

## **River Corridor Closure at DOE's Hanford Site – 12503**

**Jonathan Dowell, Joe Franco, US DOE**

jonathan.dowell@rl.doe.gov

Jose.Franco@rl.doe.gov

The discussion of Hanford's River Corridor will cover work that has already been completed plus the work remaining to be done. This includes the buildings, waste sites, and groundwater plumes in the 300 Area; large-scale burial ground remediation in the 600 Area; plutonium production reactor dismantling and "cocooning" along the river; preservation of the world's first full-scale plutonium production reactor; removal of more than 14 million tons of contaminated soil and debris along the Columbia River shoreline and throughout the River Corridor; and the excavation of buried waste sites in the river shore area. It also includes operating an EPA-permitted low-level waste disposal facility in the central portion of the site. At the completions of cleanup in 2015, Hanford's River Corridor will be the largest closure project ever completed by the Department of Energy.

Cleanup of the River Corridor has been one of Hanford's top priorities since the early 1990s. This urgency has been due to the proximity of hundreds of waste sites to the Columbia River. In addition, removal of the sludge from K West Basin, near the river, remains a high priority.

This 220-square-mile area of the Hanford Site sits on the edge of the last free-flowing stretch of the Columbia River. The River Corridor portion of the Hanford Site includes the 100 and 300 Areas along the south shore of the Columbia River.

The 100 Areas contain nine retired plutonium production reactors. These areas are also the location of numerous support facilities and solid and liquid waste disposal sites that have contaminated groundwater and soil.

The 300 Area, located just north of the city of Richland, contains fuel fabrication facilities, nuclear research and development facilities, and their associated solid and liquid waste disposal sites that have contaminated groundwater and soil.

In order to ensure that cleanup actions address all threats to human health and the environment, the River Corridor includes the adjacent areas that extend from the 100 Area and 300 Area to the Central Plateau.

For sites in the River Corridor, remedial actions are expected to restore groundwater to drinking water standards and ensure that aquatic life in the Columbia River is protected by achieving ambient water quality standards. It is intended that these objectives be achieved, unless technically impracticable, within a reasonable timeframe. In those instances where remedial action objectives are not achievable in a reasonable time

frame, or are determined to be technically impracticable, programs are being implemented to contain the plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction opportunities as new technologies become available. River Corridor cleanup work also removes potential sources of contamination, which are close to the Columbia River, and places them on the Central Plateau for final disposal. The intent is to shrink the footprint of active cleanup to within the 75-square-mile area of the Central Plateau by removing excess facilities and remediating waste sites. Cleanup actions are supporting anticipated future land uses consistent with the Hanford Reach National Monument, where applicable, and the Hanford Comprehensive Land-Use Plan (DOE 1999).

The River Corridor has been divided into six geographic decision areas to achieve source and groundwater remedy decisions. These decisions will provide comprehensive coverage for all areas within the River Corridor and will incorporate ongoing interim action cleanup activities. Cleanup levels will be achieved in order to support anticipated future land uses of conservation and preservation for most of this area and industrial use for the 300 Area. At the conclusion of cleanup actions, the federal government will implement long-term stewardship activities to ensure protection of human health and the environment.

### **Current Status**

Since 1995, DOE has implemented CERCLA records of decision for interim and final actions. These records of decision require removal of contaminated soil from waste sites (primarily the upper 15 feet of soil) and debris from demolished facilities in the 100 and 300 Areas and disposal of the resulting waste in the Environment Restoration Disposal Facility (ERDF) located in the 200 Area. The spent fuel in the K Basins has been removed and is in dry storage in the 200 Area. Reactors are being placed in interim safe storage to allow time for additional radioactive decay in the reactor core. Groundwater treatment systems have been operating and are being upgraded to prevent hexavalent chromium, uranium, and strontium-90 in groundwater from entering the Columbia River at levels harmful to human health or the environment. As described in Hanford's 2015 Vision, between 2010 and 2015 all areas of the River Corridor will be cleaned up consistent with records of decision for interim actions.

