2.3 Activities, Accomplishments, and Issues

D. G. Black

This section further describes DOE's progress in meeting its mission at the Hanford Site. Section 2.2, "Compliance Status," described activities relating to compliance with regulations. This section describes other, major, ongoing activities. Ongoing compliance selfassessments, knowledge gained in implementing Tri-Party Agreement (Ecology et al. 1989) milestones, and communications with stakeholders continue to identify environmental compliance issues. Relevant issues are discussed openly with the regulators and with the public to ensure that environmental compliance issues are resolved.

2.3.1 Hanford Federal Facility Agreement and Consent Order

Highlights of accomplishments (not documents or publications), with the associated Tri-Party Agreement milestone numbers, include the following:

- completed N Reactor/100-N Area deactivation (M-16-01E)
- initiated excavation associated with Environmental Restoration and Disposal Facility cells 3 and 4 construction near the 200-West Area (M-16-92A)
- installed 11 RCRA groundwater monitoring wells at various Hanford Site locations (M-24-00J)
- completed project W-030 tank farm ventilation upgrades (M-43-01)
- completed project W-058 replacement of cross-site transfer system between the 200 Areas (M-43-07)
- completed melter tests (for mixing waste with molten glass) and selected reference melter for treating waste stored in the underground tanks (M-51-02)
- completed Plutonium-Uranium Extraction Plant and Uranium-TriOxide Plant facility transition phase in the 200-East and 200-West Areas, respectively (M-80-00)
- completed B Plant deactivation in the 200-East Area (M-82 series)
- initiated processing of contact-handled (versus remote-handled [high radioactivity levels]) transuranic and transuranic mixed waste at the Waste Receiving and Processing Facility in the 200-West Area (M-91-02)
- completed transfer of the 14 300 Area legacy cesium capsules to the Waste Encapsulation and Storage Facility in the 200-East Area (M-92-04). All of the legacy strontium had been removed from the 300 Area previously
- completed C Reactor interim safe storage large-scale demonstration in the 100-B,C Area (M-93-03).

Since the last issue of this report, negotiated changes to the Tri-Party Agreement established 20 new enforceable milestones. A summary of the significant approved changes is given in the following sections.

2.3.1.1 Waste Management

There was one approved change request related to waste management during 1998.

After consulting with DOE in the context of Tri-Party Agreement milestone M-34 negotiations, EPA and the Washington State Department of Ecology decided to employ CERCLA provisions as the regulatory process for the cleanup of the K Basins. This change of lead regulatory agency will maintain

consistency with the approach to regulatory authority and lead regulatory agency designation as agreed to under the Sixth Amendment of the Tri-Party Agreement Action Plan (Attachment 2 to Ecology et al. 1989). Under paragraph 88 of the action plan, EPA and the Washington State Department of Ecology will have joint authority to determine the choice of lead regulatory process in consultation with DOE.

2.3.1.2 Environmental Restoration

There were nine approved change requests related to environmental restoration during 1998.

Milestone M-13-00 contains schedules for the submittal of work plans for accomplishing all 200 Areas soil investigations by December 31, 2008 (M-15-00C). The three parties jointly developed an improved approach to investigation and subsequent remediation of 200 Areas contaminated soil sites within the responsibility of the Environmental Restoration Program based on lessons learned from Hanford's 100 and 300 Areas. To date, the investigation approach for the 200 Areas has been based on a geographic boundary (operable unit), consisting of different waste site types. Remedial investigations will now focus on representative sites from groups with similar histories and waste site types (ponds, ditches, cribs), and the results will be applied generally to the entire waste site group.

The 300-FF-2 Operable Unit limited field investigation assumed that waste sites that were near or under active facilities would be deferred until such time as characterization activities could be coordinated with decontamination and decommissioning as well as RCRA activities. This would result in additional limited field investigations and subsequent records of decision. Based on this assumption, the scope of the focused feasibility study and proposed plan was limited to approximately 40 waste sites that have been addressed in the limited field investigation, out of a total of 415 waste sites that comprise the entire 300-FF-2 Operable Unit. Discussions held in the spring of 1998 with the EPA concluded that all known 300-FF-2 waste sites should be included in the focused feasibility study and proposed plan, so that only one record of decision will be necessary. With the inclusion of the additional waste sites, an extension of 4 mo was approved for the associated milestone for completion of the necessary documents.

During the fall of 1998, an effort was initiated to evaluate the waste sites identified in the 300-FF-2 Operable Unit following the waste site reclassification process. At the conclusion of 1998, a number of joint meetings were held that resulted in a significant number of waste sites requiring no further action. This effort, which is scheduled to be completed in the spring of 1999, will result in a substantial reduction in the number of waste sites that need to be addressed in the 300-FF-2 focused feasibility study and proposed plan.

Once enough hardware/waste had been removed from the N Reactor fuel storage basin, a decontamination method, using (176 kg/cm^2 [2,500 lb/in.^{2}]) water, was tested but was unsuccessful in achieving low-enough dose rates (radiation levels in the air) to be at compliant levels along the nearby Columbia River shoreline. Follow-on efforts also failed to achieve sufficient dose reduction and proved not to be viable. The option that was determined to be the most expedient and cost effective was placement of concrete panels (30.48 cm [1 ft]) over the entire basin for shielding and airborne contamination control, as well as placement of steel covers (0.64 cm [0.25 in.]). N Reactor environmental restoration milestones were met.

In 1996, interim milestones were established for remediation and backfill of 37 liquid waste sites in the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units. The volumes of contaminated material at 100-BC-1 and 100-DR-1 have increased substantially over what was originally predicted. In 1998, milestones were modified to include additional liquid

waste sites in operable units 100-BC-1, 100-DR-1, and 100-HR-1, plus sites in operable units 100-BC-2, 100-DR-2, 100-FR-1, 100-FR-2, and 100-KR-1.

In 1998, milestones were established for initiation of excavation associated with Environmental Restoration and Disposal Facility cells 3 and 4 construction and completion of construction and readiness to accept waste in these cells, located near the 200-West Area.

Milestone M-20-00 contains schedules for the submittal of closure plans for the cleanup of RCRA treatment, storage, and disposal units. Similar to milestone M-13-00, the three parties jointly developed an improved approach to investigation and subsequent remediation of waste sites closely associated with past-practice units within the Environmental Restoration Program based on lessons learned from Hanford's 100 and 300 Areas. The coordination of the treatment, storage and disposal unit's closure with the past-practice investigation and remediation activity is necessary to prevent overlap and duplication of work, thereby economically and efficiently addressing the contamination. These treatment, storage, and disposal groups/units assigned to an operable unit are prioritized in conjunction with past-practice units and are to be investigated and managed together. Remedial investigations will now focus on representative sites from groups with similar histories and waste site types (ponds, ditches, cribs), and the results will be applied generally to the entire waste site group.

New interim milestones were established for RCRA groundwater monitoring well locations in support of milestone M-24-00. This milestone requires the installation of groundwater monitoring wells at the rate of up to 50/yr. These agreed-on locations were based on RCRA permitting as well as detection and monitoring requirements.

2.3.1.3 Tank Waste Remediation System

The completion date of the cross-site transfer system between the 200 Areas was extended by 1 mo. There was no planned use for the system during the period the construction was extended. This system is used to transfer waste between underground tanks in the 200-East and 200-West Areas.

2.3.1.4 Facilities Transition

A change request extended the milestone date of the report documenting the hazardous substances/dangerous wastes remaining within B Plant in the 200-East Area. The extension of the milestone due date was made to coincide with submittal of the preclosure work plan. This timing will ensure submittal of all remaining information prior to completion of the M-82-00 major milestone.

Additional project technical baseline information was developed as part of the 324 Radiochemical Engineering Cell/High-Level Vault (300 Area) closure plan (DOE/RL-96-73, Rev. 1) after Tri-Party Agreement milestone M-89-00 was originally established.

2.3.2 Pollution Prevention Program

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 wastes. 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) will be considered only when source reduction and recycling are not possible or practical. Disposal to the environment 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 prime contractor is responsible for meeting.

Hanford Site pollution prevention efforts in 1998 helped to prevent the generation of an estimated 10,200 m^3 (13,400 yd^3) of radioactive mixed waste, 270 metric tons (300 tons) of RCRA hazardous/dangerous waste, 57.8 million L (15.3 million gal) of process wastewater, and 7,100 metric tons (7,800 tons) of sanitary waste. Estimated waste disposal cost savings in 1998 exceeded $35 million for these activities.

During 1998, the Hanford Site recycled 525 metric tons (579 tons) of office paper, 57 metric tons (63 tons) of cardboard, 66 metric tons (72.7 tons) of newspapers/magazines, 5 metric tons (5.5 tons) of telephone books, 1,433 metric tons (1,580 tons) of ferrous metal, 78 metric tons (86 tons) of nonferrous metal, 123 metric tons (135 tons) of lead, 6 metric tons (6.6 tons) of solid chemicals, 17 metric tons (19 tons) of fluorescent light tubes, 37 metric tons (40.8 tons) of lead acid/gel cell batteries, and 795 metric tons (876 tons) of miscellaneous materials. Estimated disposal cost savings in 1998 exceeded $1.6 million.

Numerous generator-specific initiatives were put into place that enabled these waste reductions and cost savings. To celebrate these pollution prevention activities, the *Hanford Site Pollution Prevention Accomplishments* (HNF-2350) was published in October 1998. The book outlines many of the initiatives that were implemented and now in use at locations throughout the Hanford Site.

2.3.3 Environmental Molecular Sciences Laboratory

The William R. Wiley Environmental Molecular Sciences Laboratory, an 18,600 m^2 (200,200 ft^2) facility in the Richland North Area, was completed and DOE Headquarters authorized full operation in October 1997. Over 180 permanent staff members have moved into the laboratory from other facilities.

The city of Richland issued an industrial wastewater permit (CR-IU005) to DOE that allows for process wastewater from this laboratory to be discharged to the city of Richland's publicly owned treatment works. The permit was issued in accordance with the provisions of city ordinances in October 1996 and expires in October 2001. The discharge permit requires monthly effluent monitoring and reporting of the analytical data to the city. Routine discharges under this permit have begun. Additionally, as required by the permit, an accidental spill prevention plan (PNNL-11311) was developed and submitted to the city. That plan describes measures taken to prevent, control, and mitigate the effects of accidental releases of hazardous materials from the laboratory to the city.

2.3.4 Spent Nuclear Fuel Project

In February 1994, the Spent Nuclear Fuel Project was established to provide safe, economic, and environmentally sound management of Hanford Site spent nuclear fuel in a manner that readies it for final disposition.

The 40-year-old K Basins are being used to store 2,100 metric tons (2,300 tons) of N Reactor irradiated fuel and a small quantity of slightly irradiated single-pass reactor fuel. Approximately 20% of the fuel has corroded and is undergoing degradation as a result of extended underwater storage. In 1995, a Spent Nuclear Fuel Project strategy was approved. The strategy stipulated that the N Reactor fuel be removed from wet storage in the K Basins and placed into dry interim storage in the 200-East Area. Prior to interim storage, the fuel will be cleaned to remove corrosion products and particulates, packaged into fuel storage containers called multicanister overpacks, and vacuum processed to remove as much water as possible from the packaged fuel. Following the drying process, the fuel will be transported to the Canister Storage Building in the 200-East Area (see Figure 1.0.2). The multicanister overpacks will be seal welded, and the fuel will be maintained in storage pending a decision by the Secretary of Energy on its final disposition. This strategy supports completion of fuel removal from the K Basins by the agreed-to target date of December 2003.

If necessary, the fuel could remain in dry storage for up to 40 yr. The Canister Storage Building has been designed and constructed with a functional storage capacity of up to 75 yr. DOE strategic planning recommends that the fuel stored in K Basins and other spent nuclear fuel on the site and throughout the complex be placed in a geologic repository for final disposition. The construction of a national repository is awaiting congressional approval.

