1.0 Introduction

The Hanford Site environmental report is produced through the joint efforts of the principal Site contractors (Pacific Northwest National Laboratory, Westinghouse Hanford Company, Bechtel Hanford Inc.) and other organizations and agencies involved in environmental and compliance work on the Site. This report, published annually since 1958, includes information and summary data that 1) characterize environmental management performance at the Hanford Site; 2) demonstrate the status of the Site's compliance with applicable federal, state, and local environmental laws and regulations; and 3) highlight significant environmental monitoring and surveillance programs.

Specifically, the report provides a short introduction to the Hanford Site and its history, discusses the current Site mission, and briefly highlights the Site's various waste management, effluent monitoring, environmental surveillance, and environmental compliance programs. Included are summary data and program descriptions for the sitewide Ground-Water Monitoring Program, the Near-Facility Environmental Monitoring Program, the Surface Environmental Surveillance Program, the Hanford Cultural Resources Laboratory, wildlife studies, climate and meteorological monitoring, and information about other programs. Also included are sections discussing environmental occurrences, current issues and actions, environmental cleanup activities, compliance issues, and descriptions of major operations and activities. Readers interested in more detail than the summary information provided in this report should consult the technical documents cited in the report text. Descriptions of specific analytical and sampling methods used in the monitoring programs are contained in the *Environmental Monitoring Plan* (DOE 1994a).

Overview of the Hanford Site

The Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State (Figure 1.0.1). The Site occupies an area of about 1,450 km^2 (approximately 560 mi^2) located north of the city of Richland and the confluence of the Yakima River with the Columbia River. This large area has restricted public access and provides a buffer for the smaller areas onsite that historically were used for production of nuclear materials, waste storage, and waste disposal. Only about 6% of the land area has been disturbed and is actively used. The Columbia River flows eastward through the northern part of the Hanford Site and then turns south, forming part of the eastern Site boundary. The Yakima River flows near a portion of the southern boundary and joins the Columbia River downstream from the city of Richland.

The cities of Richland, Kennewick, and Pasco (Tri-Cities) constitute the nearest population center and are located southeast of the Site. Land in the surrounding environs is used for urban and industrial development, irrigated and dry-land farming, and grazing. In 1993, wheat represented the largest single crop in terms of area planted in Benton, Franklin, and Grant counties. Total acreage planted in the three counties was 207,890 ha (513,700 acres) and 24,120 ha (59,600 acres) for winter and spring wheat, respectively (Washington Agricultural Statistics Service 1994). Corn, alfalfa, potatoes, asparagus, apples, cherries, and grapes are other major crops in Benton, Franklin, and Grant counties. Several processors in Benton and Franklin counties produce food products including potato products, canned fruits and vegetables, wine, and animal feed.

Population estimates for 1994 by the Forecasting Division of the Office of Financial Management of the state of Washington place the totals for Benton, Franklin, and Grant counties at 127,000, 42,900, and 62,200, respectively. The 1994 estimates for the Tri-Cities populations are Richland, 35,430; Kennewick, 46,960; and Pasco, 22,170. The estimated populations of Benton City, Prosser, and West Richland totaled 11,985 in 1994. Estimates of the percent of the population exceeding 65 years of age are 9.72, 9.48, and 13.08 in Benton, Franklin, and Grant counties, respectively, in 1994. The census for 1990 (USBC 1994) revealed that the population of Benton and Franklin counties is young, with 57% of the total population under the age of 35, compared with 44% of the total state population. An examination of age groups reveals that the largest age group in Benton and

