Executive Summary

Introduction

The Hanford Site encompasses ~1,500 square kilometers in southeast Washington State and was formerly part of the U.S. Department of Energy’s (DOE’s) nuclear weapons complex. The Hanford Site is located in the Lower Columbia Basin, with the Columbia River forming the northern and eastern boundaries. The federal government acquired the Hanford Site in 1943 and used it to produce plutonium until the 1980s. The site is currently surrounded by various units of the Hanford Reach National Monument, which was formed in 2000. Management of waste associated with plutonium production has been a major activity throughout the site’s history, with the most hazardous waste associated with underground storage tanks. Waste management continues today but now also includes managing waste generated by remediation of former waste disposal sites, and from decontaminating and demolishing unused production facilities. Beginning in the 1990s, the DOE has focused primarily on cleaning up the Hanford Site. The data presented in this report, as well as information on well locations, construction, and screened intervals can be found on the DOE’s Environmental Dashboard Application at http://environet.hanford.gov/EDA/.

The DOE is committed to protecting the Columbia River, human health, and the environment from the Hanford Site’s contaminated groundwater. As part of this commitment, the DOE’s Hanford Integrated Groundwater and Vadose Zone Management Plan (DOE/RL-2007-20) outlines the steps for addressing groundwater and vadose zone contamination.

The DOE monitors groundwater at the Hanford Site to fulfill state and federal regulations, including the Atomic Energy Act of 1954 (AEA); the Resource Conservation and Recovery Act of 1976 (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA); and various sections of the Washington Administrative Code (WAC).

DOE O 450.1, Environmental Protection Program, implements requirements of the AEA at DOE sites. This order requires environmental monitoring to detect, characterize, and respond to releases of radionuclides from DOE activities, assess impact, and characterize potential exposure pathways. The order recommends implementing a site-wide approach for groundwater protection, and it requires compliance with other applicable environmental protection requirements.

To manage the Hanford Site cleanup, waste sites are grouped within geographic areas known as operable units (OUs) so the CERCLA cleanup process can be efficiently implemented. Most of the OUs are source OUs (i.e., surface and vadose zone areas where waste was disposed), but eleven are groundwater OUs. The concept of the groundwater OU was adopted to allow separate characterization of the waste sites and the groundwater. Separate characterization recognizes differences between localized contaminants in the soil column at the sources and the more widespread, co-mingled contamination in groundwater. Groundwater samples are collected from monitoring wells to define the nature and extent of contaminant plumes, and to evaluate the effectiveness of groundwater remediation efforts.

The groundwater monitoring requirements for the Hanford Site’s RCRA units fall into one of two broad categories: interim status or final status. A permitted RCRA unit requires final status monitoring, as specified in WAC 173-303-645, “Dangerous Waste Regulations; Releases from Regulated Units.” The RCRA
Hanford Site groundwater monitoring is organized by areas of interest, which are informally named after the groundwater operable units (OUs). The areas of interest are useful for planning and scheduling groundwater monitoring and interpreting data.

The RCRA groundwater monitoring is conducted under one of three possible phases: (1) contaminant indicator evaluation/final status detection monitoring, (2) groundwater quality assessment/final status compliance monitoring, or (3) corrective action monitoring. In contaminant indicator evaluation/final status detection monitoring, four specific indicator parameters (pH, specific conductivity, total organic carbon, and total organic halides) are monitored and evaluated against statistically derived threshold values calculated from upgradient wells. In final status detection monitoring, site-specific indicators are evaluated using statistical methods identified in the respective monitoring plans. Groundwater quality assessment/final status compliance monitoring occurs when a facility is known to have impacted groundwater quality. The objective of the monitoring program shifts from detection to assessing the nature and extent of the problem. Under corrective action monitoring, some form of groundwater remediation has been stipulated by the Washington State Department of Ecology (Ecology). The goal of a corrective action groundwater monitoring program is to determine if the corrective action is effective.

Some contaminants have reached the Columbia River by moving downward from waste sites, through the vadose zone, into the groundwater, and then moving laterally with the groundwater into the river. The DOE works with the U.S. Environmental Protection Agency (EPA) and Ecology, to make cleanup decisions based on sound technical information.

This report covers the period from October 1, 2008, through December 31, 2009, and reflects 15 months of data rather than the 12 months of data typical of previous reports. The extended reporting period is the result of transition from a fiscal year (FY) reporting period (October 1 to September 30) to a calendar year (CY) reporting period (January 1 to December 31). This change is being made so all groundwater information (i.e., pump-and-treat, RCRA, CERCLA, and AEA) can be presented in a single report. As a result of this change, the following date conventions are used throughout this report.

- **FY 2009**: Refers to the fiscal year named (i.e., October 1, 2008, to September 30, 2009).
- **CY 2009**: Refers to the calendar year named (i.e., January 1, 2009, to December 31, 2009).
- **Reporting period**: Refers to the entire 15-month reporting period covered in this report (i.e., October 1, 2008, to December 31, 2009).

During the reporting period, workers sampled 922 monitoring wells and 326 shoreline aquifer tubes\(^1\) to determine the distribution and movement of contaminants. Many of the wells and aquifer tubes were sampled multiple times during the reporting period. A total of 18,899 samples were analyzed for the reporting period.

During the reporting period, a total of 4,746 samples of Hanford Site groundwater were analyzed for total chromium (with a nearly equal amount of hexavalent chromium analyses); 3,024 samples for nitrate; and 2,029 samples for tritium. Other contaminants have reached the Columbia River by moving downward from waste sites, through the vadose zone, into the groundwater, and then moving laterally with the groundwater into the river. The DOE works with the U.S. Environmental Protection Agency (EPA) and Ecology, to make cleanup decisions based on sound technical information.

\(^1\) Aquifer tubes are small-diameter, flexible tubes with screens on one end that are installed in the aquifer along the Columbia River at or below the high water mark.
constituents frequently analyzed include technetium-99 (1,502 samples), uranium (1,495 samples), and carbon tetrachloride (1,427 samples). These totals include results for routinely sampled groundwater wells, pump-and-treat operational samples, and aquifer tube samples.

**Groundwater Program Highlights**

The highlights from groundwater projects for the reporting period of October 2008 through December 2009 are summarized below. Details can be found in the appropriate chapter discussions for the OUs.

- **River Corridor baseline risk assessment.** To support the decision-making process for final CERCLA remedial actions within the River Corridor, the DOE is conducting a CERCLA remedial investigation including a baseline risk assessment for the River Corridor portion of the Hanford Site. The risk assessment consists of three components: (1) the 100 Area and 300 Area Component, (2) the Inter-Area Component, and (3) the Columbia River Component. The 100 Area and 300 Area Component and the Inter-Area Component will be integrated with groundwater into a series of final CERCLA remedial investigation reports for the operational areas of the River Corridor.

- **Remedial investigation/feasibility study.** The DOE, Ecology, and EPA recently developed a strategy for making final decisions that are necessary to complete cleanup along the River Corridor. Final decisions for the OUs will address the cleanup of contaminated soil, solid waste burial grounds, groundwater, and releases from reactor buildings. In January 2010, the DOE released the Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan (DOE/RL-2008-46). A series of addenda addresses specific segments of the River Corridor. The 300 Area OUs are included in a separate work plan, released in April 2010. The work plans, the addenda, and the related sampling and analysis
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plans identify the data gaps and the data to be collected. The data will then be used to develop the remedial investigation/feasibility studies. The selection of the remedial final actions will be documented in Records of Decision.

- **100-KR-4 OU pump-and-treat expansion.** Three pump-and-treat systems for hexavalent chromium in the 100-K Area are undergoing optimization (discussed below) and expansion. When the expansion of the KW pump-and-treat system is completed, it will have a target capacity of 757 liters per minute. The revised treatment systems operated at an average of 93% efficiency for 2009 with a combined system availability of ~91%, treating 1.33 billion liters of groundwater and removing 96.7 kilograms of hexavalent chromium.

- **100-KR-4 OU remedial process optimization.** Remedial process optimization was started at the 100-KR-4 Groundwater OU in 2009. This process is intended to improve remediation of the hexavalent chromium plumes and other plumes that have been determined to impact groundwater and the Columbia River. The approach is to model groundwater flow and to determine where the hexavalent chromium plume will reach the Columbia River without any intervention; the current treatment system well configuration will then be revised to prevent plume intrusion into the river. Additional modeling will help to determine where longer term threats exist (e.g., areas away from the Columbia River) and more extensive system changes may be required. Changes may include alternate treatment technologies.

- **100-N Area apatite barrier.** Since injections of apatite-forming chemicals ceased at the permeable reactive barrier in July 2008, a general, steady decline has been observed for strontium-90 and gross beta in the wells being sampled, with very few exceptions. As of August 2009, even wells that had not previously shown declining concentrations were beginning to show declining strontium-90/gross-beta values. Nearly all of the wells being monitored have shown ~90% decline in gross beta from measured pre-injection values.

- **100-HR-3 OU remedial process optimization.** The DOE began to expand and optimize the 100-HR-3 treatment system in 2009. Remedial process optimization is being conducted to provide expanded treatment capacity and enhanced remediation. The new DX pump-and-treat facility is being constructed to expand the treatment capacity in the 100-D Area and the southwest area of the Horn. In addition, the 100-HX facility is being planned to expand the pump-and-treat capacity in the 100-H Area and the northeast area of the Horn. As an outcome of the remedial process optimization, seventy new extraction and injection wells will be installed in this OU as part of the expanded systems. A series of resin tests at the DR-5 groundwater treatment facility was completed in August 2009. As a result, the ResinTech SIR-700\(^2\) resin was recommended for future operations at the new treatment facilities.

- **300-FF-5 OU studies.** Treatability testing using polyphosphate solutions was performed during 2009 and will continue into 2010 at a second test site, with the focus on immobilizing uranium in the vadose zone.