Fuel corrosion and fuel handling operations have led to the accumulation of sludge and corrosion products in fuel storage canisters and on the floors of the K Basins. The majority of the sludge is in the K-East Basin. Following the removal of the spent nuclear fuel from the K Basins, activities will be undertaken to retrieve the sludge from the basins and treat it as necessary to accommodate final disposal.

Debris, empty fuel canisters, and water remaining in the K Basins will also be removed or undergo treatment. The debris will be removed and disposed of on the Hanford Site at RCRA-permitted disposal facilities in compliance with existing waste acceptance criteria. The K Basins then will be prepared for interim stabilization, pending final remediation.

Other spent nuclear fuel stored on the Hanford Site (Fast Flux Test Facility fuel in the 400 Area; Training, Research, and Isotope Production General Atomics fuel in the 400 Area; fuel from the Shippingport, Pennsylvania reactor at T Plant in the 200-West Area; and miscellaneous special case and research reactor fuels in the 324, 325, and 327 Buildings in the 300 Area) will be relocated to suitable storage locations to await final disposition.

Through early 1999, the project continued to make progress on its accelerated strategy for moving the wet-stored K Basin fuel away from the Columbia River and into the Canister Storage Building. Construction of the building is complete, including installation of operating and support equipment and components. These components are now undergoing preoperational testing and validation. Operational procedures are being written in preparation for the operational readiness review and the start of fuel movement in November 2000. A concrete storage pad was constructed contiguous to the Canister Storage Building. This pad will be used to consolidate and store other spent nuclear fuel located at various places on the Hanford Site.

Construction of a cold vacuum drying facility is in progress at the 100-K Area. This facility will remove all free water from the fuel following removal from wet storage to stabilize it for dry storage at the Canister Storage Building. The first of three cold vacuum drying process units (skids) was procured and received. A test on the cold vacuum drying skid was completed, verifying the efficacy of the process using surrogate material.

Several critical pieces of equipment were obtained, constructed, or modified in 1998.

- Five transport vehicles and shipping casks were procured and delivered. These are to be used for transfer of the multicanister overpacks from the K Basins to the cold vacuum drying facility and from the cold vacuum drying facility to the Canister Storage Building.
- Thirty stainless steel fuel baskets to be used in loading the N Reactor fuel into the multicanister overpack containers were constructed onsite.
- Remote-controlled robotic fuel manipulators to be used in loading fuel into fuel baskets, commonly referred to as "Conan arms," were received.
- Existing operating systems at the K-West Basin were modified or upgraded to ensure safe lifting and manipulation of the fuel baskets, the multicanister overpacks, and the transport casks. The project is also completing design activities, safety analysis reports, and fabrication of process-related equipment.

2.3.5 Facility Stabilization Project

This project's mission is to transition those Hanford Site facilities for which it has responsibility from an operating mode to a long-term surveillance and maintenance mode. This includes maintaining facilities in a safe and compliant status, providing for the safe storage of nuclear materials, and reducing risks from hazardous materials and contamination. Under the project, the deactivation of primary systems to effectively reduce risks to human health and the environment will also be conducted. These activities will allow the lowest surveillance and maintenance costs to be attained while awaiting determination of a facility's final disposition and possible turnover to the Environmental Restoration Program.

The Facility Stabilization Project is engaged in five major deactivation efforts at the Hanford Site: B Plant, Facility Stabilization and Environmental Restoration Team, 300 Area Stabilization Project, Waste Encapsulation and Storage Facility, and Plutonium Finishing Plant. In addition, surveillance and maintenance of the Plutonium-Uranium Extraction Plant continued, following the completion of deactivation activities. The mission of each project and related accomplishments during 1998 are summarized below.

2.3.5.1 B Plant

B Plant, located in the 200-East Area, went into service in 1944 to recover plutonium by a chemical separation process. Following the advent of the more-efficient Plutonium-Uranium Extraction Plant process, B Plant's mission was modified to recover the high-heat isotopes (primarily cesium-137 and strontium-90) from highly radioactive waste. In October 1995, DOE directed that B Plant be deactivated.

The B Plant deactivation schedule was accelerated and completed 4 yr ahead of the baseline schedule and $100 million under budget. The facility, which had required $20 million annually to maintain in a standby mode, has been placed in a stable, static condition in a surveillance and maintenance phase and requires approximately $750,000 annually to maintain. The surveillance and maintenance will continue until a final disposition for the facility has been determined.

A significant effort during the B Plant deactivation was to decouple the facility from the Waste Encapsulation and Storage Facility, which continues

to provide safe storage of the high-heat isotopes recovered during B Plant's operational phase.

Significant accomplishments achieved during the accelerated B Plant deactivation effort include the following:

- All Tri-Party Agreement milestones associated with facility deactivation were completed on or ahead of schedule.
- The final 15,000 L (4,000 gal) of highly radioactive organic solvent waste from past processing operations were removed from the facility and shipped to an offsite RCRA-permitted mixed waste treatment, storage, and disposal facility for final disposition. One of the tanks constructed for interim storage of the organic solvent was never used and was redeployed to another project.
- Effluent systems were deactivated, eliminating all liquid discharges to the soil and to the 200 Areas Treated Effluent Disposal Facility. In addition, all the gaseous effluent stacks and vents were shut down, isolated, and replaced with a new ventilation system. The new system incorporated the latest ventilation design and sampling system.

2.3.5.2 Facility Stabilization and Environmental Restoration Team

The Facility Stabilization and Environmental Restoration Team (always referred to by its acronym FASTER) is a group with comprehensive cleanup experience. They were organized to share their experiences and lessons learned from the Uranium-TriOxide Plant and Plutonium-Uranium Extraction Plant deactivation projects with similar projects at Hanford and other DOE sites nationwide.

The FASTER Team has been assigned several facilities on the Hanford Site, primarily isolated facilities without associated staff, to prepare for deactivation as resources allow. The FASTER Team is also involved with deactivation planning for facilities at the Rocky Flats Plant in Colorado, the Savannah River Site in South Carolina, and the Oak Ridge Site in Tennessee.

2.3.5.3 300 Area Stabilization Project

This project has two subprojects: 1) 300 Area fuel supply shutdown subproject and 2) 324/327 Building transition subproject.

The fuel supply subproject includes buildings dating back to 1943 that housed manufacturing equipment for production of fuel for Hanford Site reactors. These processing operations were discontinued in 1987 when N Reactor was shut down and placed in a standby mode.

The other subproject includes the 324 and 327 Buildings, which were constructed in 1966 and 1953, respectively. These buildings house hot cells that were used for radiological research and development work. Both facilities were transferred to the Facility Stabilization Project in 1996.

The mission of this project is to complete deactivation and closure activities while maintaining the facilities in a safe and compliant status until turnover to the Environmental Restoration Program.

During 1998, the following significant accomplishments were achieved by this project:

- removed five billet furnaces from the 333 Reactor Fuel Manufacturing Facility as part of deactivation
- performed RCRA closure activities at the 303-K Material Storage Facility consistent with the closure plan
- completed 324 Building B cell equipment 1B rack (storage rack) size reduction activities, including grouting and shipping operations for the resulting remote-handled, low-level, radioactive waste containers
- completed the collection of dispersible materials in the 324 Building B cell under hot cell 1A rack and 1B rack
- submitted the final 324 Radiochemical Engineering Cell Closure Plan (DOE/RL-96-73, Rev. 1) and received Washington State Department of Ecology approval (Milestone M-20-55)

- completed the project planning and fabrication activities for the 324 Building cesium powder and pellet inventory and the Nordian capsules (encapsulated radioactive cesium chloride salt, used in the past for its radioactive characteristics) and completed shipment to the Waste Encapsulation and Storage Facility (Milestone M-92-04)
- packaged and shipped 236 legacy transuranic and low-level waste "buckets" from the 327 Building hot cells to safe storage in the 200-West Area
- developed and issued the management plan for 324/327 Building stabilization and deactivation (HNF-IP-1289, Rev. 1), which provides the facility's deactivation schedule
- received approval for Phase II of decontamination and inspection planning for the 300 Area Waste Acid Treatment System from the Washington State Department of Ecology
- prepared an initial draft of the Phase III decontamination and inspection plan for the 300 Area Waste Acid Treatment System which would complete closure activities for review by the Washington State Department of Ecology.

2.3.5.4 Waste Encapsulation and Storage Facility

The Waste Encapsulation and Storage Facility project's mission is to provide safe interim storage of encapsulated radioactive material (cesium and strontium). The facility was initially constructed as a portion of the B Plant complex and went into service in 1974. A primary task over the last 3 yr has been to "decouple" the Waste Encapsulation and Storage Facility from B Plant systems, such that the facility could continue its mission of providing safe storage of the encapsulated radioactive material following deactivation of B Plant. The major accomplishments during 1998 included the following:

- All activities related to decoupling the Waste Encapsulation and Storage Facility from B Plant were completed, such that B Plant could be placed in a surveillance and maintenance program and the Waste Encapsulation and Storage Facility could continue to provide safe storage for the inventory of encapsulated radioactive material.
- A low-level radioactive waste tank (Tank 100) that had become contaminated with dangerous waste was removed, and the surrounding concrete vault was decontaminated and approved as "clean-closed" by the Washington State Department of Ecology. A new tank was then installed. This project significantly reduced the amount of waste from this facility that required transfer to the double-shell tank system and allowed this waste to be treated onsite.
- Fourteen legacy cesium-137 capsules were transferred from the 324 Building and placed in safe storage at the facility.
- An emergency response system was installed to capture radioactive material in the event of a capsule failure.
- Dangerous waste management practices were modified to reduce the generation of waste and minimize the amount of waste requiring storage.
- The facility's emission monitoring system was evaluated and demonstrated to be in compliance with all current standards.

2.3.5.5 Plutonium Finishing Plant

The Plutonium Finishing Plant went into service in 1949 to process plutonium nitrate solutions into metallic forms for the production of nuclear weapons. 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, repackage, immobilize, and/or properly dispose of plutonium-bearing materials in the plant; to deactivate the processing facilities; and to provide for the safe and secure storage of nuclear materials until final disposition.

Significant accomplishments achieved at the Plutonium Finishing Plant during 1998 include the following:

- Operational readiness reviews for restart of material stabilization activities were completed. The successful completion of these detailed reviews established that the plant was ready to safely resume stabilization of plutonium-bearing materials.
- A RCRA Part A, Form 3 permit application for proposed treatment of mixed waste at the Plutonium Finishing Plant in support of transition activities was approved by the DOE Richland Operations Office and submitted to the Washington State Department of Ecology.
- The plant's emergency preparedness and response program was significantly upgraded.
- The plant's strategic vision, which defines the detailed path forward for the facility stabilization and deactivation activities, was completed ahead of schedule (HNF-3617).

Two underground diesel fuel storage tanks were successfully removed and replaced with a single underground storage tank.

2.3.5.6 Plutonium-Uranium Extraction Plant

Plant deactivation was completed in May 1997, 14 mo ahead of schedule and >$75 million under budget. The facility remained in a surveillance and maintenance phase through 1998. Prior to deactivation, the Plutonium-Uranium Extraction Plant required approximately $35 million annually to maintain in a standby condition. The plant now requires <$1 million/yr to maintain in a surveillance and maintenance phase that will continue until disposition is determined. Final arrangements are being concluded to turn the facility over to Bechtel Hanford, Inc. for continuation of the facility surveillance and maintenance program.

2.3.6 Fast Flux Test Facility

2.3.6.1 History

The Fast Flux Test Facility, a 400-MW thermal reactor cooled by liquid sodium, located in the 400 Area, was built in 1978 to test plant equipment and fuel for the Liquid Metal Reactor Development Program. Although the facility is not a breeder reactor, this program demonstrated the technology of commercial breeder reactors. Breeder reactors are so termed because they can produce both power and nuclear fuel to supply other reactors. During the Fast Flux Test Facility's years of operation, it successfully tested advanced nuclear fuels, materials, and safety designs, and also produced a variety of different isotopes for medical research.