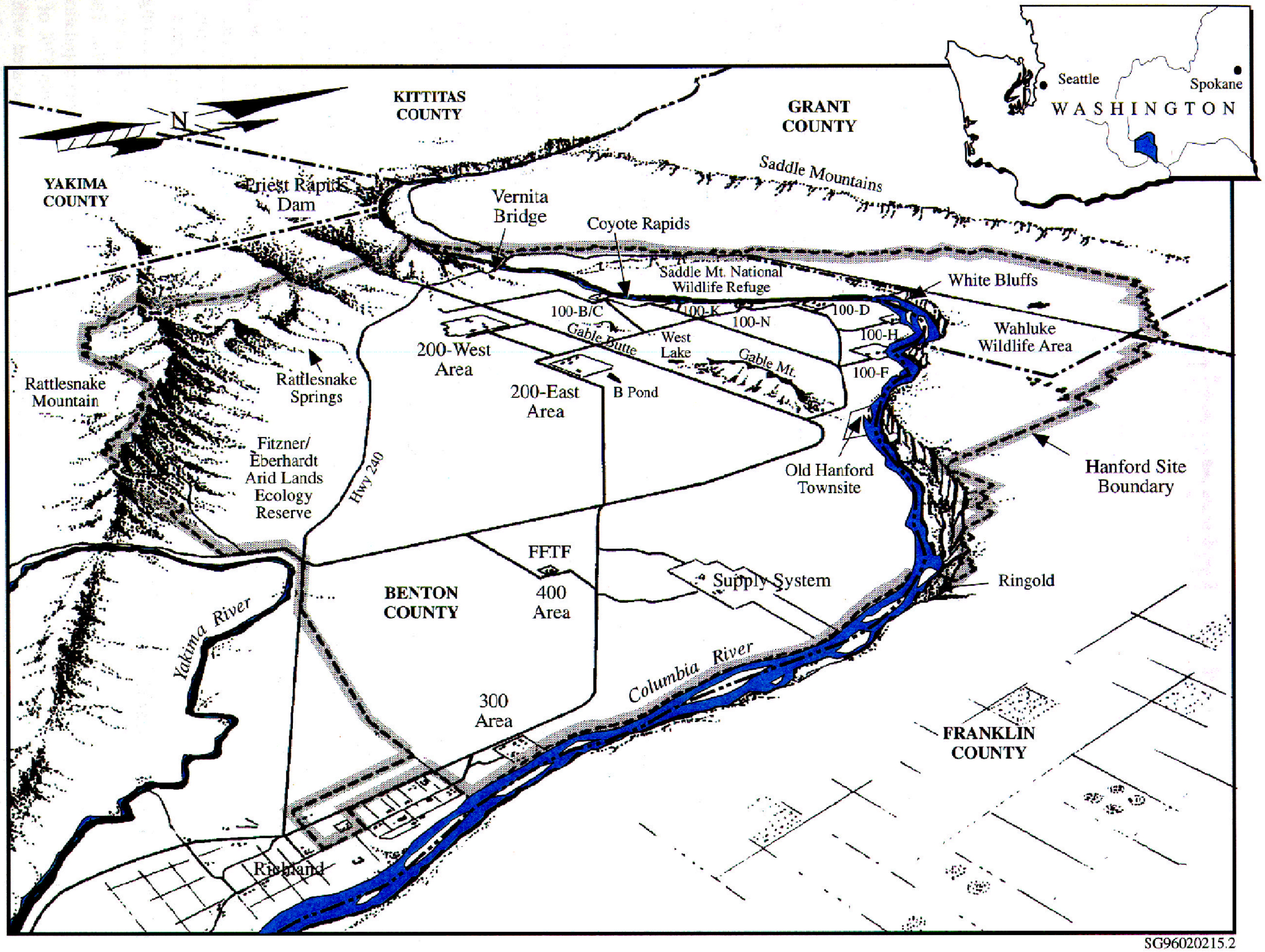

Figure 1.0.1. The Hanford Site and Surrounding Area

Franklin counties ranges from 5 to 17 years old, representing 23.2% of the total bicounty population; the largest age group in the state also ranges from 5 to 17 years and represents about 18.4% of the total state population. The bicounty Hispanic population is approximately 19% compared to the state average of 4.4%. Annual income for the bicounty area averages $28,600 while the state average is $31,000.

Site Description

The entire Hanford Site was designated a National Environmental Research Park (one of four nationally) by the former Energy Research and Development Administration, a precursor to DOE.

The major operational areas on the Site include the following:

- The 100 Areas, on the south shore of the Columbia River, are the sites of eight retired plutonium production reactors and the N Reactor. The 100 Areas occupy about 11 km^2 (4 mi^2).
- The 200-West and 200-East Areas are located on a plateau and are about 8 and 11 km (5 and 7 mi), respectively, south of the Columbia River. The 200 Areas cover about 16 km^2 (6 mi^2).
- The 300 Area is located just north of the city of Richland. This area covers 1.5 km^2 (0.6 mi^2).
- The 400 Area is about 8 km (5 mi) northwest of the 300 Area.
- The 600 Area includes all of the Hanford Site not occupied by the 100, 200, 300, 400 Areas.

Support areas near the Site in north Richland include the 1100, 3000, and Richland North Areas. The 1100 Area includes Site support services such as general stores and transportation maintenance. The 3000 Area includes facilities for ICF Kaiser Hanford Company and Boeing Computer Services. In 1995, both Kaiser and Boeing were in the process of vacating this area so that it can be made available for other uses. The Richland North Area includes the DOE and DOE contractor facilities, mostly office buildings, located between the 300 Area and the city of Richland that are not in the 1100 and 3000 Areas.

Other facilities are located in the Richland Central Area (located south of Saint Street and Highway 240 and north of the Yakima River), the Richland South Area (located between the Yakima River and Kennewick) and the Kennewick/Pasco area.

Several areas of the Site, totaling 665 km^2 (257 mi^2), have special designations. These include the Fitzner/Eberhardt Arid Lands Ecology Reserve, the U.S. Fish and Wildlife Service Saddle Mountain National Wildlife Refuge, and the Washington State Department of Game Reserve Area (Wahluke Slope Wildlife Recreation Area) (DOE 1986). The Fitzner/Eberhardt Arid Lands Ecology Reserve was established in 1967 by the Atomic Energy Commission, a precursor to DOE. In 1971, the reserve was classified a Research Natural Area as a result of a federal interagency cooperative agreement.

Non-DOE operations and activities on Hanford Site leased land include commercial power production by the Washington Public Power Supply System WNP-2 reactor, and operation of a commercial low-level radioactive waste burial site by US Ecology, Inc. Immediately adjacent to the southern boundary of the Hanford Site, Siemens Power Corporation operates a commercial nuclear fuel fabrication facility, and Allied Technology Group Corporation operates a low-level radioactive waste decontamination, super compaction, and packaging disposal facility. Kaiser Aluminum and Chemical Corporation is leasing the 313 Building in the 300 Area to use an extrusion press that was formerly DOE-owned. The National Science Foundation is building the Laser Interferometer Gravitational-Wave Observatory facility near Rattlesnake Mountain on the Hanford Site for gravitational wave studies.

Much of the above information is from Cushing (1995), where more detailed information can be found.

Historical Site Operations

The Hanford Site was established in 1943 to use technology that was developed at the University of Chicago and the Clinton Laboratory in Oak Ridge, Tennessee to produce plutonium for some of the nuclear weapons tested and used in World War II. Hanford was the first plutonium production facility in the world. Nearly all technology was developed as it was needed. The site was selected by the U.S. Army Corps of Engineers because it was remote from major populated areas. The site had ample electrical power from Grand Coulee Dam, a functional railroad, clean water available from the nearby Columbia River, and sand and gravel available onsite that could be used for constructing large concrete structures. For security, safety, and functional reasons the Site was divided into numbered areas (Figure 1.0.1).

