S.4 OVERVIEW OF NUCLEAR INFRASTRUCTURE FACILITIES AND TRANSPORTATION

The following is a brief description of the facilities involved in target fabrication and postirradiation processing and target irradiation. Detailed descriptions of these facilities and the processes associated with them are provided in Appendixes A through F of the NI PEIS. Also provided is a summary of the transportation required by each alternative.

Target Fabrication and Postirradiation Processing Facilities

Radiochemical Engineering Development Center. REDC at ORNL is a companion facility to the HFIR. REDC's two buildings house heavily shielded hot cells and analytical laboratories that are used for remote fabrication of rods and targets (for irradiation in HFIR) and processing of irradiated rods and targets for the separation and purification of transuranic elements, process development, and product purification and packaging. ORNL's REDC Building 7930 is proposed for the storage of neptunium-237 in one option of the No Action Alternative. It also is proposed for the storage of neptunium-237, fabrication of neptunium-237 targets, and processing of irradiated neptunium-237 targets for two irradiation options in Alternative 1 (Restart FFTF), three irradiation options in Alternative 2 (Use Only Existing Operational Facilities), and for one irradiation option in Alternative 3 (Construct New Accelerator[s]) and Alternative 4 (Construct New Research Reactor). REDC's current radiochemical missions would not be impacted by the addition of the proposed storage of neptunium-237, fabrication of neptunium-237 targets, and the processing of irradiated neptunium-237 targets activities. REDC would have no role in support of Alternative 5 (Permanently Deactivate FFTF [with No New Missions]). **Figure S–1** presents a map of the Oak Ridge Reservation (ORR) that depicts the location of REDC.

REDC Building 7930 is divided into four major areas: (1) a cell complex with seven cells, six shielded and one unshielded; (2) maintenance and service areas surrounding the cell complex; (3) an operating control area; and (4) an office area adjacent to, but isolated from, the operating areas. Utility services, ventilation systems, crane and manipulator systems, and liquid-waste systems also are included. The proposed plutonium-238 processing and storage activities would require equipment installation in three main areas of the second floor of REDC Building 7930. The REDC hot cell facilities that would be used for the proposed action have never been used. The activities required for target fabrication would take place in shielded gloveboxes. (Appendix A of the NI PEIS provides a description of the target fabrication process.) The mechanical operations involved in the final target fabrication may present lesser hazards that permit them to be carried out in open boxes. Cell E would contain processing equipment to purify the separated plutonium-238 product, prepare the plutonium oxide, and transfer the oxide into shipping containers. Cell E would also contain vertical storage wells for dry storage of neptunium and other actinides.

Cell D activities would include receipt of irradiated targets, as well as target dissolution, chemical separation of neptunium and plutonium from fission products, and partitioning and purification of neptunium. Cell D also contains process equipment to remove transuranic elements from the aqueous waste streams and vitrifying waste.

Fluorinel Dissolution Process Facility. FDPF is in the Idaho Nuclear Technology and Engineering Center (INTEC), which is located northeast of the Central Facilities Area at INEEL and approximately 3.2 kilometers (2 miles) southeast of ATR. **Figure S–2** presents a map of the INEEL site that depicts the location of FDPF. FDPF is proposed for fabrication of neptunium-237 targets, and processing of irradiated neptunium-237 targets for two irradiation options in Alternative 1 (Restart FFTF), three irradiation options in Alternative 2 (Use Only Existing Operational Facilities), and one irradiation option in Alternative 3 (Construct New Accelerator[s]) and Alternative 4 (Construct New Research Reactor).

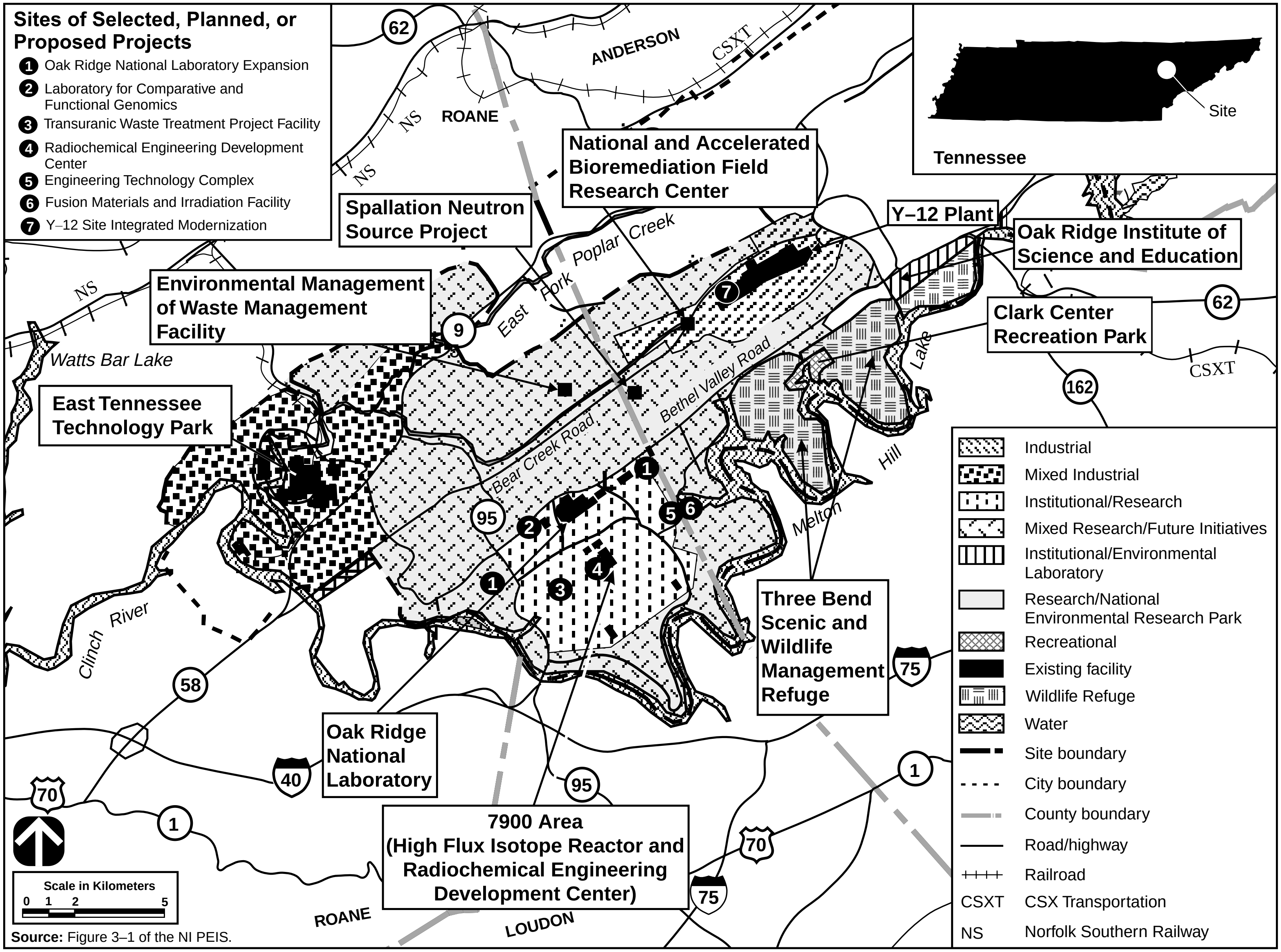

Figure S–1 Generalized Land Use at Oak Ridge Reservation and Vicinity

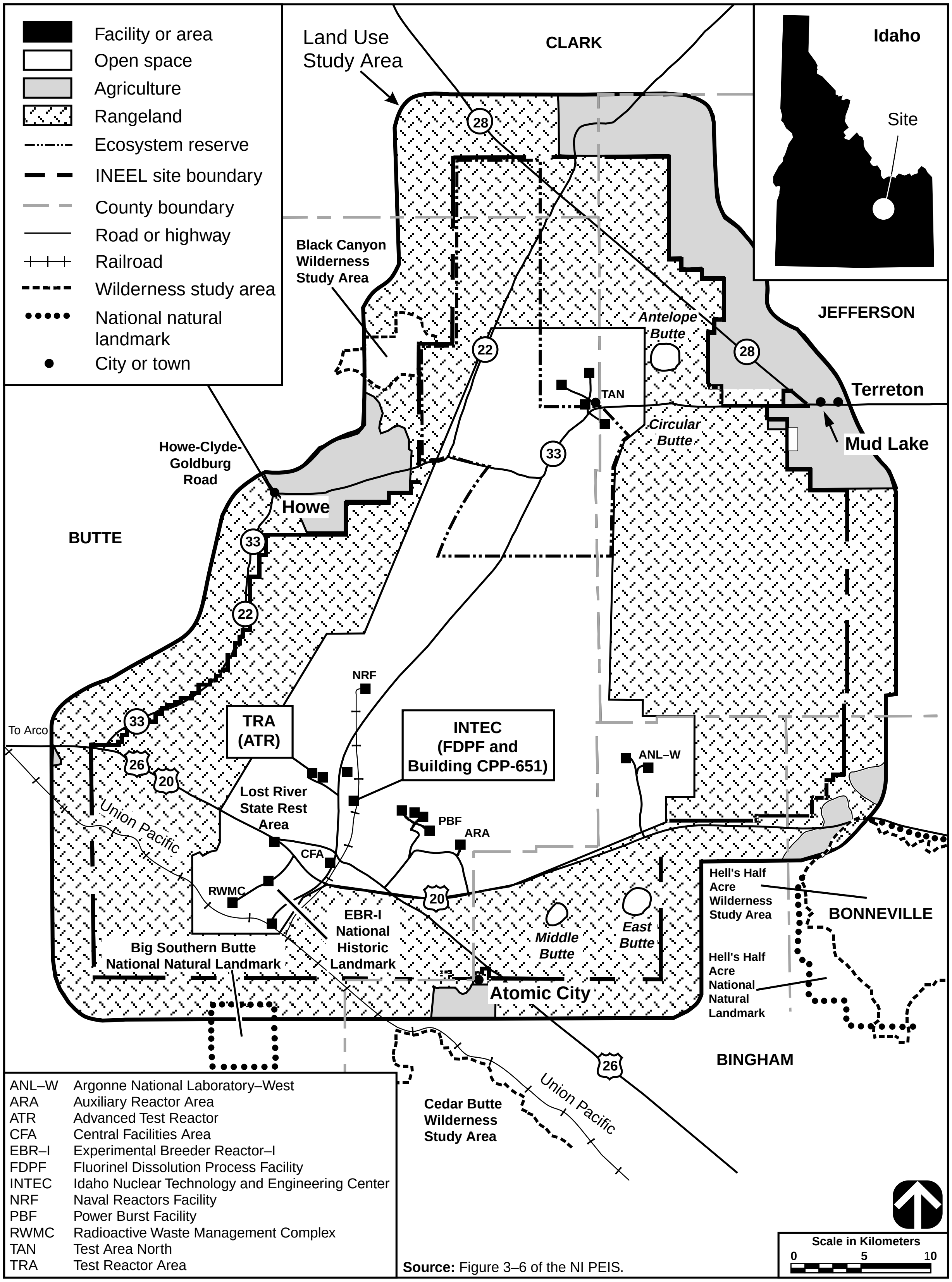

Figure S–2 Generalized Land Use at Idaho National Engineering and Environmental Laboratory and Vicinity

