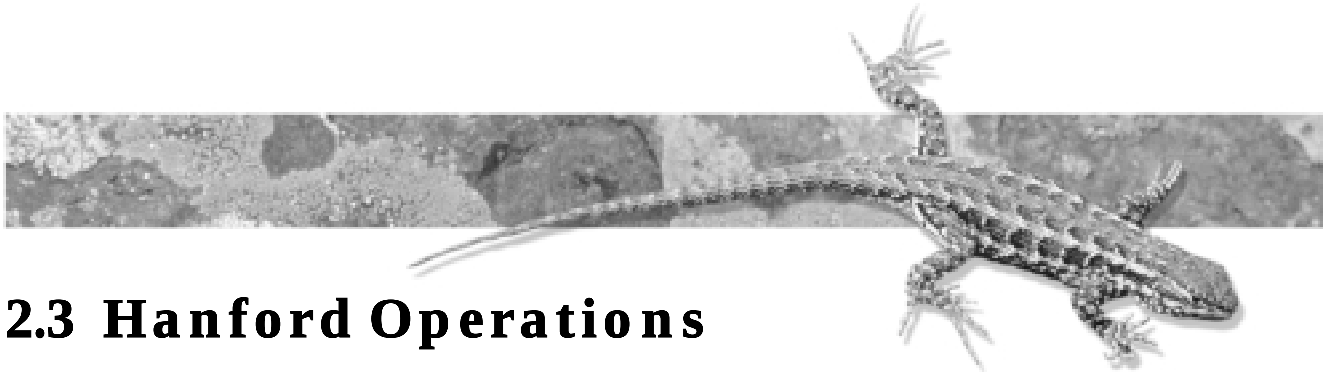

2.3 Hanford Operations

J. P. Duncan

This section describes continuing Hanford Site environmental and regulatory activities. Included are self-assessments, inspections by regulatory agencies, stakeholder communications identifying environmental compliance issues, and project compliance activities. Activities, accomplishments, and relevant issues are presented and discussed openly with the regulators and with the public to assure resolution.

2.3.1 Pollution Prevention Program

J. M. Stitt

Pollution prevention is DOE's preferred approach to environmental management. The Hanford Site Pollution Prevention Program is an organized and continuing effort to reduce the quantity and toxicity of hazardous, radioactive, mixed, and sanitary waste. The program fosters the conservation of resources and energy, the reduction of hazardous substance use, and the prevention or minimization of pollutant releases to all environmental media from all operations and site cleanup activities.

The program is designed to satisfy DOE requirements, executive orders, and federal and state regulations and requirements. In accordance with sound environmental management, preventing pollution through source reduction is the first priority in this program; the second priority is environmentally safe recycling. Waste treatment to reduce quantity, toxicity, or mobility (or a combination of these) is considered only when source reduction and recycling are not possible or practical. Approved disposal to the environment at permitted sites is the last option.

Overall responsibility for the Hanford Site Pollution Prevention Program resides with the DOE Richland Operations Office. The office defines overall program requirements that each Hanford Site prime contractor is responsible for meeting.

Hanford Site pollution prevention efforts in 2001 helped to reduce disposal quantities through source reduction and recycling by an estimated 32,405 cubic meters (1,144,371 cubic feet) of radioactive and mixed waste, 33,387 metric tons (36,803 tons) of RCRA hazardous/dangerous waste, and 3,428 metric tons (3,779 tons) of sanitary waste. Waste disposal cost savings in 2001 exceeded $23 million for these activities. During 2001, the Hanford Site recycled 673 metric tons (742 tons) of paper products and 708 metric tons (780 tons) of various metals.

2.3.2 Spent Nuclear Fuel Project

D. J. Watson

The Spent Nuclear Fuel Project was established in February 1994 to provide safe, economically, and environmentally sound management of Hanford Site spent (irradiated) nuclear fuel, and to prepare the fuel for long-term storage or final disposal. During 2001, the project continued to make progress on an accelerated strategy to move spent fuel stored in the K-West and K-East Basins in the 100-K Area, away from the Columbia River into the Canister Storage Building in the 200-East Area. The 40-year-old K Basins temporarily store 2,100 metric tons (2,300 tons) of N Reactor spent fuel and a small quantity of slightly irradiated single-pass reactor fuel. The spent fuel is removed from underwater storage in the K Basins and placed in dry interim storage in the 200-East Area. Prior to interim storage, the fuel is cleaned and packaged into containers called multi-canister overpacks. The overpacks are vacuum processed to remove any water and then mechanically sealed at the Cold Vacuum Drying Facility located in the 100-K Area. The dried overpacks are then transported to the Canister Storage

Building, a welded cap is attached over the mechanical seal, and the overpack is put in dry storage. The multi-canister overpacks will be maintained in dry storage, pending a decision by the Secretary of Energy on final disposition. If necessary, the repackaged spent fuel could remain in dry storage for up to 40 years. This strategy supports completion of fuel removal from the K Basins by the Tri-Party Agreement date of July 2004.

The corrosion of fuel, as well as fuel handling operations have led to the accumulation of sludge and debris in old fuel storage canisters and on the floors of the K Basins. The majority of the sludge is in the K-East Basin. The sludge, debris, and empty storage canisters will be removed during the same time period the spent nuclear fuel is removed. Water remaining in the basins will also be removed, treated at the Effluent Treatment Facility and disposed of onsite. Debris and old fuel canisters will be transported to the Environmental Restoration Disposal Facility for disposal to the extent possible. Debris that does not meet acceptance criteria for the Environmental Restoration Disposal Facility will be transferred to the appropriate onsite waste management facility. The K Basins will then be prepared for interim stabilization pending final remediation.

The Spent Nuclear Fuel Project also includes in its mission, the gathering of other spent nuclear fuel stored elsewhere on the Hanford Site and the relocation of that spent nuclear fuel to the 200-East Area Interim Storage Area or to the Canister Storage Building. Other spent nuclear fuels and their storage locations include:

- fuel from the Fast Flux Test Facility in the 400 Area
- fuel from the Training, Research, and Isotope Production General Atomics in the 400 Area
- reactor fuel from Shippingport, Pennsylvania, at T Plant in the 200-West Area
- miscellaneous special case and research reactor fuels in the 324, 325, and 327 buildings in the 300 Area.

Major accomplishments of the Spent Nuclear Fuel Project in 2001 included the following items:

- Installed two new underwater tables to increase productivity in the K-West Basin used to sort, inspect, and repackage the spent nuclear fuel.
- Fabricated nearly 330 fuel baskets to hold spent nuclear fuel prior to loading the fuel in a multi-canister overpack.
- Removed 38 multi-canister overpacks containing ~178.6 metric tons (~196.9 tons) of spent nuclear fuel to the Canister Storage Building. This brings the cumulative number of multi-canister overpacks removed to date to 39, representing 183.4 metric tons (202.2 tons) of spent nuclear fuel.
- Started construction at the K-East and K-West Basins to make the modifications necessary to transfer the K-East Basin spent nuclear fuel inventory to the K-West Basin.

2.3.3 River Corridor Project

G. J. LeBaron

The mission of the River Corridor Project includes the following activities:

- for assigned contaminated facilities in the 200 and 300 Areas
  - deactivate in preparation for decontamination and decommissioning
  - perform surveillance and maintenance
  - characterize as necessary to identify and mitigate hazards
- collect and treat 300 Area process wastewater
- provide for safe and secure storage of special nuclear material, nuclear material, and nuclear fuel until these materials can be transferred to another facility, sold, or otherwise dispositioned.

To accomplish these tasks, the River Corridor Project oversees the efforts discussed in the following sections.

2.3.3.1 Accelerated Deactivation Project

J. M. Barnett

The mission of the Accelerated Deactivation Project is to complete facility deactivation and closure activities while maintaining the facilities in a safe and compliant status until they are turned over to the Environmental Restoration Program.

300 Area Accelerated Deactivation. Accelerated deactivation in the 300 Area focuses on several 300 Area buildings and structures that date back to 1943. It includes fuel supply facilities that were used to support the manufacturing of nuclear fuel for the Hanford Site reactors. Significant accomplishments during 2001 included the following activities:

- demolished the 303-K Building structure
- completed the transfer of 235 metric tons (259 tons) of uranium billets (short, thick bars) to Portsmouth, Ohio
- completed the transfer of 135 metric tons (149 tons) of contaminated uranium fuel to the 200 Areas low-level burial grounds.

200 Area Accelerated Deactivation. Accelerated deactivation in the 200 Area includes the surveillance, maintenance, and deactivation of facilities in the 200-East Area, 200-West Area, and Fitzner/Eberhardt Arid Lands Ecology Reserve.

Facilities where work was conducted under this program in 2001 included the 224-T facility in the 200-West Area. The cells at the 224-T facility were deactivated and closed during the 1960s. However, no documentation could be found concerning the flushing and final state of the cells and few entries had been made since its closure. During 2001, remote entries were made into each cell and a non-destructive analysis was performed to determine the amount of plutonium remaining in each vessel. Plans are being made to more fully characterize the vessels and cells. Plans were also prepared to start characterizing the duct work at 231-Z and to determine what would need to be done to transfer the Fitzner/Eberhardt Arid Lands Ecology Reserve to the U.S. Fish and Wildlife Service.

2.3.3.2 324 and 327 Facilities Deactivation Project

D.E. Rasmussen

Construction of the 324 and 327 Buildings was completed and operations began in 1966 and 1953, respectively. These buildings contain hot cells that were used for radiological research and development work. Both facilities were transferred to Fluor Hanford, Inc. in 1996 for deactivation and closure. (Refer to Section 2.2.1 for more information about Tri-Party Agreement milestones.)

Significant accomplishments achieved at the 324 Building in 2001 included the following:

- Equipment and debris from B-Cell were removed and shipped to the 200 Areas in support of successful fulfillment of Tri-Party Agreement milestone M-89-02.
- The dispersible materials from the B-Cell floor were collected, put in containers, and shipped to the 200 Areas in support of successful fulfillment of Tri-Party Agreement milestone M-89-02.
- Twenty-one grout containers and five mixed waste containers were packaged and shipped to the 200-West Area Burial Ground and Central Waste Complex in support of completion of Tri-Party Agreement milestone M-89-02.
- Phase II Special Case Waste materials were packaged and removed from the facility on schedule, meeting Tri-Party Agreement milestone M-92-15.

Significant accomplishments achieved at the 327 Building in 2001 included the following:

- Waste packaging and shipping activities were completed for 3.8 cubic meters (134.2 cubic feet) of mixed low-level waste, 0.52 cubic meter (18.4 cubic feet) of transuranic waste, and 0.74 cubic meter (26.1 cubic feet) of non-radioactive dangerous waste.
- A Washington State Department of Ecology-witnessed inspection of the Burst Test Heat Exchanger Pit was performed, with no regulatory issues identified. Analysis and disposition of slightly radioactive residual water in the pit were completed.

- Eleven legacy waste buckets from F Cell and four legacy waste buckets from the Supplemental Enriched Recovery Facility Cell were transferred to A Cell, in support of special case waste disposition activities relating to the Tri-Party Agreement milestone M-92-16, which is ahead of schedule. Transfer of retrievable material cans from dry storage to A Cell was completed in support of dry storage cleanout activities. Washington State Department of Ecology personnel visited the 327 Facility to observe the status of special case waste disposition activities, with no issues identified.
- Interim cleanout of I Cell was completed, with removal of unneeded material/equipment.

2.3.3.3 300 Area Liquid Effluent Facilities

J. R. Hilliard

340 Waste Handling Facility. In the past, the 340 Waste Handling Facility provided for the receipt, storage, and shipment of low-level, mixed, liquid waste from the 300 Area to the double-shell tanks. The accumulated waste was pumped into railcars, transported to the 200-East Area for neutralization, then transferred to double-shell tanks for storage. The facility ceased receiving waste in September 1998 and is currently in a standby mode awaiting deactivation.