Hanford Site operations have resulted in the production of liquid, solid, and gaseous wastes. Most wastes resulting from Site operations have had at least the potential to contain radioactive materials. From an operational standpoint, radioactive wastes were originally categorized as "high level," "intermediate level," or "low level," which referred to the level of radioactivity present. Some high level solid waste, such as large pieces of machinery and equipment, were placed onto railroad flatcars and stored in underground tunnels. Both intermediate and low level solid wastes consisting of tools, machinery, paper, wood, etc., were placed into covered trenches at storage and disposal sites known as "burial grounds." Beginning in 1970, solid wastes were segregated according to the makeup of the waste material. Solids containing plutonium and other transuranium materials were packaged in special containers and stored in lined trenches covered with soil for possible later retrieval. High level liquid wastes were stored in large underground tanks. Intermediate level liquid waste streams were usually routed to underground structures of various types called "cribs." Occasionally, trenches were filled with the liquid waste and then covered with soil after the waste had soaked into the ground. Low level liquid waste streams were usually routed to surface impoundments (ditches and ponds). Nonradioactive solid wastes were usually burned in "burning grounds." This practice was discontinued in the late 1960s in response to the Clean Air Act, and the materials were instead buried at sanitary landfill sites. These storage and disposal sites, with the exception of high level waste tanks, are now designated as "active" or "inactive" waste sites, depending on whether or not the site currently is receiving wastes.

The 300 Area

From the early 1940s to the present, most research and development activities at the Hanford Site were carried out in the 300 Area, located just north of Richland (Figure 1.0.2). The 300 Area was also the location of nuclear fuel fabrication. Nuclear fuel in the form of pipe-like cylinders (fuel slugs) was fabricated from metallic uranium shipped in from offsite production facilities. Metallic uranium was extruded into the proper shape and encapsulated in aluminum or zirconium cladding. Copper was an important material used in the extrusion process, and substantial amounts of copper, uranium, and other heavy metals ended up in 300 Area liquid waste streams. Initially, these streams were routed to the 300 Area waste ponds, which were located near the Columbia River shoreline. In more recent times, the low level liquid wastes were shipped to a solar evaporation facility in the 100-H Area (100-H Area Basins).

The 100 Areas

The fabricated fuel slugs were shipped by rail from the 300 Area to the 100 Areas. The 100 Areas are located on the shore of the Columbia River, where up to nine nuclear reactors were in operation (see Figures 4.8.23, 4.8.24, 4.8.26, and 4.8.37 in Section 4.8, "Ground-Water Protection and Monitoring Program"). The main component of the nuclear reactors consisted of a large stack (pile) of graphite blocks that had tubes and pipes running through it. The tubes were receptacles for the fuel slugs while the pipes carried water to cool the graphite pile. Placing large numbers of slightly radioactive uranium fuel slugs into the reactor piles created an intense radiation field and a radioactive chain reaction that resulted in the conversion of some uranium atoms into plutonium atoms. Other uranium atoms were split into radioactive "fission products." The intense radiation field also caused some nonradioactive atoms in the structure to become radioactive "activation products."

The first eight reactors, constructed between 1944 and 1955, used water from the Columbia River for direct cooling. Large quantities of water were pumped through the reactor piles and discharged back into the river. The discharged cooling water contained small amounts of radioactive materials that escaped from the fuel slugs, tube walls, etc., during the irradiation process. The radiation fields in the piles also caused some of the impurities in the river water to become radioactive (neutron activation). The ninth reactor, N Reactor, was completed in 1963 and was a slightly different design. Purified water was recirculated through the reactor core in a closed-loop cooling system. Beginning in 1966, the heat from the closed-loop system was used to produce steam that was sold to the Washington Public Power Supply System to generate electricity at the adjacent Hanford Generating Plant.

When fresh fuel slugs were pushed into the front face of a reactor's graphite pile, irradiated fuel slugs were forced out the rear into a deep pool of water called a "fuel storage basin." After a brief period of storage in the basin and further storage in special freight cars on a railroad siding, the irradiated fuel slugs were transported by rail to the 200 Areas where the plutonium was recovered.