The reactor was shut down in December 1995 after a panel commissioned by the Secretary of Energy concluded that there was no combination of missions that had financial viability over the next 10 yr. In January 1997, the Secretary of Energy directed that the facility be maintained in "standby" condition until DOE could evaluate and decide whether it should be part of the nation's tritium production strategy. Studies and analyses completed in November 1997 addressed safety issues, environmental impacts, and the economic viability of producing tritium and medical isotopes at the facility. On December 22, 1998, the Secretary of Energy announced that the Fast Flux Test Facility would not be used for the production of tritium, but would be evaluated for other civilian missions such as the production of medical isotopes and plutonium-238 for use in future space mission power systems. The Secretary stated that the evaluation would be completed and a decision made in the spring of 1999.

Meanwhile, deactivation activities that do not preclude a restart are continuing. Fuel was removed from the reactor vessel, and fuel assemblies (sealed metal tubes that hold fuel pellets) are contained in

two fuel storage vessels and in aboveground, dry storage casks. Of the facility's 100 plant systems, 23 are deactivated. The facility continues to be maintained in a standby mode in accordance with state and federal requirements.

2.3.6.2 Possible Future Missions

Medical Isotope Production. Medical isotopes are produced in accelerators or reactors or by extracting them from byproduct materials created by the weapons program. Dozens of different isotopes can be created, each with unique characteristics and potential uses. These isotopes are used for diagnosis or therapy. Diagnostic isotopes are used for imaging internal organs, similar to the result of an x-ray. Therapeutic isotopes are injected directly into a tumor or attached to an antibody that seeks out and locates the tumor. In this manner, cancer cells are destroyed, with little or no damage to the surrounding healthy cells.

New therapeutic applications for radioisotopes are showing great promise in clinical trials, but only small quantities of radioisotopes are available for research. If clinical trials are successful and there is subsequent U.S. Food and Drug Administration approval, the number and size of operating reactors in the United States would not be able to meet the expected medical need. The Fast Flux Test Facility is capable of producing a wide variety of isotopes. Over the reactor's life, approximately 40 different medical and industrial isotopes were produced for researchers and medical practitioners.

Plutonium-238 Production. For more than 30 years, DOE developed radioisotope power systems, radioisotope heater units, and radioisotope thermoelectric generators and supplied them to the National Aeronautics and Space Administration for various space missions. The radioisotope used in these systems is plutonium-238. DOE has projected that, over the next 20 to 25 yr, the National Aeronautics and Space Administration will continue to conduct missions that will require power sources fueled with plutonium-238. Historically, the reactors and chemical processing facilities at DOE's Savannah River Site were used to produce plutonium-238. As a result of downsizing the DOE nuclear weapons complex, the reactors at Savannah River were shut down in 1988. Since then, the United States has purchased plutonium-238 from Russia.

DOE proposes to reestablish a reliable domestic capability for producing plutonium-238 for future space travel requirements. A production rate of 2 to 5 kg/yr (0.9 to 2.3 lb/yr) would be sufficient to meet the projected long-term requirements. The Fast Flux Test Facility was previously evaluated for the production of plutonium-238, and it was determined that the facility could safely produce 30 kg/yr (13.6 lb/yr). DOE is preparing an environmental impact statement on the proposed production of plutonium-238. If DOE decides in 1999 to consider the facility for a multimission role, including plutonium-238 production, input would be factored into this environmental impact statement to evaluate the facility as a reactor alternative for the irradiation of neptunium targets. The Fuels and Materials Examination Facility, located adjacent to the Fast Flux Test Facility, would also be included for storage of neptunium-237, fabrication of targets, and processing of the irradiated targets to extract the plutonium-238 product and recycle the neptunium.

The Decision Process. DOE is conducting an independent review to determine if there are sufficient facilities to meet the future programmatic needs of the Department. The results of this effort will help DOE decide whether to initiate the Fast Flux Test Facility restart environmental impact statement, continue to maintain the facility in a standby mode, or to resume shut-down activities. DOE is expected to make this decision in 1999. A decision to proceed with further consideration of restart of the Fast Flux Test Facility would trigger a full National Environmental Policy Act review.

2.3.7 Advanced Reactors Transition Project

The mission of this project is to maintain the Fast Flux Test Facility and its associated support facilities in a safe and stable condition. This project includes the Fast Flux Test Facility reactor complex, the Fuels and Materials Examination Facility, nuclear energy legacy facilities, and the 309 Plutonium Recycle Test Reactor facility.

Fast Flux Test Facility standby activities conducted in 1998 included completion of reactor vessel equipment testing to verify the condition of this equipment that was last used in 1995; completion of the design, fabrication, and full-scale mockup testing of the irradiation hardware; and completion of the conceptual design of the solid waste cast hoist and grapple upgrade. The replacement of the Freon 12 refrigerant in eight chiller units with non-ozone depleting R-134a refrigerant was also completed.

Activities completed in the 309 facility, located in the 300 Area, included the acceptance of the rupture loop annex (Room 20) and the fuel examination cell for stabilization by Bechtel Hanford, Inc. Characterization was completed on the Plutonium Recycle Test Reactor core structure and cavity, fuel storage basin, and fuel transfer pit.

A RCRA clean-closure certification for the 3718-F Alkali Metal Treatment and Storage Facility in the 300 Area was accepted by the Washington State Department of Ecology in 1998.

In the Nuclear Energy Legacy Facility Deactivation Program, a retired sodium test system in the 200-West Area was dismantled and sent to an offsite treatment center (for sodium-wetted components) for waste disposal. The storage tanks, containing sodium from the system, were transported to the 300 Area and drained into U.S. Department of Transportation-rated 208-L (55-gal) drums, which are awaiting offsite shipment. The total weight of the sodium transferred was approximately 550 kg (250 lb). Approximately 430 kg (195 lb) of sodium-potassium were drained from the 337 Building's cold trap cooling loop into U.S. Department of Transportation-rated receiving vessels. The vessels were shipped offsite to a disposal center. Residual sodium was removed from both a small (308-L [81-gal]) and a large (19,000-L [5,000-gal]) tank such that the tanks are now ready for redeployment.

2.3.8 Tank Waste Remediation System Activities

2.3.8.1 Waste Tank Status

The status of the 177 waste tanks as of December 1998 was reported in HNF-EP-0182-129. This report is published monthly; the December report provided the following information:

- number of waste tanks
  - 149 single-shell tanks
  - 28 double-shell tanks
- number of "assumed leaker" tanks[a]
  - 67 single-shell tanks
  - 0 double-shell tanks
- chronology of single-shell tank leaks
  - 1956: first tank reported as suspected of leaking (Tank 241-U-104)
  - 1973: largest estimated leak reported (Tank 241-T-106; 435,000 L [115,000 gal])

(a) "Assumed leaker" refers to tanks that have leaked or are assumed to have leaked. No tanks are known to be leaking at this time.

- 1988: Tanks 241-AX-102, -C-201, -C-202, -C-204, and -SX-104 reported as confirmed leakers
- 1992: latest tank (241-T-101) added to assumed leaker list, bringing total to 67 single-shell tanks
- 1994: Tank 241-T-111 declared an assumed re-leaker

- number of ferrocyanide tanks on the watch list
  - 0 (all 18 single-shell tanks were removed from the watch list in 1996)
- number of flammable gas tanks on the watch list
  - 19 single-shell tanks
  - 6 double-shell tanks
- number of organic tanks on the watch list
  - 2 single-shell tanks (18 tanks were removed from the watch list in December 1998).
- number of high-heat tanks
  - 1 single-shell tank.

So far, 119 single-shell tanks have been stabilized, with the tank stabilization program to be completed in 2000. At the end of 1998, 108 single-shell tanks had intrusion prevention devices completed, and 51 single-shell tanks were disconnected and capped to avoid inadvertent liquid additions to the tanks.

The total estimated volume to date of radioactive waste leakage from single-shell tanks is 2,300,000 to 3,400,000 L (600,000 to 900,000 gal).

During 1998, waste was pumped from four single-shell tanks to two double-shell tanks. Portions of Tanks 241-SX-104, SX-106, T-104, and T-110 (all in the 200-West Area) were pumped.

2.3.8.2 Waste Tank Safety Issues

The Safety Issue Resolution Projects (formerly known as the Waste Tank Safety Program) was established in 1990 to address the hazards associated with storage of radioactive mixed waste in the 177 underground storage tanks at the Hanford Site. The projects serve as the focal point for identification and resolution of selected high-priority waste tank safety issues. The tasks to resolve safety issues are planned and implemented in the following logic sequence: 1) evaluate and define the associated safety issue, 2) identify and close any associated unreviewed safety questions (DOE/EH-0173T), 3) mitigate any hazardous conditions to ensure safe storage of the waste, 4) monitor waste storage conditions, and 5) resolve the respective safety issues. Each of these steps has supporting functions 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.

The Safety Issue Resolution Projects is focusing on resolution of flammable gas, organic, high-heat, and criticality safety issues as described below. The tanks of concern are placed on a watch list and categorized by safety issue. In 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. During 1998, 18 organic complexant tanks were removed from the watch list, leaving the 2 organic solvent tanks on the list. At the end of 1998, there were 28 tanks remaining on the watch list: 25 flammable gas tanks, 1 high-heat tank, and 2 organic tanks (some of the tanks are included under more than one category). These tanks were identified in accordance with the Defense Authorization Act, Section 3137, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation" (1990).

2.3.8.3 Watch List Tanks

In early 1991, all Hanford Site high-level waste tanks were evaluated and organized into categories to ensure increased attention and monitoring. Other safety concerns, including the possibility of nuclear criticality in a waste tank, have been addressed.

Ferrocyanide. The ferrocyanide safety issue, which was an earlier concern, involved the potential for uncontrolled exothermic reactions of ferrocyanide and nitrate/nitrite mixtures (WHC-EP-0691). There were originally 24 ferrocyanide tanks on the watch list: 4 were removed in 1993, 2 in 1994, and 18 in 1996. The ferrocyanide levels have decreased by at least 90%, and in some cases by 99%, over what was originally in the tanks. Experimental studies and core samples from 10 of the ferrocyanide tanks show that hydrolysis and radiolysis of the ferrocyanide occurred and sufficient fuel to be of concern is no longer present (WHC-SD-WM-SARR-038, Rev. 1). DOE approved resolution of the ferrocyanide safety issue in December 1996.

Flammable Gas. The flammable gas safety issue involves the generation, retention, and potential release of flammable gases by the waste. Twenty-five tanks have been identified and placed on the watch list. In prior years, work controls were instituted to prevent introduction of spark sources into these tanks, and evaluations were completed to ensure that installed equipment was intrinsically safe.

The worst-case tank (241-SY-101) was successfully mitigated in 1994, with the installation of a mixing pump. The pump is operated up to three times a week to mix the waste and release gases that are generated and retained in the waste. This mitigation technique has been completely successful, and no episodic releases of gas have occurred since the pump was installed. Two spare mixer pumps are available in the event the original pump should fail.

In November 1995, more-stringent flammable gas controls were placed on all 177 high-level waste storage tanks after several events occurred where hydrogen gas was found during several waste intrusive activities. In early 1997, a complete set of operating controls with respect to flammable gases was submitted to DOE Richland Operations Office for the flammable gas unreviewed safety question. The controls specified were incorporated into the basis for interim operations (HNF-SD-WM-BIO-001, Rev. 1).

The unreviewed safety question for Tank 241-SY-101 was closed in June 1996, but in November 1996, the flammable gas unreviewed safety question was expanded to cover 176 underground storage tanks (excluding SY-101) and all auxiliary tanks in the tank farm. The DOE Richland Operations Office closed the unreviewed safety question for all single- and double-shell tanks in September 1998.