FDPF has no current mission. Historically, INTEC reprocessed spent nuclear fuel from U.S. Government reactors to recover reusable highly enriched uranium. After DOE announced in April 1992 that it would no longer reprocess spent fuel, reprocessing operations at INTEC ended. Two buildings at INTEC are candidate storage and processing sites for plutonium-238 production: Building CPP–651, the Unirradiated Fuel Storage Facility, and Building CPP–666, FDPF.

Building CPP–651 was originally designed for the storage of special nuclear materials to support Defense Programs and is flexible in terms of the size and shape of special nuclear materials that it can receive and store. The 100 storage positions in the vault use the existing structural barriers of Building CPP–651 (earth and concrete) and provide supplemental security protection via their in-ground concrete storage silo design. Each storage position houses a rack that holds seven highly enriched uranium product cans. Racks are raised and lowered in their storage positions via an overhead 1-ton hoist.

Building CPP–666 is divided into two parts, the Fuel Storage Facility and FDPF. The Fuel Storage Facility consists of receiving and unloading areas, a fuel unloading pool, and six storage pools for storing nuclear fuel. FDPF was designed and built to process Navy fuel via three dissolver trains. When fuel reprocessing was discontinued, uranium and hazardous materials were flushed from FDPF, and the facility is currently under consideration for new missions. FDPF consists of a large hot cell and supporting areas with a total area of approximately 3,700 square meters (40,000 square feet). The facility is divided into five levels identified by their elevation relative to ground level.

The chemical separation would take place in the FDPF cell using small centrifugal contactors installed for that purpose. Storage of neptunium-237 would be performed in Building CPP–651, which is located within 100 meters (328 feet) of FDPF. There are 100 in-ground concrete-shielded storage well positions in this vault. Each storage well contains a rack that can be modified to house cans of neptunium-237.

Fuels and Materials Examination Facility. Use of Hanford's FMEF is proposed for storage of neptunium-237 in one option of the No Action Alternative. It is also proposed for storage of neptunium-237, fabrication of neptunium-237 targets, and processing of irradiated neptunium-237 targets for two irradiation options in Alternative 1 (Restart FFTF), three irradiation options in Alternative 2 (Use Only Existing Operational Facilities), and for one irradiation option in Alternative 3 (Construct New Accelerator[s]) and Alternative 4 (Construct New Research Reactor). In addition to the support of the plutonium-238 production mission activities in Alternative 1, FMEF would also support medical and industrial production mission and civilian nuclear energy research and development mission activities at the Hanford Site. FMEF would have no role in supporting Alternative 5 (Permanently Deactivate FFTF [with No New Missions]). FMEF is adjacent to the west of FFTF in the 400 Area of Hanford. **Figure S–3** presents a map of Hanford that depicts the location of FMEF. FMEF was built during the late 1970s and early 1980s as a major addition to the breeder reactor technology development program at Hanford. Although it has never been used, the facility was constructed to perform fuel fabrication and development and postirradiation examination of breeder reactor fuels.

FMEF is currently being maintained in a condition suitable for a future mission. In 1998, FMEF was placed into a partial layup condition in order to reduce the cost of maintaining the facility. Many systems were shut down and most hazardous materials were removed from the building. However, FMEF is considered clean and uncontaminated because no nuclear materials have been introduced. Some critical systems remain in operation, e.g., the fire detection and protection systems. In order to avoid freezing of the fire protection water systems, limited heating and ventilation remains available. For example, the heating, ventilating, and air conditioning system has been modified to simplify its operation by clocking automatic dampers in appropriate configurations. Also, although the chillers have been laid up, including removal of the refrigerant, the chilled water system (containing an ethylene glycol-water mixture) remains available to help distribute heat within

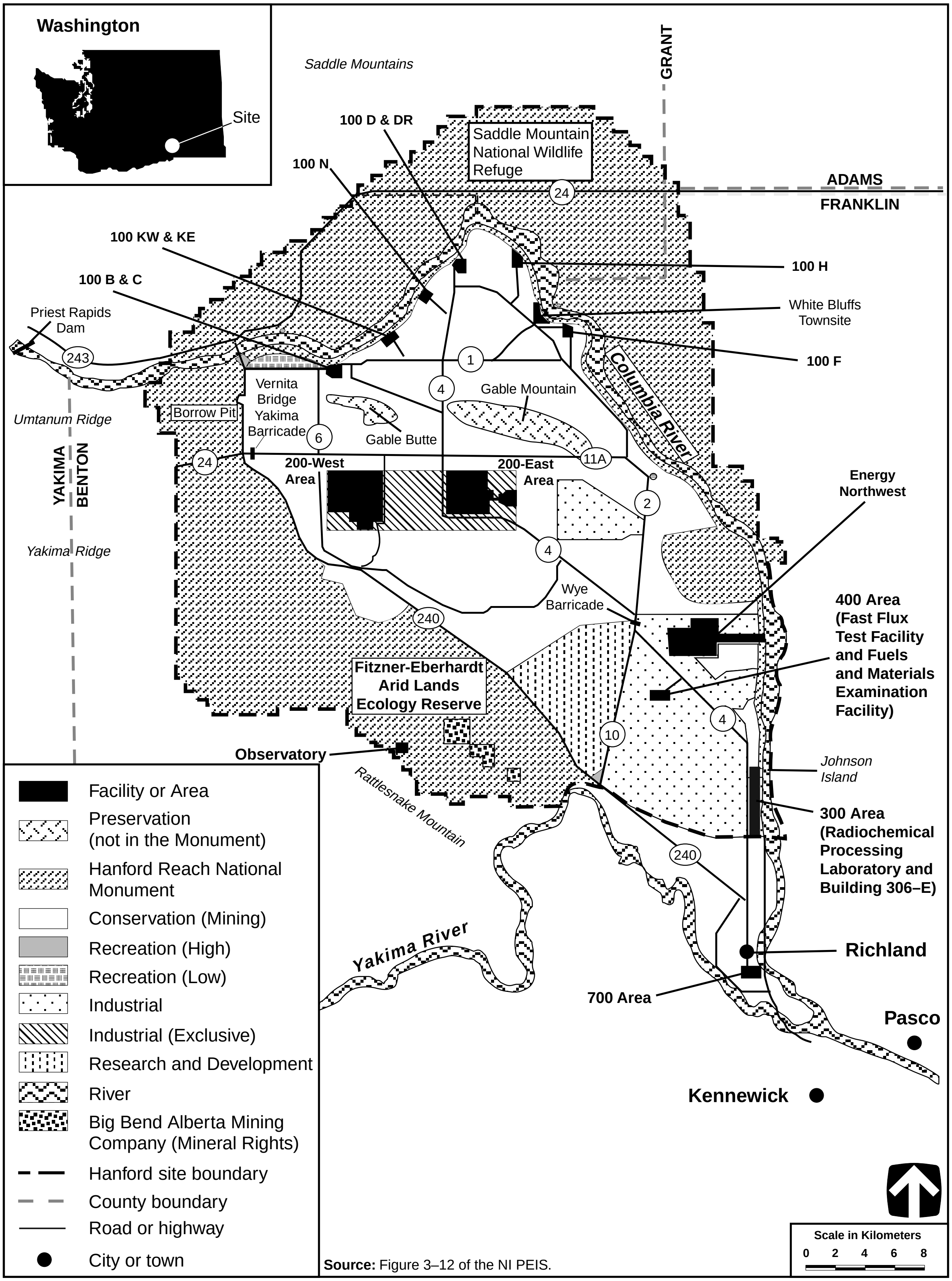

Figure S–3 Generalized Land Use at the Hanford Site and Vicinity

the building. Electrical power and lighting remain available, and the freight elevator remains in service to support routine facility walkdowns and any required maintenance. FFTF staff conducts surveillance and maintenance of FMEF.

FMEF consists of a 30-meter (98-foot) high Process Building, which has an attached Mechanical Equipment Wing on the west side and an Entry Wing on the south (front) side. The Mechanical Equipment Wing houses utility and support equipment, including water treatment equipment, air compressors, and a portion of the air conditioning equipment. The Entry Wing contains space for reactor fuel assembly (recently used as a training facility in support of Hanford's cleanup mission), lunchroom and change rooms, and heating and air conditioning equipment associated with the Entry Wing. Office space and administrative support areas are also housed on the second floor of the Entry Wing.

The Process Building is approximately 53.3 meters (175 feet) wide by 82.3 meters (270 feet) long, and extends from around 10.7 meters (35 feet) below grade to 30 meters (98 feet) above grade. Total potential operating space is approximately 17,470 square meters (188,000 square feet). The Process Building contains several large interconnected hot cells and many smaller connected hot cells. Major cranes are available, but some cranes, windows, and manipulators were not installed because construction of FMEF was halted prior to completing work on the hot cell complex. Nevertheless, the building is divided into six operating floors or levels, which are identified by their elevation relative to ground level and their primary function. The use of FMEF for neptunium-237 target material storage, target fabrication, and postirradiation processing would require the construction of a new 76-meter (250-foot) stack. The neptunium dioxide containers will be stored in specially designed storage vaults to provide secure, safe storage for the materials.