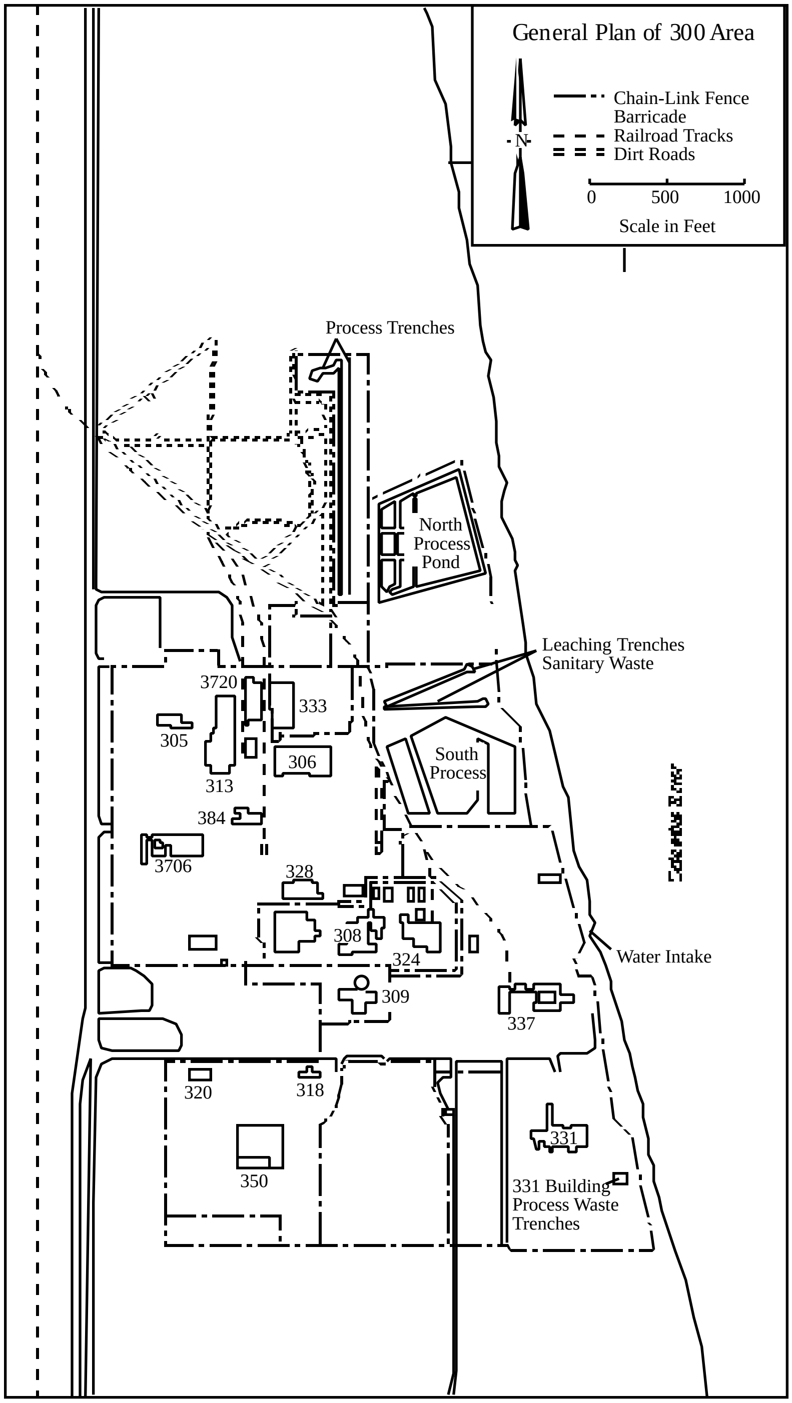

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Figure 1.0.2. The 300 Area, Located Just North of Richland

Most of the irradiated fuel slugs produced at N Reactor from the mid-1970s to late 1983 were transported by rail car to the 100-K East and 100-K West fuel basins for "temporary" storage, where they remain today.

The 200 Areas

The 200-East and 200-West Areas are located on a plateau about 11 km and 8 km (7 and 5 mi), respectively, south of the Columbia River. These areas housed facilities that received and dissolved irradiated fuel and then separated out the valuable plutonium (Figure 1.0.3). These facilities were called "separations plants." Three types of separations plants were used over the years to process irradiated fuel. Each of the plutonium production processes began with the dissolution of the aluminum or zirconium cladding material in ammonium hydroxide followed by the dissolution of the irradiated fuel slugs in nitric acid. All three separations plants therefore produced large quantities of waste nitric acid solutions containing high levels of radioactive materials. These wastes were neutralized and stored in large underground tanks. Fumes from the dissolution of cladding and fuel, and from other plant processes, were discharged to the atmosphere from tall smokestacks, that were filtered after 1950.

Both B Plant and T Plant used a "bismuth phosphate" process to precipitate and separate plutonium from acid solutions during the early days of Hanford operations. Leftover uranium and high level waste products were not separated and were stored together in large underground "single-shell" tanks, i.e., tanks constructed with a single wall of steel. The leftover uranium was later salvaged, purified into uranium oxide powder at the Uranium-TriOxide Plant, and transported to uranium production facilities in other parts of the country for reuse. This salvage process used a solvent extraction technique that resulted in radioactive liquid waste that was disposed to ground in covered trenches at the B-C Cribs Area south of the 200-East Area. Cooling water and steam condensates from B Plant went to B Pond, cooling water and steam condensates from T Plant went to T Pond, and cooling water and steam condensates from U Plant and the Uranium-TriOxide Plant were routed to U Pond.

After T Plant stopped functioning as a separations facility it was converted to a decontamination operation where large pieces of equipment and machinery could be cleaned up for reuse. B Plant was later converted into a facility to separate radioactive strontium and cesium from high level waste. The strontium and cesium were then concentrated into a solid salt material, melted, and encapsulated at the adjacent Encapsulation Facility. Canisters of encapsulated strontium and cesium were stored in a water storage basin at the Encapsulation Facility.

The REDOX (reduction oxidation) Plant (200-West Area) and PUREX (plutonium-uranium extraction) Plant (200-East Area) used solvent extraction techniques to separate plutonium from leftover uranium and radioactive waste products. Most of the irradiated fuel produced at Hanford was processed at either of these two facilities. The solvent extraction method separates chemicals based on their differing solubilities in water and organic solvents, i.e., hexone at the Reduction Oxidation Plant and tributylphosphate at the Plutonium-Uranium Extraction Plant. High level liquid wastes were neutralized and stored in single-shell tanks (Reduction Oxidation Plant) or double-shell tanks (Plutonium-Uranium Extraction Plant). Occasionally, organic materials such as solvents and resins ended up in high level liquid waste streams sent to the tanks. Because the solutions discharged to these tanks were not acidic, various chemicals and radioactive materials precipitated and settled to the bottom of the tanks. This phenomenon was later used to advantage—the liquid waste was heated in special facilities (evaporators) to remove excess water and concentrate the waste into salt cake and sludge, which remained in the tanks. The evaporated and condensed water contained radioactive tritium and was discharged to cribs. Intermediate and low level liquid wastes discharged to ground from the Reduction Oxidation and Plutonium-Uranium Extraction Plants typically contained tritium and other radioactive fission products as well as nonradioactive nitrate. Intermediate level liquid wastes discharged to cribs from the Reduction Oxidation Plant sometimes contained hexone used in the reduction oxidation process. Cooling water from the Reduction Oxidation Plant was discharged to the Reduction Oxidation Ponds. Cooling water from the Plutonium-Uranium Extraction Plant was discharged to Gable Mountain Pond and B Pond.