310 Treated Effluent Disposal Facility. Currently, industrial wastewater generated throughout the Hanford Site is accepted and treated in the 300 Area Treated Effluent Disposal Facility. Laboratories, research facilities, office buildings, and former fuel fabrication facilities in the 300 Area are the primary sources of wastewater. The wastewater consists of once-through cooling water, steam condensate, and other industrial wastewater. The facility began operation in December 1994.

This facility is designed for continuous receipt of wastewater, with a storage capacity of up to 5 days at the design flow rate of 1,100 liters per minute (300 gallons per minute). The treatment process includes iron co-precipitation to remove heavy metals, ion exchange to remove mercury, and ultraviolet light/hydrogen peroxide oxidation to destroy organics and cyanide. Sludge from the iron co-precipitation process is dewatered and used for backfill in the low-level waste burial grounds. The treated liquid effluent is monitored and discharged through an outfall to the Columbia River under a National Pollutant Discharge Elimination System permit No. WA 002591-7 (see Section 2.2.8). Capability exists to divert the treated effluent to holding tanks before discharge, if needed, until a determination can be made for final disposal based on sampling. In 2001, ~241 million liters (64 million gallons) of wastewater were treated. On December 7, 2001, the facility also processed its 2 billionth liter (529 millionth gallon) since beginning operations.

2.3.3.4 Plutonium Finishing Plant

W. J. McKenna

In 1949, the Plutonium Finishing Plant began to process plutonium nitrate solutions into metallic form for shipment to nuclear weapons production facilities. Operation of this plant continued into the late 1980s. In 1996, DOE issued a shutdown order for the plant, authorizing deactivation and transition of the plutonium processing portions of the facility in preparation for decommissioning.

The mission is to stabilize, immobilize, repackage and/or properly dispose of plutonium-bearing materials in the plant; to deactivate and dismantle the processing facilities; and to provide for the safe and secure storage of nuclear materials until final disposition. Several processes have been designed and brought on line to accelerate this work.

Significant accomplishments achieved at the Plutonium Finishing Plant during 2001 included the following:

- In March 2001, seismically qualified storage racks were installed at the 2736-Z vaults.
- Startup of the outer-can welder occurred in April 2001.
- In June 2001, packaging of the plutonium/aluminum Group 1 alloy residues was completed.
- In July 2001, the Plutonium Finishing Plant reached 2 million man-hours without a lost workday injury.
- In August 2001, the solutions stabilization oxalate precipitation process began.
- Stabilization and repackaging of plutonium metals and corrosion products from disintegrated metals was completed in September 2001, attaining a key goal set by the Defense Nuclear Facilities Safety Board.
- A second stabilization and packaging system was brought on line in December 2001, doubling plant capacity.

- The plutonium stabilization rate was quadrupled in fiscal year 2000 and again in fiscal year 2001.
- More than 30% of the total plutonium inventory was stabilized in 2001, and the project is on track to complete the stabilization and packaging phase by May 2004.

2.3.3.5 Waste Encapsulation and Storage Facility Project

F. M. Simmons

The mission of the Waste Encapsulation and Storage Facility Project is to provide safe interim storage of encapsulated radioactive cesium and strontium. The facility was initially constructed as a portion of the B Plant complex and began service in 1974. There are currently 601 strontium fluoride capsules and 1,335 cesium chloride capsules stored at the facility. The capsules will be stored at the Waste Encapsulation and Storage Facility until 2018. The capsules then will be shipped to the vitrification plant for high-level waste vitrification. The final capsule shipment is scheduled for 2022.

2.3.3.6 Equipment Disposition Project

D. L. Klages

When the Hanford Site was dedicated to the defense production mission, rail and other heavy equipment was used to handle and transport radioactive or hazardous materials and/or enter facilities where radioactive and hazardous materials were present. Through use, the equipment became radiologically and/or chemically contaminated to the point where the equipment was either removed from service and buried on site, or managed for future use or disposition.

In fiscal year 1995, the need to manage radiologically contaminated rail equipment became apparent and the Equipment Disposition Project was established. The technical objective of the project is the disposition of 37 contaminated railcars, 5 pieces of heavy equipment, 1 condenser, 1 skid-mounted concrete burial box filled with K-Basin materials, and 2 skid-mounted concrete burial boxes filled with ion exchange columns left over from past Hanford programs. During 2001, four pieces of the heavy equipment totaling 113 cubic meters (3,054 cubic feet) were radiologically surveyed, determined to be uncontaminated, and released for unrestricted use offsite. In addition, 20,455 kilograms (45,000 pounds) of steel and 38,636 kilograms (85,000 pounds) of lead were obtained when one contaminated fuel cask car was recycled by GTS Duratek in Tennessee.

2.3.4 Fast Flux Test Facility

D. A. Gantt

The Fast Flux Test Facility is a 400-megawatt thermal, liquid metal cooled reactor located in the 400 Area. It was built in the late 1970s to test plant equipment and fuel for the Liquid Metal Fast Breeder Reactor Program. The Fast Flux Test Facility operated from April 1982 to April 1992, during which time it successfully tested advanced nuclear fuels, materials, and safety designs and also produced a variety of isotopes for medical research. The reactor has been in a standby mode since December 1993. Fuel has been removed from the reactor vessel and stored in two sodium-filled vessels and in aboveground, dry-storage casks. Twenty-three of the facility's 100 plant systems were deactivated during the previous deactivation period from 1993-1997.

On December 22, 1998, Secretary of Energy Bill Richardson announced the decision to remove the Fast Flux Test Facility from consideration as a tritium supply source. However, the Secretary asked that a program plan be developed that clearly defined other potential uses of the facility and the roles and responsibilities of potential users. A program plan was prepared and reviewed by the Nuclear Energy Research Advisory Committee. The committee recommended that a comprehensive research and development plan be prepared for DOE that would include the Fast Flux Test Facility. See Section 2.2.15.2 for more information about the plan (DOE/EIS-0310).

On April 25, 2001, Secretary of Energy, Spencer Abraham, ordered a thorough and comprehensive review of the Fast Flux Test Facility, which included an initial review of all information that might be relevant to a decision on the future of the Fast Flux Test Facility, as well as a review of expressions of interest to commercially operate the facility. After these extensive review efforts, DOE announced on December 19, 2001, that the department would proceed with deactivation of the facility.

While the decision process continued, the Fast Flux Test Facility staff made progress on repairs to fuel handling machines that will be needed for deactivation. New control systems were installed on the closed loop ex-vessel machine and on the interim examination and maintenance cell sodium removal system, which is used to wash sodium from the fuel assemblies before they are placed in storage. The design was completed for the necessary repairs to the solid waste cask and procurement and fabrication of parts was initiated. Testing and repair activities are scheduled to continue through the first quarter of 2003.

A detailed summary of the status of the Fast Flux Test Facility can be found on the Internet at http://www.fftf.org/currstat/.

2.3.5 Advanced Reactors Transition Project

D. A. Gantt

The mission of this project is to transition or convert the Plutonium Recycle Test Reactor facility and the nuclear energy legacy facilities into structures that are in a safe and stable condition suitable for reuse or low cost surveillance and maintenance. Legacy facilities are those used for nuclear research projects conducted in the past at the Hanford Site. Although these legacy facilities existed in many areas of the Hanford Site, the only facilities remaining to be cleaned up are in the southeastern part of the 300 Area, the 337 Building high bay area and the adjacent storage tank building, 3718M. Deactivation of legacy facilities includes the disposition of non-radioactive sodium and sodium-potassium alloy originally used in the development and testing of components for use in liquid metal-cooled reactors.

In 2001, at the Plutonium Recycle Test Reactor/309 Building, located in the 300 Area, the fuel transfer pit was drained and residual contamination was stabilized. The exhaust fans, which provided forced exhaust flow through the stack, have been taken out of service. Except for some pending repairs to the roof, this facility is in a condition for low cost surveillance and maintenance until deactivation, decontamination, and decommissioning are performed in accordance with the 300 Area Accelerated Closure Project Plan (HNF-6465).

In 2001, a small cold trap in the high-bay of the 337 Building, containing about 91 kilograms (200 pounds) of sodium metal, was welded shut and shipped to an offsite disposal facility. (A cold trap is a device used in sodium systems to remove and trap chemical impurities.) The asbestos abatement and insulation removal was completed on the sodium test loop piping; this was the last step in preparation to remove the sodium wetted piping for disposal. The pipe loop has been severed from the 3718M storage tank (~189,000 liters [~50,000 gallons] volume), the composite reactor component test activity vessel, and the sodium cold trap (~2,650 liters [~700 gallons] volume), which were prepared for future cleaning. Removal of the sodium-wetted piping is in progress.

2.3.6 Office of River Protection

Congress established the Office of River Protection in 1998 as a DOE field office reporting directly to the DOE Assistant Secretary for Environmental Management. The Office of River Protection is responsible for managing DOE's River Protection Project to store, retrieve, treat, and dispose of high-level tank waste and close the tank farm facilities at the Hanford Site.

2.3.6.1 Waste Tank Status

P. A. Powell

The status of the 177 waste tanks as of December 2001 was reported in HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2001*. This report is published monthly; the December report provided the following information:

- number of high-level waste tanks
  - 149 single-shell tanks
  - 28 double-shell tanks
- number of high-level waste tanks assumed to have leaked
  - 67 single-shell tanks
  - 0 double-shell tanks

- chronology of single-shell tank leaks
  - 1956: first high-level waste tank reported as suspected of leaking (tank 241-U-104)
  - 1973: largest estimated leak reported (tank 241-T-106; 435,000 liters [115,000 gallons])
  - 1988: tanks 241-AX-102, 241-C-201, 241-C-202, 241-C-204, and 241-SX-104 confirmed as having leaked
  - 1992: latest tank (241-T-101) added to list of tanks assumed to have leaked, bringing total to 67 single-shell tanks
  - 1994: tank 241-T-111 was declared to have leaked again.

The total estimated volume to date of radioactive waste leakage from single-shell tanks is <2.84 to 3.97 million liters (<750,000 to 1 million gallons).

To date, 129 of the 149 (87%) single-shell tanks have been stabilized and the program is ahead of schedule. At the end of 2001, intrusion prevention work was completed on 108 single-shell tanks. This involved capping off connecting pipes, risers, and pit covers to prevent any liquids from entering the tanks. Partial interim isolation was completed on 40 single-shell tanks. This involved capping off in the same manner as intrusion prevention except risers and piping were required to stabilize the tanks.

During 2001, four tanks (241-S-106, 241-S-109, 241-U-105, and 241-U-106) were declared stabilized. Waste was pumped from 13 single-shell tanks into the double-shell tank system. Portions of the waste in tanks 241-S-109, 241-S-111, 241-SX-101, 241-SX-102, 241-SX-103, 241-SX-105, 241-U-102, 241-U-107, 241-U-108, 241-U-109, 241-BY-105, 241-BY-106, and 241-AX-101 were removed. This pumping removed 1.9 million liters (500,000 gallons) of waste from the single-shell tanks. The addition of this waste and dilution water to the double-shell tank system required the transfer of 1.4 million liters (400,000 gallons) of waste from the double-shell tank system in the 200-West Area to the double-shell tank system in the 200-East Area, through the new 10.5-kilometer (6.5-mile) long cross-site transfer pipeline. The ability to transfer waste safely from the 200-West Area to the 200-East Area has allowed a significant amount of single-shell tank waste to be transferred to the safer and environmentally compliant double-shell tank system. For the safe and timely removal of waste from the single-shell tank system, temporary transfer piping (above ground and shielded) has been installed.

To assure safe storage and retrieval, 136 of 177 (76%) tanks have been characterized. Characterization data and resulting safety controls have allowed the safe storage of tank waste and the removal of all tanks from the Watch List. Currently, the first 14 tanks that will deliver waste to the Waste Treatment Facility (i.e., vitrification plant) have been selected. Sampling has been performed in 12 of these tanks, with characterization analysis performed on 11 of them. This characterization information is being used to improve the design and operation of the Waste Treatment Facility.