- **200-ZP-1 OU pump-and-treat expansion.** During CY 2009, the 200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan (DOE/RL-2008-78) was published. This document detailed the plan and schedule for implementing all tasks to design, install, and operate a final remedy.

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\(^2\) ResinTech\(^R\) is a registered trademark of ResinTech, Inc., West Berlin, New Jersey.
pump-and-treat operation. The goal is to design a remediation system to remove carbon tetrachloride and other contaminants throughout the vertical extent of the aquifer.

**Columbia River monitoring.** The DOE and Washington Closure Hanford are investigating Hanford Site contaminant releases to the Columbia River. The information obtained from this investigation will ultimately be used to help make final cleanup decisions for Hanford Site contaminants that exist in and along the Columbia River. From 2008 through early 2010, Washington Closure Hanford conducted a study of groundwater upwelling and porewater in the river bed sediment in the Columbia River. Approximately 675 in situ measurements were taken at the study areas, which included all six reactor areas, the Hanford town site, and the 300 Area. Results indicated areas of preferential upwelling in definable locations along the Hanford Site shoreline, the opposite shoreline, and in the deep river channel. Researchers then collected samples of groundwater from a subset of the measured locations and analyzed the samples for key Hanford Site contaminants (i.e., hexavalent chromium, strontium-90, total petroleum hydrocarbons, tritium, uranium, and volatile organic compounds). Contaminants were detected in some of the porewater samples and, in a few cases, were detected at higher concentrations than anticipated. Additional samples of porewater, river sediment, and river water, at approximately five locations in each study area, will be analyzed for a comprehensive list of contaminants. The results of the study are scheduled for publication in 2010.

**Groundwater Flow**

Groundwater flow direction is illustrated on the water table map for March 2009. Groundwater flow directions are inferred from water table elevations, barriers to flow (e.g., basalt or mud units at the water table), and the distribution of contaminants. Groundwater enters the unconfined aquifer from recharge areas to the west and eventually discharges to the Columbia River. During periods of high water, the Columbia River recharges the groundwater adjacent to the river. Additional water infiltrates through the vadose zone beneath the Hanford Site. Hydrologists estimate that the total discharge of groundwater from the Hanford Site aquifer to the Columbia River is in the range of 1.1 to 2.5 cubic meters per second. This rate of discharge is less than 0.1% of the average flow of the Columbia River (~3,400 cubic meters per second).

The water table beneath much of the central portion of the site is relatively flat because the aquifer is primarily within the highly permeable sediments of the Hanford formation and natural recharge rates are small. Groundwater enters the region of the 200 East Area from the west and southwest. This flow of water divides as it approaches the central portion of the 200 East Area; some of the flow goes to the north through the gap between Gable Butte and Gable Mountain (Gable Gap), and some of the flow goes southeast toward the central portion of the Hanford Site. This groundwater divide is located near the north central portion of the 200 East Area, but the precise location is unknown and may, in fact, change over time depending on the stresses imposed on the hydrologic system.

A long-term study of the low gradient in the northwest portion of the 200 East Area was initiated in 2005. The results of this study produced unexpected results during 2009. The long-term average flow direction from September 2005 through June 2008 was to the north-northwest; however, beginning in July 2008, changes
This map shows the water table and inferred flow directions in March 2009.
were observed. From August 2008 through December 2008, flow appeared to be toward the south. The next 3 months showed no statistically significant flow direction. Beginning in April 2009, northward flow had apparently resumed. The reversal in flow appears to be related to higher-than-normal flow in the Columbia River during the spring of 2008.

The natural pattern of groundwater flow was altered during the Hanford Site’s operating years by water table mounds. The mounds were created by the discharge of large volumes of wastewater to the ground and were present in each reactor area and beneath the 200 Areas. Since the significant decrease in effluent disposal occurred in the 1990s, these mounds have dissipated in the reactor areas and have declined considerably in the 200 Areas. Wastewater is currently discharged to the ground at two locations that affect local groundwater: the State-Approved Land Disposal Site (north of the 200 West Area) and the 200 Areas Treated Effluent Disposal Facility (east of the 200 East Area).

Changes in groundwater flow in the unconfined aquifer are more pronounced where extraction or injection wells are used for pump-and-treat systems. Extraction wells in the 100-K, 100-D, 100-H, and 200 West Areas capture contaminated water from the surrounding areas. Water flows away from injection wells, which when upgradient of the contaminant plumes, increases the hydraulic gradient toward the extraction wells. Injection wells placed downgradient of a contaminant plume are often designed to act as barriers to flow, controlling plume migration.

In most places, the base of the unconfined aquifer is the Ringold Formation lower mud unit. Where this unit is absent, the dense, interior portion of the uppermost basalt flow is usually the base of the unconfined aquifer. In some locations, such as at the Liquid Effluent Retention Facility, the unconfined aquifer has been shown to occur in the basalt flow top. It is unknown how common this is, but the overlying aquifer may extend to below the top of basalt in many places at the Hanford Site where a fractured, rubble flow top is present.

Several wells north of and within the 200 East Area have shown evidence of intercommunication between the unconfined and both the Ringold and upper basalt-confined aquifers. The intercommunication has been attributed to erosion of the upper Saddle Mountains Basalt, although structural uplift, thinner basalt flows, and increased fracturing of the basalt may also be factors in intercommunication. In these areas, the uppermost sedimentary interbed within the basalts, the Rattlesnake Ridge Interbed, exhibits unconfined characteristics. Since an upward gradient now exists in the 200 East Area/Gable Gap region (except in the vicinity of the 216-B-3 Pond), the upper basalt-confined aquifer discharges to the overlying unconfined aquifer, especially within Gable Gap where the Elephant Mountain Basalt was removed by erosion.

A confined aquifer occurs in some areas within sand and gravel of the lowest sedimentary unit of the Ringold Formation. It is confined between the uppermost basalt and the Ringold lower mud unit. Groundwater in the Ringold Formation confined aquifer is still influenced by the residual recharge mound from the decommissioned 216-B-3 ponds.

Deeper confined aquifers are present in the interbeds, interflow zones, and fractures of the basalts beneath the Hanford Site. The uppermost of these basalt-confined aquifers is in the Rattlesnake Ridge Interbed, which is found between the Elephant Mountain and Pomona Members of the Saddle Mountains Basalt. Groundwater flow in this aquifer moves from west to east.
Current discharges to ground surface.
Groundwater Monitoring and Remediation

The DOE has developed a plan that includes steps for the cleanup of contaminated groundwater and the vadose zone. Key elements include the following:

- Continue to implement remedies that are working
- Gather characterization data to help make informed decisions
- Address emerging problems
- Work with regulatory agencies to make remediation decisions
- Identify and test new cleanup technologies
- Continue groundwater monitoring to detect emerging problems and determine how well the remedies are working.

Of the groundwater contaminant plumes, tritium and iodine-129 have the largest areas with concentrations above drinking water standards (DWSs). The largest of these plumes have sources in the 200 East Area and extend toward the east and southeast. Less extensive tritium and iodine-129 plumes are also found in the 200 West Area. Technetium-99 exceeds the DWS in localized plumes at the 200 East and 200 West Areas. One technetium-99 plume extends to the northwest, beyond the 200 East Area boundary. Uranium is less mobile than tritium, iodine-129, or technetium-99; plumes containing uranium are found in the 200 East, 200 West, and 300 Areas. Strontium-90 exceeds the DWS in the 100 Areas, 200 East Area, and beneath the former Gable Mountain Pond. Cesium-137, cobalt-60, and plutonium exceed DWSs in only a few individual wells in the 200 East Area.

Major Groundwater Contaminants on the Hanford Site

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Primary Locations</th>
<th>Primary Area (km²)</th>
<th>Drinking Water Standard</th>
<th>Remediation in Place?</th>
<th>Mobility and Half-Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon tetrachloride</td>
<td>200-ZP-1</td>
<td>11.5</td>
<td>5 µg/L</td>
<td>Yes</td>
<td>Mobile (denser than water)</td>
</tr>
<tr>
<td>Chromium</td>
<td>100-KR-4, 100-HR-3</td>
<td>2.0</td>
<td>100 µg/L</td>
<td>Yes</td>
<td>Mobile (hexavalent)</td>
</tr>
<tr>
<td>Cyanide</td>
<td>200-BP-5</td>
<td>0.3</td>
<td>200 µg/L</td>
<td>No</td>
<td>Mobile</td>
</tr>
<tr>
<td>Iodine-129</td>
<td>200-131-5, 200-PO-1, 200-UP-1</td>
<td>58.8</td>
<td>1 pCi/L</td>
<td>No</td>
<td>Mobile; 15.7 million years</td>
</tr>
<tr>
<td>Nitrate (as NO₃⁻)</td>
<td>100-FR-3, 200 Area</td>
<td>36.7</td>
<td>45 mg/L</td>
<td>No</td>
<td>Mobile</td>
</tr>
<tr>
<td>Strontium-90</td>
<td>100-NR-2, 200-BP-5</td>
<td>1.9</td>
<td>8 pCi/L</td>
<td>Yes</td>
<td>Moderate; 28.8 years</td>
</tr>
<tr>
<td>Technetium-99</td>
<td>200-BP-5, 200-UP-1</td>
<td>2.4</td>
<td>900 pCi/L</td>
<td>Yes</td>
<td>Mobile; 211,000 years</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>100-FR-3, 200-ZP-1</td>
<td>0.9</td>
<td>5 µg/L</td>
<td>Yes</td>
<td>Mobile</td>
</tr>
<tr>
<td>Tritium</td>
<td>200 Area, 300-FF-5</td>
<td>126.5</td>
<td>20,000 pCi/L</td>
<td>No</td>
<td>Mobile; 12.3 years</td>
</tr>
<tr>
<td>Uranium</td>
<td>200-UP-1, 200-131-5, 300-FF-5</td>
<td>1.5</td>
<td>30 µg/L</td>
<td>Yes</td>
<td>Moderate; 246,000 years (U-234), 4.5 billion years (U-238)</td>
</tr>
</tbody>
</table>

Area of combined plumes 172.3 km²

Nitrate is the most widespread chemical contaminant in Hanford Site groundwater, with plumes originating from the 100 and 200 Areas and from offsite industrial and agricultural sources near the 300-FF-5 and 1100-EM-1 OUs. Carbon tetrachloride is the most widespread organic contaminant on the Hanford Site, forming a large plume beneath the 200 West Area. Other organic contaminants include chloroform (in the 200 West Area) and trichloroethene. The 100-F Area has a trichloroethene plume, and the 100-K Area has one well that exceeded the trichloroethene DWS. In portions of the 200 West, 100-K, and 100-D Areas, chromium is found at levels above the 100 µg/L DWS and also exceeds established cleanup levels. Chromium also exceeds
Washington State’s aquatic standard of 10 μg/L in these areas and in portions of the 100-B/C, 100-H, 100-F, and 600 Areas. Local chromium plumes are also present in the 200 Areas.