### **Key Challenges for River Corridor**

Cleanup of the River Corridor has been one of Hanford's top priorities since the early 1990s. This urgency is due to the proximity of hundreds of waste sites to the Columbia River. In addition, removal of the sludge from K West Basin, which is near the river, remains a high priority and significant progress is being made. Highly radioactive materials have been removed from the 300 Area where they were stored close to populated communities. Spent fuel stored in the 100-K Area has been safely removed and placed in dry storage on the Central Plateau. Because groundwater contamination continues to threaten the Columbia River, DOE has set aggressive goals for cleaning groundwater to levels that protect the river by 2020. For one of these contaminants, chromium, DOE will take steps to ensure that by 2012 groundwater entering the

Columbia River will not be harmful to aquatic species. To successfully complete cleanup of the River Corridor, DOE and its contractors face several important challenges:

### **1. Remove and Dispose of K Basin Sludge**

What is the challenge? Although the spent fuel has been removed from the K Basins, the sludge that remains in the bottom of the K West Basin poses a significant challenge because it contains some of the highest concentrations of radioactive materials (after spent nuclear fuel) on the Hanford Site. The composition of the sludge varies greatly and, because of its hazards to workers, must be handled remotely. Shielding and other radiological controls are required once the sludge is removed from the basin for packaging. Because of the sludge's unique composition, processing it for disposal could also be difficult.

Where are we today? A total of 2,300 tons of spent fuel has been removed from the K East and K West Basins. The spent fuel was packaged and moved to dry, safe storage on the Central Plateau. Contaminated water has been removed from the K East Basin and the basin has been removed. The sludge from both basins has been placed in containers that now reside in the K West Basin. The K East Basin has been completely demolished. After completion of sludge removal, the K West Basin will be demolished. The transuranic sludge will be treated and stored on the Central Plateau pending shipment to the Waste Isolation Pilot Plant in New Mexico.

### **2. Store Surplus Production Reactors Until Final Disposal**

What is the challenge? Three surplus production reactors (K East, K West, and N) remain to be placed into interim safe storage configuration. The B Reactor is being preserved as a National Historic Landmark. Final disposition of the reactors will be determined by future decisions. If removal and burial on the Central Plateau is chosen, there will remain significant technical challenges to dismantle and move the radioactive graphite cores.

Where are we today? Final reactor decommissioning actions could be established through either a NEPA record of decision and implemented through DOE's Atomic Energy Act (AEA) authority, or through a CERCLA decision and action. Until reactor removal is complete, DOE will continue to conduct routine maintenance, surveillance, and radiological monitoring activities to ensure continued protection of human health and the environment during the interim storage period. Following reactor removal, any remaining waste sites will be remediated.

### **3. Prevent Hexavalent Chromium from Impacting the Columbia River**

What is the challenge? Hexavalent chromium is a significant groundwater contaminant in the 100-D, 100-H, and 100-K Areas. Chromium is present in groundwater at more than 10 times drinking water standards. Hexavalent chromium poses a potential threat to the health of aquatic life along the shores of the river. Chromium was used as a water treatment chemical for cooling water used in Hanford's production reactors. Cooling water from the single-pass reactors was discharged to retention basins and eventually to the Columbia River. In addition to the cooling water discharges, much more concentrated sources of chromium have been found at locations where the chemical was brought to the Hanford Site and unloaded for use. It is not known with certainty if all

of the areas have been identified where hexavalent chromium was unloaded for use at the site.

Where are we today? Remediation goals have been established that are well below drinking water standards so that cleanup is also protective of aquatic species. Pump-and-treat systems have been effective in removing chromium from groundwater at Hanford. These systems are being expanded to achieve remediation goals. Sources of chromium in the groundwater are being removed and work continues on identifying all the sources of hexavalent chromium contamination. Moreover, recent sampling within the Columbia River itself has identified locations where chromium-contaminated groundwater is upwelling into the river. This phenomenon needs to be better understood to design and implement effective remedies.