2.3.6.2 Waste Tank Safety Issues

P. A. Powell

The Waste Tank Safety Program was established in accordance with the Public Law 101-510, *Defense Authorization Act*, Section 3137, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation" (1990). The focal point of the program is the identification and resolution of safety issues involving high-priority waste tanks. The tasks to resolve safety issues are planned and implemented in the following order: (1) evaluate and define the associated safety issue, (2) identify and close any associated unreviewed safety questions, (3) mitigate any hazardous conditions to assure safe storage of the waste, (4) monitor waste storage conditions, and (5) resolve the respective safety issues. Each of these steps has supporting tasks of some combination of monitoring, mathematical analyses, laboratory studies, and in-tank sampling or testing. The path followed depends on whether the waste requires treatment or can be stored safely by implementing strict controls.

Within the Waste Tank Safety Program, the Safety Issue Resolution Project focused on resolving safety issues involving flammable gas, organic complexants, organic solvents, high-heat, and criticality. The tanks of concern were placed on a Watch List and categorized by safety issue. By 1996, all 24 ferrocyanide tanks had been removed from the Watch List, and the issue was deemed resolved by DOE and the Defense Nuclear Facilities Safety Board. In 1998, 18 tanks containing organic complexants were removed from the Watch List, and in August 2000, the 2 remaining tanks containing organic solvents were taken off the Watch List. The high-heat tank (241-C-106) was removed from the Watch List in 1999. At the end of 2000, 25 flammable gas tanks remained on the Watch List, but in January 2001 tank 241-SY-101 was removed after DOE, the Defense Nuclear Facilities Safety Board, and other stakeholders agreed the safety issue for that tank had been resolved. In August 2001, the 24 remaining flammable gas tanks were removed from the Watch List. The tank safety issues have been declared closed and there is no longer an active Watch List.

2.3.6.3 Radionuclide Assessment System

R. G. McCain and P. D. Henwood

In the past, MACTEC-ERS, under the direction of the DOE Grand Junction Office, completed baseline vadose zone characterization in the vicinity of the single-shell tank farms. Their baseline data were reported in GJ-HAN-120; DOE/ID/12584-268, GJPO-HAN-4; and GJO-99-113-TAR, GJO-HAN-28. The baseline characterization effort identified subsurface contaminant plumes in the vicinity of the single-shell tank farms, with cobalt-60, cesium-137, europium-154/152, and uranium-235/238 as the predominant contaminants. Minor amounts of antimony-125 and tin-126 also were detected.

In fiscal year 2001, a program was established to monitor changes in contaminant levels in existing wells in the vicinity of the single-shell tanks. The Radionuclide Assessment System was developed and deployed to support vadose zone monitoring in the tank farms. The system uses a simpler spectral gamma logging system that is mounted in a much smaller and lighter vehicle. Since specific contaminants have been identified and quantified by the baseline characterization, the primary focus of the monitoring program is to identify changes in contaminant levels. Therefore, the Radionuclide Assessment System records counts in eight contiguous energy "windows." Energy ranges have been chosen for optimum sensitivity to natural and commonly encountered manmade radionuclides. Detection of changes in contaminant profiles that may be indicative of continuing migration are based on comparison of successive log runs.

Radionuclide Assessment System monitoring activities began in June 2001. By September 30, 2001, a total of 1,950 meters (6,400 feet) of logging had been performed in 113 boreholes in single-shell tank farms A, U, T, BX, and SX. Specific borehole monitoring intervals are selected on the basis of intersection with known contaminant plumes, proximity to tanks known to have leaked or to subsurface contaminant plumes, or proximity to tanks containing relatively large volumes of drainable liquid. Borehole intervals also may be logged in support of tank farms operations. The logging frequency is determined by the overall priority. Most boreholes of interest will be logged on a yearly basis. A few boreholes will be logged on a quarterly basis. The goal of the monitoring program is to collect data from all boreholes at least once in a five-year period.

2.3.6.4 Waste Immobilization

P. A. Powell

Approximately 204 million liters (54 million gallons) of radioactive and hazardous waste, accumulated from more than 40 years of plutonium production operations, are stored in 149 underground single-shell tanks and 28 underground double-shell tanks. The Waste Treatment Plant will be built on 26 hectares (65 acres) located on the Central Plateau outside of the Hanford 200-East Area. Currently, three major facilities will be constructed: a pretreatment facility, a high-level waste vitrification facility, and a low-activity waste vitrification facility. Supporting facilities will be constructed also. The River Protection Project is currently upgrading tank farm facilities to deliver waste to the planned Waste Treatment Plant.

During 2001, infrastructure construction for the Waste Treatment Plant was completed. This included the installation of an electrical substation, potable water services, effluent piping systems, and roads. Additionally, excavation for the Waste Treatment Plant footprint was begun. Construction as defined by the Tri-Party Agreement is scheduled to begin in 2002.

2.3.7 Solid Waste Management

Solid waste management includes the treatment, storage, and/or disposal of solid waste produced as a result of Hanford Site operations or from offsite sources that are authorized by DOE to ship waste to the site. The following sections contain information regarding specific site locations.

2.3.7.1 Central Waste Complex

D. G. Saueressig

Waste is received at the Central Waste Complex in the 200-West Area from sources at the Hanford Site and any offsite sources that are authorized by DOE to ship waste to the Hanford Site for treatment, storage, and disposal. Ongoing cleanup, research, and development activities on the Hanford Site, as well as remediation activities, generate most of the waste received at the Central Waste Complex. Offsite waste has been primarily from other DOE sites and U.S. Department of Defense facilities. The characteristics of the waste received vary greatly, including low-level, transuranic, or mixed waste, and radioactively contaminated polychlorinated biphenyls.

The Central Waste Complex can store as much as 22,710 cubic meters (801,996 cubic feet) of low-level mixed waste and transuranic waste. This capacity is adequate to store the projected volumes of low-level, transuranic, mixed waste, and radioactively contaminated polychlorinated biphenyls to be generated from the sites identified above, assuming on-schedule treatment of the stored waste. Treatment will reduce the amount of waste in storage and make room for newly generated mixed waste. The dangerous waste designation of each container of waste is established at the point of origin based on process knowledge or sample analysis.

2.3.7.2 Waste Receiving and Processing Facility

H. C. Boynton

The Waste Receiving and Processing Facility began operations in 1997 and analyzes, characterizes, and prepares drums and boxes of waste for disposal. The facility can process 4,800 square meters (52,000 square feet) of waste and is located near the Central Waste Complex in the 200-West Area.

Waste destined for the Waste Receiving and Processing Facility includes legacy waste as well as newly generated waste from current site cleanup activities. The waste consists primarily of contaminated cloth, paper, rubber, metal, and plastic. Processed waste that qualifies as low-level waste and meets disposal requirements is buried directly onsite. Low-level waste not meeting direct burial requirements is processed in the facility for onsite burial or prepared for future treatment at other onsite or offsite treatment, storage, and disposal facilities. Waste designated at the facility to be transuranic is certified and packaged for shipment to the Waste Isolation Pilot Plant in Carlsbad, New Mexico, for permanent disposal. Other materials requiring further processing to meet disposal criteria are retained, pending treatment.

2.3.7.3 Radioactive Mixed Waste Disposal Facility

D. E. Nester

The Radioactive Mixed Waste Disposal Facility is located in the 218-W-5 low-level waste burial ground in the 200-West Area and is designated as trenches 31 and 34. Trench 34 began to be used for disposal during September 1999. Currently, there are ~1,075 cubic meters (37,963 cubic feet) of waste contained in about 715 waste packages in trench 34. No waste is currently stored in trench 31. However, trench 31 will be used for storage, when needed, to accommodate large items awaiting disposal into trench 34. The trenches are rectangular landfills, with approximate base dimensions of 76 by 30 meters (250 by 100 feet). The bottoms of the excavations slope slightly, giving a variable depth of 9 to 12 meters (30 to 40 feet). These trenches comply with RCRA requirements because they have double liners and systems to collect and remove leachate. The bottom and sides of the facilities are covered with a layer of soil 1 meter (3.28 feet) deep to protect the liner system during fill operations. There is a recessed section at the end of each excavation that houses a sump for leachate collection. Access to the bottom of each trench is provided by ramps along the perimeter walls.

2.3.7.4 T Plant Complex

B. M. Barnes

The T Plant complex in the 200-West Area provides waste treatment and storage and decontamination services for the Hanford Site. The T Plant complex currently operates under RCRA interim status. In 2001, the following activities occurred at the T Plant complex:

- performed content verification of waste being shipped to solid waste facilities for storage or disposal
- re-packaged and/or sampled waste to meet solid waste acceptance criteria or to determine acceptability of waste for treatment
- treated dangerous and mixed waste to meet RCRA requirements for land disposal
- decontaminated equipment to allow for reuse or disposal as waste
- stored 72 elements of spent reactor fuel (from Shippingport, Pennsylvania) in a water basin.

2.3.7.5 Radioactive Mixed Waste Treatment and Disposal

D. E. Nester

During 2001, 460 cubic meters (16,245 cubic feet) of DOE mixed low-level waste were treated and/or direct disposed. The waste materials were obtained from a number of projects including the following:

- 445 cubic meters (15,715 cubic feet), or about 1,125 packages of various sizes, of mixed low-level waste debris previously stored at the Central Waste Complex were shipped to the Allied Technology Group Mixed Waste Treatment Facility located in Richland, Washington. Allied Technology Group used their RCRA-permitted treatment process of macroencapsulation to make the debris compliant with the requirements of EPA and the state of Washington land disposal restrictions. The treated waste was then returned to Hanford for final disposal at the Radioactive Mixed Waste Disposal Facility.
- ~11.4 cubic meters (~14.9 cubic yards), or about 55 drums of mixed low-level waste solids (e.g., soil and granulated activated charcoal) that were contaminated with organic waste constituents and were previously stored at the Central Waste Complex were shipped to the Allied Technology Group Mixed Waste Treatment Facility located in Richland, Washington. Allied Technology Group used their RCRA-permitted thermal treatment unit (GASVIT®) to treat the waste according to EPA and Washington State Department of Ecology land disposal treatment standards. The treated waste residues were then returned to Hanford for final disposal at the Radioactive Mixed Waste Disposal Facility.
- 3.7 cubic meters (130.7 cubic feet), or ~10 packages of mixed low-level waste were disposed directly into the Radioactive Mixed Waste Disposal Facility during the reporting period. This waste came from various Hanford Site operations and either met RCRA land disposal restrictions in the as-generated state, or was treated according to Treatment-by-Generator provisions in WAC 173-303-170(3)(b) to treat the waste to meet the RCRA and state land disposal restrictions.

2.3.7.6 Radioactive Mixed Waste Treatment Contracts

D. E. Nester

In November 1995, Westinghouse Hanford awarded a contract to Allied Technology Group, Richland, Washington, for thermal treatment of Hanford's mixed waste in accordance with RCRA and the *Toxic Substances Control Act*. Transfer of the thermal treatment contract occurred in 1996 when Fluor Hanford, Inc. became the Hanford Site prime contractor. On November 19, 2001, Allied Technology Group announced a shutdown of all their facilities due to financial issues; on December 4, 2001, they filed for Chapter 11 bankruptcy. At the time of shutdown, Hanford had ~310 cubic meters (~10,948 cubic feet) of mixed low-level waste still residing at Allied Technology Groups' Richland facility. DOE Richland Operations Office and site contractors worked with Allied Technology Group during December, and will continue to work with them in calendar year 2002 to resolve the situation.