The Reduction Oxidation and Plutonium-Uranium Extraction Plants produced uranium nitrate for recycle and plutonium nitrate for weapon component production. Uranium nitrate was shipped by tank truck to the Uranium-TriOxide Plant for processing. The Uranium-TriOxide Plant used specially designed machinery to heat the uranium nitrate solution and boil off the nitric acid, which was recovered and recycled to the separation plants. The product, uranium oxide, was packaged and shipped to other facilities in the United States for recycle. Plutonium nitrate, in small quantities for safety reasons, was placed into special shipping containers (P-R cans) and hauled by truck to the Z Plant for further processing.

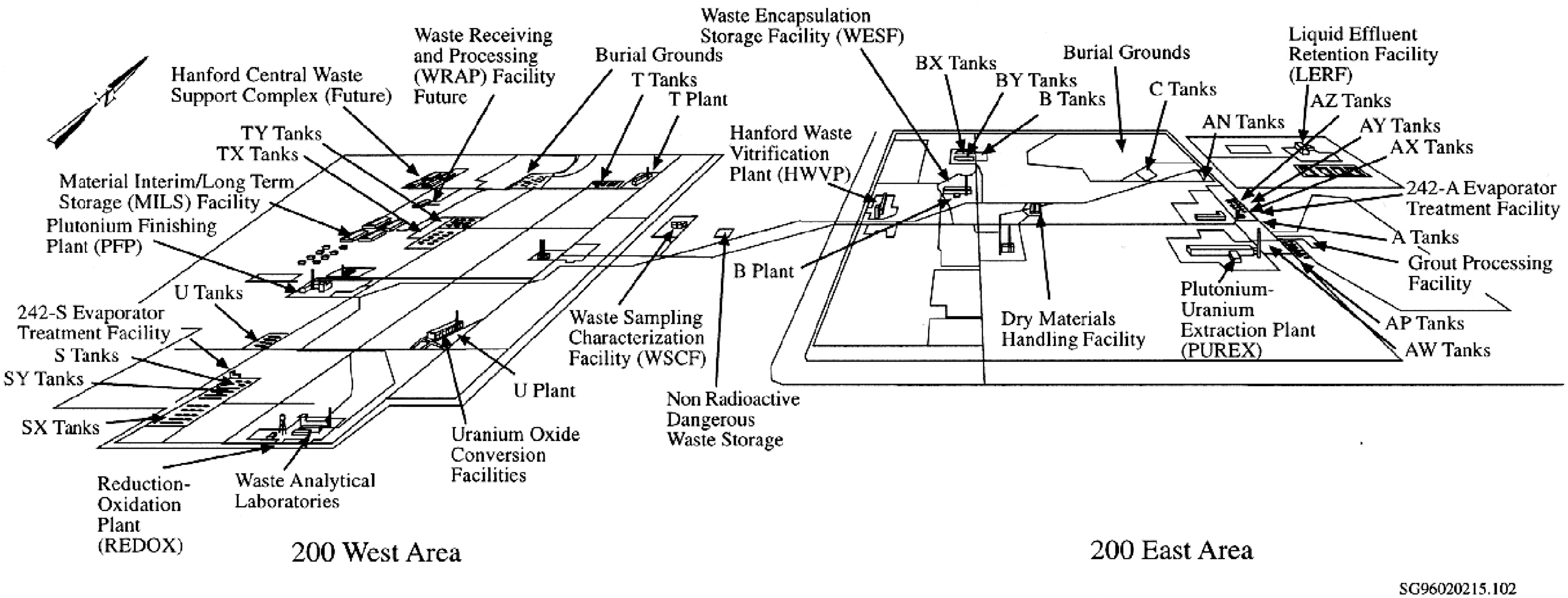

Figure 1.0.3. Waste Storage and Disposal Facilities in the 200 Areas

Plutonium was received at one of several buildings operated over the years that were collectively known as Z Plant, now called the Plutonium Finishing Plant. The purpose of Z Plant (now called the Plutonium Finishing Plant) operations was to convert the plutonium nitrate into plutonium metal blanks (buttons) that were manufactured into nuclear weapons components. The conversion processes used nitric acid, hydrofluoric acid, carbon tetrachloride, and various oils and degreasers. Varying amounts of all these materials ended up in the intermediate level liquid wastes that were discharged to cribs. Cooling water from the Z Plant was discharged via open ditch to U Pond. High level wastes containing plutonium were segregated and packaged for storage in special earth-covered trenches.

The 400 Area

In addition to research and development activities in the 300 Area, the Hanford Site has supported several test facilities. The largest was the Fast Flux Test Facility located in the 400 Area, about 8 km (5 mi) northwest of the 300 Area. This special nuclear reactor was designed to test various types of nuclear fuel. The facility operated for about 13 years and was shut down in 1993. The reactor was a unique design that used liquid metal sodium as the primary coolant. The heated liquid sodium was cooled with atmospheric air in heat exchangers. Spent fuel from the facility resides in the 400 Area, while other wastes were transported to the 200 Areas. With the exception of the spent fuel, no major amounts of radioactive wastes were stored or disposed of at the Fast Flux Test Facility site.