Conditions within Tank 241-SY-101 changed in 1997 and this led to a continuous rise in the waste level. In February 1998, the DOE Richland Operations Office declared an unreviewed safety question related to the waste surface level changes. The responsible contractor formed a project team to remediate the level rise and a project plan was recently issued (HNF-3824).

Hydrogen monitors have been installed on all 25 flammable gas watch list tanks; in addition, another 17 monitors were installed to gather more data on a variety of tanks and operations. These systems continuously monitor for hydrogen and have the capability to obtain grab samples for additional analyses.

Other instruments have been developed for characterizing the waste in the watch list tanks. These instruments include meters to measure the viscosity of the waste in the tanks, in-tank void fraction meters that determine the amount of gas in a given volume of waste, retained gas samplers that capture a waste sample in a gas-tight chamber and allows the gas composition and volume to be measured after the apparatus is brought into a hot cell, and gas characterization systems that allow a broad spectrum of dome-space gases (including hydrogen, ammonia, and nitrous oxide) to be monitored continuously in selected tanks. All of these devices became operational in 1996.

The Tri-Party Agreement milestone for resolution of the flammable gas safety issue is scheduled for September 2001.

High-Heat Tank. This safety issue concerns Tank 241-C-106, a single-shell tank in the 200-East Area, that requires water additions and forced ventilation for evaporative cooling. Without the water additions, which would have to be severely restricted in the event of a leak, the tank could exceed structural temperature limits and result in potential concrete degradation and possible tank collapse. This tank waste is scheduled for retrieval, starting in 1999, and transfer to a double-shell tank. Double-shell tanks were designed to better handle heat-bearing materials than single-shell tanks. As part of the waste removal project, a refrigerated chiller system was installed to remove radioactive decay heat and the heat generated by the waste transfer pumps. The chiller system was activated in late 1998.

Organic Tanks. This safety issue involves the potential for uncontrolled exothermic reactions of organic complexants and organic solvents present in some of the tanks. Criteria to screen tanks for possible organic compounds were established based on analyses and simulant testing. Tank waste was screened against these criteria (WHC-SD-WM-SARR-033, Rev. 1). DOE identified 20 single-shell tanks for the organic watch list between 1991 and 1994. The selection of the tanks was based on the evaluation of hazards such as spontaneous and continuous burning of material or the spontaneous combustion of the waste from selfheating. Of these tanks, 18 were identified as containing organic complexants and 2 were identified as containing organic solvents. Organic solvents do not mix with water and, therefore, float on the top of the liquid wastes, while the organic complexants are water soluble and are mixed with liquids in the tanks.

During 1990, work controls were implemented in these tanks to prevent the uncontrolled release of high-level waste. It was determined that concentrations and temperatures required to support propagating exothermic reactions are comparable to those necessary for ferrocyanide reactions (WHC-SD-WM-ER-496). During 1995, as part of the vapor-sampling program, it was shown that organic vapors in the organic tanks are too low in concentration to exceed even 25% of their lower flammability limits. In addition, moisture levels of 20 weight percent will prevent reactions from propagating regardless of the fuel concentration. Other work indicates that the aging processes have destroyed or significantly lowered the energy content of the organic tanks. (WHC-EP-0823, WHC-SD-WM-SARR-033, Rev. 1). In addition, WHC-EP-0899-1 shows that most organic complexants used during nuclear fuel reprocessing at the Hanford Site and the primary degradation products of tributyl phosphate are water soluble in nitrate/nitrite salt solutions.

During 1995 through 1997, waste samples from the organic tanks were taken to determine the quantities of organic constituents present in each tank. Most of the organics identified have been of low energy. None of the samples showed any tendency to react when tested in a special tube propagation calorimeter (FAI/96-45, FAI/96-48). In May 1994, vapor sampling and safety analyses were completed that provided the technical basis for closing the unreviewed safety question on the flammability of the floating organic layer in Tank 241-C-103 (WHC-SD-WM-SARR-001). During 1998, DOE closed the organic complexant safety issue and removed the 18 organic complexant tanks from the watch list. The evaluation concluded that hazards do not exist because the organic concentrations in the wastes are too low to support a propagating reaction and no credible means are available to increase tank temperature to runaway reaction levels.

The two remaining organic watch list tanks contain organic solvents. DOE is expected to analyze the technical data on these tanks and resolve the safety issue in 1999. The Tri-Party Agreement milestone for resolution of the organic tank safety issue is scheduled for September 2001.

Criticality. The unreviewed safety question on the potential for criticality in the high-level waste

tanks was closed in 1994 by completing additional analyses, strengthening tank criticality prevention controls, and improving administrative procedures and training (WHC-SD-WM-SARR-003). In 1996, an extensive effort was put forth to provide the technical basis for resolving the technical issues related to the criticality safety issue. Technical studies were completed that showed a criticality event within a high-level waste tank is not likely during storage (WHC-SD-WM-TI-725). All of the single- and double-shell tanks at the Hanford Site contain sufficient neutron absorbers to ensure safe storage; however, additional sampling and controls will be required for retrieval- and pretreatment-related activities. Successful completion of this review will enable DOE to close the criticality safety issue and satisfy the related Tri-Party Agreement milestone. The Tri-Party Agreement milestone for resolution of the criticality safety issue is scheduled for September 1999.

2.3.8.4 Vadose Zone Characterization Near Single-Shell Underground Waste Storage Tanks

Since 1995, the DOE Grand Junction Office has been performing a baseline spectral gamma borehole logging characterization of the vadose zone around the single-shell underground waste storage tanks at Hanford. This characterization work is being done in part to comply with RCRA requirements to identify contamination sources and to determine the nature and extent of the contamination from the single-shell tanks. The work will also assist with RCRA closure of the tanks.

The characterization program involves establishing a baseline of the contamination distribution of gamma-emitting radionuclides in the vadose zone by logging the existing boreholes surrounding the tanks with spectral gamma-ray logging systems. Once the activities of the subsurface radionuclides are determined around a single tank, an interpretation of the contaminant distribution correlation is made and presented in a tank summary data report for the particular tank. When all of the tank summary data reports for tanks in a particular tank farm have been completed, the results of characterization around the single-shell tanks are assembled into a comprehensive tank farm report. In the tank farm report, inter-borehole correlations of contamination intervals are presented as three-dimensional representations of contamination plumes in the vadose zone. The log data along with the visual representations can provide a basic understanding of the contamination distribution and can be of importance as a guide for directing future characterization work. In addition, the data acquired in this initial characterization serve as a baseline against which future comparisons can be made for evaluating the stability of intervals of contamination.

This project, as planned, has inherent limitations. These limitations were understood in the original planning; however, as designed, the project serves as the initial investigation needed prior to beginning a thorough vadose zone characterization. First, the gamma-emitting radionuclides are assayed because they are easy to detect and quantify, whereas many of the radionuclides and hazardous constituents that pose potential health and safety risks are not detected. The project is also limited to providing log assays of the contamination in existing boreholes. No new boreholes are being drilled for logging alone, though the equipment has been used to log three new characterization boreholes put in the SX single-shell tank farm in the 200-West Area. This includes the extension of borehole 41-09-39 to groundwater, results of which are reported in Section 6.2, "Vadose Zone Characterization and Monitoring." Another limitation relates to questions about the representativeness of the three-dimensional contamination plume visualizations. The accurate determination of the distributions and quantification of contaminants is just beginning. Statistically rigorous cross-borehole correlations are not yet developed, thereby making the representativeness of portions of some visualizations questionable.

The baseline characterization program has been successful in its original objective by identifying the nature of the vadose zone contamination problem and locating areas needing further and more-comprehensive characterization. The utility of the baseline characterization has been shown by the discovery of cesium-137 deeper in the vadose zone than previously predicted, thereby questioning the understanding of the mobility of cesium-137 in soils at the Hanford Site.

The logging operations for the baseline characterization began in 1995 and should be completed in early 1999. During 1998, 79 additional boreholes surrounding tanks in the T and B tank farms, in the 200-West and 200-East Areas, respectively, were logged. Also, 15 boreholes in the SX tank farm (200-West Area) were relogged to evaluate the stability of intervals of contamination that were identified in the initial 1995 logging. The details of this work are discussed in Section 6.2, "Vadose Zone Characterization and Monitoring."

Preparation of tank summary data reports began in 1995. During 1998, 25 additional tank summary data reports for tanks in the A, B, BX (all 200-East Area), and T tank farms (200-West Area) were prepared using data acquired from boreholes logged between 1996 and 1998 (e.g., GJ-HAN-106).

During 1998, tank farm reports were prepared for the BX and C tank farms in the 200-East Area and for the S tank farm in the 200-West Area. The preparation of the A tank farm report was well under way at the end of 1998, with scheduled publication in the first quarter of 1999.

During 1998, additional experiments were performed to enhance spectral shape factor analysis, which was developed in 1996 as an analytical method to distinguish distributions of radionuclides detected in the tank monitoring boreholes. This method basically allows a qualitative assessment of the gamma-ray spectra to help differentiate between regions where contamination may be distributed adjacent to the casing versus regions where the contamination may be distributed uniformly in the formation materials surrounding the borehole as a source remote from the borehole. Spectral shape factor analysis has been used routinely in the processing of log data since the latter part of 1997.

The SX tank farm expert panel reviewed the improvements made to shape factor analysis through June 1998 and recommended several considerations for refinement. In response to these recommendations, additional experiments were conducted in 1998 that were directed at evaluating source/detector distributions involving point sources of contamination on the exterior of the borehole casing and at a distance from the borehole.

Additionally, spectral shape factor analysis was evaluated in response to uniformly distributed contamination in thick and thin horizontal tabular zones. Details of the results are documented in GJO-99-80-TAR, GJO-HAN-24.

When used in conjunction with other analysis and information, and with experience gleaned from reviewing many logs, spectral shape factor analysis can help in the identification of contaminant distribution. Incorporation of spectral shape factor results and other interpretations has made significant improvements to the quality and accuracy of three-dimensional representations of the contaminant plumes.

The AX, BY, SX, TX, and U tank farm reports (GJ-HAN-12; GJ-HAN-6; DOE/ID/12584-268, GJPO-HAN-4; GJ-HAN-11; GJ-HAN-8; respectively) were completed before spectral shape factor analysis was implemented in 1997. Reevaluation of the SX tank farm log data was initiated in 1998 and is scheduled for completion in 1999. The data will be evaluated on the basis of knowledge gained since the SX tank farm report was completed in 1996, and the visualization will be recreated to reflect

interpretations. The remaining four tank farms will be reevaluated in 1999, and addenda will be prepared for each of these five tank farm reports.

The baseline characterization work completed in 1998 identified several areas where additional work is required to broaden knowledge of contamination conditions in the tank farm vadose zone. See Section 6.2, "Vadose Zone Characterization and Monitoring," for additional details regarding specific tank farms. Section 6.2 gives a more-comprehensive description of the single-shell tank vadose zone characterization program and for references to detailed reports.

2.3.8.5 Waste Immobilization

Approximately 204 million L (54 million gal) of radioactive and hazardous wastes, accumulated from >40 yr of plutonium production operations, are stored in 149 underground single-shell tanks and 28 underground double-shell tanks. It is planned to pretreat the waste and then solidify it into a glass matrix. Pretreatment will separate the wastes into a low-radioactivity fraction and a high-radioactivity and transuranic fraction. In separate facilities, both fractions will be vitrified in a process that will destroy or extract organic constituents, neutralize or deactivate dangerous wastes and immobilize toxic metals. The immobilized low-radioactivity fraction will be disposed of in a near-surface facility on the Hanford Site in a retrievable form. The immobilized high-radioactivity fraction will be stored onsite until a geologic repository is available offsite for permanent disposal. Tri-Party Agreement milestones specify December 2028 for completion of pretreatment and immobilization of the tank wastes.

During 1996, a change request to Tri-Party Agreement milestones was approved, allowing DOE to proceed with the planned privatization of the initial pretreatment and immobilization function of the Tank Waste Remediation Program. The approach to privatization will be conducted in two phases.