During 1997, a competitive procurement was conducted to process mixed waste requiring non-thermal treatment in accordance with RCRA. The contract was also awarded to Allied Technology Group. During 2001, Allied Technology Group processed 445 cubic meters (15,715 cubic feet) of Hanford's mixed low-level waste debris and process solids via this contract. The treated waste was returned to Hanford for disposal at the Radioactive Mixed Waste Disposal Facility.

2.3.7.7 Navy Reactor Compartments

S. G. Arnold

Eight disposal packages containing defueled United States Navy reactor compartments were received and placed in trench 94 in the 200-East Area during 2001. Four were submarine reactor compartments, and four were cruiser reactor compartments. This brings the total number of reactor compartments received to 102. All Navy reactor compartments shipped to the Hanford Site for disposal have originated from decommissioned nuclear-powered submarines or cruisers.

2.3.8 Liquid Effluent Treatment

Liquid effluents are managed in treatment, storage, and disposal facilities to comply with RCRA and state regulations.

2.3.8.1 242-A Evaporator

S. S. Lowe

The 242-A evaporator in the 200-East Area concentrates dilute liquid tank waste by evaporation. This reduces the volume of tank waste and eliminates the need to construct additional double-shell tanks. The concentrated tank waste is returned to the double-shell tanks for storage. One operational run was conducted at the evaporator in 2001. The process treated 3.2 million liters (840,000 gallons) of tank waste and produced 3.1 million liters (820,000 gallons) of process condensate. One operational run is planned at the 242-A evaporator for 2002.

Effluent treatment and disposal capabilities are available to support the continued operation of the 242-A evaporator. The Effluent Treatment Facility in the 200-East Area (see Section 2.3.8.3) was constructed to treat the process condensate from the evaporator and other radioactive liquid waste. The process condensate is sent to the Liquid Effluent Retention Facility for interim storage while awaiting treatment in the Effluent Treatment Facility. Cooling water and non-radioactive steam condensate from the evaporator are discharged to the 200 Area Treated Effluent Disposal Facility.

2.3.8.2 Liquid Effluent Retention Facility

S. S. Lowe

The Liquid Effluent Retention Facility in the 200-East Area consists of three RCRA-compliant surface basins to temporarily store process condensate from the 242-A evaporator and other aqueous waste. The Liquid Effluent Retention Facility provides equalization of the flow and pH of the feed to the Effluent Treatment Facility. Each basin has a maximum capacity of 29.5 million liters (7.8 million gallons). Generally, spare capacity is maintained in the event a leak should develop in an operational basin. Each basin is constructed of two, flexible, high-density polyethylene membrane liners. A system is provided to detect, collect, and remove leachate from between the primary and secondary liners. Beneath the secondary liner is a soil/bentonite clay barrier should the primary and secondary liners fail. Each basin has a floating membrane cover constructed of very low-density polyethylene to keep out unwanted material and to minimize evaporation of the basin contents. The facility began operating in April 1994 and receives liquid waste from both RCRA- and CERCLA-regulated cleanup activities. Approximately 32.7 million liters (8.6 million gallons) of aqueous waste were stored in the basins at the end of 2001. Groundwater is receding from beneath the facility, which is affecting facility-related groundwater monitoring activities. Alternative monitoring methods are being investigated.

2.3.8.3 Effluent Treatment Facility

S. S. Lowe

Liquid effluents are treated in the Effluent Treatment Facility (200-East Area) to remove toxic metals, radionuclides, and ammonia and destroy organic compounds. The treated effluent is stored in verification tanks, sampled and analyzed, and discharged to the State-Approved Land Disposal Site (also known as the 616-A crib). The treatment process constitutes best available technology and includes pH adjustment, filtration, ultraviolet light/peroxide destruction of organic compounds, reverse osmosis to remove dissolved solids, and ion exchange to remove the last traces of contaminants. The facility began operating in December 1995. Treatment capacity of the facility is a maximum of 570 liters per minute (150 gallons per minute). Approximately 95.0 million liters (25.1 million gallons) of aqueous waste were treated in 2001.

The treated effluent is sampled to verify that the radioactive and hazardous waste constituents have been reduced to regulatory levels, then discharged via a dedicated pipeline to the State-Approved Land Disposal Site. The disposal site is located north of the 200-West Area and consists of an underground drain field. Tritium in the liquid effluent cannot be removed practically, and the location of the disposal site maximizes the time for migration of contaminated groundwater to the Columbia River, and allows time for radioactive decay of the tritium (12-year half-life). The disposal site is permitted under the WAC 173-216 *State Waste Discharge Permit Program*. The discharge permit requires monitoring of the groundwater and the treated effluent to assure that levels for certain constituents are not exceeded. Permit limits were not exceeded in 2001. The discharge permit for the Effluent Treatment Facility is due to be renewed in 2005.

Secondary waste from treating aqueous waste is concentrated, dried, and packaged in 208-liter (55-gallon) drums. The solid secondary waste from treating RCRA-regulated aqueous waste (e.g., 242-A evaporator process condensate) is transferred to the Central Waste Complex for subsequent treatment, if needed, to meet land disposal restriction treatment standards and disposed in the Mixed Waste Disposal Unit in the 200-West Area. The solid secondary waste from treating CERCLA-regulated aqueous waste (e.g., 200-UP-1 groundwater) is disposed of in the Environmental Restoration Disposal Facility near the 200-West Area.

2.3.8.4 200 Area Treated Effluent Disposal Facility

S. S. Lowe

The 200 Area Treated Effluent Disposal Facility is a collection and disposal system for non-RCRA permitted waste streams. The individual waste streams must be treated or otherwise comply with best available technology/all known available and reasonable treatment in accordance with WAC 173-240, which is the responsibility of the generating facilities. The 200 Area Treated Effluent Disposal Facility consists of ~18 kilometers (~11 miles) of buried pipeline connecting three pumping stations, one disposal sample station (6653 Building) and two 2-hectare (5-acre) disposal ponds located east of the 200-East Area. The facility began operating in April 1995 and has a capacity of 12,900 liters per minute (3,400 gallons per minute). There are currently 13 waste streams being sent to the 200 Area Treated Effluent Disposal Facility. Approximately 484 million liters (~128 million gallons) of effluent were discharged in 2001.

The discharge from the 200 Area Treated Effluent Disposal Facility must comply with limits in the WAC 173-216 State Waste Discharge Permit. The discharge permit requires monitoring of the effluent and the groundwater to assure that concentrations for certain constituents are not exceeded. End-of-pipe sampling and continuous online monitoring (for flow, pH, and conductivity) of the combined waste stream are performed at the 6653 Building. The individual generating facilities also are required to perform online monitoring and sampling; the requirements depend on the individual waste streams. There were no violations of permit limits or conditions in 2001. The discharge permit for the 200 Area Treated Effluent Disposal Facility is due to be renewed in 2005.

2.3.8.5 Miscellaneous Streams

J. C. Sonnichsen

In February 1995, the Washington State Department of Ecology approved a *Plan and Schedule for Disposition and Regulatory Compliance for Miscellaneous Streams* (DOE/RL-93-94). This plan and schedule required that all miscellaneous streams be permitted under WAC 173-216. Categorical permits were used to permit miscellaneous streams with similar characteristics. Categorical permits have been issued for the following:

- hydrotesting, maintenance, and construction discharges (Permit ST 4508, May 1997)
- cooling water discharges and uncontaminated streams condensate (Permit ST 4509, May 1998)
- industrial stormwater discharge (Permit ST 4510, April 1999).

The permitting process was completed in 1999 with the issuance of the last Categorical Permit ST 4510. All milestones identified in the plan and schedule (DOE/RL-93-94) have been fulfilled, and the annual submittal of the Hanford Site Miscellaneous Streams Inventory report is no longer required.

In January 2000, DOE issued the *Pollution Prevention and Best Management Practices Plan for State Waste Discharge Permits ST 4508, ST 4509, and ST 4510* (DOE/RL-97-67). This plan summarized the compliance requirements stated in all the categorical permits and set conditions for the individual streams. The pollution prevention and best management practices plan details implementation of remediation activities to prevent further contamination of groundwater.

Permit ST 4508 is scheduled to expire on May 30, 2002. Its renewal application is required to be submitted 180 days prior to permit expiration. Recognizing that Permits ST 4509 and ST 4510 are scheduled to expire over the next two calendar years, it was decided that it was cost-effective to submit a permit application for all three categorical permits. The single permit application for all three permits, *Documentation for Renewal of State Waste Discharge Permits ST 4508, ST4509, and ST 4510* (DOE/RL-2001-60), was completed and submitted to the Washington State Department of Ecology during November 2001.

In compliance with WAC 173-218, which requires registration of Class V underground injection control wells, a significant and ongoing effort to verify the location and status of all Class V underground injection control wells on the Hanford Site began in February 2000. On the Hanford Site, Class V injection wells include the injection of stormwater and other small quantities of uncontaminated wastewater (i.e., condenser condensate). A large number of underground injection control wells were determined to be inactive and were removed from the list of active wells. In most cases, these injection wells amount to locations where small quantities of non-contaminated wastewater percolate into the soil (i.e., small percolation drains).

Registration of Hanford Site Class V Underground Injection Wells (DOE/RL-88-11) was submitted to the Washington State Department of Ecology in March 2001.

2.3.9 Revegetation and Mitigation Planning

A. R. Johnson and M. R. Sackschewsky

Bechtel Hanford, Inc. completed revegetation on 50 hectares (124 acres) of remediated lands in the 100 Areas. Planting occurred in November and December 2001 and included 22 hectares (55 acres) in the 100-H Area and 28 hectares (69 acres) in the 100-D/DR Area. Both areas were seeded with Hanford-derived native grass and forb seed. Following the seeding, the area was mulched, and 21,700 sagebrush (*Artemisia tridentata*) seedlings were planted. Representative plots within each of the areas will be monitored to document plant survival and community establishment.

The wetland habitat by the 100-B/C Area created in early 2000 near the Columbia River was enhanced with the planting of an additional 1.6 hectares (4 acres) along the slopes of the pit. The area included 0.8 hectares (2 acres) that were seeded with grass and forbs and 2 separate acres that were planted with sagebrush tubelings. This planting effort will provide the borrow area with a much needed seed source to promote continual restoration of the pit.

Two sites in the 600 Area, the J.A. Jones and 600-23 sites were revegetated following remediation. The J.A. Jones site, north of the 300 Area, and the 600-23 site (which lies within the boundary of gravel pit 11 just off of Route 2 South ~1.6 kilometers [~1 mile] north of the Wye Barricade) were seeded with native grasses and forbs, and then planted with sagebrush and bitterbrush (*Purshia tridentata*) seedlings. These sites will be incorporated into the monitoring program to document plant survival and succession.

The 600-104 bioremediated site on the Wahluke North Slope was originally broadcast seeded with native species in the fall of 1997. To further promote the establishment of shrubs in this community, 900 sagebrush seedlings were planted across the 0.8-hectare (2-acre) site in the spring of 2001.

In January 2001, 50 bitterbrush seedlings were planted as additional mitigation for shrubs lost during the initial stages of the 618-4 Burial Ground remediation. The plants were protected with biodegradable plastic mesh tubes and staked to prevent browsing by deer. In June and August, each bitterbrush plant was irrigated with 19 liters (5 gallons) of water. A 19-liter (5-gallon) bucket with a 0.04-centimeter (1/64-inch) hole drilled in the bottom to slowly release the water was placed at the base of each plant. These shrubs will be monitored for survival in future years.

A new electrical transmission line with tower pads was installed to provide electrical power to the planned vitrification plant near the 200-East Area. The areas surrounding the tower pads that were disturbed during pad installations were revegetated during February 2001. This revegetation was considered a rectification planting and was part of the overall vitrification plant mitigation effort. The effort included broadcast seeding of Sandberg's bluegrass and sagebrush at each tower pad. Total area was ~8 hectares (~20 acres).