**Groundwater Remediation**

<table>
<thead>
<tr>
<th>Remedial Action Site</th>
<th>Dates Active</th>
<th>Progress from Start to December 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-K Area – KR4 pump-and-treat system</td>
<td>1997 to present</td>
<td>Decreases chromium to river; 330 kilograms removed. System is being expanded.</td>
</tr>
<tr>
<td>100-K Area – KW pump-and-treat system</td>
<td>2007 to present</td>
<td>Decreases chromium to river; 31 kilograms removed. System is being expanded.</td>
</tr>
<tr>
<td>100-K Area – KX pump-and-treat system</td>
<td>2009 to present</td>
<td>Decreases chromium to river; 44 kilograms removed. System was completed and brought online.</td>
</tr>
<tr>
<td>100-N Area – 100-NR-2 pump-and-treat system</td>
<td>1995 to 2006</td>
<td>1.8 Ci of strontium-90 removed.</td>
</tr>
<tr>
<td>100-N Area – apatite barrier</td>
<td>2006 to present</td>
<td>Test injections of low- and high-concentration solutions; apatite barrier beginning to form; currently in performance monitoring.</td>
</tr>
<tr>
<td>100-D/H Area – 100-HR-3 pump-and-treat system</td>
<td>1997 to present</td>
<td>Decreases chromium to Columbia River; 362 kilograms removed.</td>
</tr>
<tr>
<td>100-D/H Area – 100-DR-5 pump-and-treat system</td>
<td>2004 to present</td>
<td>Decreases chromium to river; 251 kilograms removed.</td>
</tr>
<tr>
<td>100-D Area – In-Situ Redox Manipulation</td>
<td>1999 to present</td>
<td>Decreases chromium concentrations downgradient of barrier. Showing breakthrough; amendments being tested.</td>
</tr>
<tr>
<td>200 West Area – 200-ZP-1 pump-and-treat system</td>
<td>1994 to present</td>
<td>Prevents high-concentration portion of carbon tetrachloride plume from spreading; 11,977 kilograms removed. System is being expanded to implement final Record of Decision.</td>
</tr>
<tr>
<td>200 West Area – soil vapor extraction</td>
<td>1992 to present</td>
<td>Reduces carbon tetrachloride movement to groundwater; 79,400 kilograms removed from vadose zone.</td>
</tr>
<tr>
<td>200 West Area – Waste Management Area T pump-and-treat system</td>
<td>2007 to present</td>
<td>Removes technetium-99 from the aquifer; 46.3 grams (0.4 Ci) removed.</td>
</tr>
<tr>
<td>200 West Area – 200-UP-1 pump-and-treat system</td>
<td>1994 to 2005, 2007 to present</td>
<td>Removes technetium-99 and uranium from the aquifer; 126 grams of technetium-99 (2.1 Ci) and 219.4 kilograms of uranium removed.</td>
</tr>
<tr>
<td>200 West Area – Waste Management Area S-SX well 299-W23-19 extended purging</td>
<td>2003 to present</td>
<td>Removes some technetium-99 from the aquifer; 0.49 grams (0.0084 Ci) removed.</td>
</tr>
<tr>
<td>300 Area – 300-FF-5 natural attenuation</td>
<td>Through present</td>
<td>Uranium concentrations remain above the target value, with contamination level relatively constant and or gradually decreasing (300 Area). Cis-1,2-dichloroethene concentrations remain above target value at one well, with constant trend (300 Area). Trichloroethene concentrations are below target value in unconfined aquifer, but well above it in finer grained subinterval (300 Area). Tritium concentrations remain highly elevated above target value (618-11 Burial Ground).</td>
</tr>
<tr>
<td>1100-EM-1 – natural attenuation</td>
<td>Complete</td>
<td>Trichloroethene concentrations below 5 μg/L since 2001.</td>
</tr>
</tbody>
</table>

The following discussion summarizes groundwater contamination, monitoring, and remediation for each of the eleven groundwater OUs and in the confined aquifers.

**200-BP-5 Operable Unit**

The 200-BP-5 OU includes groundwater beneath the northern 200 East Area and the region to the northwest where mobile contaminants, including tritium and technetium-99, historically moved northward between Gable Mountain and Gable Butte. Most of the groundwater contamination originated in facilities in the north-central portion of the 200 East Area known as the B Complex.

During CY 2009, the DOE continued the 200-BP-5 OU remedial investigation/feasibility study. A full suite of chemical and physical analyses were completed and reported on eight new wells during CY 2009.

The primary CERCLA accomplishments for the reporting period included (1) successful sampling and analyses of all but three wells stated in the *Groundwater*
This map shows the distribution of the major contaminant plumes at concentrations above the drinking water standard during the reporting period in the upper portion of the unconfined aquifer.
Sampling and Analysis Plan for the 200-BP-5 Operable Unit (DOE/RL-2001-49), (2) completion of chemical and physical property analyses for eight remedial investigation wells, and (3) compilation of data to allow for the publication of chemical analyses reports on four of the wells.

Contaminants of concern defined in DOE/RL-2001-49 include nitrate, cyanide, iodine-129, technetium-99, uranium, strontium-90, cobalt-60, cesium-137, plutonium-239/240, and tritium. Technetium-99 and tritium plumes extend northward between Gable Mountain and Gable Butte. Uranium forms a narrow plume that extends northwest of the 200 East Area. Nitrate and cyanide also extend to the northwest, likely originating from multiple sources within the northwestern portion of the 200 East Area.

Six treatment, storage, and disposal (TSD) units in the 200-BP-5 OU are monitored under RCRA in conjunction with CERCLA and AEA requirements. The monitoring results are summarized below.

**Low-Level Waste Management Area 1 (LLWMA-1).** The LLWMA-1 continued to be monitored under RCRA interim status contaminant indicator monitoring requirements, and specific conductance continued to exceed its threshold value. These exceedances were previously reported and do not indicate contamination from the waste management area (WMA). All other indicator parameters were below their respective threshold values. Recent evaluation of water levels (low-gradient evaluation) supports a predominantly northwestern groundwater flow direction. A gradient reversal, with subsequent erratic gradient measurements, was observed at LLWMA-1 from the summer of 2008 until the spring of 2009. The northwestern flow direction was statistically re-established by July 2009. The monitoring network remains adequate for detection of indicator constituents given a predominant northwestern flow direction.

**Low-Level Waste Management Area 2 (LLWMA-2).** The LLWMA-2 continued to be monitored under RCRA interim status contaminant indicator monitoring requirements. All RCRA indicator parameters were below their respective threshold values, with the exception of one total organic carbon sample. Resampling in early 2010 did not verify the exceedance.

**Waste Management Area B-BX-BY (WMA B-BX-BY).** The RCRA groundwater quality assessment monitoring continued at this site. Contaminants of interest include cyanide (a dangerous constituent under RCRA) and nitrate. The AEA contaminants uranium and technetium-99 are also monitored regularly. Contaminants show a clear migration to the northwest, with the most mobile constituents (nitrate and technetium-99) having moved some 2.5 kilometers from their source area. Five new wells installed under the 200-BP-5 OU remedial investigation/feasibility study were also sampled and the results were evaluated. The current network, with the addition of the 200-BP-5 remedial investigation/feasibility study wells, is adequate for evaluating the rate and extent of contaminant migration sourced from WMA B-BX-BY.

**Waste Management Area C (WMA C).** This site began the reporting period under a RCRA interim status contaminant indicator monitoring program. In July 2009, the indicator parameter of specific conductance was verified to have exceeded the threshold value in a downgradient well. A RCRA groundwater quality assessment plan was prepared and reviewed by Ecology. The first sampling under the new assessment plan was completed in December 2009. Cyanide, a dangerous constituent, has been detected in groundwater monitoring wells. Under the assessment plan, two new wells will be installed to better define the extent of contamination.
**Liquid Effluent Retention Facility.** The Liquid Effluent Retention Facility operates under final status permit conditions. A revised monitoring plan was drafted and includes two new wells, for a total of four wells in the monitoring network. Although this plan is not yet in the Permit, all four of the wells in the network were sampled twice during CY 2009. Statistical evaluations of monitoring data have not yet been implemented.

**216-B-63 Trench.** This RCRA site continued to be monitored under a RCRA interim status contaminant indicator evaluation monitoring program. With the exception of pH, all indicator parameters were below their threshold values. The pH in one sample exceeded the lower-bound threshold value in October 2008. Verification sampling did not confirm the exceedance, and pH values returned to within the threshold value range for the remainder of the reporting period. All other indicator parameters were below their threshold values for the reporting period. The monitoring network is adequate for detection of indicator constituents from the TSD unit.

**200-PO-1 Operable Unit**

The 200-PO-1 OU encompasses the southern portion of the 200 East Area and a large region to the east and southeast where groundwater is contaminated with tritium and iodine-129. Concentrations of tritium continued to decline as the groundwater plume attenuates naturally due to radioactive decay and dispersion. Nitrate covers a large area, with levels elevated above background but mostly below the DWS.