Phase I is proof of concept/commercial demonstration. This phase involves pretreatment and vitrification of the low-level and high-level wastes. The objectives of this phase are to 1) demonstrate technologies and processes in a production-level environment; 2) treat and immobilize sufficient waste to demonstrate early progress in remediating the tank situation to the stakeholders; 3) better understand the costs, risks, and benefits of the fixed-price privatization framework; 4) ascertain the financial viability of the private marketplace to accomplish the mission; 5) establish conditions for DOE to be a "smart buyer" and for private companies to be "smart providers" of treated waste products for Phase II; and 6) balance the private companies' objectives with DOE's objectives.

A contract with British Nuclear Fuels Limited, Inc. reflects an evolution of the original tank waste remediation system privatization approach. Part A lasted 20 mo and ended in mid-1998. The purpose of Part A was to evaluate the technical, operational, regulatory, business, and financial elements required by privatized facilities that would provide treatment and immobilization services on a fixed-unit-price basis. Part B has been restructured and one contractor, British Nuclear Fuels Limited, Inc., has been authorized to proceed to the design phase of Phase I. The revised approach allows DOE to move forward on design without delay, but defers a final decision until the project is further refined with respect to its design and technical approach, regulatory requirements, and financial and incentive structure. Part B begins with: a design phase, leading to all major process and facility systems (approximately 30% design) being completed in 24 mo. If British Nuclear Fuels Limited, Inc. is authorized to proceed beyond the design phase, it will move forward to the completion of the design, construction, startup, testing, and operation of the facility to provide waste treatment services at the fixed-unit prices established at the end of the design phase. Under the contract negotiated with British Nuclear Fuels Limited, Inc., DOE forecasts that waste treatment will begin in 2005 to 2006

and will continue for at least 10 yr. During that period, DOE expects the contractor to immobilize approximately 10% of Hanford's waste by mass. That waste processing will include both high-level and low-activity waste treatment and immobilization. The waste processed will be retrieved from 11 tanks and will free up valuable double-shell tank space to enable transfer of waste from the high-risk single-shell tanks. The waste to be processed constitutes between 20% and 25% of the total radioactivity in the Hanford tanks and includes waste from some of the highest safety-risk tanks at the site. The facility design provides for the ability to expand the capacity of the plant at a later date. This could allow a significant amount of the waste planned for the tank waste remediation system Phase II to be processed in the expanded facility.

Phase II will be the full-scale production phase. Facilities will be sized so all of the remaining waste can be processed and immobilized on a schedule that will accommodate removing the waste in single-shell tanks by 2018, or a subsequent date if the Tri-Party Agreement is renegotiated. Objectives of the full-scale production phase are to 1) implement the lessons learned from Phase I; 2) process all tank waste into forms suitable for final disposal while meeting environmental, health, and safety requirements; 3) meet or exceed the Tri-Party Agreement benchmark performance milestones; and 4) as in Phase I, balance the private vendor's objectives with DOE's objectives. At the end of any contract, the contractor will deactivate all contractor-provided facilities.

2.3.9 Solid Waste Management Activities

2.3.9.1 Central Waste Complex

Solid waste is received at the Central Waste Complex in the 200-West Area (see Figure 1.0.2) from all radioactive waste generators at the Hanford Site and any offsite generators authorized by DOE to ship waste to the Hanford Site for treatment, storage, and disposal. The waste received at the Central Waste Complex is generated by ongoing site and research and development activities. Offsite waste has been primarily from DOE research facilities and other DOE sites. The characteristics of the waste received vary greatly, from nondangerous, solid waste to solid, transuranic, mixed waste.

The planned capacity of the Central Waste Complex to store low-level mixed waste and transuranic waste is 15,540 m^3 (20,330 yd^3). This capacity is adequate to store the projected volumes of low-level, transuranic, and mixed waste to be generated, assuming on-schedule treatment of the stored waste. Plans call for treatment of the mixed waste to begin in 1999, which will reduce the amount of waste in storage and make room available for newly generated mixed waste. The majority of waste shipped to the Central Waste Complex is generated in small quantities by routine plant operation and maintenance activities. The dangerous waste designation of each container of waste is determined at its point of generation based on process knowledge of the waste placed in the container or on sample analysis if sufficient process knowledge is unavailable.

2.3.9.2 Waste Receiving and Processing Facility

During 1994, construction was started on the first major solid waste processing facility associated with cleanup of the Hanford Site. Having started operation in March 1997, the Waste Receiving and Processing Facility is staffed to analyze, characterize, and prepare drums for disposal of waste resulting from plutonium operations at Hanford. The 4,800-m^2 (52,000-ft^2) facility is near the Central Waste Complex in the 200-West Area (see Figure 1.0.2). The

facility is designed to process approximately 6,800 drums and 70 boxes of waste annually for 30 yr.

Wastes destined for the Waste Receiving and Processing Facility include Hanford's inventory of >37,000 drums of stored suspect-transuranic waste as well as materials generated by future site cleanup activities. Consisting primarily of clothing, gloves, face masks, small tools, and particulates suspected of being contaminated with plutonium, waste containers may also contain other radioactive materials and hazardous components. Processed waste that qualifies as low-level waste and meets disposal requirements will be buried directly at the Hanford Site. Low-level waste not meeting burial requirements will be treated in the facility until it meets the requirements or will be prepared for future treatment at other onsite or offsite treatment, storage, and disposal facilities. Waste determined in the facility to be transuranic will be certified and packaged for shipment to the Waste Isolation Pilot Plant in Carlsbad, New Mexico for permanent storage. Materials requiring further processing to meet disposal criteria will be retained at Hanford, pending treatment.

2.3.9.3 Radioactive Mixed Waste Disposal Facilities

The radioactive mixed waste disposal facilities at the Hanford Site are the first in DOE's complex for disposal of radioactive mixed wastes. These facilities are located in the low-level burial grounds in the 200-West Area and are designated Trenches 218-W-5, -31, and -34. Trench 34 is operating in a storage mode containing long-length contaminated equipment, macroencapsulated tubes, and a DOE laboratory reactor core basket. This storage mode will continue until sufficient volumes of mixed waste meeting RCRA land disposal requirements are available to economically operate the facility in a disposal mode. The trenches are rectangular landfills, with approximate base dimensions of 76 by 30 m (250 by 100 ft). The bottoms of the excavations slope slightly, giving a variable depth of 9 to 12 m (30 to 40 ft).

These trenches are designed to comply with RCRA requirements for double liners and leachate collection and removal systems. The bottom and sides of the facilities are covered with a deep layer of soil (1 m [3 ft]) to protect the liner system during fill operations. There is a recessed section at one end of the excavations that houses the sumps for leachate collection. Access to the bottom is provided by ramps along the perimeters.

2.3.9.4 T Plant Complex

The function of the T Plant complex in the 200-West Area (see Figure 1.0.2) is to provide waste processing and decontamination services for the Hanford Site. Two facilities are used to provide these services: the T Plant canyon and the 2706-T complex. Other areas around these facilities are also used to support these services. The T Plant complex is a RCRA-permitted facility, which can store waste for >90 d and perform treatment in tanks and other containers. T Plant's waste handling activities in 1998 included the following:

- performing content verification of wastes being shipped to solid waste facilities for storage or disposal
- repackaging and/or sampling waste to meet solid waste acceptance criteria or to determine acceptability of waste for treatment
- treating dangerous and mixed wastes to meet RCRA requirements for land disposal
- decontaminating equipment to allow for reuse or disposal as waste
- storing 27 metric tons (30 tons) of spent reactor fuel (from Shippingport, Pennsylvania) in a water basin.

Upgrades to the 2706-T complex liquid waste storage tank system were started in January 1997 and completed in December 1998. These upgrades have made the 2706-T tank system fully compliant with RCRA regulations and will allow for improved liquid waste handling capabilities. Since December 1998, the 2706-T complex has been undergoing readiness

activities. After about June 1999, all decontamination, packaging, and verification work will be performed exclusively in the 2706-T complex.

2.3.9.5 Radioactive Mixed Waste Treatment and Disposal

After a banner year in 1997, budget constraints severely reduced the amount of mixed waste treated and/or disposed of in 1998; 13 m^3 (17 yd^3) of mixed waste were treated and/or disposed of. The waste materials were obtained from a number of projects and included the following:

- 11,000 L (3,000 gal) of organic liquid (tributyl phosphate) from the B Plant facility were incinerated at Diversified Scientific Services, Inc. in Tennessee.
- 1 m^3 (1.3 yd^3) of elemental lead was decontaminated and released for reuse during 1998. The lead was sorted and removed from approximately 290 containers. This was a waste minimization "return-on-investment" project.
- A total volume of 1 m^3 (1.3 yd^3) of ash from the Waste Experimental Reduction Facility in Idaho was stabilized at the T Plant facility in the 200-West Area. This waste came to Hanford under a federal facility consent agreement between Bettis Atomic Power Laboratory and the Hanford Site. After the waste was successfully treated, it was shipped back to Bettis.
- 96 drums of combustible hazardous debris were shipped to the Waste Experimental Reduction Facility in Idaho and are awaiting treatment. Treatment is planned in 1999, with return of the treatment residues to Hanford by September 1999. This activity is considered an inter-site demonstration between the Idaho National Engineering and Environmental Laboratory and Hanford. If deemed successful, additional treatment campaigns will be arranged.

2.3.9.6 Radioactive Mixed Waste Treatment Contracts

In November 1995, a contract was awarded to Allied Technology Group, Inc., Richland, Washington for thermal treatment of Hanford's mixed waste in accordance with RCRA and the Toxic Substances Control Act of 1976. The contract provides for treating up to 5,135 m^3 (6,715 yd^3) of mixed waste over 5 yr with five 1-yr renewal options. Waste processing is scheduled to begin in fiscal year 2001.

During 1997, a competitive procurement was conducted for the processing of mixed waste requiring nonthermal treatment in accordance with RCRA. The resulting contract provides for treatment of up to 1,860 m^3 (2,432 yd^3) of waste. The contract, which was also awarded to Allied Technology Group, Inc., has a 1-yr base period (fiscal year 1999) with two 1-yr renewal options (fiscal years 2000 and 2001).

During September 1998, a National Environmental Policy Act environmental assessment (DOE/EA-1189) was completed for this activity, with a finding of no significant impact. Completion of this assessment met Tri-Party Agreement compliance agreement M-19-01-T03.

These contracts, together with follow-on procurements, will provide cost-effective alternatives for continued mixed waste treatment.

2.3.9.7 Navy Reactor Compartments

Six defueled United States Navy reactor compartment disposal packages were received and placed in Trench 94 in the 200-East Area during 1998. This brings the total number received to 77. The compartments originate from decommissioned nuclear-powered submarines.

The reactor compartment disposal packages are being regulated by Washington State as dangerous waste because of the presence of lead used as shielding and by EPA because of the presence of small amounts of polychlorinated biphenyls tightly bound within the composition of solid materials such as

thermal insulation, cable coverings, and rubber. Also, the compartments are regulated as mixed waste because of radioactivity in addition to dangerous waste.

2.3.9.8 325 Building Hazardous Waste Treatment Units

The 325 Building hazardous waste treatment units in the 300 Area receive, store, and treat mixed and hazardous waste generated by Pacific Northwest National Laboratory programs. The units consist of the Shielded Analytical Laboratory and the Hazardous Waste Treatment Unit. These units are operating under RCRA final permit status granted in February 1998.

The Shielded Analytical Laboratory is a facility that has a dual role as an analytical laboratory and a treatment facility. The laboratory performs tank treatment and bench-scale treatment of high-dose-rate laboratory waste (2,000 rem/h capability).

The Hazardous Waste Treatment Unit is a facility that contains fume hoods and gloveboxes for bench-scale treatment of mixed and dangerous waste from various Pacific Northwest National Laboratory programs and for treating transuranic and transuranic mixed waste by neutralization and stabilization.