Monitoring of survival and growth continued for ~90,000 sagebrush seedlings that were planted on about 90 hectares (222 acres) at 9 locations on the Fitzner/Eberhardt Arid Lands Ecology Reserve Unit during December 2000. This effort was the last phase of sagebrush transplanting as compensatory mitigation for the disturbance of sagebrush habitat resulting from the development of the site and infrastructure for the planned waste vitrification facility. Monitoring of these plants will continue through fiscal year 2004.

2.3.10 Environmental Restoration Project

DOE selected an environmental restoration contractor in 1994 to perform environmental restoration projects at the Hanford Site. The Environmental Restoration Project includes characterization and remediation of contaminated soil and groundwater, sitewide vadose zone/groundwater project integration, decontamination and decommissioning of facilities, surveillance and maintenance of inactive waste sites, and the transition of facilities into the surveillance and maintenance program.

2.3.10.1 Environmental Restoration Disposal Facility

M. A. Casbon

The Environmental Restoration Disposal Facility is located near the 200-West Area. The facility began operations in July 1996 and serves as the central disposal site for contaminated waste removed during cleanup operations conducted under CERCLA on the Hanford Site. To provide a barrier to contaminant migration from the facility, the Environmental Restoration Disposal Facility was constructed to RCRA Subtitle C Minimum Technology Requirements including a double liner and leachate collection system. Remediation waste disposed in the facility include soil, rubble, or other solid waste materials contaminated with hazardous, low-level radioactive or mixed (combined hazardous, chemical, and radioactive) waste.

In 2000, waste was first placed into the first of two new cells (cells 3 and 4) that were constructed in 1999. Later in 2000, an interim cover was placed over portions of cells 1 and 2 that had been filled to their final configuration. Waste continued to be placed in cells 3 and 4 during 2001; as of early 2002, the facility had received over 3.1 million metric tons (3.43 million tons) of contaminated soil and other waste.

2.3.10.2 Waste Site Remediation

J. G. April, F. V. Roeck, G. R. Frank, R. D. Belden, J. A. Lerch, and D. F. Obenauer

Full-scale remediation of waste sites began in the 100 Areas in 1996. Remediation and backfill activities continued through 2001 at several liquid waste disposal sites in the 100-B/C, 100-H, and 100-F Areas. Remediation of the treatment, storage, and disposal units at 100-N Area continued through 2001. Figure 1.0.1 shows the former reactor areas along the Columbia River.

In 2001, 110,000 metric tons (121,000 tons) of contaminated soil in the 100-B/C Area were removed and shipped to the Environmental Restoration Disposal Facility. The cumulative amount of contaminated soil removed and shipped to the facility through December 2001 were 732,000 metric tons (806,000 tons).

In the 100-H Area, 136 metric tons (150 tons) of soil were removed from the waste sites during 2001. Since the beginning of remediation, 413,000 metric tons (455,000 tons) of contaminated soil were removed and shipped to the Environmental Restoration Disposal Facility.

Remediation in the 100-F Area continued with the removal of 321,000 metric tons (353,000 tons) of contaminated soil in 2001. A total of 470,000 metric tons (517,000 tons) of contaminated soil has been removed from the 100-F Area and disposed of at the Environmental Restoration Disposal Facility.

Remediation continued at the 116-N-3 Treatment, Storage, and Disposal Facility and began at the 116-N-1 Treatment, Storage, and Disposal Facility, which are both located within the 100-NR-1 Operable Unit. Remediation of these treatment, storage, and disposal facilities is being completed as required by the Hanford Sitewide RCRA Permit. In 2001, 109,000 metric tons (120,000 tons) of contaminated soil were removed from 116-N-3 and 3,200 metric tons (3,500 tons) of contaminated soil were removed from 116-N-1. The total contaminated soil removed through 2001 from the 100-NR-1 Operable Unit is 137,520 metric tons (151,121 tons), all of which was disposed of at the Environmental Restoration Disposal Facility.

The interim record of decision for the 100 Areas Burial Grounds, issued September 16, 2000, specified a cleanup remedy to remove/treat/dispose contaminated soil, structures, and debris from the 100 Areas burial ground sites. Remedial design for 9 burial ground sites in the 100-B/C Area began in 2001.

Remediation work at the 300-FF-1 Operable Unit began in the 300 Area in 1997 (see Figure 1.0.1). Historically, both chemical and radiological materials were disposed of at the 300-FF-1 waste sites. With the exception of the 618-4 burial ground, excavation of all 300-FF-1 Operable Unit waste sites has been completed and more than 482,000 metric tons (531,000 tons) of contaminated material and debris have been transported to Environmental Restoration Disposal Facility through 2001. Excavation of the 618-4 burial ground is scheduled to be complete in 2002.

An interim action record of decision for the 300-FF-2 Operable Unit (EPA 2001) was issued in 2001. The record of decision includes 56 waste sites that require remedial action based on an anticipated industrial land use scenario. The selected remedy prescribed by the record of decision consists of removal of contaminated soil and debris, treatment (as necessary) and disposal at the Environmental Restoration Disposal Facility or other approved facility, site re-contouring/backfill and infiltration control measures, and institutional controls. Cleanup of the 300-FF-2 Operable Unit waste sites is scheduled to begin in 2002.

A record of decision (EPA 1999) was issued for the 100 Areas remaining sites in 1999. The record of decision includes 207 waste sites that were not previously addressed in the 1995 100 Areas record of decision, or the 1997 amendment to the 100 Areas record of decision (100 Areas solid waste burial sites and waste sites at 100-N Area were not included). It specified a remove/treat/dispose remedy for contaminated soil, structures, and debris at 46 of the remaining sites. The cleanup remedy is the same method applied to 100 Areas record of decision sites and is consistent with other cleanup actions that are currently being conducted within the 100 Areas. The remaining 161 sites are classified as candidate sites for confirmatory sampling to determine if there is residual contamination above cleanup levels. Based on the confirmatory sampling efforts, sites shown to be contaminated will move directly into remove/treat/dispose while uncontaminated sites will be closed out. In 2001, DOE completed design of remedial actions for the remaining sites.

2.3.10.3 Facility Decommissioning Project

R. R. Nielson

Decontamination and decommissioning activities continued in 2001 in the 100-D/DR, 100-H, and 100-F Areas. These activities are conducted to support the interim safe storage of the four reactor buildings (D, DR, F, and H) for up to 75 years. Interim safe storage minimizes potential risks to the environment, employees, and the public and reduces surveillance and maintenance costs. These activities are conducted as non-time-critical removal actions under CERCLA. During the year, all planned pourback work at DR and F Reactors was completed. (Pourbacks are the process of enclosing openings in the safe storage enclosure wall with structural concrete to prevent inadvertent pest or weather intrusion.) The subcontract for the safe storage enclosure roofs for DR and F Reactors was awarded. The roof design for the DR Reactor was completed by the subcontractor and approved by the environmental restoration contractor; the subcontractor began work onsite at the end of 2001. The roof design for F Reactor was completed by the subcontractor as well. Biological cleanup, legacy waste removal, asbestos abatement, liquid pipe checks, and other pre-demolition activities were ongoing in 2001 in various demolition areas of the D and H Reactors. Demolition of D Reactor also was initiated in 2001 and progressed through three areas (the lunchroom, the valve pit and shops, and the fan room and ventilation system tunnels).

Demolition work at F Reactor Fuel Storage Basin continues. A de-watering system was installed to remove remaining water from the basin. Wastewater was shipped to the Effluent Treatment Facility for treatment and disposal. EPA approval was obtained to reuse the upper 5.2 meters (17 feet) of fill as backfill. A remote-controlled excavator was deployed in the fuel storage basin to assist in sample collection and removal of high contamination areas within the remaining 1 meter (3.28 feet) of fill. A small number of spent nuclear fuel elements were removed and shipped to the K Area fuel storage basins.

A de-watering system also was installed at the 100-H Area fuel storage basin. Wastewater is being removed and shipped to the Effluent Treatment Facility for treatment and disposal.

2.3.10.4 233-S Plutonium Concentration Facility Decommissioning Project

R. R. Nielson

Decontamination and decommissioning activities continued in 2001 at the 233-S Plutonium Concentration Facility located in the 200-West Area adjacent to the Reduction-Oxidation Plant. This work is being performed as a non-time-critical removal action under CERCLA. The 233-S facility and associated process equipment were used to concentrate plutonium produced at the Reduction-Oxidation Plant from 1955 to 1967. Dismantling of the process hood area continued, including the removal of 11 process vessels and over 500 meters (1,600 feet) of process hood piping. The ventilation system was modified to increase flow in the process hood area to better protect workers. The non-destructive assay of several hundred waste packages was completed. The facility poses special challenges to workers, engineering methods, safety documentation, and work methods because of the estimated large quantities of fissile material in the facility and high levels of contamination.

2.3.10.5 Surveillance/ Maintenance and Transition Project

J. W. Golden

This project performs surveillance and maintenance of inactive facilities and waste sites until final disposition can begin. The project also provides for the transfer, or transition, of facilities and waste sites into the Environmental Restoration Program after deactivation has been completed. Facilities transferred in 1998 and 1999 included the Plutonium-Uranium

Extraction Plant, B Plant, and 224-B Building. Also, the project performs surveillance and maintenance of the Reduction-Oxidation Plant, U Plant, the 224-U Building, N Reactor, B Reactor, C Reactor, and the KE and KW Reactors (excluding the fuel storage basins). The project maintains 14 interim status RCRA treatment, storage, and disposal units awaiting closure. Also, the project maintains three major air emission stacks and three minor emission stacks as defined by 40 CFR 61.

Outdoor tasks within the project include the Radiation Area Remedial Action Program, which is responsible for the surveillance, maintenance, and decontamination or stabilization of 955 inactive waste sites that include former cribs, ponds, ditches, trenches, unplanned release sites, and burial grounds. These sites are maintained by performing periodic surveillances, radiation surveys, and herbicide applications and by initiating timely responses to identified problems. The overall objective of this project is to maintain these sites in a safe and stable configuration until final remediation strategies are identified and implemented. The objective is to prevent the contaminants in these sites from spreading in the environment.

Plutonium-Uranium Extraction Plant and B Plant. The Plutonium-Uranium Extraction Plant (also referred to as the PUREX Plant) was transferred to the environmental restoration contractor after deactivation in 1999 and is being maintained in a surveillance and maintenance mode before decommissioning. The plant has a single effluent stack emission point that is a major emission unit as defined in 40 CFR 61. Also, there are 45 RCRA treatment, storage, and disposal vessels within the facility and containment structure. An annual roof inspection is performed from within the facility and from the outside to assess the condition of a facility that no longer has heat or utility services.

The B Plant, excluding the 296-B-1 stack, was transferred to the environmental restoration contractor in 1999. The facility effluent emission point through the 296-B-1 stack was transferred on August 10, 2000. The facility is being maintained in a surveillance and maintenance mode before decommissioning. The plant maintains two stack emission points that are major emission units by definition of 40 CFR 61. The plant contains 54 RCRA treatment, storage, and disposal vessels within the facility and containment structure. An annual roof inspection is performed from within the facility and from the outside to assess the condition of a facility that no longer has heat or utility services.

