authored plans included:

- Liquid Effluent Retention Facility groundwater evaluation plan
- 183-H monitoring plan
- 300-Area Process Trenches monitoring plan
- 200-PO-1, 100-BC-5, and 100-FR-3 Sampling and Analysis Plans
- U-12 monitoring plan
- 1324-N/NA, 1301/1325-N monitoring plan.

PNNL began the formal decision-making process for final cleanup of Hanford's *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) groundwater operable units that are currently not being actively remediated. A statement of work was created for developing plans for final cleanup of the 300-FF-5 Groundwater Operable Unit and significant progress was made toward updating the conceptual model for uranium fate and transport in 300 Area groundwater. Draft schedules were provided for the other non-action Operable Units: 200-PO-1, 200-BP-5, 100-BC-5 and 100-FR-3.

Because of the large size of the Hanford Site and the cost of taking groundwater samples, DOE is interested in finding ways to optimize groundwater monitoring and reduce costs, while maintaining protection. PNNL participated in the Groundwater Monitoring Optimization Technical Assistance Workshop sponsored by DOE-Headquarters. The workshop participants made suggestions to optimize the monitoring network at the 300 Area, which contains both a *Resource Conservation and Recovery Act* Treatment, Storage and Disposal site, and a CERCLA Operable Unit. The final report from the committee is pending. PNNL also continued to reduce costs associated with collecting and managing groundwater monitoring data.

Soil-gas survey was performed north of the 100-K Burial Ground in response to increased tritium and technetium-99 levels.

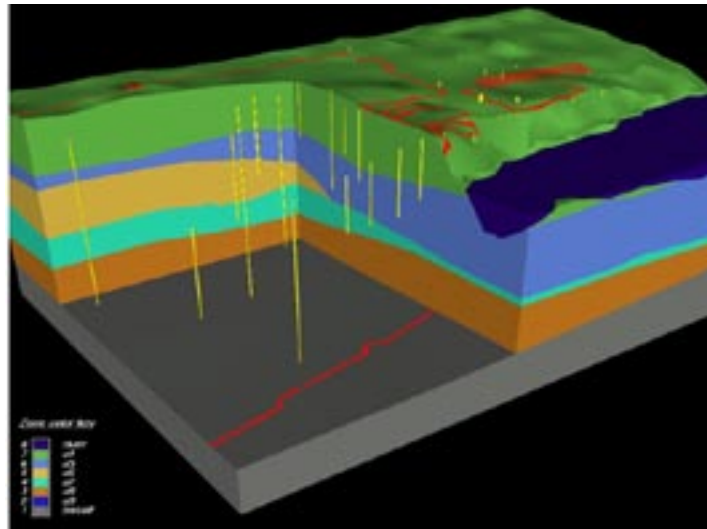
The transport of chemicals and radionuclides in the groundwater was simulated for several Hanford Site projects.

Simulating Groundwater Flow

PNNL uses a broad set of tools to assess Hanford's impacts on groundwater and the Columbia River for DOE and users of those resources. A key element of this work is providing the calibrated Hanford Site groundwater model for assessments performed by PNNL and other contractors at the Site.

PNNL performed simulations of contaminant transport in groundwater for various projects at Hanford, including:

- Site-wide groundwater model transport calculations with local- and regional-scale groundwater models to estimate groundwater dilution factors used in the 2005 Integrated Disposal Facility and Single-Shell Tank Performance Assessments
- Site-wide groundwater model transport calculations to estimate average groundwater transport parameters used in analytical groundwater models in support the T-TX-TY Tank Farms Field Investigation Report and S-SX Tank Farm Closure Projects
- Development of a detailed three-dimensional local-scale model of the 300 Area to support the focused feasibility study of remedial alternatives for the 300-FF-5 Operable Unit.



A groundwater model domain for the local-scale model was developed by PNNL to study remedial alternatives for 300-FF-5 Operable Unit.

Review, Evaluation, and Interpretation of Groundwater Data

More than 11,000 chemical and radiological analyses were performed on the groundwater samples taken from the Hanford Site. The review, evaluation, and interpretation of the groundwater monitoring data were provided by PNNL in several reports. The reports included the *Groundwater Monitoring for Fiscal Year 2003*, PNNL-14548; the groundwater chapter in *Hanford Site Environmental Report for Calendar Year 2003*, PNNL-14687; quarterly *Resource Conservation and Recovery Act* monitoring reports; the annual Hanford seismic monitoring report; and informal monthly highlight reports. These reports supported the Area Closure Strategy, Hanford Federal Facility Agreement and Consent Order milestones, Records of Decision, and Permit Modifications. PNNL also assessed the contamination at Single-Shell Tank Waste Management Areas.