Current Site Mission

For more than 40 years, Hanford Site facilities were dedicated primarily to the production of plutonium for national defense and to the management of the resulting wastes. In recent years, efforts at the Hanford Site have been focused on developing new waste treatment and disposal technologies and cleaning up contamination left over from historical operations.

The current Site mission includes:

- **Management of Wastes** and the handling, storage, and disposal of radioactive, hazardous, mixed, or sanitary wastes from current operations
- **Environmental Restoration** of approximately 2,100 inactive radioactive, hazardous, and mixed waste disposal sites and about 117 surplus facilities
- **Research and Development** in energy, health, safety, environmental sciences, molecular sciences, environmental restoration, waste management, and national security
- **Development of New Technologies** for environmental restoration and waste management, including site characterization and assessment methods; waste minimization, treatment, and remediation technology.

DOE has set a goal of cleaning up Hanford's waste sites and bringing its facilities into compliance with local, state, and federal environmental laws. In addition to supporting the environmental management mission, DOE is also supporting other special initiatives in accomplishing its national objective.

Site Management

Hanford Site operations and activities are managed by the DOE Richland Operations Office through the following prime contractors and numerous subcontractors. Each contractor is responsible for safe, environmentally sound maintenance and management of its activities or facilities and operations; for waste management; and for monitoring operations and effluents to ensure environmental compliance.

The principal contractors and their respective responsibilities include:

- Westinghouse Hanford Company, the management and operations contractor, which manages wastes, maintains the Fast Flux Test Facility, Plutonium-Uranium Extraction Plant, and other shutdown facilities, and provides support services such as fire protection, stores, and electrical power distribution. Site computer services are provided by Boeing Computer Services, a subcontractor to Westinghouse. Administration of the ICF Kaiser Hanford Company contract is assigned to Westinghouse Hanford Company. ICF Kaiser is responsible for fabrication, custodial work, maintenance, design/drafting, and computer-aided mapping, and operates the utilities, railroad system, bus and van fleets, and roads.

- Battelle Memorial Institute, the research and development contractor, operates Pacific Northwest National Laboratory for DOE, conducting research and development in environmental restoration and waste management, environmental science, molecular science, energy, health and safety, and national security.

- Bechtel Hanford, Inc. is the Hanford environmental restoration contractor, with responsibility for remedial action at past-practice waste sites, closure of Resource Conservation and Recovery Act land-based treatment, storage, and disposal units, and decontamination and decommissioning of facilities. The Bechtel Team includes three preselected subcontractors: CH2M Hill, IT Corporation, and ThermoAnalytical, Inc.

- Hanford Environmental Health Foundation is the occupational and environmental health services contractor.

Major Operations and Activities

Waste Management

Current waste management activities at the Site include the management of high- and low-activity defense wastes in the 200-East and 200-West Areas (Figure 1.0.3) and the storage of irradiated fuel in the 100-K Area. Key facilities include the waste storage tanks, Low-Level Burial Grounds, 100-K Fuel Storage Basins, Plutonium-Uranium Extraction Plant, Plutonium Finishing Plant, B Plant/Waste Encapsulation Storage Facility, T Plant, 616 Non-Radioactive Hazardous Waste Storage Facility, the Central Waste Complex, the Transuranic Storage and Assay Facility, the Waste Receiving and Processing Facility, and 242-A Evaporator.

Waste management activities involving single-shell and double-shell tanks currently include ensuring safe storage of wastes through surveillance and monitoring of the tanks, upgrading monitoring instrumentation, and imposing strict work controls during intrusive operations. Earlier, concerns had been raised about the potential for rapid exothermic reactions from ferrocyanide and/or organic fuels or hydrogen gas accumulation in the waste tanks. One safety issue stems from the fact that under conditions of sufficient chemical concentration, low moisture, and high temperature, ferrocyanide and/or organic materials, combined with nitrates also present in the tanks, could result in runaway chemical reactions that would release radioactive debris to the environment. The other issue is that in up to 25 tanks flammable hydrogen gases are generated in the waste and may be trapped and episodically released. DOE and external oversight groups have concluded that there is no imminent danger to the public from either situation. The Tank Waste Remediation System Division has the responsibility to identify any hazards associated with the waste tanks and to implement the necessary actions to resolve or mitigate those hazards.

The 40-year-old 100-K East and 100-K West Fuel Storage Basins are currently being used to store N Reactor irradiated fuel. In 1995, the strategy for transitioning irradiated fuel from wet storage in the K Basins to dry interim storage in the 200-East Area was further developed. This strategy supports completion of fuel removal from the K Basins three years ahead of the target date of December 2002 stipulated in the Tri-Party Agreement.

The Plutonium-Uranium Extraction Plant, located in the 200-East Area, formerly processed irradiated reactor fuel to extract plutonium and uranium. Plant operation was stopped in December 1988. From December 1989 through March 1990, the facility completed a stabilization run to process the fuel remaining in the plant. After the stabilization run, the Plutonium-Uranium Extraction Plant began a transition to a “standby condition.” In December 1992, DOE directed the facility to be deactivated and transitioned to “surveillance and maintenance” until final disposition. The nitric acid and process solutions have been recovered and the last of the organic component is being flushed from the facility.

The Plutonium Finishing Plant, located in the 200-West Area, operated from 1951 until 1989 to produce plutonium metal and oxide for defense use and to recover plutonium from scrap materials. In 1993, the planned startup of a major process line, the Plutonium Reclamation Facility, was suspended pending completion of an environmental impact statement. A series of interim actions have been initiated to enhance safety features to reduce risks in the facility while the environmental impact statement is prepared. Sludge stabilization processing and 10-L container downloading and development testing were completed in 1995. Current plans are to complete stabilization and cleanout of the Plutonium Finishing Plant in accordance with a record of decision for the pending environmental impact statement expected in June 1996.