Hanford 300 Area Facilities (Radiochemical Processing Laboratory/Building 306–E). Two Hanford 300 Area facilities are proposed to support medical and industrial isotope target fabrication and postirradiation: RPL and the Development Fabrication Test Laboratory (Building 306–E). The facilities support the four irradiation options in Alternative 1 (Restart FFTF) that are not supported by FMEF. RPL/306–E would be used to support medical and industrial isotope production and civilian nuclear energy research and development activities. These activities would not impact current missions at the facilities. RPL/306–E have no role in support of the No Action Alternative, Alternative 2 (Use Only Existing Operational Facilities), Alternative 3 (Construct New Accelerator[s]), Alternative 4 (Construct New Research Reactor), and Alternative 5 (Permanently Deactivate FFTF [with No New Missions]). Figure S–3 presents a map of Hanford that depicts the location of RPL/306–E.

Radiochemical Processing Laboratory: The research and development activities of the Radiochemical Processing Group are conducted at RPL in the 300 Area of Hanford. RPL consists of a central area that contains general purpose laboratories designed for low-level radioactive work, a front wing that contains office space and shops, and two annexes that provide shielded enclosures with remote manipulators for high-level radiochemical work. The facility also contains laboratories and specialized facilities designed for work with nonradioactive materials, microgram-to-kilogram quantities of fissionable materials, and up-to-megacurie quantities of radionuclides. RPL would be the primary site for fabricating the radioactive targets (i.e., targets containing radium-226 or recycled materials from previous irradiations).

Total space within RPL is 13,350 square meters (143,700 square feet), of which 4,140 square meters (44,500 square feet) are occupied by general chemistry laboratories. A recent space utilization survey of RPL indicated that 646 square meters (6,950 square feet), representing 15.6 percent of the laboratory area, are presently unoccupied. All of the occupied and nearly all of the unoccupied laboratories are functional and are fully equipped with standard utilities. Several of the laboratories, especially those used for radioanalytical work, have been renovated during the past few years. Upgrading and modernization of the equipment within the chemistry laboratories has been given a high priority during the past 2 years. During the space utilization survey at RPL, an assessment was made of the number of fume hoods and shielded gloveboxes (including several small hot cells) that are available in the chemistry laboratories for additional programmatic work. Of the 79 functional fume hoods and 23 shielded gloveboxes, 50 fume hoods and 15 gloveboxes are available for additional work.

A special feature of RPL is the existence of two heavily shielded hot cell facilities located in annexes on the east and west sides of the building. These shielded facilities are the High-Level Radiochemistry Facility and the Shielded Analytical Laboratory. These two hot cell complexes are heavily used because they provide capabilities for conducting bench-scale to pilot-scale work with a wide variety of highly radioactive materials. Their capabilities include those required to conduct radiochemical separation and purification procedures, irradiated fuel or target sectioning and processing, metallography, physical properties testing of activated metals, thermal processing (including waste vitrification), and radioanalytical and preparatory chemistry operations.

The High-Level Radiochemistry Facility contains three large, interconnected hot cells designated as A-Cell, B-Cell, and C-Cell. Each of the three cells is 4.6 meters (15 feet) high and 2.1 meters (7.0 feet) deep. The A-Cell is 4.6 meters (15 feet) wide, and the B-Cell and C-Cell are each 1.8 meters (6.0 feet) wide. In-cell operations are performed using medium-duty electromechanical manipulators, and operators view their work through leaded-glass, oil-filled windows. Closed-circuit television cameras and videocassette recorders have been installed for detailed inspection work within the hot cells. The A-Cell and C-Cell also have overhead bridges that contain hoists with a 2,200-kilogram (4,840-pound) capacity. The hot cells are fully equipped with utilities and have shielded service penetrations at the front wall to allow insertion of special instruments. Each hot cell contains several process vessels located below the work deck that range in capacity from 4.0 to 320 liters (1.1 to 84.5 gallons). A large shielded door and a shielded double-door transfer port located in the rear wall of the cell provide access to each hot cell in the High-Level Radiochemistry Facility. Cask payloads weighing up to 2,200 kilograms (4,840 pounds) can be transferred into and out of the hot cells using a bridge crane located in the canyon behind the cells.

The Shielded Analytical Laboratory contains six interconnecting hot cells, each of which is 1.7 meters (5.5 feet) wide, 1.7 meters (5.5 feet) deep, and 2.9 meters (9.5 feet) high. Each hot cell is equipped with a pair of medium-duty manipulators. Turntables built into the rear walls of the hot cells provide rapid transfers of radioactive samples into and out of the cells. The Shielded Analytical Laboratory hot cells are equipped to perform a wide variety of analytical chemistry operations with highly radioactive samples.

Building 306–E: Building 306–E was constructed in 1956 as part of the nuclear material production program at Hanford, and was used to develop the co-extrusion process for N-Reactor fuel. Major upgrades and renovations were completed in the late 1960s and early 1970s to support the civilian reactor development program (Liquid Metal Reactor Program–FFTF). The building has 4,273 square meters (46,000 square feet) of floor space, with a 36.5-meter by 61-meter by 6.4-meter high (120-foot- by 200-foot- by 21-foot-high) bay containing three 10-ton, one 5-ton, and one 1.5-ton cranes. The facility has electron beam laser welding, certified nondestructive testing, a 3.7-meter by 3.7-meter (12-foot by 12-foot) vertical assembly and test station with 24.4-meter (80-foot) hook height, a machine shop, and an instrument development laboratory.

The building is serviced by three 1,416-cubic-meter-per-minute (50,000-cubic-feet-per-minute) supply units complete with filters, steam coils and spray chambers. Two of the units have refrigeration coils for summer time cooling. Two ceiling mounted 1,012-cubic-meter-per-minute (35,750-cubic-feet-per-minute) recirculation fans with freon compressors provide additional cooling and air movement. Fume hoods have individual exhaust fans. Chemical and acid tanks exhaust through two 340-cubic-meter-per-minute (12,000-cubic-feet-per-minute) fume scrubbers to a 12.2-meter-high 7.6-centimeter diameter (40-foot-high 3-inch diameter) stainless steel exhaust stack. Equipment exhaust collects through a grid that leads to two 566-cubic-meter-per-minute (20,000-cubic-feet-per-minute) exhaust fans. Plastic hoods and duct work are provided for highly corrosive service. Major equipment includes three industrial x-ray machines, a 6-kilowatt Hamilton Standard electron beam welder, five open face hoods, two inert gas welding chambers and one electrolytic cutoff saw.

Utilities include hot and cold water, deionized water, propane, helium, compressed air, argon, steam, and sanitary and process sewers as well as a special acid drain and neutralizing tank. Normal power is provided by a 1500-kilovolt-ampere transformer with 15-kilovolt-ampere backup power from an adjoining building, and a 30-kilovolt-ampere emergency transformer. The building is protected by redundant emergency alarm systems, fire gongs, and an evacuation siren.

New Support Facility. A new generic support facility would have the mission of preparing medical and industrial isotope targets for irradiation, processing exposed targets, and housing the materials research and development activities in association with Alternatives 3 and 4. Siting of the generic support facility for medical and industrial isotope production would require that the facility be located in the same general vicinity (0.2 to 20 kilometers [0.07 to 12.4 miles]) as the new irradiation facility (accelerator or reactor). Colocation with the irradiation facility would be needed to process some irradiated target materials promptly after removal from the reactor/accelerator. Colocation would also minimize transportation time, which is desirable because some isotopes have short half-lives. Although the facility could be located within the irradiation facility security protection area, the lack of a defense mission and the lack of a fissile material presence in the generic support facility indicates that a high level of physical protection would not be warranted.

The generic support facility mission would be accommodated by a one-story, 3,345-square-meter (36,000-square-foot) above-grade building with a 1,490-square-meter (16,000-square-foot) basement area under a portion of the footprint. The facility is designed around a center area containing the highest-risk activities and the material inventories requiring the highest level of engineered controls. Irradiated materials in casks or other shielded transport containers would enter a loading dock with a straight-line access to the primary facility hot cell. The hot sample entry area would be a high bay area with a high floor loading area between the loading dock and the hot cell access port. This configuration would allow transport cask access to the hot cell. In addition, an overhead hoist would be available to facilitate handling of materials and devices in the proximity of the hot cell.

The hot cell would accept high-radiation-level samples or those difficult to shield or manipulate (e.g., reactor core components containing samples). The hot cell would have access to a conveyor that can remotely transport samples to the hot process laboratories. In addition, samples from the hot cell could be transferred to the hot research and development laboratory gloveboxes for detailed analysis and testing. Hot cell manipulators would be located on both the operating gallery and the research and development sides of the hot cell. Adjacent to that would be the central receiving station for all other radioactive and short-exposure samples not in the reactor core components. This area, while not a hot cell, would provide personnel protection (i.e., shielding and controlled ventilation) for preliminary sample preparation and examination. It would also provide interim irradiated sample storage prior to delivery to the designated processing laboratory. When needed, samples would be transported remotely to the processing laboratories by the conveyor system.

Samples requiring a lesser degree of control would be distributed for processing throughout the remaining process laboratory wing. After processing, the radiopharmaceuticals would be either stored or packaged and shipped immediately to offsite vendors. Radioactive waste would be packaged and stored for eventual disposal. Those materials containing short-lived isotopes would be delivered to a decay/holding room so that, given appropriate decay time, they could be disposed of without a radioactive component. The process and research and development areas would be considered radiologically controlled areas, but no routinely occupied areas would require control as contaminated radiological areas. Radioactive contamination would be controlled at the hood or glovebox face. Due to this configuration, protective clothing and change rooms would be needed only for occasional maintenance activities when temporary radiological areas are established. Cold sample (nonradioactive) preparation would be accomplished in a set of three large laboratories where radiological conditions are not anticipated. Completed samples would be stored in an adjacent room along with raw sample materials (nonradioactive). Radioactive sample preparation and irradiated material recycling activities would be conducted in one of the laboratories adjacent to the conveyor. Irradiated research and development samples introduced into the hot cell could be processed or examined using manipulators within the hot cell. Samples could also enter the research and development suite of lab rooms through the hot cell port into a hot cell or glovebox. From there, they could be moved to additional research and development laboratory rooms within a controlled environment for detailed analysis and testing.