#### **4. Achieve Strontium-90 River Protection Goal**

What is the challenge? The strontium-90 plume at 100-N Area exceeds drinking water standards by approximately three orders of magnitude. There is no ambient water quality standard for strontium-90, so the drinking water standard is used as a default standard. However, the actual dose to aquatic receptors is significantly below published risk-based dose guidelines. Strontium-90 tends to bind tightly to soil and consequently is difficult to remove by standard pump-and-treat systems.

Where are we today? In the mid-1990s, a CERCLA interim action led to operation of a pump-and-treat system to reduce the amount of strontium-90 entering the Columbia River. However, this effort was discontinued when it was determined that the system was ineffective and provided only about one-tenth of the mass removal compared to natural radioactive decay (DOE 2006b). The pump-and-treat system is currently in cold-standby status. Subsequently, DOE has begun testing alternate remedies including a permeable reactive barrier using apatite sequestration (Strontium-90 Treatability Test Plan for 100-NR-02 Groundwater Operable Unit [DOE 2006a reissue]) and a method called phytoextraction that uses plants to extract and sequester soil and waterborne contaminants.

#### **5. Remediate the 300 Area Uranium Plume**

What is the challenge? The uranium plume in the 300 Area has proven to be difficult to understand, predict, and remediate. An original remedy of monitored natural attenuation did not achieve cleanup levels within the predicted timeframe (EPA 1996 and DOE 2006b).

Where are we today? A new remedial investigation/feasibility study supported by advanced science and technology investigations and applications is underway to tackle this complex uranium plume and other contaminants of concern. One of the new technologies is the experimental application of polyphosphate injection aimed at sequestering uranium in the vadose zone. In addition, DOE's Office of Science has put in place an Integrated Field Challenge test site in the 300 Area to enhance the understanding of the complex geochemistry and interactions with fluctuating Columbia River levels. This project is expected to improve the understanding of this plume and support development of effective remedies.

### **River Corridor – Final Decisions**

Final records of decision are required for the 100 and 300 Areas to guide future remediation, to ensure that remedial actions performed under interim action records of decision are protective of human health and the environment, and to determine if additional actions are required. To proceed toward records of decision for the 100 and 300 Areas, six geographic decision areas have been defined for the River Corridor: 100 B/C Area, 100-K Area, 100-N Area, 100-D and H Areas, 100-F Area combined with 100-IU-2/6 Areas, and 300 Area (including nearby 600 Area waste sites). These decision areas contain liquid waste sites, solid waste burial grounds, surplus facilities and infrastructure, contaminated groundwater plumes, and surplus production reactors. These decision areas encompass the 100 and 300 Areas NPL sites.

To support decisions, DOE is undertaking remedial investigations in each of the six geographic decision areas. In addition, DOE is assessing Hanford releases into the Columbia River to determine the extent of Hanford contamination in the river. These six decision areas have been developed to ensure that final remedy decisions address the entirety of the 100 and 300 Areas. Together, surface remedies (i.e., for waste sites and facilities) and groundwater remedies must protect human health and the environment. Cleanup levels for final remedies will be protective of future uses consistent with the land use designations in the Hanford Comprehensive Land-Use Plan (DOE 1999), i.e., conservation and preservation for most of the area and industrial use in the 300 Area. When interim records of decision for River Corridor 100 Area waste sites were selected in the mid-1990s, a conservative residential exposure scenario was used to determine protectiveness for those interim actions because DOE had not yet designated land uses. Cleanup goals established through interim records of decision will continue to be used to guide future remedial actions and will support reasonably foreseeable land uses in the River Corridor.