There are no production activities currently taking place at B Plant/Waste Encapsulation Storage Facility. The current mission is to provide for the safe deactivation of the B Plant facilities and the safe management of approximately 75 million curies of cesium and strontium in the Waste Encapsulation and Storage Facility.

The 242-A Evaporator in the 200-East Area is used to reduce the volume of liquid wastes removed from double-shell tanks. The process condensate is stored in liquid effluent retention basins until treated in the Liquid Effluent Treatment Facility, which started operations in November 1995. The concentrated waste from the evaporator is returned to the double-shell tanks. The Liquid Effluent Treatment Facility was constructed in the 200-East Area to remove regulated chemical constituents from the 242-A Evaporator process condensate. The recovered chemicals are packaged in 55-gal drums and transferred to the Central Waste Complex.

Solid waste is received at the Central Waste Complex from all radioactive waste generators at the Hanford Site and any offsite generators that are 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 operations and research and development activities conducted at the Site. Offsite waste has been primarily from DOE research facilities and other DOE sites. The characteristics of the waste received at the Central Waste Complex vary greatly, from waste that is nondangerous solid low-level waste to solid transuranic mixed waste.

The planned capacity of the Central Waste Complex to store low-level waste and transuranic mixed waste is 15,540 m^3 (20,330 yd^3). This capacity is adequate to store the current projected volumes of mixed waste to be generated through the year 1999, assuming no treatment of the stored waste. Current plans call for treatment of the mixed waste to begin in 1999, which will reduce the amount of waste in storage and make storage room available for newly generated mixed waste. The capacity of the Central Waste Complex to store mixed waste is continually evaluated and additional storage buildings will be constructed if necessary. 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.

The newly constructed Waste Receiving and Processing Facility (planned for operations in March 1997) will have the capability to process retrieved suspect transuranic solid waste (waste that may or may not meet transuranic criteria), certify newly generated and stored transuranic solid waste and low-level waste for either disposal or shipment to the Waste Isolation Pilot Plant in New Mexico (transuranic only), and process small quantities of radioactive mixed low-level waste for permanent disposal. Current funding only addresses low-level waste processing. These capabilities will be in accordance with Land Disposal Restrictions and Hanford Site disposal criteria for low-level waste and in accordance with waste acceptance criteria and transportation criteria for transuranic waste.

Three facilities are in the T-Plant area: the Transuranic Storage and Assay Facility for storage and assay of transuranic waste; the T Plant canyon building used for radiological decontamination of large equipment; and the 2706-T facility used for the repackaging of radioactive wastes and small equipment decontamination. T Plant was selected as the Hanford Site decontamination facility in 1994. Various activities were performed at the facility in 1995 including waste repackaging/processing, equipment decontamination, and verification that waste met acceptance criteria. Other activities that can be done in T Plant are Land Disposal Restriction determination for mixed waste soils; stabilization of toxic characteristic regulated soils; macroencapsulation of debris and contaminated equipment; neutralization and solidification of inorganic labpacks; and neutralization and repackaging of organic labpacks (specially packaged dangerous waste that may or may not originate from a laboratory).

Environmental Restoration

Environmental Restoration includes activities to decommission facilities, clean up inactive waste sites and prevent the spread of contamination. Cost estimates and schedules for all the facilities currently in the program are included in the *Hanford Site Environmental Restoration Project Plan* (DOE 1994b).

The Decontamination and Decommissioning Project conducts surveillance and maintenance of surplus facilities awaiting decommissioning, stabilizes large radioactive contaminated sites, provides for transition of surplus facilities from other programs into the Decontamination and Decommissioning Project, conducts asbestos abatement Site wide and does the actual decommissioning/demolition of the buildings.

The surveillance and maintenance activities associated with the inactive, surplus facilities include monitoring the condition of building structures until final decommissioning can be accomplished. These activities will continue for as long as necessary until the structures are successfully demolished. There are currently 117 facilities in the program.

The Site stabilization program is responsible for the decontamination/stabilization of approximately 870 ha (2,150 acres) on the Hanford site, including: inactive cribs; ponds; ditches; trenches; unplanned release sites and burial grounds. These sites have been maintained by performing periodic surveillances, radiation surveys and herbicide applications and by initiating timely responses to problems. The overall objective of this program is to prevent the exposure of the inventories contained within these sites to the natural forces of wind and erosion that would create contamination spread to the environment or personnel.

The facility transition group was set up to act as the gate for all facilities entering the surveillance and maintenance program. This group is tasked with ensuring the programmatic acceptance criteria are met and documented at each building prior to acceptance for long term surveillance and maintenance. In January, 1995, the Uranium-Trioxide Complex was accepted for long term surveillance and maintenance. This was the first application of a formal transition process and end point criteria at Hanford, and possibly the first of its size in the national DOE complex.

Research and Technology Development

Research and technology development activities on the Hanford Site are a relatively minor contributor to Site releases. Most of these activities are located in the 200, 300, 400, and Richland North Areas, and releases occur primarily from the operation of research laboratories and pilot facilities. Many of these activities are intended to improve the techniques and reduce the costs of waste management, cleanup, environmental protection, and Site restoration.