Target Irradiation Facilities

Fast Flux Test Facility. FFTF is proposed to support the three proposed missions: (1) plutonium-238 production, (2) medical and commercial isotope production, and (3) civilian nuclear energy research and development.

FFTF is a 400-megawatt thermal, liquid-cooled (sodium) nuclear test reactor that is owned by DOE and is at the Hanford Site in southeastern Washington State near Richland, Washington. Figure S–3 presents a map of Hanford that depicts the location of FFTF. Following extensive testing, FFTF was started in April 1982. During its operation, FFTF successfully tested advanced nuclear fuels, materials, components, operating protocols, and reactor safety designs. FFTF also produced a wide variety of medical isotopes and made tritium for the U.S. fusion research program.

FFTF was originally designed and operated as a science test bed for U.S. liquid metal fast reactor programs. These programs, which were canceled in 1993, were key elements both in closed fuel cycle and actinide waste disposition technology development. In December 1993, DOE decided not to operate FFTF due to a lack of economically viable missions at that time. In accordance with NEPA, DOE published an environmental assessment (EA) and Finding of No Significant Impact (FONSI) for the shutdown and deactivation of FFTF in May 1995 (DOE 1995a). The EA contained an evaluation of the environmental impacts associated with the actions necessary to place FFTF in a radiologically and industrially safe shutdown condition suitable for long-term surveillance and maintenance before final decontamination and decommissioning.

The FFTF complex includes the reactor, as well as equipment and structures for heat removal, containment, reactor safety and shutdown systems core component handling and examination, fuel off-loading and storage, utilities, and other essential services. There are 100 systems supporting various functions of FFTF during operations. The central structure of FFTF is the reactor containment building, an all-welded cylindrical steel structure 41 meters (135 feet) in diameter and 57 meters (187 feet) high. The reactor is located below grade in a shielded cell in the center of the containment structure. Heat is removed from the reactor by circulating liquid sodium under low pressure through three separate closed primary piping loops, which include pumps, piping, and intermediate heat exchangers. These loops are located within inerted cells (cells filled with inert gases) within the containment structure. Three secondary sodium loops transport reactor heat from the intermediate heat exchangers to the air-cooled tubes of the dump heat exchangers. From there, the heat dissipates into the atmosphere through the forced draft dump heat exchanger. [Commercial nuclear power reactors use reactor heat to create steam, which turns a turbine to produce electricity. FFTF, however, does not generate electricity.]

FFTF has demonstrated its capability to function as a nuclear science and irradiation services user facility. It has five distinct features: size, flux, test evaluation and irradiation capabilities, fuel type, and coolant type. In combination, these features provide a multipurpose facility suitable for medical and industrial isotopes production, plutonium-238 production, and civilian nuclear energy research and development purposes.

Although FFTF was used primarily to evaluate reactor fuels and different fuel assembly materials during its 10 years of operation, the reactor facility has also supported large and varied test programs for industry, nuclear energy (domestic and international), medical isotope applications and research, space nuclear power, and fusion research programs.

FFTF is currently defueled and is being maintained in a standby condition. Seventy-seven of the 100 systems are operational; the other 23 are in a recoverable standby state. System integrity and configuration control are being maintained. The Main Heat Transport System is being operated at approximately 200 °C (400 °F) to keep the sodium coolant in the reactor liquefied and circulating. If a decision were made to restart FFTF, several equipment upgrades are planned to return systems to operation, improve reliability, conform to current standards, improve efficiency, and minimize waste. Most of the required modifications would consist of either mechanical equipment upgrades or replacement of outdated control and computer systems.

The NI PEIS postulates that FFTF would operate at a nominal power level of 100 megawatts, one quarter of the reactor design power level, to meet the irradiation requirements of the proposed missions. Periodic increases in power level between 100 and 400 megawatts may be required to support civilian nuclear energy research and development activities. Operating FFTF at a nominal 100-megawatt power level extends the reactor life and significantly reduces the generation rate of spent fuel. FFTF is currently designed to operate using mixed oxide fuel, however, it can also be operated using highly enriched uranium fuel.

There are eight locations available in the FFTF reactor core that are termed Open Test Assembly positions. These positions are located under spool pieces in the reactor head and allow the installation of 38-foot-long assemblies that extend from the reactor head down to the reactor core. Within the 82 active core locations, there are up to 20 or more additional locations that could contain a standard length (3.6-meter or 12-foot) test assembly. In addition to the test locations within the active fueled region of the core, there are 108 locations available in the surrounding reflector region where other tests could be inserted.

The FFTF core would be modified to include an array of target assemblies and rapid radioisotope retrieval systems capable of producing a number of long- and short-lived isotopes for medical and industrial applications and plutonium-238 for space power applications. In addition, reactor space would be provided for research and development test articles.

Fifteen plutonium-238 production targets would be included in the reflector region with an annual production rate of 5 kilograms. The residence time for these targets would be three 100-day cycles with five assemblies being harvested at the end of each cycle.

Long-Term Irradiation Vehicles would be used to irradiate targets to produce long-lived isotopes, installed in the reactor during normal refueling operations, and handled using standard FFTF handling equipment. The Long-Term Irradiation Vehicle would consist of a bundle of target pins installed inside a nozzle, duct, and handling socket assembly similar in appearance to an FFTF 3.6-meter (12-foot) long fuel assembly. Rapid radioisotope retrieval systems would be installed in selected Open Test Assembly positions for the production of short-lived isotopes. There would be a maximum of eight systems in the core.

Advanced Test Reactor. ATR is a light-water-cooled and moderated reactor with a design thermal power of 250 megawatts that is owned by DOE and is in the Test Reactor Area in the southwest portion of INEEL. Figure S–2 presents a map of INEEL that depicts ATR's location. ATR would continue to operate and meet its current mission requirements including naval reactor research and development, medical and industrial isotope production, and civilian nuclear energy research and development activities, at its current operating levels under the No Action Alternative, Alternative 1 (Restart FFTF), Alternative 3 (Construct New Accelerator[s]), Alternative 4 (Construct New Research Reactor), Alternative 5 (Permanently Deactivate FFTF [with No New Missions]), and Alternative 2 (Use Only Existing Operational Facilities) when it is not providing irradiation services in support of the plutonium-238 production mission. When ATR is supporting the plutonium-238 production mission, it would fully support its primary mission, naval reactor research and development; however, it would support the medical and industrial isotope production and civilian nuclear energy research and development activities to the extent possible within its current reactor operating levels. Consideration must be given to the need to maintain appropriate levels of neutron flux to support ATR's primary mission. Neutron flux levels can be impacted by the placement of targets, such as neptunium-237 targets for production of plutonium-238, in the reactor core. The production planning assumption for ATR is from 3 kilograms (6.6 pounds) of plutonium-238 per year (if used in conjunction with HFIR) to 5 kilograms (11 pounds) of plutonium-238 per year (if ATR were used alone). Thus, ATR alone could meet the program goal of up to 5 kilograms (11 pounds) per year and could be used in combination with any one of the three processing facilities for the plutonium-238 production mission.

Special features of ATR include high neutron flux levels (ranging from 1×10^{15} neutrons per square centimeter per second in the flux traps to 1×10^{13} neutrons per square centimeter per second in the outer reflector positions) and the ability to vary power to fit different experiment needs in different test positions. The primary user of ATR is the U.S. Naval Nuclear Propulsion Program. A variety of other users include foreign and domestic government programs, a commercial isotope production company, industrial customers, and research and development interests. A number of support facilities are important to the operation of ATR. Among these are the Advanced Test Reactor Critical Facility, which is used to baseline experiment impacts to ATR flux profile, and the Nuclear Materials Inspection and Storage facility, which is used to receive, store and inspect reactor fuel prior to its placement in ATR.

The reactor, its primary coolant system, control room, and much of its auxiliary and experimental support equipment are in Test Reactor Area Building 670. ATR began operation in 1967 and is expected to continue operating for several decades. The reactor vessel is entirely stainless steel and the core internals are replaced every 7 to 9 years. Buildings and structures in other parts of the Test Reactor Area provide additional support functions.

ATR is currently operating at approximately 140 megawatts or less. ATR operates with highly enriched uranium fuel. Typical operating cycles are 42 days or 49 days at power followed by a 7-day outage for refueling and changeout of experiments and isotope production targets. The core is 1.2 meters (4 feet) high and is surrounded by a 1.3-meter-diameter (4.25-foot-diameter) beryllium reflector. Beryllium is an excellent neutron reflector and is used to enhance the neutron flux essential to a test reactor. ATR has nine flux traps in its core and achieves a close integration of flux traps and fuel by means of a serpentine fuel arrangement. When viewed from above, the ATR fuel region resembles a four-leaf clover. The four flux traps positioned within the four lobes of the reactor core are almost entirely surrounded by fuel, as is the center position. Four other flux trap positions between the lobes of the core have fuel on three sides. The ATR's unique control device design permits large power shifts among the nine flux traps. Testing can be performed in test loops installed in some flux traps with individual flow and temperature control or in reflector irradiation positions with primary fluid as coolant. The curved fuel arrangement brings the fuel closer on all sides of the test loops than is possible in a rectangular grid.

Of the nine flux traps, five are configured with pressurized-water loops that allow for individual temperature, pressure, flow, and chemistry controls. The five test loops are used by the Naval Reactors program. Of the remaining four flux traps, one is dedicated to the Naval Reactors program, one is used for isotope production, one is used for low-specific-activity cobalt production, and the fourth has recently had the Irradiation Test Vehicle installed. The Irradiation Test Vehicle can be described as three small pressurized-gas test loops. The use of one of these three test loops was recently purchased by a British corporation; negotiations for use of the other two are currently under way.