2.3.9.9 Underground Fuel Storage Tanks

There are 13 underground fuel storage tanks on the Hanford Site registered with the Washington State Department of Ecology (WAC 173-360). Four of the tanks contain gasoline or diesel fuel (two each) for vehicles and nine are diesel storage tanks for supplying emergency diesel generators. Two of the fuel tanks, located within the former 1100 Area, will be transferred to the Port of Benton in the near future. Of the 13 registered tanks, 3 were upgraded and 10 were replaced to meet the new compliance standards for leak detection and inventory control that went into effect on December 22, 1998.

2.3.10 Liquid Effluent Activities

2.3.10.1 242-A Evaporator

Available storage space to support remediation of tank waste and cleanup of the Hanford Site is limited in the double-shell tanks. The 242-A Evaporator in the 200-East Area (see Figure 1.0.2) processes double-shell tank waste into a concentrate (that is returned to the tanks) and a process condensate stream. Only a cold (nonradioactive) run was conducted at the 242-A Evaporator in 1998 because of delays in preparing for waste processing. The purpose of the cold run was to demonstrate operational readiness of the evaporator using the newly installed package boiler. The run produced 280,000 L (74,000 gal) of aqueous waste that were sent to the Liquid Effluent Retention Facility (discussed in Section 2.3.10.2). One 242-A Evaporator campaign is planned for 1999, two are scheduled for 2000.

Effluent treatment and disposal capabilities are available to support the continued operation of the 242-A Evaporator. The 200 Areas Effluent Treatment Facility near the 200-East Area was constructed to treat the process condensate. Process condensate is temporarily stored in the Liquid Effluent Retention Facility while awaiting treatment in the 200 Areas Effluent Treatment Facility. Cooling water and nonradioactive steam condensate from the evaporator are discharged to the 200 Areas Treated Effluent Disposal Facility.

2.3.10.2 Liquid Effluent Retention Facility

This facility consists of three RCRA-compliant surface impoundments for storing and treating process condensate from the 242-A Evaporator and other

aqueous wastes. The facility provides treatment through equalization of the flow and adjustment of pH of the feed to the 200 Areas Effluent Treatment Facility. The maximum capacity of the Liquid Effluent Retention Facility is 89 million L (23.4 million gal). The basins are 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 barrier should the primary and secondary liners fail. Each basin has a mechanically tensioned 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 operation in April 1994. Aqueous waste is being received from both RCRA- and CERCLA-regulated cleanup activities. Approximately 28 million L (7.4 million gal) of aqueous waste were stored in the basins at the end of 1998.

2.3.10.3 200 Areas Effluent Treatment Facility

This facility provides treatment and storage for hazardous and radioactive aqueous waste. The treated effluent is stored in verification tanks, sampled and analyzed, and discharged to the 616-A Crib (also called the State-Approved Land Disposal Site) (north of the 200-West Area). 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 operation in December 1995. Treatment capacity of the facility is 570 L/min (150 gal/min). Approximately 108 million L (28.4 million gal) of aqueous waste were treated in 1998.

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 is an underground drain field. The percolation rates for the field have been established by site testing and evaluation of soil characteristics. Tritium in the liquid effluent cannot be practically removed, and the location of the disposal site maximizes the time for migration to the Columbia River to allow for radioactive decay. The final delisting (40 CFR 261, Appendix IX, Table 2) excludes the treated effluent from the requirements of dangerous waste regulations and RCRA; however, certain effluent quality restrictions are imposed. An application was submitted in 1998 to remove the restrictions on the type of multisource leachate (dangerous waste number F039 under RCRA) that can be treated at the 200 Areas Effluent Treatment Facility; the final delisting applies to multisource leachate that is derived from RCRA waste coded F001 through F005 solvent wastes. Application was also made to change the final delisting to increase the allowable discharge volume. The disposal site is permitted under WAC 173-216. The discharge permit requires monitoring of the groundwater and the treated effluent to ensure that levels for certain constituents are not exceeded.

Secondary waste from treating aqueous waste is concentrated, dried, and packaged in 208-L (55-gal) drums. The secondary waste from treating regulated aqueous waste is transferred to the Central Waste Complex for subsequent treatment (if needed to meet land disposal restriction treatment standards) and disposal in the radioactive mixed waste disposal facility, Trench 31 or 34, in the 200-West Area. The secondary waste from treating CERCLA-regulated aqueous waste is disposed of in the Environmental Restoration Disposal Facility near the 200-West Area.

2.3.10.4 200 Areas Treated Effluent Disposal Facility

This disposal facility is a collection and disposal system for non-RCRA-permitted waste streams that have implemented “best available technology/all

known and reasonable treatment." Implementation of regulatory "best available technology/all known and reasonable treatment" is the responsibility of the generating facilities. There are 14 waste generating facilities in the 200 Areas that send waste to the 200 Areas Treated Effluent Disposal Facility (see Figure 1.0.2).

This facility began operation in April 1995 and has a capacity of 12,900 L/min (3,400 gal/min). Approximately 742 million L (196 million gal) of effluent were discharged in 1998. The effluent is discharged to two 2-ha (5-acre) disposal ponds located east of the 200-East Area. The discharge permit requires monitoring of the effluent and the groundwater to ensure that concentrations for certain constituents are not exceeded.

2.3.10.5 300 Area Treated Effluent Disposal Facility

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 constitute the primary sources of wastewater. The wastewater consists of once-through cooling water, steam condensate, and other industrial wastewaters. Laboratory services are particularly critical to Hanford Site cleanup activities, including tank waste remediation efforts.

This facility is designed for continuous receipt of wastewaters, with a storage capacity of up to 5 d at the design flow rate of 1,100 L/min (300 gal/min). The treatment process includes iron coprecipitation to remove heavy metals, ion exchange to remove mercury, and ultraviolet light/hydrogen peroxide oxidation to destroy organics and cyanide. Sludge from the iron coprecipitation process is dewatered and used for backfill in the low-level 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 (40 CFR 122). The National Pollutant Discharge Elimination System permit is being revised to allow for the treatment of dangerous waste in accordance with WAC-173-303-802. 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. This facility began operation in December 1994. In 1998, approximately 297 million L (78 million gal) of wastewater were treated. The National Pollutant Discharge Elimination System permit is being revised (public comment ended February 11, 1999) to allow for the treatment of dangerous waste in accordance with state dangerous waste regulations.

2.3.10.6 340 Waste Handling Facility

This facility ceased receiving waste in September 1998 and is planned to be deactivated. A new waste handling facility, with storage and truck loadout capability, is being provided in the 325 Building to serve Pacific Northwest National Laboratory programs. For other wastes, waste handling systems are being developed at the 324 and 327 Buildings in the 300 Area. Mixed, low-level, liquid waste will be transported to either the 200 Areas Effluent Treatment Facility for treatment or to double-shell tanks for storage.

The 340 Waste Handling Facility provided receipt, storage, and loadout capability for low-level, mixed, liquid waste generated during laboratory operations in the 300 Area. The waste was accumulated and stored in two 57,000-L (15,000-gal) tanks located in a covered, below-grade vault in the 340 Building. Six additional 30,000-L (8,000-gal) tanks in the adjacent 340-A Building provided backup storage capability. The accumulated waste was pumped into railcars and transported to the 204-AR Unloading Facility in the 200-East Area for neutralization and transfer to double-shell tanks for

storage. The 340 Waste Handling Facility does not have a RCRA permit for storage; therefore, wastes could not be stored for >90 d.

2.3.10.7 Miscellaneous Streams

Miscellaneous streams are lower priority wastewater streams that discharge to the soil column throughout the Hanford Site and are subject to requirements in Consent Order DE 91NM-177. The *Plan and Schedule for Disposition and Regulatory Compliance for Miscellaneous Streams* (DOE/RL-93-94, Rev. 1) was approved by the Washington State Department of Ecology in February 1995. That plan and schedule ensure that miscellaneous streams will be in compliance with the applicable state regulations (e.g., WAC 173-216, 173-218). The commitments established in the plan and schedule include annually updating the miscellaneous streams inventory (through 1998), registering injection wells, submitting categorical permit applications, and implementing best management practices.

The inventory includes more than 640 miscellaneous streams. Not included in the inventory are streams that already have discharge permits in place or streams for which permit applications have been submitted. All injection wells were registered under WAC 173-218 in August 1995, including injection wells that were previously registered. This ensured that the registrations were current, complete, and in the same format.

Use of categorical permits provides a vehicle to easily permit miscellaneous streams with similar characteristics. Categorical permit applications have been submitted or permits have been issued for the following:

- hydrotesting, maintenance, and construction discharges; permit #ST-4508 was issued in May 1997
- cooling water discharges and uncontaminated steam condensate; permit #ST-4509 was issued in May 1998
- stormwater discharges; permit application was submitted in 1998.

Another categorical permit was planned for vehicle washing, coal ramp washdowns, and safety shower discharges. These streams have either been eliminated or were included in another existing permit. A best management practices report (DOE/RL-96-40) was submitted to the Washington State Department of Ecology in August 1997, identifying preferred options and an implementation plan to remediate those streams that have a potential to affect the groundwater.

2.3.10.8 Vadose Zone Characterization Summary

Vadose zone monitoring of past-practice liquid waste disposal facilities is part of the Hanford Site Groundwater Monitoring Project's responsibilities for monitoring and tracking groundwater contamination in fulfillment of the requirements of RCRA and DOE Orders. Vadose zone monitoring can serve as an early warning for potential impacts on groundwater quality. Vadose zone monitoring of liquid waste disposal facilities is conducted at those sites deemed most threatening to groundwater. Vadose zone monitoring at those sites is scheduled to be conducted periodically until the threat to groundwater is remediated through the efforts of the Environmental Restoration Program.

In 1998, the Hanford Groundwater Monitoring Project produced proposed guidance for vadose zone monitoring of liquid waste disposal facilities (PNNL-11958). Prior to this, the most recent published vadose zone monitoring plan was written in 1984 (RHO-RE-PL-23) before the Hanford Site mission changed from production to cleanup and before the availability of the high-quality, field-deployable, spectral gamma-ray tools at Hanford. The 1998 proposal incorporated both the mission and strategies of the Hanford Site and the use of spectral gamma-ray (as opposed to gross gamma-ray) monitoring technologies. The proposal provided a framework and general criteria directing site-specific vadose zone monitoring plans and a path to achieve site-specific

vadose zone monitoring. The proposal was submitted for review and comment by all interested parties and will be finalized in 1999.

The vadose zone at three inactive liquid waste disposal facilities associated with the Plutonium Finishing Plant in the 200-West Area was monitored in 1998. Those facilities were the 216-Z-1A Tile Field, the 216-Z-9 Trench, and the 216-Z-12 Crib. Monitoring consisted of spectral gamma-ray logging of 21 boreholes. The three facilities were chosen for monitoring because they were identified as containing some of the most significant sources of radioactive contamination in the Hanford Site vadose zone. Transuranic contamination is known to exist beneath the facilities, and most boreholes had not been monitored for several years. The basic question addressed by the monitoring was "Has the configuration of subsurface contamination changed since it was last measured?" The conclusion of the monitoring effort was that there has been very little change in the distribution of gamma-emitting contamination beneath the facilities. The monitoring is discussed in detail in Section 6.2.2, "Vadose Zone Monitoring at Waste Disposal Facilities."

2.3.11 Revegetation and Mitigation Planning

The DOE Richland Operations Office and Bechtel Hanford, Inc. work cooperatively with the Natural Resource Trustees on the mitigation action plans for the various remedial action projects. The plans describe the planning and implementation of appropriate mitigation measures for areas disturbed during remediation. Mitigation measures include avoidance, minimization, rectification, or compensation of impacted resources. Revegetation/mitigation plans will include the use of native plant species (seeds and shrubs) as appropriate to restore the areas disturbed by remediation activities.