DOE will complete remedial investigations/feasibility studies for both source and groundwater operable units within each geographic decision area. The purpose of the remedial investigation is to characterize the nature and extent of Hanford contaminants and assess the risk from exposure to those contaminants within a decision area. The River Corridor Baseline Risk Assessment, Columbia River remedial investigation (Remedial Investigation of Hanford Site Releases to the Columbia River, waste site cleanup verification data, and field investigation data will provide characterization and baseline risk assessment information for contaminated areas within all six decision areas and the Columbia River. The feasibility studies will compare cleanup alternatives using the CERCLA criteria. A plan will be prepared for each of the six decision areas to propose final remedies for both source and groundwater operable units. The six records of decision will describe the remaining cleanup actions required for River Corridor cleanup completion. These six decisions (proposed plans and records of decision) are scheduled to be completed by 2014. Most cleanup actions are scheduled to be completed by 2015. However, some waste site cleanup associated with some major facilities will not be completed until after the facilities have been removed, e.g., waste sites associated with 100-K Area and K Basins.

### **Cleanup of Major Facilities within the River Corridor**

Within the six geographic decision areas described in Section 3.3, there are major facilities whose final disposition must be included in the completion of the River Corridor remediation. There are nine surplus plutonium production reactors along the Columbia River in the 100 Areas. In the 100-K Area, the spent fuel storage basins have had the spent fuel removed. However, the K West Basin contains approximately 1000 cubic feet (~30 cubic meters) of sludge that presents a significant challenge to completion. The Fast Flux Test Facility (FFTF), a prototype breeder reactor, also must be put into a final safe configuration. Finally, within the 300 Area, the DOE Office of Science will retain four facilities that will need to be removed on a schedule that is a decade or more after other work in the 300 Area is to be completed.

### **Surplus Production Reactors**

In 1998, C Reactor was the first reactor in the DOE complex to transition to safe storage. Cocooning the reactor demonstrated new technologies to reduce worker exposure to radiation, lower maintenance costs, and accelerate site cleanup by transferring lessons learned about safe storage<sup>16</sup> to other reactors.

The NEPA *Record of Decision for the Decommissioning of Eight Surplus Production Reactors EIS* (58 FR 48509) documents DOE's decision of interim safe storage followed by one-piece removal to a Central Plateau disposal facility. N Reactor was not included in the EIS as it was not available for decommissioning at the time of the NEPA EIS and interim safe storage was approved through the CERCLA process. Final disposition will be handled by a subsequent NEPA or CERCLA decision process. B Reactor has been designated as a National Historic Landmark and will be placed in a configuration consistent with that use and controlled access by the general public for the foreseeable future. For all reactors except B, interim safe storage actions, selected through the CERCLA removal action process, are designed to prevent deterioration and release of contamination from the reactors for up to 75 years.

The NEPA record of decision for the reactors (58 FR 48509) also indicated DOE's intent to complete these decommissioning actions consistent with the proposed cleanup schedule for remedial actions. As DOE completes remedial investigation/feasibility study reports for the six geographic areas, these reports will describe how and when final reactor decommissioning actions will be coordinated with cleanup actions. Final reactor decommissioning actions, however, could be established through either a NEPA record of decision and implemented through DOE's AEA authority, or through a CERCLA decision and action. Until reactor removal is complete, DOE will continue to conduct routine maintenance, surveillance, and radiological monitoring activities to ensure continued protection of human health and the environment during the interim storage period. Following reactor removal, any remaining waste sites will be remediated.

### **K Basins**

The 100-K Area includes the K East and K West spent fuel storage basins (K Basins). The spent fuel has been removed and is in dry storage in the 200 Area. Over the lifetime of these basins, debris, silt, sand, and material from operations resulted in the formation of sludge that accumulated in the bottom of these basins. There is a total of

about 1000 cubic feet (~30 cubic meters) of sludge contaminated with fission and activation products and uranium. The sludge from both basins has been placed in containers that now reside in the K West Basin. The K East Basin has been completely demolished. After completion of sludge removal, the K West Basin will be demolished. The transuranic sludge will be treated and stored on the Central Plateau pending shipment to the Waste Isolation Pilot Plant in New Mexico. The 100-K Reactors will be placed in interim safe storage.