2.3.10.6 Canyon Disposition Initiative

J. W. Golden and C. W. Hedel

The environmental restoration contractor completed the final feasibility study report (under CERCLA) for the Canyon Disposition Initiative in September 2001. The purpose of the Canyon Disposition Initiative is to investigate the potential for using the five canyon buildings at the Hanford Site as disposal facilities for Hanford Site remediation waste, rather than demolishing the structures for onsite disposal. While Canyon Disposition Initiative strategy, planning, and sampling activities actually began in the mid-1990s, the final feasibility study (DOE/RL-2001-11) was completed in 2001 and was the final phase in the CERCLA remedial investigation/ feasibility study planning for disposition of the 221-U Facility. The 221-U Chemical Processing Facility (U Plant) was used as a pilot project for the Canyon Disposition Initiative. The Tri-Parties consider the process for the evaluation of U Plant to also apply to the remaining four canyon buildings. There were five alternatives selected for final evaluation and screening: (1) Alternative 0 – No Action, (2) Alternative 1 – Full Removal and Disposal, (3) Alternative 3 – Entombment with Internal Waste Disposal, (4) Alternative 4 – Entombment with Internal/External Waste Disposal, and (5) Alternative 6 – Close in Place – Collapsed Structure. The final feasibility study (DOE/RL-2001-11) determined that Alternatives 3, 4, and 6 met the requirements to protect human health and the environment, as well as being consistent with the 2012 cleanup plan for the Central Plateau. The final remedy will be selected during the record of decision process. Determining the final state of the five canyon buildings figures prominently in DOE's plan for the Central Plateau as an area for long-term waste treatment, storage, and disposal operations in support of Hanford cleanup operations. The final feasibility study report (DOE/ RL-2001-11) was, therefore, a strategic document for decision-making affecting the future of the Hanford Site.

2.3.11 Groundwater/Vadose Zone Integration Project

G. B. Mitchem, M. N. Jarayssi, and L. R. Curry

DOE established the Groundwater/Vadose Zone Integration Project (Integration Project) in 1997 as its centerpiece for water resources protection for the Hanford Site. Specifically, the Integration Project coordinates all projects at Hanford involved in characterizing, monitoring, and remediating the groundwater, the vadose zone (the soil above the groundwater), and the Columbia River.

The project team includes staff from Bechtel Hanford, Inc. and its environmental restoration contractor team, CH2M HILL Hanford Group, Inc.; Fluor Hanford, Inc.; and Pacific Northwest National Laboratory, as well as support from other national laboratories and universities. The Hanford Groundwater Monitoring Project is under the umbrella of the Integration Project.

During 2001, the Integration Project team compiled an array of accomplishments that span its key focus areas – Site-Wide Fieldwork Integration Focus Area, the System Assessment Capability Focus Area, Science and Technology Focus Area, Integration of Information Focus Area, Technical Review Focus Area, and Public Involvement Focus Area. The efforts within these task areas directly support the DOE's plan for the Hanford Site.

2.3.11.1 Site-Wide Fieldwork Integration Focus Area

Groundwater Restoration

L. C. Swanson

The overall objectives of groundwater restoration at sites adjacent to the Hanford Reach are to:

- protect aquatic receptors in the river bottom substrate from contaminants in the groundwater entering the Columbia River
- reduce levels of contamination in the areas of highest concentration
- prevent further movement of contamination
- protect human health and the environment.

Summary descriptions of the groundwater restoration activities are discussed below.

Chromium. Groundwater contaminated with chromium underlies portions of the 100-D, 100-H, and 100-K Areas (the 100-HR-3 and 100-KR-4 Operable Units) and is of concern because of a potential to affect the Columbia River ecosystem. Low levels of chromium are toxic to aquatic organisms, particularly those that use the riverbed sediment as habitat (DOE/RL-94-102; DOE/RL-94-113). The relevant standard for protection of freshwater aquatic life is 10 μg/L of chromium (WAC 173-201A). Chromium concentrations exceeding 600 μg/L have been measured in the pore-water of riverbed sediment adjacent to the 100-D Area (BHI-00778).

In 1994, a groundwater extraction system was installed in the 100-D Area to test chromium removal from groundwater using ion exchange technology. Following the record of decision in 1996 (EPA 1996), full-scale pump-and-treat systems were constructed in the 100-D, 100-H, and 100-K Areas. The objective of these systems is to remove hexavalent chromium contamination from the groundwater and, thus, prevent or reduce the movement of chromium to the river.

In 2001, the total amount of groundwater treated by pump-and-treat systems in the 100-D and 100-H Areas was 222.6 million liters (58.8 million gallons), with the removal of 26.3 kilograms (58 pounds) of hexavalent chromium. Since 1997, more than 1.18 billion liters (311.8 million gallons) of groundwater have been treated, with 129.4 kilograms (285.4 pounds) of chromium removed (DOE/RL-2002-05). Treated groundwater is re-injected into the aquifer upgradient from the 100-H Area extraction wells. Groundwater from both the 100-D and 100-H sites is treated in the 100-H Area using separate treatment systems.

In 2001, the 100-KR pump-and-treat system treated 338.8 million liters (89.5 million gallons) of groundwater. During the process, 36.2 kilograms (79.8 pounds) of chromium were removed. Total chromium removed since operations began in 1997 is 148.3 kilograms (328.1 pounds) through treatment of 1.24 billion liters (327.4 million gallons) of water (DOE/RL-2002-05). Treated groundwater is re-injected into the aquifer upgradient from the 100-KR-4 extraction wells.

To further evaluate chromium and other groundwater contamination that might enter the Columbia River between monitoring wells, 178 aquifer sample tubes were installed in 1997 along and parallel to the Columbia River shoreline. The distance between the sample tubes was ~610 meters (~2,000 feet), except in known chromium plumes, where distance was reduced to ~305 meters (~1,000 feet). Sample tubes are constructed of 0.6-centimeter (0.25-inch) inner-diameter polyethylene tubing with a screen at the bottom that is placed anywhere from 0.9 to 9 meters (3 to 30 feet) below ground surface. Sample tube installations begin upstream from the 100-B/C Area and continue downstream ~40 kilometers (~25 miles) to near the Hanford town site. Sample tube locations are shown in Figure 7.1.8.

In the fall of 2001, 28 tube samples were collected and analyzed for carbon-14, chromium, gross beta, nitrate, strontium-90, sulfate, total uranium, and tritium. The results are being used to characterize groundwater near the Columbia River in support of remediation operations, monitoring objectives, and other environmental programs. Sample tube data provide site-specific information on the distribution of chromium that enters the river at locations near sensitive ecological receptors (e.g., salmon spawning areas). Additional discussion of chromium in groundwater in the 100 Areas is presented in Section 7.1.6.2.

In addition to pump-and-treat remediation, in situ redox manipulation technology continues to be demonstrated in the southwestern 100-D Area to address hexavalent chromium contamination in groundwater. This technology immobilizes hexavalent chromium by reducing the soluble, more toxic, chromate ion to highly-insoluble, less toxic, chromium hydroxide or iron chromium hydroxide. This is accomplished by injecting a chemical-reducing agent into closely spaced wells to form a permeable reactive barrier. Following reduction, the reagent and reaction products are pumped out of the wells. Chromium is immobilized as groundwater naturally flows past the barrier. This groundwater cleanup technique was tested in 1997 through 1999 in five injection wells and then expanded to include additional injection wells in 2000 and 2001. In 2001, the treatment zone was expanded by injecting the chemical-reducing agent into 28 new wells. Chromium concentrations are low (<100 μg/L) along the line of the reactive barrier and to the northwest (downgradient) of the center of the barrier ~100 meters (~330 feet) toward the Columbia River.

Barrier construction continued in 2001 and is expected be completed in late 2002 or early 2003. By the end of calendar year 2001, 28 additional wells had been constructed and treated, increasing the barrier length to 433 meters (1,420 feet) (DOE/RL-2002-01). The barrier is 15 meters (48 feet) wide along its entire length. The final barrier should be over 680 meters (2,230 feet) long. The barrier will intercept and neutralize chromium-contaminated groundwater moving from the aquifer to the Columbia River. The current pump-and-treat systems will also continue to operate.

Strontium-90. The 100-NR-2 (N Springs) pump-and-treat system began operating in 1995 north of N Reactor and was designed to reduce the flux of strontium-90 to the Columbia River. The pump-and-treat system operates extraction wells to maintain hydraulic capture. Groundwater is pumped into a treatment system to remove the strontium-90 contamination, with treated water re-injected upgradient into the aquifer. The system was upgraded in 1996 and has continued to operate through 2001. About 114.7 million liters (30.3 million gallons) were processed in fiscal year 2001. During that period, 0.18 curies of strontium were removed from the groundwater. Over 665.4 million liters (175.7 million gallons) of groundwater have been processed since the system began operation, removing 1.1 curies of strontium (DOE/RL-2002-05).

Carbon Tetrachloride. The carbon tetrachloride plume in the 200-West Area (originating in the 200-ZP-1 Operable Unit) covers over 11 square kilometers (4.2 square miles). The 200-ZP-1 pump-and-treat system has operated as a pilot-scale treatability test from 1994 to 1996, with full operation beginning in 1996. In 2001, 326 million liters (86.1 million gallons) of groundwater were treated, removing over 1,177 kilograms (2,595 pounds) of carbon tetrachloride. A total of 1.67 billion liters (441 million gallons) have been processed since startup, removing 6,084 kilograms (13,413 pounds) of carbon tetrachloride.

Uranium, Technetium-99, Carbon Tetrachloride, and Nitrates. Treatment of the groundwater plume underlying the 200-UP-1 Operable Unit in the 200-West Area continued throughout 2001. The contaminant plume contains uranium, technetium-99, carbon tetrachloride, and nitrate. A pump-and-treat system has operated since 1994 to contain the high concentration area of the uranium and technetium-99 plume. During early operations, groundwater was treated using ion-exchange resin to remove the uranium and technetium-99, and granular activated carbon to remove carbon tetrachloride. Since 1997, contaminated groundwater has been transferred by pipeline to basin 43 at the 200 Area Effluent Treatment Facility. Sophisticated treatment technology removes all four contaminants. Treated groundwater is then discharged north of the 200-West Area at the State-Approved Land Disposal Site.

The pump-and-treat system operated continually during 2001, with the single extraction well pumping 98.2 million liters (25.9 million gallons) of groundwater, which were treated to remove 8.3 grams (0.0183 pound) of technetium-99, 15.5 kilograms (34.2 pounds) of uranium, 2.41 kilograms (5.3 pounds) of carbon tetrachloride, and 3,540 kilograms (7,804 pounds) of nitrate. The pump-and-treat operation made significant progress toward reducing technetium-99 concentrations to below required cleanup concentration levels, but less progress was made with uranium (DOE/RL-2001-53).

Tritium. An investigation to determine the source and extent of tritium in groundwater near an old radioactive burial site was completed. DOE will use the findings from this work to determine if any action is needed at the burial site to protect public health and environmental safety.

Soil-Vapor Extraction

V. J. Rohay

Soil-vapor extraction systems designed to remove carbon tetrachloride vapor from the vadose zone beneath the 200-West Area began operating in 1992 and continued through 2001. Soil-vapor extraction has been conducted in the vicinity of three historical carbon tetrachloride disposal sites: the 216-Z-1A tile field, the 216-Z-9 trench, and the 216-Z-18 crib. Extracted soil vapor is pumped through granular activated carbon, which absorbs carbon tetrachloride. The granular activated carbon is then shipped offsite for treatment.

Three soil-vapor extraction systems have operated at three different flow rates: 14.2 cubic meters (500 cubic feet) per minute, 28.3 cubic meters (1,000 cubic feet) per minute, and 42.5 cubic meters (1,500 cubic feet) per minute. However, only the 14.2 cubic meters (500 cubic feet) per minute system operated during 2001; the other two systems were maintained in standby mode. Passive soil-vapor extraction systems, which use atmospheric pressure fluctuations to pump carbon tetrachloride vapor from the vadose zone, were installed at wells near the 216-Z-1A tile field and 216-Z-18 crib in 1999. These passive systems operated throughout 2001. Since operations began, soil-vapor extraction has removed 77,170 kilograms (170,130 pounds) of carbon tetrachloride from the vadose zone.

Remedial Investigation/Feasibility Studies in the 200 Areas

B. H. Ford and M. E. Todd

Remedial investigation/feasibility studies continued in 2001 at soil waste sites in the 200 Areas. Work was performed within the characterization and regulatory framework defined in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan* (DOE/RL-98-28). Work was performed at several operable units, which were at various stages of the CERCLA process for remedial investigation/feasibility study. Summary descriptions of activities performed in 2001 are provided below.