In 1994, the Environmental Restoration Program completed the prototype Hanford waste site barrier, which is instrumented to permit accurate measurement of surface subsidence, water balance, wind and water erosion, and vegetation changes under ambient and elevated precipitation. The first year of testing and monitoring was completed in October 1995. The barrier is intended to prevent the intrusion of water into underground waste sites. Despite an unusually wet year (twice normal precipitation) and an irrigation treatment that elevated the precipitation total to three times the annual average, there was no infiltration of water through the barrier to the underlying wastes. This demonstrates the prototype barrier is effective in preventing infiltration by retaining water above the barrier until it is recycled to the atmosphere by plants. In contrast, drainage was observed from the gravel and basalt side slopes, and there is evidence of a potential waste site infiltration at the periphery of barrier. Wind erosion was confined to the first three months of monitoring, before the soil surface was revegetated. The results of the first year of testing and monitoring of the prototype Hanford barrier represent a unique data set that will prove useful in the performance evaluation of surface barriers in arid and semiarid environments. Testing and monitoring of the prototype Hanford waste site barrier is scheduled to continue in 1996 with continued focus on water balance evaluation, evaluation of side slope performance, response to extreme precipitation events, and establishing an accurate basis for estimating the cost of long-term monitoring of engineered barriers.

Initial field testing of an in situ ground-water cleanup technology, redox manipulation, was performed during 1995. Redox manipulation involves changing the oxidation-reduction state of aquifer sediments so that contaminants dissolved in ground water are destroyed or immobilized. An injectable redox barrier using sodium dithionite as the reductant was successfully field tested in the 100-H Area to address chromate contamination. Extensive monitoring and characterization activities were initiated in 1995. Initial results indicate that reduction of the aquifer sediments was achieved and dissolved chromate concentrations were significantly reduced.

DOE's Tanks Focus Area is funding the development of a mobile robotic system called the Light Duty Utility Arm System. This new robotic arm technology will be used to support cleanup of Hanford's defense wastes and at other DOE sites such as the Waste Heel Removal Project at the Idaho National Engineering Laboratory and the Gunite and Associated Tanks Treatability Study at the Oak Ridge National Laboratory. At Hanford, the robotic arm will be used for surveillance, inspection, and retrieval applications in single-shell tanks. The robotic arm is capable of positioning a variety of scientific instruments, cameras, and small-scale retrieval devices within the tanks. These tools will help reveal the condition of the tank structures and also provide information about the nature of the waste materials inside. A cold test facility for the Light Duty Utility Arm System has been completed in the Fuels and Materials Examination Facility in the 400 Area and is ready for testing activities to be initiated.

The Tanks Focus Area is also supporting the Confined Sluicing End Effector. This tool uses manipulators to position water jets inside waste tanks to dislodge stubborn wastes (e.g., rock-hard saltcake). The dislodged pieces are removed from the tanks using a pneumatic transport system or jet pump transport.

The Pacific Northwest National Laboratory, in conjunction with DOE Richland Operations Office and Westinghouse Hanford Company, successfully completed two Cooperative Research and Development Agreements titled "Adaptation of Commercial Borehole Geophysics for Use at Arid DOE Sites" in 1995. The two largest providers of borehole geophysics for the petroleum industry, Halliburton Energy Services and Schlumberger Well Services, were the industry partners in the agreements. Each successfully adapted three different logging services to support the environmental mission at the Hanford Site and other arid DOE sites. The adapted technologies include: 1) scintillation spectral gamma ray logging for identifying and quantifying both naturally occurring and created radionuclides; 2) neutron-neutron logging for determining subsurface moisture concentrations; and 3) gamma-gamma density logging for determining the bulk density and porosity of the formation surrounding the borehole. Data from these three logging services are used to characterize environmental sites and monitor contaminant migration. Since completion of the agreements, these technologies were deployed by the Hanford Environmental Restoration Contractor in 1995 to characterize several waste sites (see Vadose Zone Characterization in Section 2.3).

Site Environmental Programs

Effluent Monitoring, Waste Management, and Chemical Inventory Programs

Liquid and airborne effluents are monitored or managed through contractor effluent monitoring programs. These programs are designed to monitor effluents at their point of release into the environment whenever possible. Waste management and chemical inventory programs document and report the quantities and types of solid waste disposed of at the Hanford Site and the hazardous chemicals stored across the Site. Results for the 1995 effluent monitoring and waste management and chemical inventory programs are summarized in Sections 3.1, "Facility Effluent Monitoring," and 3.3, "Waste Management and Chemical Inventories."

Near-Facility Environmental Monitoring Programs

The Near-Facility Environmental Monitoring Program is responsible for facility-specific environmental monitoring immediately adjacent to facilities on the Site. This monitoring is conducted to ensure compliance with DOE and contract requirements and local, state, and federal environmental regulations. The program is also designed to evaluate the effectiveness of effluent treatments and controls, waste management and restoration activities, and to monitor emissions from diffuse/fugitive sources. Results for the 1995 programs are summarized in Section 3.2, "Near-Facility Environmental Monitoring."

Sitewide Environmental Surveillance Program

The Sitewide environmental surveillance program is conducted by Pacific Northwest National Laboratory independent of facility specific monitoring programs conducted by other Site contractors. The program's main focus is on assessing the impacts of radiological and chemical contaminants on the environment and human health, and confirming compliance with pertinent environmental regulations and federal policies. Surveillance activities are conducted both on and off the Site to monitor for contaminants from the entire Hanford Site, rather than from specific contractor-owned or managed facilities. Results for the 1995 Sitewide environmental surveillance program are summarized in Section 4.0, "Environmental Surveillance Information."

Other Environmental Programs

Other aspects of the environment are studied for reasons other than specific impacts from possible contamination. These aspects include climate, wildlife, and cultural resources. These studies are summarized in Section 6.0, "Other Hanford Site Environmental Programs."