The *Hanford Site Biological Resources Management Plan* (DOE/RL-96-32) was developed to provide DOE and its contractors with a consistent approach to protect biological resources and monitor, assess, and mitigate impacts to them from site development and environmental cleanup and restoration activities. This comprehensive plan provides a framework to enable Hanford Site resource professionals to effectively fulfill their responsibilities and address tribal, resource agency, and other stakeholder concerns about the site's biological resources. The policies and guidelines described in the plan were developed based on legal requirements and policy initiatives that direct an ecosystem management approach toward resources management. DOE is in the process of revising the biological resources management plan.

The *Hanford Site Biological Resources Mitigation Strategy Plan* (DOE/RL-96-88) contains strategy that is part of the broader biological resource policy contained in the biological resources management plan (DOE/RL-96-32). The strategy is designed to aid DOE in balancing its primary missions of waste cleanup, technology development, and economic diversification with its stewardship responsibilities for the biological resources it administers. This biological resources mitigation strategy will help ensure consistent and effective implementation of mitigation recommendations and requirements, ensure mitigation measures for biological resources meet the responsibilities of DOE under the law, enable Hanford Site development and cleanup projects to anticipate and plan for mitigation needs via early identification of mitigation requirements, and provide guidance to site personnel in implementing mitigation in a cost-effective and timely manner. DOE is in the process of revising the mitigation strategy plan.

Planning was initiated for habitat mitigation for Project W-519 (a project to provide utilities to various 200-East facilities). This effort will involve the planting of approximately 130,000 sagebrush plants

on the Fitzner-Eberhardt Arid Lands Ecology Reserve (see Figure 1.0.1), replanting native grass and sagebrush seed east of the 200-East Area, and research on the introduction of additional species into restoration/mitigation sites.

Bechtel Hanford, Inc. conducted three habitat mitigation and restoration projects in 1998. Seventy-seven hectares (190 acres) of sagebrush were planted in several small plots on the Fitzner-Eberhardt Arid Lands Ecology Reserve as compensatory mitigation for the construction of Cells 3 and 4 of the Environmental Restoration Disposal Facility; 1.2 ha (3 acres) were replanted with sagebrush, Sandberg's bluegrass, snow buckwheat, and yarrow on the remediated 116-C-1 Liquid Waste Disposal Trench in the 100-B,C Area. At the 105-DR Reactor Interim Safe Stabilization Project in the 100-D Area, a noncontaminated processwater tunnel was preserved to provide habitat for a Washington State-protected bat species that had been living in the reactor building (Washington State Department of Fish and Wildlife 1996). A new access to the tunnel was constructed for the bats that would prevent human intrusion but allow the bats to enter the tunnel. This mitigation project used an existing structure to preserve an important maternity roost that the bats had been using for many years.

Previous mitigation plantings continued to be monitored during 1998, including the sagebrush planting performed as mitigation for the replacement cross-site transfer system, and the planting performed as mitigation for the Solid Waste Complex (Project W-112). Monitoring of these plantings indicate relatively high survival of the planted sagebrush (70% to 85% overall).

2.3.12 Environmental Restoration Project

2.3.12.1 Environmental Restoration Disposal Facility

This facility opened in July 1996. The 918,000-m^3 (1,200,000-yd^3) earthen facility is located near the 200-West Area (see Figure 1.0.2). Constructed with double liners and a leachate collection system, the facility was designed to serve as the central disposal site for contaminated waste removed during cleanup operations conducted under CERCLA on the Hanford Site. Cleanup materials may include soil, rubble, or other materials (excluding liquids) contaminated with hazardous, low-level radioactive or mixed (combined hazardous chemical radioactive) wastes.

In 1998, the facility received 620,908 metric tons (684,574 tons) of contaminated soil. This was also the year that the facility received the one-millionth ton of contaminated material from Hanford Site cleanup operations. From the startup of the facility, 1,248,070 metric tons (1,376,042 tons) of contaminated materials have been received.

Ongoing and upcoming remediation projects will require additional space for contaminated materials. In 1998, a contract was awarded for expansion of facility disposal cells three and four. The project design calls for excavation and removal of approximately 1,120,000 m^3 (1,460,000 yd^3) of material. By the end of 1998, the project had removed approximately 990,000 m^3 (1,300,000 yd^3), with the completion date scheduled for November 1999.

2.3.12.2 Waste Site Remediation Activities

Full-scale remediation of waste sites began in the 100 Areas in 1996. Remediation continued through 1998 at several liquid waste disposal sites in the 100-B,C and 100-D Areas.

In the 100-B,C Area, 122,315 metric tons (134,857 tons) of soil were removed in 1998. Through December 1998, 463,347 metric tons (510,857 tons)

of contaminated soil have been removed and shipped to the Environmental Restoration Disposal Facility.

Remediation operations continued in 1998 at the 100-D Area. Cleanup operations for the 116-D-7 Retention Basin and associated sludge pits began in March 1997 and continued through 1998 and into 1999. Over 450,000 metric tons (500,000 tons) of contaminated soils have been removed and transported to the Environmental Restoration Disposal Facility. Cleanup operations that began in March 1997 were completed in December 1998 for the 116-DR-9 Retention Basin and two associated sludge pits. The 1607-D2 Septic Tile Field was remediated in January and February 1998.

Remediation activities for the 300-FF-1 Operable Unit began in the 300 Area in 1997. Historically, both chemical and radiological materials were disposed of at the 300-FF-1 waste sites. In 1998, remediation operations removed nearly 138,000 metric tons (152,000 tons) of contaminated soils and debris that were shipped to the Environmental Restoration Disposal Facility. Over 175,000 metric tons (192,000 tons) have been removed to date.

Remediation was completed in the 300 Area at the 316-5, 300-10, 300-44, and 300-45 waste sites. The two parallel ditches of the 316-5 Process Trenches were fully remediated to "clean closure" standards: one was backfilled and revegetated, the other was partially backfilled and will be completed and revegetated at a later date. Remediation operations will continue into 1999 for the 628-4 Landfill and the 316-2 Process Pond. Remediation work at the 618-4 Burial Ground was temporarily halted in 1998 when drums of uranium mill shavings and uranium oxide powders were discovered. Work is expected to resume in 1999, following a scope of work change for the disposal of the drums.

2.3.12.3 100-N Area Project

Decontamination and decommissioning of N Reactor were completed in 1998, completing the Tri-Party Agreement Interim Milestone M-16-01E. This was the last production reactor to be deactivated on the Hanford Site. Bechtel Hanford, Inc., jointly with the Washington State Department of Ecology, created an effective working relationship necessary to meet cleanup challenges. A significant challenge during the 3-yr cleanup operation was presented with the cleanup and stabilization of 105-N Basin. The N Basin facility contained two deep pools (7.3 m [24 ft]), with a capacity of >3.8 million L (1 million gal) of water, which were used to store highly radioactive spent fuel. Even though the fuel was previously removed, large amounts of contamination and contaminated equipment remained. Innovative techniques and special tools were developed to remove contaminated water, hardware, and debris. During the 3-yr 100-N Area deactivation effort, 86 facilities were deactivated and stabilized.

2.3.12.4 Decommissioning Project

Decontamination and decommissioning continued in 1998 in the 100-B,C Area. During the year, the interim safe storage project for C Reactor was completed, satisfying Tri-Party Agreement milestone M-93-03. The footprint of the reactor was reduced by 81%, with the removal of 23 of the 24 associated facilities. High-strength, corrosion-resistant steel was placed on the roof. The enclosure is designed to protect people and the environment for the next 75 yr. Interim safe storage for C Reactor will reduce maintenance costs for the reactor by an estimated $185,000/yr. With the completion of this project, C Reactor became the first full-scale reactor to be placed in safe storage. Eight of the nine Hanford reactors are slated for interim safe storage.

Interim safe storage projects were also started for F and DR Reactors and are approximately 2 yr ahead of Tri-Party Agreement milestones.

Decommissioning and demolition began in 1998 for the 233-S Plutonium Concentration Facility in the 200-West Area. Because of high levels of radiation, this facility poses special challenges. During the year, decommissioning activities took place in the nonprocess pipe gallery and control room. Equipment, asbestos, and electrical equipment were also removed from three other process rooms.

2.3.12.5 Surveillance/Maintenance and Transition Project

This project performs surveillance and maintenance of inactive facilities until final disposition activities commence. The project also provides for the transition of facilities and waste sites into the Environmental Restoration Program after deactivation is complete. The project includes the Radiation Area Remedial Action Program, which is responsible for the surveillance, maintenance, and decontamination or stabilization of approximately 800 inactive waste sites. These include 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 main focus of this objective is to prevent the contaminants contained in these sites from spreading in the environment.

This project is also analyzing the end state (final status/condition) of the canyon facilities (i.e., large concrete structures formerly used in Hanford Site production missions) that exist in the project and those that are coming to the project through facility transition activities. The canyon disposition initiative is evaluating the potential to use the canyon facilities as waste disposal units, compared to standard decontamination and decommissioning of the facilities. The canyon disposition initiative has a potential to achieve a savings of $1 billion compared to removal of the facilities.

2.3.13 Groundwater/Vadose Zone Integration Project

2.3.13.1 Integration

In late 1997, the DOE Richland Operations Office established the Hanford Site Groundwater/Vadose Zone Integration Project and directed Bechtel Hanford, Inc. to lead. The Groundwater/Vadose Zone Project Team includes Fluor-Daniel Hanford, Inc. and Pacific Northwest National Laboratory. The project team members bring significant technical expertise and resources to the effort and help to ensure close coordination with site programs, projects, and contractors.

The project's vision centers on establishing trust and collaboration among participants and stakeholders in Hanford Site cleanup work to develop credible, defensible decisions that protect water resources. The project coordinates and integrates Hanford Site work that could impact water resources, with the goal of protecting those resources, including the Columbia River.

In 1998, the project issued *Management and Integration of Hanford Site Groundwater and Vadose Zone Activities* (DOE/RL-98-03) for review. Also during 1998, the public involvement process for the

project was implemented, an expert panel selected, and panel meetings initiated.

2.3.13.2 Groundwater Restoration Activities

Chromium. Chromium-contaminated groundwater that underlies portions of the 100-D, 100-H, and 100-K Areas (the 100-HR-3 and 100-KR-4 Operable Units) is of potential ecological concern (i.e., impact on Columbia River ecosystem). High 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). 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 approval of the record of decision (1996), full-scale pump and treat systems were constructed in the 100-D, 100-H, and 100-K Areas and completed in 1997. Treated water is reinjected into the ground.

In 1998, the combined total of water treated for the 100-D and 100-H pump-and-treat systems totaled 254 million L (67.2 million gal), with the removal of 38.7 kg (85 lb) of chromium. To date, 458.3 million L (102.6 million gal) of groundwater have been treated, with 50.6 kg (111.6 lb) of chromium removed. The objective of chromium removal is to prevent the chromium from getting into the Columbia River.

The 100-KR-4 pump-and-treat system began operation in late September 1997. Since inception, approximately 242 million L (64 million gal) of groundwater have been processed, with 34.3 kg (73 lb) of chromium removed. Because of sedimentation problems and inadequate screen size, extraction well 199-K-118A was replaced with well 199-K-125A to continue treating groundwater for chromium.

To further evaluate chromium and other constituent contamination in groundwater near the Columbia River shoreline, 178 aquifer sample tubes were installed in 1997. Sample tubes were installed approximately every 610 m (2,000 ft), except in known chromium-contaminated plumes, where the tubes were installed approximately every 305 m (1,000 ft) parallel to the shoreline. Installation of the tubes began near the 100-B,C Area and continued downstream approximately 40 km (25 mi) to near the Old Hanford Townsite.

In 1998, samples were taken from approximately 50 sample tube locations. Samples are being analyzed for chromium, nitrates, tritium, strontium-90, and technetium-99. Collected data will provide information to support remediation operations, monitoring objectives, and environmental efforts now and into the future. Sample tube data will provide highly detailed information on the distribution of chromium in groundwater entering the river at locations very close to sensitive ecological receptors such as aquatic organisms.