These maps show Hanford Site-wide tritium plumes in the upper portion of the unconfined aquifer in 1980 and 2009. Concentrations in the core of the plume have decreased over the years and the south margin is no longer spreading.
Other contaminants include strontium-90, technetium-99, and uranium, but these contaminants are limited to smaller areas.

During CY 2009, characterization sampling and routine monitoring continued under the Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit (DOE/RL-2007-31). Contaminants of concern listed in the remedial investigation/feasibility study work plan include nitrate, iodine-129, strontium-90, technetium-99, tritium, and uranium. Other contaminants of potential interest are arsenic, chromium, manganese, and vanadium.

The primary CERCLA accomplishments for the reporting period included the following:

- Completing the remedial investigation/feasibility study field investigation requirements (including groundwater sampling)
- Conducting a baseline risk assessment

Among the 79 far-field wells monitored in the 200-PO-1 OU, two well transects (containing fourteen wells) are routinely monitored under the approved CERCLA sampling and analysis plan. Most of the anions, metals, and radioactive constituents detected in southeast transect wells during the reporting period are naturally occurring or are typical of Hanford Site background values. Technetium-99 was detected at levels above Hanford Site background, but it was at the low levels expected downgradient from the 200 East Area. Other detected constituents that are not naturally occurring or that exceeded the DWSs are tritium, iodine-129, iron, and certain volatile organic compounds. Results of sampling from wells in the Columbia River transect were similar to the results from the southeastern transect in that most of the anions, metals, and radioactive constituents detected are naturally occurring or are typical of Hanford Site background values. Tritium, nitrate, manganese, and technetium-99 were detected at levels above typical Hanford Site background values. Tritium, manganese, and iron exceeded their respective DWSs.

Groundwater is monitored at eight regulated units in the 200-PO-1 OU. Water supply wells in the 400 Area, which falls within the footprint of the 200-PO-1 OU, are also monitored. Monitoring results for the reporting period are summarized below.

Integrated Disposal Facility. The Integrated Disposal Facility will be an expandable, lined, RCRA-compliant landfill. The unit is not currently operational, thus results from monitoring are added to the baseline data set.

Plutonium-Uranium Extraction (PUREX) Cribs. The 216-A-10, 216-A-36B, and 216-A-37-1 Cribs are monitored under a RCRA interim status groundwater quality assessment program, in conjunction with CERCLA, and AEA requirements. The cribs have contributed to widespread contaminant plumes in the area, including nitrate, tritium, and iodine-129, which have migrated to the Columbia River. The nitrate and tritium plumes are generally attenuating throughout most of the area. With changing groundwater flow conditions resulting from the cessation of wastewater discharges at B Pond, the flow direction is changing from southwest to the more regional south or southeast direction near the 216-A-37-1 Crib. This change in groundwater flow direction is sufficient to warrant changing the associated upgradient well to a more westerly location. During FY 2010, the current groundwater monitoring plan will be revised to include a change in upgradient well to the west.

The PUREX cribs contributed to the regional plumes of iodine-129, nitrate, and tritium. Nitrate and tritium concentrations are generally declining.
**Waste Management Area A-AX (WMA A-AX).** The RCRA groundwater quality assessment monitoring continued in CY 2009 for this WMA following installation of a new well in 2008. No dangerous constituents have been detected; however, technetium-99 (not regulated under RCRA) concentrations continued to exceed the 900 pCi/L DWS in two wells. With the installation of new well 299-E25-236 in 2008, the WMA A-AX well network was considered complete and met the requirements of the first determination groundwater monitoring plan. Although WMA A-AX is most likely impacting groundwater quality with tank waste constituents; dangerous waste constituents have not been reported in groundwater in concentrations greater than in upgradient wells. The groundwater monitoring plan will be updated during 2010.

**216-A-29 Ditch.** The groundwater beneath this site continued to be monitored as required under RCRA interim status indicator evaluation regulations. Indicator parameters have continued on historic trends, with specific conductance exceeding the threshold values; the elevated specific conductance is caused by non-dangerous constituents. Groundwater quality beneath the ditch closely resembles the regional composition, and the site remains in indicator evaluation monitoring. Groundwater flow direction is changing from southwest to the south and southeast beneath the 216-A-29 Ditch as a result of the cessation of wastewater discharges at the B Pond. This change in groundwater flow direction is sufficient to warrant additional network evaluation in 2010.

**216-B-3 Pond.** The groundwater beneath this site also continued to be monitored as required by RCRA interim status indicator evaluation regulations. None of the threshold values were exceeded during the reporting period. The monitoring network is adequate to detect and evaluate indicator constituents from the TSD unit.

**Nonradioactive Dangerous Waste Landfill.** This RCRA site is located in the 600 Area, within the footprint of the regional tritium and iodine-129 plumes. Monitoring for interim status indicator parameters continued, while the first determination groundwater assessment monitoring for an exceedance of total organic carbon was completed during CY 2009. The groundwater quality assessment, conducted in accordance with a plan that was submitted to Ecology, concluded that the elevated total organic carbon detected at the unit was not related to dangerous waste/dangerous waste constituents attributable to the facility. Therefore, the site returned to interim status indicator evaluation monitoring.

**Solid Waste Landfill.** This facility is adjacent to the Nonradioactive Dangerous Waste Landfill and is regulated under Washington State solid waste handling regulations. As in previous years, some of the downgradient wells showed higher chemical oxygen demand, chloride, coliform bacteria, specific conductance, sulfate, total organic carbon, and lower pH than upgradient wells. Some of these constituents may be related to past disposal of sewage materials to the landfill.

**200 Areas Treated Effluent Disposal Facility.** A state waste discharge permit governs groundwater sampling and analysis in the three monitoring wells at this facility. None of the permit criteria for constituents in groundwater were exceeded in CY 2009.

**400 Area water supply wells.** Three water supply wells provide drinking water and serve as an emergency water supply for the 400 Area. Because the 400 Area is in the path of the Hanford Site-wide tritium plume, the wells are routinely monitored for tritium. These wells are screened deep in the unconfined aquifer, just above the Ringold lower mud unit. Tritium concentrations in all samples were below the DWS in during the reporting period.
200-UP-1 Operable Unit

The 200-UP-1 OU underlies the southern portion of the 200 West Area and adjacent areas to the east and south. Groundwater in this area is contaminated with carbon tetrachloride, nitrate, iodine-129, technetium-99, tritium, and uranium above DWSs. During CY 2009, the DOE continued groundwater monitoring under the remedial investigation/feasibility study work plan for the 200-UP-1 OU.

Accomplishments related to CERCLA actions during the reporting period included the following:

- Initiating work on the remedial investigation/feasibility study report and a proposed plan
- Issuing an explanation of significant differences and modified interim action Record of Decision to address changes in the uranium remedial action goal, to add extended purging of well 299-W23-19 as an interim action for the removal of technetium-99, and to update other provisions of the 200-UP-1 pump-and-treat system.

The primary contaminants forming extensive plumes within the OU are technetium-99, uranium, tritium, iodine-129, nitrate, and carbon tetrachloride. Chromium and strontium-90 plumes also have sources in this OU. Carbon tetrachloride, chloroform, and possibly trichloroethene in the 200-UP-1 OU originated from sources in the 200-ZP-1 OU.

The 200-UP-1 OU contains one CERCLA interim action site, three TSD units monitored under RCRA (in conjunction with CERCLA and AEA), and one CERCLA disposal site.

**Interim remedial action.** Since 1994, DOE operated an interim remedial action pump-and-treat system to remove technetium-99 and uranium from the groundwater. Uranium concentrations have declined, but two of the wells in the original baseline plume continued to exceed the revised remedial action goal for uranium of 300 µg/L in CY 2009.

Extraction wells 299-W19-36 and 299-W19-43 were offline from August 2008 through November 2008 while facility upgrades were made at the Effluent Treatment Facility. A total of 219.5 kilograms of uranium, 126.5 grams of technetium-99, 40.3 kilograms of carbon tetrachloride, and 47,585 kilograms of nitrate have been removed from the 881 million liters of treated groundwater.

**Waste Management Area S-SX (WMA S-SX).** The RCRA groundwater quality assessment monitoring continued at this WMA in CY 2009. Groundwater beneath WMA S-SX is contaminated with tank waste constituents, including nitrate, chromium, and technetium-99, which are attributed to two general source areas within the WMA. These contaminants have migrated up to approximately 600 meters downgradient from the TSD unit at concentrations above DWSs. All three contaminants were above their respective DWSs during the reporting period. A new well is planned to be installed to define the southwest boundary of the contamination.

**Waste Management Area U (WMA U).** The RCRA groundwater quality assessment monitoring at WMA U continued during CY 2009. This WMA has been identified as the source of groundwater contamination that is limited to the downgradient (east) side of the unit. Constituents of interest include nitrate and technetium-99. During the reporting period, both contaminants were above their respective DWSs.

The average annual technetium-99 groundwater concentrations were below the 9,000 pCi/L remedial action objective at all wells during 2009.
A pump-and-treat system at the 200-UP-1 OU (200 West Area) has decreased the size of the technetium-99 plume in the upper portion of the aquifer. The system began operation in the fall of 1995.

Uranium contamination in the 200-UP-1 OU (200 West Area) does not respond to the pump-and-treat system as quickly as technetium-99. Unlike technetium-99, uranium interacts with sediment grains, slowing its movement and response to remediation.
**216-S-10 Pond and Ditch.** The 216-S-10 Pond and Ditch continued to be monitored under a RCRA interim status contaminant indicator evaluation monitoring program during CY 2009. One upgradient well and two downgradient wells installed as part of the 200-UP-1 remedial investigation/feasibility study work plan in FY 2008 were sampled quarterly beginning in October 2008. No threshold values for indicator parameters were exceeded during the reporting period. The monitoring network is adequate for the continued detection and evaluation of indicator constituents from the TSD unit.