In addition, PNNL continued work on alternate statistical methods for evaluating groundwater data. These methods were published in the chapter "Groundwater Monitoring: Statistical Methods for Testing Special Background Conditions" in the CRC Press book *Environmental Monitoring* and in *Evaluation of an Alternative Statistical Method for Analysis of RCRA Groundwater Monitoring Data at the Hanford Site*, PNNL-14521.



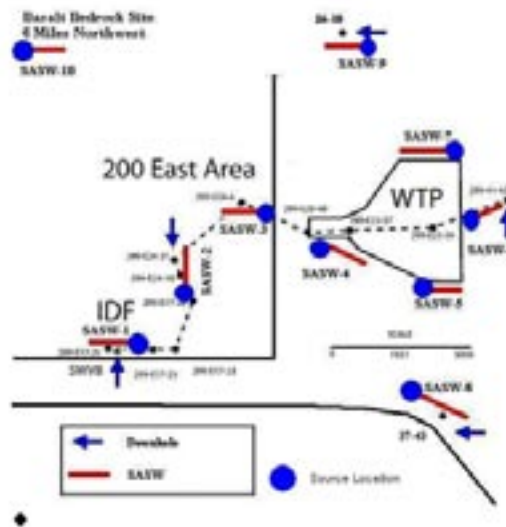
PNNL collects groundwater samples from across the Hanford Site and prepares them for transport to an analytical laboratory.

More than 11,000 chemical and radiological analyses were performed on the groundwater samples taken from the Hanford Site.



Addressing Seismic Hazard Issues at the Waste Treatment Plant

PNNL has been assisting DOE's Office of River Protection on seismic hazard issues at the Waste Treatment Plant, where Hanford tank waste will be vitrified. The adequacy of the 1996 seismic study used in the design of the plant was questioned by the Defense Nuclear Facilities Safety Board in 2002. The issues pertained to tectonic conditions and seismic ground motion conditions. At the request of DOE's Office of River Protection, PNNL resolved all tectonic issues related to seismic design with the Defense Nuclear Facilities Safety Board. This resolution was completed by providing further documentation and explanations. To address this ground motion response to seismic events, PNNL and Ridpath/Northland Geophysics collected new downhole compressional-wave and shear-wave soil data from one new borehole and five existing boreholes around the Waste Treatment Plant site. In addition, the University of Texas at Austin made measurements of surface wave dispersion (SASW sites) at ten locations near the Waste Treatment Plant site. A final report will be completed in 2005.



Surface wave dispersion was measured at locations near the Waste Treatment Plant by the University of Texas at Austin.



Assessing Hanford Waste Sites

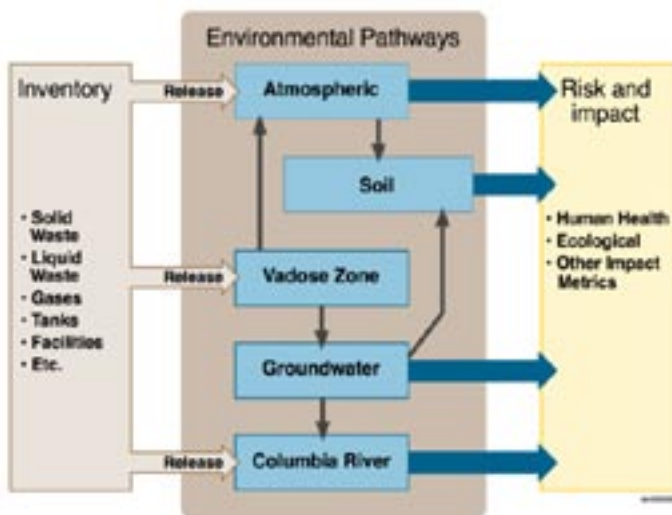
Assessing the Impacts of Hanford After the Site is Closed

During fiscal year 2004, PNNL focused on performing the Composite Analysis, required by DOE Order 435.1. The Composite Analysis is an effort updated every 5 years to estimate the cumulative impact of all radioactive waste that will remain at Hanford after closure. An annual summary is prepared each year to document changes in waste disposal practices and any changes in Site characterization that could change the outcome of previous analysis. In fiscal year 2004, PNNL prepared the annual summary for the Composite Analysis for 2003. The report was transmitted to DOE-Headquarters.

Preparations were also completed for performing a complete update to the Composite Analysis. Specifically, PNNL

- Prepared all input data for the analysis
- Improved the groundwater model to improve results near waste sites
- Completed initial model runs
- Compared preliminary model results to measured contaminant concentrations from wells to evaluate model performance
- Documented the scope of the analysis and the approach that will be taken.

The Composite Analysis is performed using a set of computer models called the System Assessment Capability. PNNL prepared the users' guides for this set of models. These documents provide guidance to future users of the software and provide information about the models to reviewers.



In fiscal year 2004, PNNL focused on performing the Composite Analysis. This conceptual model shows the relationships among the analysis' elements.