Strontium-90. The 100-NR-2 (N Springs) pump-and-treat system began operations in 1995 north of the N Reactor complex 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. The water is pumped through a treatment system to remove strontium-90 from contaminated groundwater. The system was upgraded in 1996 and continued to operate through 1998, with treated water reinjected into the ground. Approximately 109 million L (27 million gal) were processed in 1998. During that period, 0.096 Ci of strontium was removed from the groundwater. Over 329 million L (87 million gal) have been processed since the system began operation.

Carbon Tetrachloride. The carbon tetrachloride plume in the 200-West Area (underlying the 200-ZP-1 Operable Unit) covers approximately 9 km^2 (3.5 mi^2). Phase I of a pump-and-treat system initiated in 1994 was designed to test the removal of carbon tetrachloride and other organics from the groundwater using liquid-phase activated carbon, with the treated groundwater reinjected into

the aquifer. The pilot-scale system was expanded to include Phases II and III that were completed in 1996 and 1997, respectively. The 200-ZP-1 pump-and-treat system reached full operation in 1997, following a three-phase operational approach that included the use of air stripping and vapor-phase granulated activated carbon adsorption technology to remove volatile organic compounds. The system contains six extraction wells and five injection wells. The system was designed to extract, contain, and reduce the contaminated portion of the plume. In 1998, approximately 335 million L (88.4 million gal) of water were treated, with 1,270 kg (2,800 lb) of carbon tetrachloride removed. Over 695 million L (184 million gal) have been processed since the system began operation.

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 in 1998. The plume contains uranium, technetium-99, carbon tetrachloride, and nitrates. Since 1994, a pump-and-treat system has been operated to remove contaminants from groundwater using ion exchange. Contaminated groundwater is extracted from a well in the 200-West Area and treated at the 200 Areas Effluent Treatment Facility near the 200-East Area. Treated groundwater is discharged north of the 200-West Area at the State-Approved Land Disposal Site. The objective is to prevent the contaminants from getting into the Columbia River.

In 1998, the system was shut down from mid-January to mid-February so the 200 Areas Effluent Treatment Facility could support other Hanford Site treatment operations. For the remainder of the year, the pump-and-treat system pumped 87 million L (23 million gal) and removed 7.2 g (0.017 lb) of technetium-99, 17.3 kg (39.9 lb) of uranium, 16.6 kg (38 lb) of carbon tetrachloride, and 4,120 kg (9,084 lb) of nitrates. The pump-and-treat operation made measurable progress toward reducing uranium and technetium-99 to below required cleanup concentration levels (DOE/RL-99-02).

2.3.13.3 Vadose Zone Activities

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 1998. Soil vapor is passed through aboveground granular activated carbon, which absorbs carbon tetrachloride. The granular activated carbon is then shipped offsite for treatment. Beginning in 1993, contaminant concentrations have been monitored using infrared photoacoustic spectrometers at the soil vapor extraction system inlets, vent stacks, individual wells, and soil vapor probes.

In 1996, the system was shut down for 8 mo to study and evaluate the magnitude and rate of carbon tetrachloride rebound. During the shutdown, data indicated the carbon tetrachloride concentrations increased at the three sites. Following the study, the system was restarted in 1997, and the mass-removal rates gradually declined to preshutdown rates. Following the 1997 rebound study that noted a declining rate of carbon tetrachloride removal during continuous extraction operations, the 1998 operating strategy was modified. The modification resulted in the operation of only the 14.2-m^3/min (500 ft^3/min) system for the removal of carbon tetrachloride. The 28.3- and 42.5-m^3/min (1,000- and 1,500-ft^3/min) vapor extraction systems were placed on standby. The modification allowed the 14.2-m^3/min (500-ft^3/min) system to be moved between the well fields that encompass the 216-Z-1A Tile Field, 216-Z-9 Trench, 216-Z-12 Crib, and 216-Z-18 Crib. In 1998, a planned 6-mo system shutdown was initiated to let carbon tetrachloride concentrations rebound. The shutdown allowed a more-efficient, per-hour operation for mass removal of carbon tetrachloride.

2.3.14 Noxious Weed Control Program

The noxious weed control program on the Hanford Site has been developed in response to federal, state, and local laws requiring eradication or control of noxious weeds. Developed in an effort to satisfy agreements made in the federal interagency memorandum of understanding (1994) signed by the DOE, the noxious weed control program at the Hanford Site has been designated as a model for noxious weed control at other DOE sites around the country.

Nine species of noxious weeds are on the high-priority list for control at Hanford: yellow starthistle, rush skeletonweed, babysbreath, Dalmatian toadflax, spotted knapweed, diffuse knapweed, Russian knapweed, saltcedar, and purple loosestrife. A detailed discussion of 1998 noxious weed control can be found in Section 7.5, "Noxious Weed Control Program."

2.3.15 Research and Technology Development Activities

Research and technology development activities are conducted in the 200, 300, 400, and Richland North Areas. Many of these activities are intended to improve the techniques and reduce the costs of waste management, cleanup, environmental protection, and site restoration. Specific 1998 accomplishments for technology deployment are given in DOE/RL-98-79.

Surface barrier monitoring and testing continue at the Hanford Site. A 4-yr treatability test, which began in 1994, was successfully completed in 1998 for the Hanford barrier prototype project. The project was designed to document surface barrier constructability, construction costs, and physical and hydrologic performance over the 216-B-57 Crib in the 200-East Area. Treatability tests were undertaken in two phases: Phase I included the design and construction of the prototype and was completed in 1994 and Phase II included the 4-yr testing and monitoring program.

The primary function of the surface barrier was to ensure buried wastes were contained and protected from the infiltration of water. The barrier consisted of a layer of fine soil overlaid by coarser materials such as sand, gravels, and basalt rip-rap. Silt loam provided a medium to store moisture until the evaporation and transpiration cycles could recycle moisture back into the atmosphere. The silt loam also provided a suitable area for plant growth. Coarser materials located below the silt loam created a capillary break that inhibits the downward percolation of water through the silt. Coarser soils also helped deter root penetration, animal burrowing, and inadvertent human intrusion.

Testing was completed for water balance within the barrier under conditions of ambient and extreme precipitation, surface wind and water erosion, stability of the barrier foundation, surface and rip-rap side slope, surface vegetation dynamics, and animal intrusion. During the testing period, results demonstrated the ease of construction with standard construction equipment, all design performance criteria were met or exceeded, and the design components were highly effective (DOE/RL-99-11, Decisional Draft).

In situ redox manipulation is a groundwater remediation technique that is based on changing the oxidation-reduction conditions of an aquifer so that hazardous constituents are either destroyed or immobilized in place. When ferrous iron is present within the aquifer, certain hazardous metallic ions, such as

hexavalent chromium or uranium, precipitate out of solution and become immobilized. A fixed, permeable, treatment zone is created because the ferrous iron is located within the aquifer sediments.

During 1991 to 1996, laboratory research was performed that indicated hexavalent chromium is reduced in concentration by a chemically reduced (oxygen-depleted) aquifer environment. During 1995 to 1996, in situ redox manipulation was successfully field tested at a single well site in the 100-H Area. The field test, which was located in a previously uncontaminated area, showed complete reduction of the aquifer sediments, with no dissolved oxygen present. Previously detected background levels of hexavalent chromium were no longer present in the reduced environment. During 1997 and 1998, in situ redox manipulation was deployed as a treatability test in the 100-D Area in an area of hexavalent chromium contamination. Test results to date indicate the permeable treatment zone is completely reduced and that hexavalent chromium concentrations have been reduced to below detection limits.

DOE's Tanks Focus Area, in partnership with the Tank Waste Remediation System, continued efforts within the Hanford Tanks Initiative Project to 1) develop retrieval performance criteria supporting readiness to close single-shell tanks, 2) demonstrate and deploy improved sampling and characterization technologies, and 3) demonstrate tank waste retrieval technologies to establish risk/performance data for future waste retrieval operations. In 1998, significant progress was made in several of these areas.

- Four samples from the floor of a high-level waste tank were retrieved using a new auger-sampling tool. The successful sampling campaign demonstrated for the first time that waste can be recovered from the deepest tanks at Hanford with simple auger tools. After retrieval from the tank, the auger samples were transferred to an onsite laboratory for analysis. Analyses of the retrieved waste samples will be used to validate or revise inventory estimates of the key risk-based radionuclides and hazardous chemicals left in the tank. The successful deployment resulted in auger sampling using the new tool being reintroduced as the baseline sampling technology.
- A light-duty utility arm was prepared for routine underground waste tank applications. Initially, it will be used to gather key in-tank waste characterization information (e.g., chemical and radionuclide inventory) from a representative sluiced and near-empty single-shell tank (241-AX-104 in the 200-East Area) that is assumed to have leaked. This information is needed to support a decision basis for future National Environmental Policy Act, safety, and regulatory actions affecting both waste retrieval and operable unit closure of the tank farms. A tank waste sampler and end effector (i.e., tool for sampling and other activities attached to the end of the arm) were developed and tested, system engineering drawings were updated, and staff were trained in preparation for deployment.
- In an effort to provide additional input for the decision basis for tank waste retrieval and tank farm closure decisions, the Hanford 32-metric-ton (35-ton) cone penetrometer platform was readied and probes were designed and tested for application in the upper vadose zone at the 241-AX-104 tank site in the 200-East Area. A multisensor integrated probe that includes a gamma spectrometer, moisture sensor, x-ray fluorescence sensor, and standard sleeve and tip rheology sensors was designed, fabricated, and tested. Semiquantitative information from this probe is intended to support the selection of positions at depth for retrieval of soil samples for confirmatory laboratory analysis. A unique sampler probe was also designed and successfully tested that can obtain soil samples at preselected depths without withdrawal of the pipe string. This demonstration is expected to introduce to Hanford an alternative technology to augment current gamma-logging and drilled well techniques to characterize the extent and magnitude of contaminant leakage into the upper vadose zone that is fast, less expensive, produces less secondary waste, results in less radiological risk to workers, and can be used to guide the location for expensive drilled wells.

In addition to the Hanford Tanks Initiative Project, the Tanks Focus Area also supported the

Tank Waste Remediation System by providing technical data and assistance to address one of the most critical Hanford safety issues, Tank 241-SY-101 in the 200-West Area. As a result of advancements in the understanding of saltcake dissolution chemistry, the Tanks Focus Area was able to provide technical assistance to Hanford Tank Farm Operations. The crust in the tank has been growing, and the growth raises safety questions. Researchers used dilution and pumping models to determine the consequences of adding water containing corrosion inhibitors to the tank's crust. The extensive thermodynamic calculations done as part of the modeling showed that solids volume could be reduced by 30%. These modeling calculations are being used to further evaluate waste transfers and water additions.

Interim safe storage activities at the C Reactor provided a stage for showcasing innovative decontamination and decommissioning technologies. At least 20 technologies and approaches were field tested to demonstrate safer, less-expensive, and more-efficient ways of decommissioning aging nuclear facilities. Through 1998, 13 innovative or improved technologies were demonstrated. Eight have since been adopted, replacing baseline technologies. Four of these technologies have been deployed at other Hanford projects and at other DOE facilities. One has been selected for use at the Chornobyl Reactor in Ukraine.

A gamma camera, which was designed to provide real-time images and source strengths of contamination sites, has been used to record the radiation fields in the 221-B Plant canyon building in the 200-East Area. The camera produces a two-dimensional map of radiation fields that is overlaid on an image of equipment and piping. The map includes topographic contours of different colors that depict the intensity of exposure. This new technology cost-effectively reduces the collective radiation exposure of personnel and provides documentation of facility conditions that are necessary for future decontamination and decommissioning work in the B Plant facility. The camera is operated remotely from an overhead crane, and eliminates the need to use manual sampling techniques while providing a higher quality assessment.