**Environmental Restoration Disposal Facility.** This low-level, mixed waste facility is used for disposal of waste generated from surface remedial actions and other activities on the Hanford Site. The facility was constructed under CERCLA and is designed to meet all hazardous waste landfill standards. Gross-alpha concentrations in groundwater show a slight long-term decrease, and gross-beta concentrations show an increase in most downgradient wells. Gross alpha and gross beta in groundwater will be closely monitored in the future. The results of groundwater monitoring continue to indicate that the facility has not adversely impacted groundwater quality.

**200-ZP-1 Operable Unit**

The 200-ZP-1 OU encompasses the northern and central portions of the 200 West Area and adjacent areas to the north and east. Groundwater monitoring continued under the Sampling and Analysis Plan for the 200-ZP-1 Groundwater Monitoring Well Network (DOE/RL-2002-17). Groundwater at this OU is monitored...
During the reporting period, CERCLA accomplishments included DOE’s publication of the 200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan (DOE/RL-2008-78), which details the plan and schedule for implementing all tasks for design, installation, and operation of the final remedy. Several documents were also issued related to pump-and-treat operations.

The primary contaminant of concern is carbon tetrachloride. Other contaminants include tritium, nitrate, chloroform, chromium, fluoride, iodine-129, technetium-99, trichloroethene, and uranium. The distribution of carbon tetrachloride is complex because it can migrate as a dense nonaqueous-phase liquid, as a gas, and dissolved in water. The contamination occurs at increasing depth to the east (downgradient) of the known source areas in the 200-ZP-1 OU. In this area, density-driven contaminant migration and recharge may have led to reduced carbon tetrachloride concentrations in the upper portion of the aquifer.

The 200-ZP-1 groundwater interest area contains one CERCLA interim action for groundwater, one remediation system for the vadose zone, four TSD units monitored under RCRA (in conjunction with CERCLA and AEA), and one state-permitted unit.

Interim remedial action. Since 1994, the DOE has operated an interim action pump-and-treat system to prevent carbon tetrachloride in the upper portion of the aquifer from spreading. The system is limiting movement of the shallow, high-concentration portion of the plume but does not address contamination deeper in the aquifer and at the periphery of the plume. In 2009, under a Record of Decision for final remediation (Declaration of the Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington [EPA et al. 2008]), the DOE began construction on an expanded pump-and-treat system to address the full plume. From 1994 to date, the system has removed 12,000 kilograms of carbon tetrachloride from the groundwater.

A pump-and-treat test system began operation in September 2007 as part of a designed interim remediation activity to treat technetium-99 contamination. The total volume treated is 75 million liters, allowing for removal of 22.6 grams (0.38 Ci) of technetium-99 from the aquifer.

Low-Level Waste Management Area 3 (LLWMA-3). The RCRA groundwater monitoring continued under interim status contaminant indicator evaluation requirements in CY 2009. There are no upgradient monitoring wells for LLWMA-3. Until new upgradient monitoring wells are installed and background conditions are established, statistical evaluations have been suspended.

Low-Level Waste Management Area 4 (LLWMA-4). The RCRA groundwater monitoring continued under interim status contaminant indicator evaluation requirements in CY 2009. Total organic carbon exceeded the threshold value in August 2008 (during FY 2008) in well 299-W15-224. A resampling event in December 2008 did not identify any organic compounds that would account for the elevated total organic carbon. In January 2009, a groundwater quality assessment plan was prepared to evaluate the elevated total organic carbon. In July 2009, the results of the first determination did not find dangerous waste/dangerous waste constituents in the groundwater at LLWMA-4. Therefore, monitoring at the LLWMA returned to contaminant indicator evaluation monitoring. The monitoring network remains adequate for the continued detection and evaluation of indicator constituents from the TSD unit.
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**Waste Management Area T (WMA T).** The RCRA groundwater quality assessment monitoring for this WMA continued in CY 2009. Sources in WMA T have contaminated groundwater with the dangerous waste constituent chromium. In addition, technetium-99, nitrate, and other non-RCRA tank waste contaminants from the WMA have impacted the unconfined aquifer in the area. Groundwater chromium contamination extends to at least 2.5 kilometers downgradient. A groundwater extraction system has operated in two wells, and contaminant concentrations fluctuated as a result of the extraction activities.

**Waste Management Area TX-TY (WMA TX-TY).** The RCRA groundwater quality assessment monitoring continued during CY 2009. Sources in WMA TX-TY have contaminated groundwater with chromium (a dangerous waste constituent), technetium-99, nitrate, and other non-RCRA tank waste constituents. The more mobile contaminants have migrated to wells approximately 250 meters downgradient of the WMA. Groundwater flow beneath WMA TX-TY is changing due to operation of the 200-ZP-1 pump-and-treat system. Extraction wells are operating south and west of the WMA.

**State-Approved Land Disposal Site.** This active disposal facility is regulated under a state waste discharge permit. Groundwater is monitored for tritium and fifteen other constituents. Concentrations of all constituents considered in the permit did not exceed enforcement limits during CY 2009.

**100-BC-5 Operable Unit**

The 100-BC-5 OU includes groundwater beneath the B and C Reactors and adjacent area along the Columbia River. Contamination is related to the disposal of both solid and liquid wastes associated with the operations of the two water-cooled reactors. Contaminants present include both non-radioactive (nitrate and chromium) and radioactive (tritium and strontium-90) constituents. Groundwater monitoring during the reporting period continued under the existing 100-BC-5 sampling and analysis plan (DOE/RL-2003-38, **100-BC-5 Operable Unit Sampling and Analysis Plan**).

A major CERCLA accomplishment for the 100-BC-5 OU was submittal of the draft **Integrated 100 Area Remedial Investigation Study/Work Plan, Addendum 3: 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units** (DOE/RL-2008-46-ADD3) and the **Sampling and Analysis Plan for the 100-BC Decision Unit Remedial Investigation/Feasibility Study** (DOE/RL-2009-44) to EPA. Four new monitoring wells were installed in the 100-B/C Area in CY 2009 and early CY 2010. Characterization data from the wells helped to define the vertical distribution of contamination in the unconfined aquifer.

At the 100-BC-5 OU, most of the groundwater contamination is found beneath former waste trenches and retention basins. Tritium and strontium-90 exceeded their DWSs in several wells. Nitrate and chromium continued to be below DWSs in CY 2009, but chromium exceeded the 10 μg/L aquatic standard.

Chromium concentrations of up to 112 μg/L were detected in locations beneath the deepest part of the Columbia River channel during a study of groundwater upwelling in the river channel along the 100-B/C Area segment. The DOE is continuing to investigate the source and persistence of this contamination.
100-KR-4 Operable Unit

The 100-KR-4 OU underlies the 100-K Area and extends to the northeast to the 100-NR-2 OU. The principal groundwater issues for this OU are cleaning up chromium in the groundwater, tracking plumes from past-practice sites, and monitoring groundwater near the KE and KW Basins. Interim remedial actions include three pump-and-treat systems to remove chromium from the groundwater.

A number of CERCLA activities were accomplished during the reporting period. These included the following:

- Initiated the remedial optimization process
- Prepared the draft Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 2: 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units (DOE/RL-2008-46-ADD2) and the Sampling and Analysis Plan for the 100-K Decision Unit Remedial Investigation/Feasibility Study (DOE/RL-2009-41)
- Continued operation of the three pump-and-treat systems.

Additional highlights on the remedial optimization process and pump-and-treat operations are provided in the following discussion.

Hexavalent chromium is the primary contaminant of concern in groundwater beneath the 100-K Area and is associated with disposal trenches and cribs and also materials handling areas. A principal cause for the hexavalent chromium contamination was the routine disposal of reactor coolant, which contained sodium dichromate as a corrosion inhibitor. Periodic spills and leaks of sodium dichromate stock solution to the ground are another potential source of hexavalent chromium.

These maps show the chromium in the upper portion of the unconfined aquifer in the 100-K Area. Two pump-and-treat systems reduce the amount of chromium entering the Columbia River.
chromium contamination. Chromium is distributed in plumes, with concentrations remaining above the 20 μg/L remedial action goal in all areas of the 100-KR-4 OU.

Tritium, carbon-14, and nitrate concentrations remained above the DWS in several 100-K Area wells. Carbon-14 was detected above its DWS in several wells around the KE and KW Reactors. Technetium-99 was not detected above the DWS. Trichloroethene was measured above the DWS in samples from wells in the KW Reactor area. Total petroleum hydrocarbons, previously detected in several wells near the KW Reactor building, were not detected in CY 2009.

**Interim remedial action.** Two pump-and-treat systems are in place for removing hexavalent chromium from the aquifer beneath the 116-K-2 Trench. A total of ~391 kilograms of chromium has been removed since system startup in 1997. Chromium concentrations in most of the compliance wells near the Columbia River have decreased. The concentration goal for the interim remedial action is 20 μg/L.

In 1998, chromium concentrations in groundwater near the KW Reactor began to increase, with the concentrations in this plume the highest observed in the 100-K Area. The DOE has operated a pump-and-treat system for cleanup of the plume since 2007. The system removed 49.3 kilograms of chromium in CY 2009 (and 83.3 kilograms since CY 2007 start) from the aquifer, and concentrations in the extraction wells have declined.

**Remedial process optimization activities.** Remedial process optimization was implemented at the 100-KR-4 OU in CY 2009. This process is intended to improve treatment system performance to meet Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1989) milestones. The goal of the Tri-Party Agreement milestones is to improve remediation of the hexavalent chromium plumes and other plumes that have been determined to impact groundwater and the Columbia River. The approach is to model groundwater flow and determine where the hexavalent chromium plume would reach the Columbia River without any intervention, and then revise the current treatment system well configuration to prevent plume intrusion into the river. Additional modeling will then be used to determine where longer term threats exist so more extensive system changes away from the river (including alternate treatment technologies) can be applied. Details of the modeling effort can be found in *100-KR-4 Remedial Process Optimization Modeling Data Package* (SGW-41213) and *Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model* (SGW-46279).