200-CW-1 Operable Unit. The 200-CW-1 Operable Unit consists of former ponds and ditches located within the 200-East Area and north and east of the 200-East Area. These sites received mostly cooling water from facilities such as the Plutonium-Uranium Extraction Plant and B Plant. A remedial investigation report was prepared and conditionally approved by the regulators pending some additional ecological work for the 200 Areas (DOE/RL-2000-35). This remedial investigation report evaluated the results of the fieldwork (i.e., the remedial investigation) performed the previous year. The report analyzed soil contaminant data collected from 27 test pits, 2 boreholes, and 191 soil samples from 4 waste sites (216-A-25 pond, 216-B-2-2 ditch, 216-B-3-3 ditch, and 216-B-3 pond) as reported in BHI-01367. The feasibility study for the operable unit began in 2001. Regulatory comments on the remedial investigation report required a delay in the feasibility study pending preparation of a 200 Area ecological evaluation report and a data quality assessment process to determine the need for additional data to support the ecological assessment of the operable unit. In addition, work on the Central Plateau risk assessment framework resulted in a delay to the feasibility study while exposure scenarios were negotiated and evaluated for the plateau. The feasibility study will re-start in 2002 and will incorporate information from both the ecological evaluation and the risk framework project.

200-CS-1 Operable Unit. The 200-CS-1 Operable Unit consists of waste sites that received chemical sewer wastewater from major plant facilities in both the 200-West and 200-East Areas. A remedial investigation/feasibility study work plan was approved in 2000 that defines planned remedial investigation activities at four representative waste sites: 216-S-10 pond, 216-S-10 ditch, 216-B-63 trench, and 216-A-29 ditch (DOE/RL-99-44). The work conducted in 2001 included test pit characterization at the 216-A-29 ditch. The installation of vadose zone boreholes, geophysical logging, and completion of the remaining test pits will be conducted in 2003.

200-LW-1 Operable Unit. The waste sites in this operable unit received two types of waste: liquid waste from 300 Area process laboratories that supported radiochemistry metallurgical experiments and liquid waste resulting mainly from 200 Area laboratories that supported the major chemical processing facilities and equipment decontamination from T Plant. The draft work plan (DOE/RL-2001-66) was prepared and submitted for regulatory review. The work plan proposed remedial investigation at four representative waste sites (216-T-28 crib, 216-B-58 trench, 216-S-20 crib, and 216-Z-7 crib) and included borehole drilling, soil sampling, and geophysical logging.

200-MW-1 Operable Unit. The waste sites in this operable unit consist mainly of crib, French drain, and trench waste sites that received moderate-to-low volume equipment, decontamination, and ventilation system waste, plus small-volume waste streams commonly disposed to French drains. The draft work plan (DOE/RL-2001-65) was prepared and submitted for regulator review. The work plan proposes remedial investigation at five representative waste sites (216-A-4 crib, 216-T-33 crib, 216-T-13 trench, 216-U-3 French drain, and 200-E-4 French drain). The work includes installing vadose zone boreholes and test pits to collect soil samples and conducting geophysical logging at the boreholes.

200-PW-2 Operable Unit. Waste sites in this operable unit received uranium-rich condensate/process waste, primarily from waste streams generated at U Plant, Reduction-Oxidation Plant, and Plutonium-Uranium Extraction Plant, as well as B Plant and semi-works facilities. The draft work plan (DOE/RL-2000-60) was prepared and submitted for regulator review. The work plan proposes remedial investigation activities at four representative waste sites (216-A-19 trench, 216-B-12 crib, 216-A-10 crib, and 216-A-36B crib). The work includes installing vadose zone boreholes to collect soil samples, and conducting geophysical logging.

200-TW-1 and 200-TW-2 Operable Units. The 200-TW-1 Operable Unit consists of waste sites, mostly cribs and trenches, that received waste associated with uranium recovery activities at U Plant. The 200-TW-2 Operable Unit consists of waste sites, mostly cribs and trenches, that received waste from the decontamination processes at B Plant and T Plant. The work plan (DOE/RL-2000-38) was prepared and approved by the regulators. The work plan proposes remedial investigation activities at three representative waste sites (216-T-26 crib in the 200-TW-1 Operable Unit, and the 216-B-7A crib and 216-B-38 trench in the 200-TW-2 Operable Unit). The field efforts for these two operable units were completed in 2001 and consisted of installation, soil sampling, and geophysical logging of three vadose zone boreholes (one each at the 216-T-26 crib, the 216-B-38 trench, and the 216-B-7A crib). In addition, five drive casings were installed and geophysically logged at the 216-B-38 trench. The drive casing data were used to determine the optimum location for the borehole at that waste site. Borehole summary reports were initiated for each operable unit and will be completed in 2002. Data from the laboratory analysis will be compiled into a remedial investigation report in 2002.

200-PW-1 Operable Unit. The 200-PW-1 Operable Unit contains waste sites that received significant quantities of both carbon tetrachloride and plutonium, as well as other contaminants associated with process waste, from the Plutonium Finishing Plant and Plutonium Reclamation Facility. A remedial investigation/feasibility study work plan for this operable unit was submitted for regulatory review in 2001 (DOE/RL-2001-01). The work plan includes a strategy to reduce carbon tetrachloride levels. Remedial investigation is expected to focus on two representative waste sites including the 216-Z-1A tile field and the 216-Z-9 trench and on potential carbon tetrachloride waste sites and associated pipelines.

200-BP-1 Prototype Hanford Barrier Performance Monitoring. Performance monitoring of the Prototype Hanford Barrier continued in 2001. Activities included water balance monitoring, stability surveys, and biotic surveys. An annual letter report will be prepared in 2002 to document the monitoring results.

2.3.11.2 System Assessment Capability Focus Area

B. W. Bryce

The first assessment using the System Assessment Capability was completed. The System Assessment Capability is a suite of computer models and analysis techniques that is used to predict the movement and fate of contaminants that will remain on the Hanford Site after closure. It also is used to estimate the effects of those contaminants to human health, the environment, the Columbia River, and the local economy and cultures. The System Assessment Capability is envisioned as a tool to assess the merits of remediation, isolation, and containment alternatives for specific areas of the Hanford Site. Refer to Sections 6.3.3 and 7.4.2 for more information on the System Assessment Capability.

2.3.11.3 Integration of Information, Technical Review, and Public Involvement Focus Areas

M. N. Jarayssi and E. A. Jenkins

As part of the Integration Project's mission to integrate and provide information Hanford staff can use in their work, a Virtual Library was issued as a user-friendly means for reviewing and using site environmental data. Additional data sources will be incorporated into the Virtual Library during the coming year.

Another integration effort the project began in 2001 was the Central Plateau Risk Framework Guidance. This effort is aimed at establishing a set of short- and long-term risk parameters, such as site future uses and geographic buffer zones, that will be used consistently to make cleanup and closure decisions by all programs operating on Hanford's Central Plateau.

Technical review and public involvement remained key to the Integration Project's success in the past year. The expert panel, which provides oversight and review of the project, continued to give the effort high marks for its work. Staff met regularly with interested individuals, organizations, and Tribal Nations to obtain feedback about the project. These activities range from monthly public meetings to opportunities to learn about the project via the environmental restoration contractor Internet site (http://www.erc.rl.gov).

2.3.11.4 Vadose Zone Characterization in the Vicinity of 200 Areas Waste Sites

R. G. McCain and P. D. Henwood

In fiscal year 2001, the methods developed for vadose zone baseline characterization around the single-shell tanks was extended to liquid waste disposal sites and burial grounds in the 200 Areas. The DOE Grand Junction Office developed two logging systems to detect and identify manmade gamma-emitting radionuclides in the vadose zone. The Spectral Gamma Logging System uses a high-purity germanium semiconductor detector with a relative efficiency of ~35%. This detector is capable of quantifying gamma-emitting radionuclides from background levels to several thousand picocuries per gram. A second system, the high-rate logging system, was specifically developed for use in zones of high gamma flux. With supplemental shielding, this system is capable of measuring radionuclide levels up to several hundred million picocuries per gram (cesium-137). In June 2001, these logging systems were deployed in existing boreholes within and adjacent to waste disposal sites in the 200 Areas. In addition, new groundwater monitoring wells and new boreholes associated with ongoing waste site investigations were logged.

Approximately 860 boreholes have been identified in the vicinity of waste sites. It is intended that all available boreholes will be logged as part of the baseline vadose zone characterization project. Prioritization of individual boreholes is based on data needs of Hanford remedial investigation or remediation projects as well as published estimates of waste discharges.

Existing boreholes in the 200 Areas have been evaluated in terms of proximity to waste sites, waste site disposal history, waste site location, and relevance to near-term characterization efforts in the ongoing remedial investigation/feasibility study process. This forms the basis for initial project scheduling. This schedule will be periodically updated to fulfill the needs of ongoing site characterization activities as necessary and to support the installation of new groundwater monitoring wells.

The log data will provide a comprehensive baseline of existing subsurface contamination conditions to support waste site characterization activities. The logs also provide input to subsurface transport and risk assessment models implemented under the System Assessment Capability. Finally, a comprehensive and consistent baseline data set constitutes a benchmark against which future measurements can be compared to track gamma-emitting radionuclides in the vadose zone. Section 7.1 of this report provides additional information on vadose zone characterization.

2.3.11.5 Science and Technology Focus Area

M. D. Freshley

The Integration Project's Science and Technology efforts focus on providing new knowledge, data, and tools to enable the cleanup and stewardship mission at the Hanford Site. In addition to promoting new technologies and methods to solve Hanford's soil and groundwater cleanup problems, Science and Technology seeks to improve the scientific basis for decisions on actions taken by DOE to protect the Columbia River and its ecological systems, while preparing the Hanford Site for the future. The activities of the Science and Technology Focus Area are funded by the Integration Project, by the DOE Environmental Management Science Program, and by the DOE Office of Science and Technology.

During 2001, the Integration Project Science and Technology Focus Area completed the following:

Soil Inventory. The soil inventory team delivered estimates of contaminant inventories at individual waste disposal locations to the System Assessment Capability for use in their Rev. 0 assessment. A report was published on development and application of the Soil Inventory Model and its application to soil waste sites on the Central Plateau (BHI-01496). The Soil Inventory Model was applied to generate inventory estimates for 46 radionuclides and 27 chemicals at 88 liquid-waste disposal sites.

S-SX Tank Farm Investigation. Laboratory and modeling studies were completed for the S-SX field investigation. These studies, performed by the Integration Project Science and Technology Focus Area and Environmental Management Science Program, addressed a number of scientific issues associated with the composition of tank wastes that leaked to the vadose zone, the chemical species present in the vadose zone associated with the tank wastes, movement of water and contaminants through the vadose zone, and the geochemical behavior of cesium-137, chromium, and technetium-99. The results of these investigations were summarized in an appendix of the S-SX Field Investigation Report prepared by the River Protection Project for the DOE Office of River Protection (RPP-7884).

Vadose Zone Transport Field Study. This study involved completion of a field experiment that called for the injection of a high-salt solution (sodium thiosulfate) into the vadose zone to emulate the behavior of tank waste. Field data on the movement of this solution were collected using various geophysical methods and neutron probes, and by collecting core samples and evaluating tracer movements. The solution spread laterally, and moved downward more deeply into the vadose zone that did a dilute solution injected during earlier field experiments in 2000. The new field data provide refined estimates for transport parameters determined from actual field observations. These results were compared with results obtained from laboratory-scale experiments, to better understand how to apply the results of laboratory experiments to real-life scenarios in the field. The results are summarized in PNNL-13679. Section 7.3.2 of this report also provides a discussion of this study.