In addition to the primary flux trap irradiation positions, there are some 70 irradiation positions in the beryllium reflector (and aluminum support structure) that are available for experiment irradiation and isotope production. These position diameters range from 1.6 centimeters (0.625 inch) to 12.7 centimeters (5.0 inches) with thermal neutron flux levels ranging from 1×10^{15} neutrons per square centimeter per second to 1×10^{13} neutrons per square centimeter per second.

INEEL has privatized the production of medical and industrial isotopes through contracting with a commercial entity, which specializes in producing isotope targets for irradiation in ATR and processing and distributing commercial-grade isotopes to its customers. Prior to commercialization, INEEL's isotope production operations were limited in types and quantities. Since the start of commercial activities, production has expanded. Incremental investments have been identified for ATR that would make it a more versatile and capable reactor for isotope production. Commercial companies are in the discussion phase of investing in ATR to install an isotope shuttle (or rabbit) system for the production of short-lived radioisotopes. Many of these short-lived radioisotopes are expected to be in growing demand for various cancer therapies.

High Flux Isotope Reactor. HFIR is a beryllium-reflected, light-water-moderated and -cooled reactor operating at a thermal power level of 85 megawatts. HFIR is owned by DOE and is in the 7900 Area in the southern portion of ORR. Figure S–1 presents a map of ORR that depicts the location of HFIR.

HFIR would continue to be operated to meet the primary mission of neutron science based research for DOE's Office of Science. In addition, medical and industrial isotope production and civilian nuclear energy research and development activities would be performed on a not-to-interfere basis at the current operating level in the No Action Alternative, Alternative 1 (Restart FFTF), Alternative 3 (Construct New Accelerator[s]), Alternative 4 (Construct New Research Reactor), Alternative 5 (Permanently Deactivate FFTF [with No New Missions]), and Alternative 2 (Use Only Existing Operational Facilities). When HFIR is supporting the plutonium-238 production mission, it would fully support its primary mission, but would support the medical and industrial isotope production and civilian nuclear energy research and development activities to the extent possible within the current reactor operating levels. Consideration must be given to the need to maintain appropriate levels of neutron flux to support HFIR's primary mission. Neutron flux levels can be impacted by the placement of targets, such as neptunium-237 targets for the production of plutonium-238, in the reactor core. Under the planning assumptions for plutonium-238 production, HFIR could only produce from 1 to 2 kilograms (2.2 to 4.4 pounds) per year without impacting ongoing missions. As the program goal is to achieve a production rate of 5 kilograms (11 pounds) per year, production at HFIR would need to be augmented by the use of ATR to meet this goal. HFIR and ATR together could meet the program goal of up to 5 kilograms (11 pounds) per year, and could be used in combination with any one of the three processing facilities for the plutonium-238 production mission.

HFIR was originally designed as both an isotope production and a research reactor with a thermal flux of 3 to 5×10^{15} neutrons per square centimeter per second and a full power level of 100 megawatts-thermal (3.4×10^{8} British thermal units per hour). It is currently operating at a maximum authorized power level of 85 megawatts-thermal (2.9×10^{8} British thermal units per hour) to extend the useful life of the reactor. Many experiment-irradiation facilities were provided for in the original design and several others have been added. The primary mission of HFIR is neutron science research. Isotope production is done on a not-to-interfere basis.

HFIR transfers its primary coolant heat load to secondary coolant through heat exchangers for dissipation to the atmosphere by an induced-draft cooling tower. The reactor uses highly enriched uranium and aluminum-clad plate fuel. The reactor vessel itself is immersed in a pool in a poured-concrete reactor building that also houses the primary coolant pumps and heat exchangers, a spent fuel pool, and experiment areas. The control and water wing of the reactor building contains the reactor control room; relay and amplifier areas; heating and ventilating equipment; pool and fire alarm equipment; instrumentation systems; and office and support rooms. A separate electrical building adjacent to the reactor building contains switchgear, diesel generators, and associated transformers that connect the facility to offsite power. The reactor building is essentially airtight and provides dynamic confinement. A special hot exhaust system exhausts air from potentially contaminated areas of the building through filters (two high-efficiency particulate air and two charcoal filters) before being released to the atmosphere through a 76-meter (250-foot) stack. The stack serves as the exhaust point for both HFIR and REDC at ORNL.

After the reactor completed 17.2 full-power years of its 20 full-power year design life in November 1986, several measures were taken to extend the useful life of the reactor, including reducing the 100 megawatts-thermal (3.4×10^8 British thermal units per hour) rated power level to 85 megawatts-thermal (2.9×10^8 British thermal units per hour); adjusting the primary coolant temperature and pressure; conducting periodic hydrostatic tests; establishing an irradiation embrittlement surveillance program; and installing an emergency depressurization system. Subsequent life extension programs can enable HFIR to provide support during the total 35-year evaluation period for operations.

Experiment-irradiation facilities available include (1) the hydraulic tube facility, located in the very high flux region of the flux trap, which allows for insertion and removal of irradiation samples while the reactor is operating; (2) 30 target positions in the flux trap, which normally contain transuranium production rods but which can be used for the irradiation of other experiments (two are instrumented target positions provided by a recent modification); (3) six peripheral target positions located at the outer edge of the flux trap; (4) numerous vertical irradiation facilities of various sizes located throughout the beryllium reflector; (5) two pneumatic tube facilities in the beryllium reflector, which allow for insertion and removal of irradiation samples while the reactor is operating for activation analysis; (6) four horizontal beam tubes, which originate in the beryllium reflector; and (7) four slant access facilities, called "engineering facilities," located adjacent to the outer edge of the beryllium reflector. In addition, spent fuel assemblies are used for gamma irradiation in the gamma irradiation facility in the reactor pool.

The reactor core assembly is contained in a 2.44-meter (8-foot) diameter pressure vessel located in a pool of water. The top of the pressure vessel is 5.18 meters (17 feet) below the pool surface, and the reactor horizontal midplane is 8.38 meters (27.5 feet) below the pool surface. The control plate drive mechanisms are located in a subpile room beneath the pressure vessel. These features provide the necessary shielding for working above the reactor core and greatly facilitate access to the pressure vessel, core, and reflector regions.

The neutron flux within HFIR is primarily a thermal neutron flux ranging from approximately 2×10^{15} neutrons per square centimeter per second in the flux trap to approximately 4×10^{14} neutrons per square centimeter per second in the outer regions of the beryllium reflector. Specially designed neutron beam tubes provide access to neutrons that supply intense neutron beams to various specialized instruments used for neutron scattering research.

ORNL produces a variety of medical isotopes using the HFIR for irradiation and various hot cell and glovebox facilities for target fabrication and final product purification. The nine hydraulic tube positions in the central high flux region permit the insertion and removal of targets at any time during the operating cycle (22 to 24 days) and have traditionally represented a major site for the production of medical radioisotopes. In addition to providing radioisotopes for extramural research and development and commercial applications by distribution through the DOE Isotope Production and Distribution Program, there are medical radioisotope research and development programs at ORNL that depend on the availability of HFIR-produced radioisotopes.

Commercial Light Water Reactor. A CLWR would continue to operate and meet its primary mission requirement, providing steam for the generation of electrical power in the No Action Alternative, Alternative 1

(Restart FFTF), Alternative 3 (Construct New Accelerator[s]), Alternative 4 (Construct New Research Reactor), Alternative 5 (Permanently Deactivate FFTF [with No New Missions]), and Alternative 2 (Use Only Existing Operational Facilities) when it is not providing irradiation services in support of the plutonium-238 production mission. When the CLWR is supporting the plutonium-238 production mission, it would still fully support its primary mission. The production planning assumption for the generic CLWR is 5 kilograms (11 pounds) per year of plutonium-238 or 7.5 kilograms (16.5 pounds) per 18-month operating cycle. Thus, the CLWR alone could meet the program goal of up to 5 kilograms (11 pounds) per year and could be used in combination with any one of the three processing facilities for the plutonium-238 production mission. The use of a CLWR for the medical and industrial isotope production mission and the DOE civilian nuclear energy research and development mission were not considered practical.

A typical pressurized water reactor core consists of 170 to 200 fuel assemblies arranged in the reactor vessel in an approximately cylindrical pattern. Most pressurized water reactors operating in the United States are licensed to operate at thermal power levels of 2,500 to 3,500 megawatts (8.5×10^9 to 1.2×10^{10} British thermal units per hour) for net station electrical outputs of 800 to 1,200 megawatts electric (2.7×10^9 to 4.1×10^9 British thermal units per hour).

The nuclear steam supply system powered by the pressurized water reactor is generally arranged as two heat transport loops, each with two primary coolant circulating pumps and one steam generator in which the primary coolant dissipates heat generated in the reactor core to the secondary fluid in the steam generator. In addition to serving as a heat transport medium, the primary coolant also serves as a neutron moderator and reflector and as a solvent for the soluble boron used in chemical reactivity control. All nuclear steam supply system components are designed to withstand the effects of earthquakes and loss-of-coolant accidents.

The containment for a pressurized-water reactor plant consists of two structures: (1) a steel containment vessel and (2) a reinforced-concrete shield building. The containment, including all of its penetrations, is a low-leakage steel structure designed to withstand a postulated loss-of-coolant accident and to confine a postulated release of radioactive material. It houses the reactor pressure vessel, reactor coolant piping, pressurizer, pressurizer quench tank and coolers, reactor primary coolant pumps, steam generators, core flooding tanks, and letdown coolers. Safety systems directly associated with this vessel include the containment spray system, the containment air cooling system, and the containment isolation system. An annular space is provided between the wall of the containment vessel and the shield building. Overhead clearance from the dome of the shield building is also provided.

The shield building itself is a concrete structure surrounding the containment that is designed to provide biological shielding during both normal operations and hypothetical accident conditions. The shield building enables the collection and filtration of fission product leakage from the containment following a hypothetical accident by means of its emergency ventilation system. In addition, the shield building provides environmental protection for the containment from adverse atmospheric conditions and external missiles (e.g., tornado debris).