**KE and KW Basins.** These concrete basins are integral parts of each reactor building. From the late 1970s to 2004, the K Basins were used to store irradiated fuel from the last run of the N Reactor, as well as miscellaneous fuel fragments recovered during remedial actions at other reactor areas. Shielding water has been removed from the KE Basin, the basin has been demolished, and soil remediation around the basin has begun.

### 100-NR-2 Operable Unit

The 100-NR-2 OU covers groundwater beneath the N Reactor area along the Columbia River. The principal groundwater issues for this OU are cleanup of groundwater contamination and monitoring groundwater near the former wastewater disposal sites. A permeable reactive barrier has been installed as an interim remedial action to keep strontium-90 in the groundwater from reaching the Columbia River.
Primary CERCLA accomplishments during the reporting period included the following:

- Submittal of the draft Integrated 100 Area Remedial Investigation Study/Work Plan, Addendum 5: 100-NR-1 and 100-NR-2 Operable Units (DOE/RL-2008-46-ADD5) and the Sampling and Analysis Plan for the 100N Decision Unit Remedial Investigation Feasibility Study (DOE/RL-2009-42) to Ecology for review
- Continued operation/monitoring of the permeable reactive barrier
- Completion of several alternate strontium-90 treatment technology tests.

Additional highlights on the permeable reactive barrier and alternate treatment technologies are discussed below.

The primary groundwater contaminant plume in the 100-N Area is strontium-90, which originated at two liquid waste disposal facilities. Chromium, iron, manganese, nitrate, sulfate, total petroleum hydrocarbons, and tritium are also found in the groundwater.

In 2009, only well 199-N-32 had a tritium concentration at the DWS of 20,000 pCi/L. Nitrate concentrations continue to exceed the 45 mg/L DWS in much of the 100-N Area. Sulfate concentrations were all below the 250 mg/L secondary DWS. Several wells exceeded the secondary DWS of 50 µg/L for manganese and the 300 µg/L secondary DWS for iron. With the exception of well 199-N-32, other wells with iron concentrations above the DWS are under the influence of the current diesel plume. Natural biodegradation of hydrocarbons creates chemically reducing conditions, which increases the solubility of metals such as iron and manganese.

The overall shape of the 100-N Area strontium-90 plume at the 8 pCi/L level has not changed in many years, despite the operation of the pump-and-treat system from 1995 until March 2006.
Only one well in the 100-N Area has dissolved chromium concentrations above the DWS of 100 µg/L, because of known corrosion of the stainless-steel well screen.

The 100-NR-2 OU contains one active CERCLA interim action for groundwater, multiple alternate treatment test sites, and four RCRA TSD units.

**Interim remedial actions.** The DOE is applying an in situ technology, apatite sequestration, for treatment of strontium-90 contamination in the 100-N Area. The goal is to create a permeable reactive barrier that will capture strontium-90 as groundwater flows through the barrier to the Columbia River. Apatite-forming chemicals were injected into a line of wells along the river shoreline in FY 2006, FY 2007, and FY 2008. As the injected chemicals reacted with the aquifer and sediments, strontium-90 levels initially increased in downgradient wells and aquifer tubes. However, since injections ceased at the permeable reactive barrier in July 2008, a general, steady decline has been observed for strontium-90 and gross beta in the wells being sampled, with very few exceptions. Nearly all of the wells have shown ~90% decline in gross beta from measured pre-injection values.

Other forms of remediation being investigated at the 100-N Area include jet injection of apatite-forming chemicals, phytoextraction (plants) to treat contamination above the average water table, and passive infiltration of apatite forming chemicals. In December 2009, jet injection tests were performed in three plots located along the 100-N Area shoreline, upriver from the existing apatite permeable reactive barrier. The three plots each received a specific injection solution either a phosphate-only solution, or a phosphate-only solution followed by a suspension of fish-bone apatite, or a suspension of fishbone apatite-only solution. Groundwater is being monitored to assess the effectiveness of the 2009 injections.

The third year of a phytoextraction test was completed in 2009. During the 3-year testing period, the trees survived multiple flooding events (including total immersion), none of the coyote willow trees was uprooted or displaced, and most survived the entire 3-year period. Observed calcium and strontium concentrations found in harvested biomass suggest that the trees could prove effective in removing strontium-90 in the riparian zone.

**Water line rupture.** In December 2008, an unplanned rupture of a 30.5-centimeter water line occurred during remediation activities at the 1524-N pad. The line leaked water into the surrounding area, resulting in the release of at least 189,000 liters of water. To monitor the effect of this release on water in nearby wells, and known vadose and groundwater contamination, additional monitoring was authorized for three wells in the vicinity of the release for March, April, and May 2009. Results for the 3 months of additional monitoring at these wells indicated that the effects of the broken water main appear to have been very limited and temporary in nature.

**1301-N and 1325-N Cribs.** These two RCRA units are located in the 100-N Area. During 2009, the sites remained under interim status contaminant indicator evaluation monitoring programs. The indicator parameters of specific conductance continued to exceed the threshold value at both these facilities. This is the result of elevated sulfate and sodium (both non-RCRA/WAC constituents) associated with releases to the 1324-NA pond. The AEA and CERCLA monitoring continued to track strontium-90 and tritium plumes from the 1301-N and 1325-N facilities. The monitoring network remains adequate for detection of indicator constituents.

**1324-N Surface Impoundment and 1324-NA Percolation Pond.** These two ponds are located in the 100-N Area and share a common footprint. The sites began the reporting period under interim status contaminant indicator
evaluation monitoring programs. Specific conductance, associated with the non-RCRA/WAC contaminants sodium and sulfate, continued to exceed the threshold value. In March 2009, the threshold value for total organic carbon was exceeded at a downgradient well. The exceedance was confirmed in July 2009. Ecology was notified of the exceedance, and a letter from DOE indicated that no organic wastes were disposed to these units. Therefore, the elevated total organic carbon could not be related to waste disposed at this TSD unit. The DOE’s letter was accepted and the unit will remain in interim status contaminant indicator evaluation monitoring. The AEA and CERCLA monitoring continued to track sulfate from the 1324-NA percolation pond. The monitoring network remains adequate for detection of indicator constituents.

100-HR-3 Operable Unit

The 100-HR-3 OU underlies the 100-D and 100-H Areas, as well as the region between these two areas. Hexavalent chromium is the primary contaminant of concern in groundwater. A principal cause for the hexavalent chromium contamination was the routine disposal of reactor coolant, which contained sodium dichromate as a corrosion inhibitor. Additionally, periodic spills and leaks of sodium dichromate stock solution to the ground are another potential source of hexavalent chromium contamination. Chromium concentrations remain above the remedial action goal at the 100-HR-3 OU.

The CERCLA accomplishments related to the 100-HR-3 OU include the following:
- Preparation and Ecology review of the draft Integrated 100 Area Remedial
Investigation/Feasibility Study Work Plan, Addendum 1: 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units (DOE/RL-2008-46-ADD1) and the Sampling and Analysis Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units Remedial Investigation/Feasibility Study (DOE/RL-2009-40)

- Continued operation of two pump-and-treat systems and operation/monitoring of an In Situ Redox Manipulation (ISRM) system
- Completion of several 5-year review actions.

Additional highlights on these activities are discussed below.

Strontium-90 continued to exceed the DWS in a plume in the 100-H Area. Tritium concentrations remained below the DWS during 2009, except in a small plume in the 100-D Area. Nitrate levels exceeded the DWS beneath the 100-D Area and in one well near the 100-H Area.

The 100-HR-3 OU contains two active CERCLA groundwater interim actions, one passive interim action site, and one facility monitored under RCRA regulations, in conjunction with CERCLA and AEA requirements.

**Interim remedial action.** Hexavalent chromium is the target of two pump-and-treat systems that are designed to reduce the amount of chromium entering the Columbia River in the 100-D and 100-H Areas. In CY 2009, chromium concentrations remained above the 20 μg/L remedial action goal in compliance wells for the pump-and-treat systems. During the reporting period, the 100-HR-3 extraction systems removed 15.9 kilograms of chromium from the aquifer during the reporting period, and the DR-5 system removed 44.2 kilograms of chromium. An additional chromium plume in the 100-D Area have removed 613 kilograms of chromium from the aquifer since 1997.

A pump-and-treat system in the 100-H Area has reduced the amount of chromium entering the Columbia River. Concentrations have decreased beneath the 100-H Area but remain elevated in a plume to the west (upgradient).
in the southern 100-D Area is being remediated using a permeable chemical barrier that immobilizes chromium in the aquifer. Data from recent years indicate that chromium is breaking through the barrier. At the end of CY 2009, concentrations in barrier wells ranged from below detection limits to 783 μg/L. Most of the elevated concentrations are in the northeastern half of the barrier. Downgradient of the barrier, the 20 μg/L remedial action goal was met at two of the seven compliance wells.

**Nano-size iron injection.** Laboratory and field tests were performed in 2007 and 2008 to evaluate the effectiveness of injecting tiny particles of iron into the aquifer to repair portions of the ISRM barrier. Existing monitoring wells indicated the iron reached over 3 meters from the injection well but not as far as 12 meters. A well drilled in 2009 verified that iron was communicated over 7 meters from the injection well in significant amounts, which accomplished a primary goal of the test.

**Chromium source investigation.** Three new wells were installed in the northern plume in an attempt to refine the location of the source area. These wells served to better define the high-concentration portion of the northern plume but did not identify a “hot spot” similar to that associated with the southern plume where hexavalent chromium reached concentrations of nearly 60,000 μg/L in 2009. The shallow and intermediate vadose zone was also sampled in 2009 using innovative drilling technology in an attempt to identify vadose zone chromium sources. This work did not find significant levels of hexavalent chromium at depth, but total chromium was elevated beneath waste site 100-D-104, where soil staining is evident.