Groundwater/River Interface. Conceptual models were completed for the groundwater/river interface at the 100-D, 100-K, and 100-H Areas. The conceptual models included descriptions of the groundwater flow and contaminant distributions in the near-river groundwater. A numerical model demonstrating water and contaminant particle movement was developed for the 100-H Area and the model was used to evaluate dilution factors for future revisions of the System Assessment Capability. The results are summarized in a report (PNNL-13674).

Biological Fate and Transport. Laboratory experiments for the uptake of technetium-99 by rainbow trout through the water pathway were completed. The results will be used to develop risk assessment parameters needed for sitewide and site-specific risk assessments at the Hanford Site.

National Academy of Sciences Review. The National Academy of Sciences/National Research Council Committee on Environmental Remediation Science and Technology at the Hanford Site completed its 18-month review of the Integration Project Science and Technology Focus Area. The results of their review were presented on August 1, 2001, to DOE Environmental Management, who commissioned the review. The committee concluded there is a long-term and continuing need for the Science and Technology Focus Area to support cleanup and stewardship of the Hanford Site. The committee also noted that given the technical and organizational complexity of the task, the Integration Project has made a good start in creating a science and technology roadmap, defining and initiating a science and technology program, and fulfilling the promise of its mission (National Research Council 2001). They recommended increased documentation of science and technology projects, prioritization of research activities, and effective use of peer review. Additionally, they made recommendations for reprioritization of work as well as several specific technical recommendations.

2.3.12 Research and Technology Development

T. M. Brouns

The Tanks Focus Area was created in 1994 by DOE's Office of Environmental Management to integrate radioactive tank waste remediation efforts across the DOE complex. In support of the DOE Office of River Protection, the Tanks Focus Area addressed a number of high priority issues in 2001 that are discussed in the following sections.

2.3.12.1 Corrosion Control

Because of the time and cost involved with baseline corrosion control methods, the Tanks Focus Area and contractors at the Hanford Site established a program to develop electrochemical noise-based corrosion monitoring systems for the Hanford double-shell tanks. The corrosion monitoring system, like most electrochemical noise-based systems, measures fluctuations in current and voltage on carbon-steel electrodes immersed in the tank waste. Different forms of corrosion create different patterns in current and voltage; by monitoring the fluctuations in current and voltage on each channel, the active form of corrosion can be established. Four systems, designed and fabricated by Hiline Engineering in Richland, Washington, have been installed under this program since 1997. The most recent installation occurred on January 3, 2001, with deployment of a probe in double-shell tank AN-104. In addition to eight channels of corrosion monitoring electrodes on the probe, the AN-104 system is also fitted with an array of 22 thermocouples, a movable verification thermocouple, a tank waste high-surface level detector, ports for pressure/gas sampling, a set of strain gauges, and an integrated water lance (a high-pressure water nozzle used to cut a path through the waste) to facilitate rapid installation. These features add a great deal of functionality to the probe, could provide for a better understanding of the relationship between corrosion and other tank operating parameters, and optimize the use of the riser that houses the probe in the tank.

2.3.12.2 Remote Pit Operation Enhancements at Hanford

To reduce worker exposure and enable more thorough removal of discarded materials in valve pits throughout Hanford's tank farms, the Tanks Focus Area worked with site users to develop functions and requirements for the "Pit Viper," a remote pit-operations system. In 2001, Pacific Northwest National Laboratory issued awards for the various Pit Viper components. The backhoe, which serves as the deployment platform and provides gross positioning capability, was purchased from FERMEC. The manipulator arm, which performs the more dexterous movements within the pit area, was purchased from Cybernetix of Marseilles, France. A previously developed remote control console was modified for use with the Pit Viper components.

During the summer of 2001, assembly and cold testing of the system components took place at the Hazardous Materials Management and Emergency Response Facility (also known as the HAMMER Training and Education Center). Following a safety review and numerous demonstrations for site users and other interested parties, the system was moved to the C tank farm and deployed in the heel pit of tank C-104 in December 2001. The system successfully performed various pit cleanup, repair and maintenance tasks during the 3-day deployment.

2.3.12.3 Double Salt Experiments

Double salts are chemical compounds made up of multiple anions or cations. Historically, Hanford tank characterization data provided scant evidence of double salts, and commercial chemistry models used to predict solid formation scenarios during waste transfer did not adequately predict their formation. The high ionic strength of Hanford Site tank waste solutions can lead to uncertainties in equilibrium calculations for transporting dissolved saltcake. As new discoveries of double salts in Hanford tank waste are uncovered, the model database to predict waste transfer behaviors requires updating. A series of calculations was performed on concentrated sodium nitrate to compare experimental results with predictions made by the Environmental Simulation Program for actual Hanford saltcake dissolution in an effort to improve the Environmental Simulation Program database. Approximately 180 double-salt samples were prepared in 2000 to conduct aging experiments. In 2001, experiments to determine the effectiveness of the saltcake dissolution process with double salts and at higher operating temperatures were conducted. Data from this effort will be used to expand the Environmental Simulation Program model to include information on critical double salts found in Hanford waste.

2.3.12.4 High-Level Waste Melter Review

At the request of DOE Headquarters, in 2001 the Tanks Focus Area coordinated a technical review of alternatives for solidification of Hanford Site high-level waste that could achieve major cost reductions within reasonable long-term risks. The review method consisted of an in-depth data collection and analysis effort conducted by a study team. The study included information on Hanford Site waste; identification of improvements in waste loading, waste processing, and waste forms; waste forms produced through a melting process; waste canister packaging modifications that relate to increasing the waste form volume in repository waste form packages; and an assessment of melter technologies. The results of the study team analyses were documented in a detailed report (PNNL-13582), which was then reviewed by a panel of independent technical experts. Based on their review, the technical experts recommended a research and development program for future melter advancements.

Their principal conclusions and recommendations included the following: (1) no waste forms were found to be better than the current borosilicate glass form; (2) modest research should be conducted on other silicates and iron-phosphate glasses; (3) no melters were found better than the current Joule-heated ceramic melter technology; (4) substantial improvements are needed in the current melter technology to achieve higher waste loading, a higher and more predictable processing rate, and lower disposal costs; (5) a short but intense research effort should be conducted on the advanced cold crucible melter to determine the potential for replacing the current technology; and (6) the biggest challenge in containing cost is the development of a total system plan. The review team cautioned that in developing the system plan, concentrating on one segment of the system could unbalance the overall system and eliminate the potential for cost savings.

Although the review team's findings included recommendations for improvements in vitrification operations and melter technology, it also reinforced the baseline high-level waste treatment path using Joule-heated melters.

2.3.12.5 Salt Waste Retrieval Methods

In compliance with the Tri-Party Agreement (Ecology et al. 1998), saltcake waste must be removed from Hanford single-shell tank S-102 by fiscal year 2006. In an effort to determine a method that does not increase liquid waste volume during retrieval, in 2001 the Tanks Focus Area supported investigations into two potential low-water retrieval technologies. One is the Dual Nozzle Pulsating Mixer Pump, a collaboration with the DOE Office of Defense Nuclear Nonproliferation and experts from the Mining Chemical Combine Facility in Zheleznogorsk, Russia. Adapted from the original single-nozzle design, the Dual Nozzle Pulsating Mixer Pump contains a second nozzle located at a higher elevation for spraying a jet of water (with a projected cleaning radius of between 6 to 13 meters [19.5 to 42.5 feet]) at tank residuals near the tank's edge in order to wash the solids toward the retrieval pump. After cold testing, the system will undergo testing in radioactive plutonium-uranium extraction waste in two sizes of tanks.

The other retrieval method is a fluidic-based pulse-jet system developed by AEA Technology of the United Kingdom. In August 2001, full-scale-system testing was completed at the vendor's U.S. facility in Charlotte, North Carolina. The testing provided the basis to determine how much – or how little – water is needed for retrieval operations using the fluidic system. Hanford Site users will evaluate each technology's development and testing efforts in determining a preferred retrieval method for tank S-102.

2.3.12.6 Tank Integrity Inspection Techniques

To maintain safe storage of radioactive waste in Hanford's 28 double-shell tanks, the knuckle area (i.e., the curved "corners" near the bottom of the tank where the wall meets the floor) of each primary tank must be inspected for integrity – not an easy task considering this area is inaccessible using conventional measurement techniques. In 2001, the Tanks Focus Area helped make adaptations to a crawler-based, ultrasonic Synthetic Aperture Focusing Technique to assess tank integrity using remotely operated nondestructive examination equipment. In September 2001, a report (PNNL-13682) was issued describing the functions, requirements, development, and procurement strategy of the double-shell tank knuckle region ultrasonic scanning system. The system also includes an adapted off-the-shelf crawler, which serves as a delivery vehicle for the system. As part of the development effort, the Center for Nondestructive Evaluation at Iowa State University joined the Synthetic Aperture Focusing Technique Team to help them understand sound propagation of the knuckle region of these tanks. The Center for Nondestructive Evaluation provided the team with a computational algorithm to perform experimental flaw manipulation without having to fabricate a large number of flawed samples. Following a peer review of the development effort and subsequent successful cold testing, the system is ready for deployment. It will provide the ability to provide long-term measurements of the entire knuckle region – where areas of mechanical stress are concentrated – and a portion of the tank floor to accurately size in length and depth any cracks found.

2.3.12.7 Topographical Mapping System

In a collaborative effort that began a decade ago, the Tanks Focus Area sponsored development of a Topographical Mapping System, a tool capable of gathering and analyzing topographical data on obstacles and tank waste topography, and generating a three-dimensional computer map of the data. The system will help waste retrieval planning and assessment and will provide a measure of retrieval performance. It also will furnish data on residual tank-waste volumes, which will be helpful when planning tank closures. In 2001, testing and demonstration work on Topographical Mapping System started anew to update the system in support of deployment in tank U-107 to measure the waste surface profile and estimate the volume before and after a "sprinkler/salt well" retrieval test. The system uses a structured light technique that projects a laser plane onto the surface to be mapped. A camera is then used to image the resulting laser plane's contour line and, using a triangulation-based analytical method, generates a surface profile from the data gathered. In 2001, the system underwent computer upgrades and measurement accuracy testing, followed by acceptance testing. In September 2001, the Topographical Mapping System was installed in single-shell tank U-107. Site users will evaluate the performance of the Topographical Mapping System and, if acceptable, will recommend the system for deployment in Hanford Site tank S-112 before, during, and after retrieval of the tank waste.

2.3.12.8 Tanks Cold Test Facility

To adequately prepare for deployment of various retrieval technologies in Hanford's single-shell tanks, and eventual testing of waste mixing and mobilization technologies for Hanford's double-shell tanks, cold testing of the retrieval equipment is needed, as well as a facility in which to develop and cold test the equipment. In 2001, the Tanks Focus Area assisted the River Protection Project with the development of facility requirements by calling on retrieval equipment cold testing experts from across the DOE complex. The 4-hectare (10-acre) Cold Test Facility, to be located near Hanford's Hazardous Materials Management Emergency Response training facility (also known as the HAMMER facility), will be used for testing, equipment acceptance, and training to support a broad range of River Protection Project retrieval activities in a non-radioactive, simulated environment. The facility will include (1) a mock waste tank made of steel that is 23 meters (75 feet) in diameter with an open top capable of staging up to 2.3 million liters (600,000 gallons) of simulated waste that will include sand, clay, soluble salts, and liquids containing sodium nitrate (materials similar to sludge, saltcake, and supernatant liquid, the three basic types of Hanford tank waste); and (2) a superstructure spanning this tank, with platforms at ~11 and 17 meters (~35 and 55 feet) above the tank bottom to simulate the heights of Hanford's older single-shell tanks and newer double-shell tanks. Initial activities at the facility will focus on equipment testing, operator training, and retrieval demonstrations of Tanks Focus Area-sponsored retrieval technologies planned for use in tanks C-104, S-102, and S-112. Construction of the facility began in fall 2001, with equipment development and testing scheduled for summer 2002.