All fuel assemblies are identical in mechanical construction and are interchangeable in any core location. The basic fuel assembly is normally composed of 208 fuel rods, 16 control rod guide tubes, and one centrally located position for instrumentation, all within a 15×15 position square array. The fuel assembly is approximately 20.3×20.3 centimeters (8×8 inches) in cross section and has an overall length of 419 centimeters (165 inches).

The neptunium-237 targets can be placed in numerous locations within the reactor core region (i.e., fuel assembly region) and outside the reactor core region to be irradiated for the production of plutonium-238. Three potential target arrangements were considered for evaluation in the NI PEIS: (1) all targets located in the center fuel assembly position in the reactor core, (2) all targets distributed within locations in the reactor core, and (3) all targets distributed outside the reactor core region. The center fuel assembly position was selected for evaluation in the NI PEIS because it was assumed that this would be the worst-case location during postulated beyond-design-basis accident conditions. This assumption conservatively postulated that during a beyond-design-basis core disruptive accident, temperatures in the center fuel assembly position would reach levels that would fail the cladding on all of the neptunium-237 targets located in that position, resulting in worst-case releases.

The substitution of target rods for fuel rod positions in the center fuel assembly would only minimally impact reactor operations. The fuel rods located in the center fuel assembly position would normally not be fresh fuel (i.e., fuel inserted within the first 18-month operating cycle in the reactor); instead, they would be in their second or third operating cycle. The normal power distribution within the core and reactor coolant flow and its distribution within the core would remain within existing technical specification limits.

New Accelerator(s). One or two new accelerators would be constructed and operated in Alternative 3 (Construct New Accelerator[s]). Preconceptual designs have been developed for a low-energy accelerator and a high-energy accelerator for evaluation in the NI PEIS. The low-energy accelerator would support the medical and industrial isotope production missions and the civilian nuclear energy research and development mission. This could effectively be accomplished with accelerator energies in the range of 30 to 70 million electron volts. The high-energy accelerator design would support the plutonium-238 production mission and the civilian nuclear energy research and development mission. An accelerator with an energy level of 1,000 million electron volts is required to support the plutonium-238 and civilian nuclear energy research and development missions.

The preconceptual design of the high-energy accelerator presented in Appendix F of the NI PEIS focused on supporting the plutonium-238 production mission. Although not analyzed in the NI PEIS, the design of the high-energy accelerator could be refined and expanded to perform additional missions such as the production of a select set of medical and industrial radioisotopes. In addition, DOE is aware of longer-term concepts that would apply high-energy accelerators to produce "tuneable" neutrons in a subcritical assembly. Such a facility could be used to address some of the missions more familiar to reactor facilities and may hold considerable promise for future science and technology research. A facility of this nature could provide unique capabilities in areas such as the testing of many different nuclear system coolant, fuel, and materials interactions.

The accelerator(s) would be constructed and operated at one or two existing DOE sites. The low-energy accelerator would be located on the same DOE site as the new support facility or at a DOE site with an existing support facility. The high-energy accelerator could be located at a different DOE site. Alternative 3 site selection is not evaluated as part of the NI PEIS.

Because Alternative 3 is evaluated at a generic DOE site, no credit was taken for any existing support infrastructure at the site(s), and it was postulated that a new support facility would be required to support operation of the low-energy accelerator and its missions and the high-energy accelerator civilian nuclear energy research and development missions if both accelerators are located on the same site. While this approach bounds the environmental impact assessment for the implementation of Alternative 3, it overstates the impacts because the NI PEIS integrates the impacts associated with constructing new support facilities and infrastructure that may be available at the existing DOE site(s). In the event that Alternative 3 or the low-energy accelerator alone is selected in the Record of Decision for subsequent consideration, follow-on NEPA reviews would evaluate potential locations for either both or one of the accelerators. It is unlikely that DOE would consider locating the new low-energy or high-energy accelerator on a DOE site that does not have an existing infrastructure capable of supporting all or most of the mission requirements. To determine the environmental impacts if Alternative 3 is implemented at a site with adequate support infrastructure, the environmental impacts for the construction of the support facility could be subtracted from the environmental impacts of Alternative 3 as presented in the NI PEIS. Section 4.5 of the NI PEIS presents the environmental impacts from construction and operation of the new support facility separately.

Low-Energy Accelerator: Three low-energy accelerator options would be available for the production of medical and industrial isotopes and to support nuclear energy research and development: (1) a high-current proton linear accelerator, (2) a multiparticle cyclotron, or (3) a proton-only cyclotron. The proton-only cyclotron would have distinct technical advantages over the other two options and is described further in the section that follows.

The proton-only cyclotron can be either a positive proton or negative ion type and is referred to as a proton cyclotron H^+ or proton cyclotron H^-. The alternative of a positive proton cyclotron would offer lower vacuum requirements and, with the latest technology, high-extraction efficiency can be achieved. But obtaining variable energy output would be complicated; extraction can be into only a single port and splitting the beam would require a complicated septum magnet. In comparison, the negative ion cyclotron would offer a continuous beam with high-current capacity using very simple high-efficiency extraction, a simple method to vary the particle energy, and the possibility of simultaneous irradiation of two different target arrays at different energies. The high-extraction efficiency would be achieved simply by passing the negatively charged beam through a thin foil that strips the electrons from the ion, creating a positive proton. The proton would be directly ejected from the machine by the existing magnetic field with high efficiency (greater than 98 percent). This feature would be important to minimize the activation of the cyclotron structure and thus reduce radiation exposure to the operational staff.

A high-beam current would be advantageous because more products could be prepared in a shorter time. In addition, a much higher specific-activity radioisotope could be prepared at the higher-beam current of the cyclotron. Specific activity is often a critical parameter in many nuclear medicine applications, including research and clinical use. The cyclotron can also continuously tune the beam energy, which would be an advantage for research. The ability to tune the energy with precision can also help achieve high-purity isotope production by avoiding energies where impurity isotopes would be readily co-produced. These are important advantages for flexibility in research isotope production and are within the capabilities of commercially proven technology.

A new building, with a 43-meter (140-foot) by 43-meter (140-foot) footprint, would be constructed to house the cyclotron and the four beam lines. The walls of the facility would be 4.6 meters (15 feet) thick behind the target stations to minimize the neutron flux outside the building. The walls surrounding the cyclotron itself would be 3 meters (10 feet) thick. The mazes throughout the building in general would have walls 1.5 meters (5 feet) thick, so that the total thickness surrounding the cyclotron area would be 3 meters (10 feet). The beam would be diverted to the four target stations by switching magnets located in the cyclotron vault. The beam would be directed through focusing and steering magnets to the target. In the isotope production beam line (northwest cave), the targets would be installed and removed vertically from a hot cell, which would be located on the second floor directly above the target station. The power supplies for the magnets would be housed with the power supplies for the cyclotron. The mechanical equipment for cooling water would be housed in a shielded mechanical room adjacent to the cyclotron vault. Recirculating water for cooling of the targets and systems that could contain potentially radioactive material would be separated to prevent cross-contamination. These systems would be contained in mechanical equipment rooms near the respective target station. Piping would be contained in waterproof trenches with leak detection.

High-Energy Accelerator: In accelerator production of plutonium-238, an energetic beam of protons generated by a linear accelerator would be transported to a heavy metal target where spallation neutrons would be produced and moderated in a surrounding blanket. The blanket containing neptunium-237 would capture the slowed neutrons to produce plutonium-238 through the same nuclear sequence that occurs in a reactor. The accelerator would be housed in a concrete tunnel, buried below ground to provide radiation shielding for operating personnel. A building housing radio frequency power systems and other equipment used to drive, monitor, and control the accelerator would be located above ground close to the accelerator tunnel. The target/blanket assembly would be housed inside a steel and concrete shield located within a multistory building that would contain appropriate service equipment. At the target, the small-diameter proton beam transported magnetically from the accelerator would be converted to a much larger cross section by a beam expander to reduce the power density to acceptable levels for the target cooling systems.

A source of neutrons produced by an accelerator can be used to produce plutonium-238 from neptunium-237 feedstock through the capture and decay nuclear processes. A 1,000-million-electron-volt proton beam produced by a radio frequency linear accelerator would bombard a heavy metal (uranium-238) target, with each proton producing about 40 neutrons.

A very preliminary target/blanket design has been developed for scoping purposes, based on the architecture employed in the accelerator production of tritium target/blanket design. It would use uranium-238 (cooled by heavy water [D_2O]) as the neutron-production target. The target would be surrounded by a blanket of neptunium-237 in a dilute mixture of aluminum and water coolant. Enclosing the blanket would be a beryllium reflector.

To meet the plutonium-238 production goal of 5 kilograms (11 pounds) per year, the high-energy accelerator facility would conduct three 4-month production campaigns. Each campaign would be divided into 100 days of production and 21 days for recycling the production blanket. A 90 percent plant availability during the scheduled operating periods is assumed. Based on operating experience at the Los Alamos Neutron Science Center Linear Accelerator, the 90 percent plant availability should be achievable.

The preconceptual design of the high-energy accelerator presented in Appendix F of the NI PEIS focused on supporting the plutonium-238 production mission. While not evaluated in the NI PEIS, the design of the high-energy accelerator could be refined and expanded to perform additional missions such as the production of a select set of medical and industrial radioisotopes. In addition, DOE is aware of longer-term concepts that would apply high-energy accelerators to produce "tuneable" neutrons in a subcritical assembly. Such a facility could be used to address some of the missions more familiar to reactor facilities and may hold considerable promise for future science and technology research. A facility of this nature could provide unique capabilities in areas such as the testing of many different nuclear system coolant, fuel, and materials interactions. The accelerator designs for Alternative 3 were developed to a level of detail that was adequate to assess the environmental impacts associated with the construction and operation of the proposed facilities and the technical feasibility of meeting the mission objectives. In the event that the NI PEIS Record of Decision selects Alternative 3, DOE would prepare conceptual, preliminary, and detailed designs and optimize the facility designs to accomplish the stated missions. Additional NEPA review would be required for site selection and to evaluate the environmental impacts of integrating the more refined accelerator designs with the existing site infrastructure(s).