Public meetings were conducted in Richland, Seattle, Portland, and Hood River on the end state of the Hanford Site.

Supporting the Hanford Site Risk-Based End State Report

At the request of DOE-Headquarters, each DOE site must prepare a report documenting its risk-based end state vision, or what the site will look like when cleanup is done. PNNL assisted DOE's Richland Operations Office with preparing a draft of the report, which was submitted to DOE's Headquarters. In addition, PNNL supported the Richland Operations Office in conducting public meetings on the end state document in Richland and Seattle, Washington, and Portland and Hood River, Oregon.

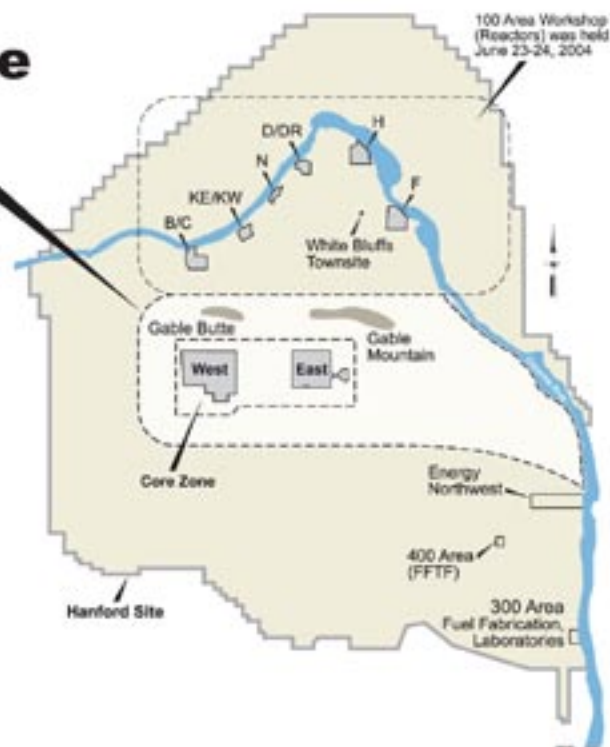
In addition to public comments, DOE Richland Operations also received comments from DOE's Headquarters. PNNL supported the Richland Operations Office in revising the report to address comments on the vision, waste site specific hazards, and variances. DOE presented the revisions to the Hanford Advisory Board.

Additional workshops were held on the Hanford Site. PNNL supported the Richland Operations Office in conducting stakeholder workshops on the 100 and 200 Areas. The results of these workshops were incorporated into the end states vision document. A final workshop on the future of the 300 Area is planned for fiscal year 2005.

Focus of the 200 Area Workshop

Break Out Groups

- Central Plateau Uses and Activities
- Buried Waste and Contaminated Soil Sites
- Legacy Facilities



In support of determining Hanford's risk-based end state vision, PNNL and DOE's Richland Operations Office conducted a workshop on the future of the 200 Areas.

Developing the Scientific Basis for Site Cleanup Decisions

PNNL conducted studies to document the scientific basis for cleanup decisions by DOE. Specifically, PNNL

- Completed Soil Inventory Model estimates to support the 2004 Composite Analysis. The model estimates incorporated Plutonium Finishing Plant and Z Plant waste sites.
- Updated the conceptual model of uranium transport in the 300 Area. The update was based on laboratory experiments completed on vadose zone, capillary fringe, and aquifer sediments from the 300 Area. These experimental results collectively provide scientific explanations of why the 300 Area uranium plume has been slow to disperse and provide the basis for reactive transport models, which are under development, to forecast future behavior.
- Drilled three boreholes and collected data to determine depth-dependent variations of strontium-90 concentrations and flux to the Columbia River at the 100-N Area. Using samples from these wells, PNNL evaluated the ion-exchange properties that will provide the basis for a rigorous reactive transport model for 100-N Area strontium-90. The model will then be used to assist in selecting a final remedy for the subsurface contamination.
- Developed and implemented a new theory for residual-phase non-aqueous phase liquid carbon tetrachloride in the Subsurface Transport Over Multiple Phases (STOMP) code and conducted field-scale simulations of the soil vapor extraction system in the 200 West Area. This new theory will help guide characterization and remediation of the carbon tetrachloride in the subsurface.
- Analyzed the Vadose Zone Transport Field Study reactive transport experiment (field work completed in fiscal year 2003), including inverse modeling. The results of this analysis were used to develop simulations of moisture flow and contaminant transport beneath the B-26 Trench that show extensive lateral spreading and closely match field observations. The simulations are being used by Fluor Hanford to assist with remedial design.
- Completed laboratory studies of strontium-90 uptake by rainbow trout via the water pathway and completed three of four experiments for uptake via the food pathway. These results provide site-specific data for ecological risk assessments to support the final record of decision at the 100-N Area.

Transport models for uranium in the 300 Area environment have been updated.

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