### **Fast Flux Test Facility**

The FFTF lies within the 300 Area decision area. DOE is currently evaluating decommissioning and final disposition options for FFTF through the *Tank Closure and Waste Management Environmental Impact Statement* (DOE 2009e). The EIS record of decision will identify the final disposition approach for FFTF. Pending implementation of a final decision, DOE has placed the facility in a minimum-safe surveillance and maintenance mode by deactivation of appropriate FFTF plant systems and components and removal of potential hazards.

### **Retained Facilities in the 300 Area**

In 2007, DOE's Office of Science elected to retain four facility complexes in the 300 Area – Buildings 325, 331, 318, and 350 – for up to 20 years. These facilities will continue to support Office of Science missions implemented through the Pacific Northwest National Laboratory. When these facilities are determined to be excess to these missions, they will be returned to DOE-RL for final removal and remediation of any associated waste sites. The 300 Area record of decision will identify mitigation actions needed to address waste sites associated with these buildings.

### **Interfaces with Central Plateau Cleanup**

#### **Impact of Central Plateau Groundwater Contamination on River Corridor Cleanup**

There are historical groundwater contaminant plumes from the Central Plateau (200-BP-5 and 200-PO-1 Operable Units) that have reached the 100 and 300 Areas and the Columbia River. The principal contaminants are tritium, iodine-129, and nitrate that resulted from Hanford's last fuel processing operations at the Plutonium Uranium Extraction (PUREX) Plant in the 1980s. For legacy groundwater contamination plumes that have migrated off the Central Plateau, the higher concentration portion of the plumes has declined significantly in the past 10 years (DOE 2008c). It is anticipated that ongoing efforts to decrease groundwater recharge in the Central Plateau (e.g., cut-and-cap leaking water lines), coupled with natural processes occurring within the groundwater system itself, will result in these plumes meeting drinking water standards in a reasonable time frame.

The remedial investigation/feasibility study for the affected 100 Area decision area (100-IU-2/6 and 100-F) and the 300 Area decision area will evaluate current groundwater conditions to determine the overall protectiveness of the proposed source remedies. However, remedy decisions for the iodine, tritium, and nitrate plumes will be made

through the record of decision for 200-PO-1 Operable Unit as part of the Central Plateau cleanup. Cleanup decisions and actions for the Central Plateau, including pump-and-treat systems and monitoring networks, are anticipated to prevent additional plumes from reaching the River Corridor area above drinking water standards; therefore, future plumes from the Central Plateau do not need to be considered in River Corridor decisions.

### **Environmental Restoration Disposal Facility**

Remediation of River Corridor waste sites and contaminated facilities generate low-level, mixed low-level and other remediation waste requiring disposal. These types of waste will be transported to ERDF, an engineered disposal facility with its own CERCLA record of decision (EPA 1995a). ERDF is located on the Central Plateau between the 200 East and 200 West Areas, more than 7 miles from the Columbia River. Other materials, such as transuranic materials and spent nuclear fuel will be removed for appropriate disposition.

### **Close Out of the 100 Area and 300 Area National Priorities List Sites**

Upon completion of cleanup as specified in the CERCLA records of decision, DOE will close out the 100 Area and 300 Area NPL sites in accordance with CERCLA requirements (EPA 2000). NPL close out procedures, such as site deletion, include a cumulative assessment of remedial actions taken to ensure they are protective of human health and the environment and that no future response action is likely. Close out of these units will also include integration with the DOE-RL Long-Term Stewardship Program to ensure institutional controls are implemented in accordance with records of decisions.

The CERCLA process requires DOE as lead agency for the Hanford Site, to conduct five-year reviews to be triggered by any remedial action that leaves hazardous substances onsite at levels that do not allow for unlimited use and unrestricted exposure (EPA 2001).