New Research Reactor. A new research reactor would be constructed and operated in Alternative 4 (Construct New Research Reactor). A preconceptual design for a new research reactor was developed to meet the following DOE missions: (1) producing medical and industrial isotopes, (2) producing plutonium-238 (annual production of up to 5 kilograms [11 pounds]), and (3) supporting nuclear energy research and development. In accordance with U.S. nuclear nonproliferation policy, a design limitation of this new research reactor is that it can only use low-enriched uranium with an enrichment of less than 20 percent uranium-235. This preconceptual design includes the basic elements of the research reactor facility, which are sufficient to support the NI PEIS, but does not include the design details (e.g., system and layout drawings, bill of materials, electrical and piping routing) commensurate with a complete preliminary reactor design.

The reactor design was developed to a level of detail that was adequate to assess the environmental impacts associated with the construction and operation of the proposed facilities and the technical feasibility of meeting the mission objectives. The design of the new research reactor is based on current research reactor designs that have been approved by both the NRC and the International Atomic Energy Agency, as well as nuclear regulatory authorities of many nations. Reactor core physics calculations were performed to evaluate three different nuclear fuel designs. Based on this analysis, the desired mission for this reactor, current nuclear fuel manufacturing capabilities, and safety considerations; a training, research, isotope General Atomics (TRIGA) production reactor fuel design was selected for the new research reactor. The principal distinguishing features of the TRIGA fuel are its proven safety performance during power pulsing and its demonstrated long-term irradiation integrity.

To concurrently produce medical and industrial isotopes along with the required quantity of plutonium-238 production goal of 5 kilograms (11 pounds) per year and provide irradiation services for civilian nuclear energy research and development, it was determined that a reactor core power of 50 megawatts-thermal would be necessary. Higher power levels and alternative target designs capable of meeting production requirements were also considered in the new research reactor design analysis but were not analyzed in the NI PEIS. For example, although not analyzed in the NI PEIS, operating at 100 megawatts-thermal could reduce the amount of neptunium-237 required to meet plutonium-238 production requirements. At the 50-megawatts-thermal power level, the core would require an active cooling system with forced coolant flow to maintain the fuel below its material thermal limits. The new research reactor cooling system would use a tank within a pool that is connected to primary coolant circulating pumps, heat exchangers, and an ultimate heat sink consisting of two cooling towers. The pool would be housed in a reactor building that would also enclose the pumps, heat exchangers, secondary systems, and spent nuclear fuel storage pool. The spent nuclear fuel storage pool, sized to store the reactor core's discharged spent nuclear fuel for its entire 35-year production period, could be hydraulically connected to the reactor core pool for refueling and emergency reflooding. The ultimate heat sink cooling towers, air exhaust stack, and emergency diesel generators would be located outside the reactor building.

The fuel for the new research reactor would be based on an extension of current licensed low-enriched uranium TRIGA fuel designs for 10- to 16-megawatts-thermal reactors. The new research reactor fuel design would be identical to current low-enriched uranium TRIGA fuel for higher power cores, except the new reactor fuel would have a larger assembly configuration array (i.e., 8 by 8 versus 4 by 4) and a longer active fuel length (153.7 centimeters [60.5 inches] versus 55.88 centimeters [22.0 inches]). The larger array and length were selected to meet the plutonium-238 production requirements and to maintain high safety factors with respect to fuel thermal performance.

Along with the fuel rods, the core would contain a number of medical and industrial isotope and plutonium-238 production target rods. These rods would occupy positions in a fuel assembly where a fuel rod would otherwise exist. Each of these positions would have an Incoloy-800 alloy guide tube with the same dimensions as the fuel rod cladding. The target rods would be inserted into these guide tubes for their design irradiation time period. In addition, some fuel rod positions in core fuel assemblies would be replaced with similar guide tubes to accommodate Incoloy-800-clad boron carbide control rods. Boron carbide is a widely used, proven, and accepted neutron absorber for control rods. The new research reactor core design would consist of 68 fuel assemblies, each of which would be enclosed in a square aluminum shroud for structural support and coolant flow control. The core would include eight rabbit tubes for short irradiation time production of medical or industrial isotopes and civilian nuclear energy research and development. These rabbit tubes would be located outside the fuel region of the core, but still within an area with a relatively high neutron flux.

The new research reactor would be constructed and operated at an existing DOE site. Since the potential site has not been selected, it is evaluated in the NI PEIS as a generic DOE site. Because Alternative 4 was evaluated at a generic DOE site, no credit was taken for any existing support infrastructure at the site, and it was postulated that a new support facility would be required to support operation of the new research reactor and its medical isotope production and civilian nuclear energy research and development missions. While this approach bounds the environmental impact assessment for the implementation of Alternative 4, it overstates the impacts because the NI PEIS integrates the impacts associated with constructing new support facilities and infrastructure that may be available at the existing DOE site. In the event that Alternative 4 were selected in the Record of Decision for subsequent consideration, follow-on NEPA reviews would evaluate potential site locations. It is unlikely that DOE would consider locating the new research reactor on a DOE site that does not have an existing infrastructure capable of supporting all or most of the mission requirements. To determine the environmental impacts if Alternative 4 were implemented at a site with adequate support infrastructure, the environmental impacts for the construction of the support facility could be subtracted from the environmental impacts of Alternative 4 as presented in the NI PEIS. Section 4.6 of the NI PEIS presents the environmental impacts from construction and operation of the new support facility separately.

Transportation

For all alternatives, overland shipments of nuclear materials are assumed to use trucks, either commercial vehicles or DOE safe secure trailers. Transatlantic shipments of mixed oxide fuel would use purpose-built ships and certain isotopes would be shipped in aircraft. The types of packaging used to transport materials is discussed in Appendix J of the NI PEIS.

Plutonium-238 purchased from Russia under all options of the No Action Alternative would be transported from St. Petersburg to a U.S. port of entry, and from there to LANL where it would be prepared for use in radioisotope power systems and heating units. The impacts of the transportation of a total of 40 kilograms (88.2 pounds) of plutonium-238 are estimated in the *Environmental Assessment of the Import of Russian Plutonium-238* (DOE 1993) and are summarized in Section 4.2 of the NI PEIS. The impacts associated with transporting 175 kilograms (385 pounds) (5 kilograms per year for the 35-year evaluation period) of plutonium-238 have been determined by extrapolation and are included in the same section. Under Options 2 through 4 of the No Action Alternative, neptunium-237 would be shipped from SRS to the designated storage facilities at ORNL, INEEL, or Hanford for long-term storage. Under Alternatives 1 through 4, the neptunium-237 would be shipped to the same facilities for storage and subsequent processing for fabrication of targets for plutonium-238 production. Under all alternatives, medical isotopes would continue to be shipped to commercial vendors via truck and air from DOE locations throughout the country.

Under Alternative 1, targets for plutonium-238 production would be fabricated in one of three alternative facilities at ORNL, INEEL, or Hanford. The targets would be irradiated at FFTF using mixed oxide fuel currently stored at Hanford or shipped from Europe and/or highly enriched uranium fuel from a commercial fuel fabricator in the United States. The irradiated targets would be transported back to the fabricating facilities for postirradiation processing. The separated plutonium-238 would be transported to LANL for fabrication into heat sources for radioisotope power systems. Targets for medical and industrial isotope production would be fabricated in one or more facilities at Hanford. Target materials would be shipped to Hanford from other offsite facilities. The targets would be irradiated in FFTF and returned to the fabrication facilities for postirradiation processing. Medical and commercial isotopes would then be shipped to commercial vendors via truck and air.

Under Alternative 2, targets for plutonium-238 production would be fabricated in one of three facilities at ORNL, INEEL, or Hanford. The targets would be irradiated at ATR, HFIR, or a CLWR and transported back to the fabricating facilities for postirradiation processing. The separated plutonium-238 would than be shipped to LANL following postirradiation processing. Medical isotopes would continue to be shipped to commercial vendors via truck and air from DOE locations throughout the country.

Under Alternative 3, the targets for plutonium-238 production would be fabricated in one of three facilities at ORNL, INEEL, or Hanford. The targets would be irradiated at the new high-energy accelerator and transported back to the fabricating facilities for postirradiation processing. The separated plutonium-238 would than be shipped to LANL following postirradiation processing. Targets for medical and industrial isotope production would be fabricated in a new facility at the generic DOE site. Target materials would be shipped to the new facility from offsite. The targets would be transported to the on site low-energy accelerator for irradiation and returned to the fabrication facilities for postirradiation processing. Products would then be shipped to commercial vendors via truck and air transport.

Under Alternative 4, the targets for plutonium-238 production would be fabricated in one of three facilities at ORNL, INEEL, or Hanford. The targets would be irradiated at the new reactor and transported back to the fabricating facilities for postirradiation processing. The separated plutonium-238 would then be shipped to LANL following postirradiation processing. Targets for medical and industrial isotope production would be fabricated in a new facility at the generic DOE site. Target materials would be shipped to the new facility from offsite. The targets would be transported to the new on site research reactor for irradiation and returned to the fabrication facilities for postirradiation processing. Products would then be shipped to commercial vendors via truck and air transport.

No transportation is analyzed for Alternative 5, the deactivation of FFTF, with no new missions. Medical isotopes would continue to be shipped to commercial vendors via truck and air from DOE locations throughout the country.

For alternatives that include fabrication and irradiation of targets at one site, intrasite transportation between facilities is analyzed. The shipment of fuel to the irradiation facilities is also analyzed. For Alternative 4, this includes the shipment of low-enriched uranium fuel to the new reactor. For alternatives involving irradiation at FFTF, this includes the shipment of mixed oxide fuel from Europe and/or highly enriched uranium fuels from a commercial fuel fabricator in the United States. At this time, however, DOE has not proposed to import the European fuel through any specific port. DOE did, however, review the potential maximum impacts from the marine transportation of mixed oxide fuel from Europe to a representative military port (i.e., Charleston, South Carolina). If DOE ultimately decides to import fuel from Europe, it would perform a separate NEPA analysis to select a port.

S.5 APPROACH TO ENVIRONMENTAL IMPACT ANALYSIS

The environmental impact analysis addresses the full range of natural and human resource areas pertinent to the sites considered for the nuclear infrastructure alternatives. Impacts are assessed for land resources, noise, air quality, water resources, geology and soils, ecological resources, cultural and paleontological resources, socioeconomics, waste management, and cumulative impacts. A region of influence for each resource area is identified and analyzed for each candidate site.