**Chromium in the Ringold upper mud unit.** Aquifer tests were performed in 2009 to gather additional data on the deep chromium contamination. The aquifer tests were performed using existing monitoring wells in the 100-H Area, grouped into three sets of wells with each set containing three wells. Each of the three-well sets had wells completed at increasing depths in the unconfined aquifer. Some rebound in hexavalent chromium concentration occurred as a result of the shutdown of the 100-HR-3 pump-and-treat system for a rebound study, but a zone to the north and northeast of the H Reactor building was identified as a potential pathway for downward migration of hexavalent chromium-contaminated groundwater during reactor operations. Overall, hexavalent chromium within the tested zone appears to be of finite extent, which should be amenable to remediation via pump-and-treat. The results of this investigation will be published in 2010.

**Other research.** Pacific Northwest National Laboratory completed an in situ biostimulation treatability test at the 100-D Area in CY 2009. The purpose of biostimulation is to induce the reduction of chromate, nitrate, and oxygen and to remove these compounds from the groundwater. Test data indicated that injected materials were successfully distributed to the target radius from the injection wells. Microbial activity and the ability to reduce the targeted species were observed throughout the monitored zone, and low oxygen, nitrate, and chromium concentrations were maintained for the duration of monitoring. Aquifer permeability reduction within the test zone was moderate while the injected substances and associated organic degradation products persisted for a period of at least one year.

**116-H-6 (183-H) solar evaporation basins.** The former 183-H solar evaporation basins are the only RCRA site located in the 100-HR-3 OU. Leaks from the basins contaminated groundwater with chromium, fluoride, nitrate, technetium-99, and uranium. Concentrations of all five contaminants of interest were below their respective DWSs in CY 2009. The site is monitored in accordance with RCRA corrective action regulatory requirements (WAC 173-303-645) during the post-closure
period to track contaminant trends during operation of the CERCLA interim action for chromium.

### 100-FR-3 Operable Unit

The 100-FR-3 OU covers groundwater beneath the former F Reactor area along the Columbia River. The principal groundwater issues for this OU are related to the disposal of both solid and liquid wastes associated with operation of the water-cooled F Reactor. Contaminants present include both non-radioactive (nitrate, chromium, and trichloroethene) and radioactive (tritium and strontium-90) constituents. Groundwater monitoring during the reporting period continued under the 100-FR-3 Operable Unit Sampling and Analysis Plan (DOE/RL-2003-49).

A major CERCLA accomplishment for the 100-FR-3 OU was submittal of the draft Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 4: 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units (DOE/RL-2008-46-ADD4) and the Sampling and Analysis Plan for the 100-F/IU-2/IU-6 Decision Unit Remedial Investigation/Feasibility Study (DOE/RL-2009-43) to EPA.

Nitrate concentrations in groundwater exceed the DWS beneath much of the 100-F Area and the downgradient region. One well in the eastern 100-F Area has strontium-90 concentrations above the DWS. Three wells in the southwestern 100-F Area exceed the DWS for trichloroethene, but concentrations are declining overall. Chromium exceeds the 10 μg/L aquatic standard in wells located near the 116-F-14 retention basins and 116-F-9 Trench.

### 300-FF-5 Operable Unit

The 300-FF-5 OU includes three geographic regions: the 300 Area, the 618-11 Burial Ground region, and the 618-10 Burial Ground/316-4 Cribs region. The OU is currently regulated under a Record of Decision (EPA/ROD/R10-96/143, Declaration of the Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington) for interim remedial action, which requires groundwater monitoring and institutional controls for groundwater use.

A major CERCLA accomplishment for the 300-FF-5 OU was the submittal of the draft 300 Area Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units (DOE/RL-2009-30) to EPA. Other CERCLA accomplishments during the reporting period included treatability testing and research on uranium contamination in the vadose zone and groundwater. Five new Tri-Party Agreement milestones have been established that pertain to the 300-FF-5 OU. Additional highlights on the uranium treatability tests and research activities are discussed below.

Contaminants of concern in 300 Area groundwater are uranium, trichloroethene, and cis-1,2-dichloroethene. Monitoring and plume characterization activities indicate relatively constant or gradually decreasing levels for these contaminants, with some exceptions. Uranium is the primary contaminant of concern, as it has persisted far longer than expected and remains above the DWS of 30 μg/L beneath part of the 300 Area. Trichloroethene continued to be below the 5 μg/L DWS in wells monitoring the top of the unconfined aquifer; however, higher concentrations are present in a deeper, relatively fine-grained interval of sediment within a limited area. Because of low yield, monitoring wells have not been completed in this sediment. At least one
The DOE is investigating remediation methods for uranium in the 300 Area.

Groundwater downgradient of the 618-11 Burial Ground is contaminated by a high-concentration tritium plume, likely originating from irradiated material in the burial ground. Concentrations at a well adjacent to the burial ground have decreased from the peak values observed in 1999 and 2000. The plume extends eastward from the burial ground across the northern portion of the Energy Northwest complex.

The 300-FF-5 OU contains multiple treatability test sites, as well as one TSD unit monitored under RCRA regulations.

**Uranium treatability test.** Following an aquifer test in June 2007, groundwater monitoring has indicated that the injection of polyphosphate solutions has not performed as well as anticipated in permanently sequestering uranium on aquifer solids. A final report on the aquifer injection test is provided in *300 Area Uranium Stabilization Through Polyphosphate Injection: Final Report* (PNNL-18529). Additional treatability testing using polyphosphate solutions was conducted during 2009 and continues during 2010 at a second test site, where the focus is on immobilizing uranium in the vadose zone.

**Integrated Field-Scale Research Challenge program.** The DOE’s Office of Biological and Environmental Research (Office of Science) is supporting field research involving the mobility of uranium under a program referred to as Integrated Field-Scale Research Challenge. The Hanford Site 300 Area is one of three DOE sites where field and laboratory research activities are being performed. A highly instrumented, three-dimensional array of sensors is installed in the vadose zone and upper portion of the aquifer beneath a portion of the former South Process Pond.
liquid waste disposal site. A closely associated project uses a variety of near-surface geophysical methods to characterize preferential pathways for groundwater movement and discharge to the Columbia River channel. The project is in its third year, and the results will be published in 2010.

The DOE has also funded a groundwater flow and uranium transport modeling project for the 300 Area via the Scientific Discovery Through Advanced Computing Program. This project involves massively parallel, high-speed computing and conducts calculations that would otherwise require exceedingly long computing times using conventional computer equipment. Two reports on the initial results of the project will be published in 2010.

300 Area Process Trenches. This former liquid waste disposal site was the last site in the 300 Area to receive uranium-bearing effluent, with uranium discharges ending in 1985 and all discharges ending in December 1994. The site, which has been remediated, is regulated under RCRA and is monitored in accordance with post-closure corrective action requirements (WAC 173-303-645), in conjunction with CERCLA and AEA. Uranium currently exceeds the DWS in wells downgradient from the waste site. Cis-1,2-dichloroethene concentrations exceed the DWS at downgradient well 399-1-16B, which is completed near the bottom of the unconfined aquifer. Most results for trichloroethene and tetrachloroethene were below detection limits during the reporting period, with the exception of two detections of trichloroethene in samples from well 399-1-16B, but at concentrations near the detection limit.

1100-EM-1 Operable Unit

The 1100-EM-1 OU is located in the southern portion of the Hanford Site. Groundwater is also monitored south of the Hanford Site, including the areas formerly designated as the 1100-EM-2 and 1100-EM-3 areas, the 3000 Area of the Hanford Site, the City of Richland’s landfill, and the North Richland Well Field. Groundwater monitoring continued during the reporting period under the Sampling and Analysis Plan Update for Groundwater Monitoring – 1100-EM-1 Operable Unit (PNNL-12220) and AEA requirements.

Trichloroethene was the primary contaminant of concern in the 1100-EM-1 OU, but concentrations remained below the 1 µg/L detection limit in CY 2009. Contaminants also flow into the area from offsite sources (e.g., nitrate from agricultural and industrial sources). The final remedy selected for 1100-EM-1 OU groundwater is monitored natural attenuation of volatile organic compounds.

Wells in the North Richland Well Field are monitored frequently to detect any changes in potential Hanford Site contaminants near these wells. The tritium plume originating from sources in the 200 East Area has not been detected in these wells. Low levels of tritium (less than 500 pCi/L) continued to be detected.

Elevated levels of gross alpha are detected downgradient of an offsite industrial facility. Uranium concentrations in wells downgradient of DOE’s inactive Horn Rapids Landfill have slowly been increasing since 1996 but remained below the DWS in CY 2009.

Confined Aquifers

Although most of Hanford Site groundwater contamination is found in the unconfined aquifer, the DOE monitors wells in deeper aquifers due to the potential for downward movement of contamination and the potential migration of that
contamination offsite through the confined aquifers. No evidence has been detected of offsite migration via the confined aquifers.

The Ringold confined aquifer occurs within sand and gravel comprising the lowest sedimentary unit of the Ringold Formation. This aquifer is confined below by basalt and above by the Ringold lower mud unit. Groundwater in this aquifer flows generally west to east in the vicinity of the 200 West Area. In the central portion of the aquifer, flow appears to converge into the 200 East Area from the west, south, and east. Some groundwater discharges from the confined aquifer to the overlying unconfined aquifer where the confining Ringold lower mud unit has been removed by erosion.

While effluent disposal was occurring at the B Pond system, mounding within the unconfined aquifer in this area led to the downward movement of groundwater into the Ringold confined aquifer. During CY 2009, five wells completed in the Ringold confined aquifer were sampled. Two common soil minerals, iron and manganese, exceeded the secondary DWSs. Because these contaminants are common soil minerals and are not contaminants of concern from any nearby Hanford waste sites, the elevated concentrations are likely the result of local groundwater/soil interactions rather than contamination from Hanford Site operations.

Groundwater within basalt fractures and joints, interflow contacts, and sedimentary interbeds make up the upper basalt-confined aquifer system. Groundwater in the upper basalt-confined aquifer generally flows from west to east across the Hanford Site. Groundwater also flows vertically through fractures or other pathways in the confining layers, into the overlying unconfined aquifer and into the Columbia River downstream of the 300 Area. Vertical gradients between the upper basalt-confined aquifer and the unconfined aquifer are upward across most of the Hanford Site. Localized downward gradients occur in the western portion of the Hanford Site, as well as near B Pond and to the north and east of the Columbia River.

In CY 2009, fifteen upper basalt-confined aquifer wells were sampled. Tritium continued to be detected at low levels in some wells, primarily in wells located in or near the 200 East Area. Elevated cyanide, nitrate, and technetium-99 measured in CY 2008 in the new upper basalt-confined aquifer well 299-E33-340 (located in the northwestern portion of the 200 East Area) declined significantly during CY 2009. Concentrations are now similar to those found in other upper basalt-confined aquifer wells in the area. Migration of contamination via the wellbore during well construction is likely responsible for the elevated levels.

###Aquifer Tubes

The DOE monitors groundwater along the Columbia River by collecting samples from aquifer tubes and riverbank springs (seeps). Aquifer tubes are small-diameter, flexible tubes with a screen at the lower end. The aquifer tubes are implanted into the shallow aquifer and natural seep points or springs along the Columbia River shore. Shoreline monitoring for the reporting period provided the following data:

- Concentrations of strontium-90 continued to exceed the 8 pCi/L DWS in aquifer tubes in the 100-B/C, 100-N, and 100-H Areas. Levels exceed the 1,000 pCi/L derived concentration guideline in certain aquifer tubes in the 100-N Area.
- Tritium concentrations exceeded the 20,000 pCi/L DWS in one tube in the 100-B/C Area and one tube in the southern 100-D Area. Tritium also exceeded...
the DWS in riverbank springs and aquifer tubes at the Hanford town site in the 200-PO-1 OU.

- Uranium concentrations exceed the 30 μg/L DWS in aquifer tubes and riverbank springs in the 300 Area.
- Chromium concentrations in aquifer tubes or seeps exceeded the 10 μg/L aquatic standard in the 100-B/C, 100-K, 100-D, 100-H, and 100-F Areas.
- Nitrate concentrations exceeded the 45 mg/L DWS in aquifer tubes in the 100-K, 100-N, and 100-H Areas.
- Trichloroethene is detected in several aquifer tubes in the 300 Area and continued to exceed the 5 μg/L DWS in some tubes monitoring a fine-grained unit.

Columbia River

Pacific Northwest National Laboratory conducts environmental surveillance on and around the Hanford Site, including sampling Columbia River water, river sediment, and riverbank seeps. The surveillance data provide a historical record of radionuclides and chemicals in the environment. The DOE is also conducting a risk assessment and remedial investigation of contaminant releases to the Columbia River.

Washington Closure Hanford is performing the River Corridor baseline risk assessment. The 100 Area and 300 Area component of the baseline risk assessment addresses post-remediation, residual contaminant concentrations in these areas, as well as the Hanford and White Bluffs town sites. The assessment is also investigating the risks related to the potential transport of Hanford Site contaminants into Columbia River riparian and near-shore environments adjacent to the operational areas.

The DOE and Washington Closure Hanford began an investigation of Hanford Site contaminant releases in the Columbia River in 2008. Samples were collected of river bottom sediment porewater (i.e., groundwater upwelling beneath the river bottom into the space between rocks and sediment of the river bed), river sediment, river water, fish, and island soil.

Phase I of the study, a test of the applicability of the Trident™ probe technology for Hanford Reach conditions, was successfully completed in 2008. Phase II of the study was designed to delineate areas where groundwater was discharging (upwelling) to the river and was completed in 2009. This study was divided into two sub-phases (Phase IIA and Phase IIB). Phase IIA included ~675 in situ measurements of specific conductance and temperature to define areas of upwelling. The results of Phase IIA indicated areas of preferential upwelling in definable locations along the Hanford shoreline, the opposite shoreline, and in the deep river channel. The results of Phase IIA were used to select sites to be sampled in Phase IIB.

Phase IIB of the study involved collecting samples of groundwater from a subset of Phase IIA locations and analyzing the samples for key Hanford Site contaminants. Contaminants were detected in some of the porewater samples and, in a few cases, were detected at higher concentrations than anticipated.

Phase III of the study was conducted in early 2010 and included additional sampling of approximately five locations in each study area. Samples of porewater, river sediment, and river water were analyzed for a more comprehensive list of contaminants.

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3 Trident™ probe is a trademark of Environmental Sciences, San Diego, California.
Well Installation, Maintenance, and Decommissioning

The DOE installs new wells when needed for monitoring or characterization, maintains wells to ensure good operating/usable condition, and decommissions wells that are no longer needed by a program or that can no longer be used. Ecology, EPA, and DOE worked together to develop a prioritized list of new wells needed to meet the requirements of various groundwater monitoring regulations. During CY 2009, the DOE installed 14 new wells on the Central Plateau and 38 new wells along the River Corridor.

During the reporting period, the DOE installed 52 new wells and decommissioned one soil tube.

This chart shows the number of monitoring wells that went dry each year since 1999. Most of the wells were in the 200 West Area, where the water table declined the most.

Approximately 10,416 unique well identification numbers have been identified at the Hanford Site, which includes all wells, characterization boreholes, aquifer tubes, soil vapor probes, piezometers, or other subsurface installations. During CY 2009, a total of 3,489 unique well identification numbers were documented as “in use.” One soil tube well was physically decommissioned during CY 2009, and no boreholes were administratively decommissioned during the reporting period.

During CY 2009, 95 temporary characterization boreholes were installed in the Central Plateau to support various projects. Eight characterization boreholes were installed in the River Corridor in the 100-HR-3 OU. Temporary boreholes are installed for subsurface characterization of radiological constituents, volatile organic compounds (e.g., carbon tetrachloride), or hydrogeologic property determination (e.g., moisture and grain-size distribution). While typically installed to characterize the vadose zone, temporary borings can be drilled to groundwater to obtain a one-time sample and are then decommissioned.
Staff performed maintenance on 194 wells on the Central Plateau and 136 wells along the River Corridor during CY 2009. Surface maintenance includes labeling wells, maintaining well caps, and repairing surface casing, wiring, or pump-discharge fittings. Subsurface tasks include repairing and replacing sampling pumps, performing camera surveys, retrieving pumps and equipment, and replacing discharge tubing.

**Vadose Zone**

Vadose zone activities during the reporting period included leachate monitoring, soil vapor extraction and monitoring, surface geophysics, and borehole geophysical logging.

*Leachate monitoring at the Environmental Restoration Disposal Facility.* This facility is used for disposal of radioactive and mixed waste generated during waste management and remediation activities at the Hanford Site. Leachate is collected and sent to the Effluent Treatment Facility. The composite leachate samples contained detectable concentrations of common metals, anions, and mobile radionuclides. Constituents that generally increased in concentration included gross alpha and total uranium.

*Leachate and soil vapor monitoring at the Solid Waste Landfill.* Leachate (collected from beneath two of the trenches) is sampled and tested quarterly. Concentrations during the reporting period were similar to previously reported concentrations and did identify areas of concern. Soil vapor is monitored quarterly to determine concentrations of oxygen, carbon dioxide, methane, and several key volatile organic compounds. From September 2008 to May 2009, only methane and carbon dioxide were detected in soil vapor samples.

*Soil vapor extraction.* Soil vapor extraction is used to remove carbon tetrachloride from the vadose zone in the 200 West Area. A new system was online in CY 2009 at the 216-Z-9 well field. Both the new system and the existing system operated from April 1 through September 30, 2009. During the reporting period, the 216-Z-9 well field system removed 103 kilograms of carbon tetrachloride, and the 216-Z-1A and 216-Z-18 system removed 73 kilograms.

*Tank farm vadose zone activities.* The Vadose Zone Integration Program is responsible for implementing the tank farm RCRA corrective action program through field characterization, laboratory analyses, technical analyses, risk assessment for past tank leaks, and installation of interim measures to reduce the threat from contaminants until permanent solutions can be found. In CY 2009, the Vadose Zone Integration Program drilled 32 direct-push boreholes for soil sampling and geophysical logging in the C, SX, and TY Tank Farms. The first installation of a multi-depth electrode string was made at the C Tank Farm in CY 2009 for future use with surface geophysics. A surface geophysical survey at WMA S-SX was also completed. Effectiveness monitoring at the interim surface barrier over a portion of the T Tank Farm continued with the installation of a solar-powered and remotely controlled soil-water monitoring system. Conditions are continuously monitored at four locations beneath the barrier and at one site outside the barrier footprint. Analysis of the first-ever, fully three-dimensional surface geophysical exploration survey was completed during the reporting period at an unplanned release site associated with the CR-151 diversion box.

*As of September 2008, ~79,600 kilograms of carbon tetrachloride have been removed from the vadose zone since vapor extraction operations began in 1991.*
Conclusion

Groundwater monitoring remains a crucial part of the Hanford Site baseline throughout the cleanup mission and will remain a component of long-term stewardship after remediation is completed. The DOE will continue monitoring the groundwater to meet of its obligations under the AEA, CERCLA, RCRA, and WAC regulations. During ongoing groundwater remediation, the Groundwater Monitoring Project will monitor, assess, and report on activities at the groundwater OUs. More detailed information about the Groundwater Project can be found online at http://www.hanford.gov/page.cfm/GroundwaterRemediation.