Baseline conditions at the three DOE sites (ORR, INEEL, and Hanford) assessed in the NI PEIS, as well as an existing CLWR, include present and reasonably foreseeable future actions at each site. Option 1 of the No Action Alternative was used as the basis for the comparison of impacts that would occur under implementation of the other options and alternatives.

Impacts within each resource area were analyzed consistently; that is, the impact values were estimated using a consistent set of input variables and computations. Moreover, calculations in all areas used accepted protocols and up-to-date models. The following is a brief summary of the affected resources and their impact assessment methodologies.

Land Use

Land use includes the land on and adjacent to each site, the physical features that influence current or proposed uses, pertinent land use plans and regulations, and land ownership and availability. The region of influence for land use varies due to the extent of land ownership, adjacent land use patterns and trends, and other geographic or safety considerations. The amount of land disturbed and conformity with existing land use were considered in order to evaluate impacts. Conformity with existing land use was evaluated for each alternative. Land disturbance was considered only for those alternatives involving new construction. However, because the location of one or two new accelerators or a research reactor and support facility is unknown, the acreage required is only an approximation. In order to determine the range of potential effects from new facilities, the analysis considered potential impacts from construction and operation at both a disturbed and undisturbed location at a generic DOE site.

Visual Resources

Visual resources are the natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. The region of influence for visual resources includes the geographic area from which the proposed facilities may be seen. Impacts to visual resources were determined by evaluating whether or not the Bureau of Land Management Visual Resource Management classification of the site would change as a result of the proposed action. For those alternatives involving existing facilities at known DOE sites, alterations to visual features were readily evaluated and the impact on the current Visual Resource Management classification determined. For those alternatives involving construction and operation of one or two new accelerators or a research reactor at a generic DOE site, the visual characteristics of the site are unknown. Thus, to determine the range of potential visual effects, the analysis considered potential impacts from construction and operation at both a disturbed and an undisturbed location at the generic site. Impacts associated with the use of an existing CLWR are also described in a general manner because its location is not known.

Noise

Sound results from the compression and expansion of air or some other medium when an impulse is transmitted through it. Sound requires a source of energy and a medium for transmitting the sound wave. Propagation of sound is affected by various factors, including meteorology, topography, and barriers. Noise is undesirable sound that interferes or interacts negatively with the human or natural environment. The region of influence for each site includes the site and surrounding area, including transportation corridors, where proposed activities might increase noise levels. Impacts from facility modification and operation were assessed according to the types of noise sources and the locations of the proposed facilities relative to the site boundary. Potential noise impacts from traffic were based on the likely increase in traffic volume. Possible impacts to wildlife were evaluated based on the possibility of sudden loud noises occurring during facility modification and operation. Acoustic impacts from facility construction and operation at generic sites were assessed according to the types of new noise sources and characteristics identified for a generic site. The change in traffic noise levels at a generic site could not be assessed without site-specific data.

Air Quality

Air pollution refers to the introduction, directly or indirectly, of any substance into the air that could result in harmful effects of such nature as to endanger human health and harm living resources and ecosystems, as well as material property, and impair or interfere with the comfortable enjoyment of life and other legitimate uses of the environment. For the purpose of the NI PEIS, only outdoor air pollutants were addressed, which may be in the form of solid particles, liquid droplets, gases, or a combination of these forms. Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Potential air quality impacts of pollutant emissions from facility modification and normal operations were evaluated for those alternatives associated with FFTF restart and the use of existing facilities. This assessment included a comparison of pollutant concentrations from each alternative with applicable Federal and state ambient air quality standards. If both Federal and state standards exist for a given pollutant and averaging period, compliance was evaluated using the more stringent standard. Air quality impacts associated with a CLWR were addressed as a contribution from the facility operation. Air quality impacts from one or two new accelerators or a new research reactor were discussed for construction and operation at a generic DOE site. Emissions of potential stratospheric ozone-depleting compounds were not evaluated, as no emissions of these pollutants were identified in conceptual engineering design reports.

Water Resources

Water resources are the surface and subsurface waters that are suitable for human consumption, aquatic or wildlife propagation, agricultural purposes, irrigation, or industrial and commercial purposes. The region of influence used for water resources encompasses those surface water and groundwater systems that could be impacted by water withdrawals, effluent discharges, and/or spills or stormwater runoff associated with construction and operation of the proposed facilities. Water use analysis involved the review of engineering estimates of expected water use and effluent discharges associated with each alternative, and the impacts on local water availability and quality, including surface water and groundwater. Impacts on water use were assessed by determining changes in the volume of current water usage and effluent discharges as a result of the proposed activities. Water quality analysis consisted of determining how effluent discharges to surface water, as well as discharges reaching groundwater, from the proposed facilities would affect current water quality. A comparison of the projected water quality with relevant regulatory standards was made. Separate analyses were conducted for surface water and groundwater impacts.

Geology and Soils

Geologic resources include consolidated and unconsolidated earth materials, including mineral assets such as ore and aggregate materials, and fossil fuels such as coal, oil, and natural gas. Geologic conditions include hazards such as earthquakes, faults, volcanoes, landslides, and land subsidence. Soil resources include the loose surface materials of the earth in which plants grow, usually consisting of mineral particles from disintegrating rock, organic matter, and soluble salts. Prime farmland includes cropland, pasture land, rangeland, and forest land. The region of influence for geology and soils includes all areas subject to disturbance by construction and operation of the proposed facilities, as applicable, and those areas beneath existing or proposed new facilities that would remain inaccessible for the life of the facilities. The geology and soils impact analysis considered the risks to the existing and proposed new facilities of large-scale geologic hazards such as faulting and earthquakes, lava extrusions and other volcanic activity, landslides, and sinkholes, (i.e., conditions that tend to affect broad expanses of land). As the exact nature of the generic DOE or CLWR sites is not known, bounding assumptions were made regarding the range of potential geologic and soils conditions that could be present, coupled with the use of highly conservative estimates of expected impacts. If a DOE or CLWR site were selected, subsequent NEPA assessment would be required.

Ecological Resources

Ecological resources include terrestrial and aquatic resources (plants and animals), wetlands, and threatened and endangered species. Terrestrial resources are defined as those plant and animal species and communities that are most closely associated with the land; for aquatic resources, a water environment. Wetlands generally include swamps, marshes, bogs, and similar areas. Endangered species are defined as those species in danger of extinction throughout all or a large portion of their range. Threatened species are defined as those species likely to become endangered within the foreseeable future. Critical habitat is defined as specific areas that contain physical and biological features essential to the conservation of species and that may require special management consideration or protection. The region of influence used for the ecological resource analysis encompassed the area potentially disturbed by construction and operation of the proposed facilities. Impacts to ecological resources may occur as a result of land disturbance, water use, air and water emissions, human activity, and noise associated with project implementation. For alternatives involving construction and operation of one or two new accelerators or a research reactor at a generic DOE site, the analysis generally considered impacts at both a disturbed and an undisturbed location at a generic DOE site. Impacts to terrestrial and aquatic ecosystems and wetlands from water use and air and water emissions were evaluated based on the results of the analysis conducted for air quality and water resources.

Cultural and Paleontological Resources

Potential impacts were assessed separately for each of the three general categories of cultural resources: prehistoric, historic, and Native American. Prehistoric resources are physical remains of human activities that predate written records. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. The region of influence for the cultural and paleontological resource analysis encompassed the area potentially disturbed by construction and operation of the proposed facilities. The analysis of impacts to cultural and paleontological resources addressed potential direct and indirect impacts at each site. Potential indirect impacts include those associated with reduced access to a resource site, as well as impacts associated with increased traffic and visitation to sensitive areas. Direct impacts include those resulting from groundbreaking activities associated with new construction. Because the specific location is unknown, impacts from new construction of one or two new accelerators or a research reactor, as well as operation of an existing CLWR, were addressed in a general manner. In order to determine the range of potential impacts, the analysis for new construction considered potential effects at both a disturbed and an undisturbed location at a generic DOE site.

Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics of a region. The socioeconomic environment is made up of two geographic regions, the regional economic area and region of influence. Regional economic areas are made up of regional economies and include descriptions of industrial and service sector characteristics and their linkages to the communities within a region. For each regional economic area, data were compiled on the current socioeconomic conditions, including unemployment rates, economic industrial and service sector activities, and the civilian labor force. The workforce requirements of each alternative were determined in order to measure their possible effect on these socioeconomic conditions. Similarly, potential demographic impacts were assessed for the region of influence. The region of influence could represent a smaller geographic area. For each region of influence, census statistics were compiled on population, housing demand, and community services. U.S. Census Bureau population forecasts for the regions of influence were combined with overall projected workforce requirements for each of the alternatives being considered at each of the sites to determine the extent of impacts on housing demand and levels of community services. For those alternatives involving construction and operation of one or two new accelerators or a research reactor at a generic DOE site, the socioeconomic characteristics of the site are unknown. Specific impacts cannot be measured until candidate sites are identified and therefore, impacts were addressed in a general manner. Impacts associated with the use of an existing CLWR were also addressed in a general manner as the location is unknown.

Public and Occupational Health and Safety—Normal Operations

An individual may be exposed to ionizing radiation externally (from a radioactive source outside the body) or internally (from ingesting or inhaling radioactive material). For the analyses conducted in the NI PEIS, exposure to a radioactive source as a result of releases to air and water pathways has been considered. The dose from internal exposure was calculated over 50 years following the initial exposure. The three types of doses calculated are external dose, internal dose, and combined external and internal dose. The external dose can result from several different pathways (exposure to a radioactive source in the air, water, or ground), all having in common the fact that the radiation causing the exposure is external to the body. The appropriate measure of dose is called the effective dose equivalent. The internal dose results from a radiation source entering the human body through either ingestion of contaminated food or inhalation of contaminated air. The unit of measure for internal dose is the committed effective dose equivalent. The units used for combined external and internal dose are the rem and millirem (1/1000 of 1 rem). The corresponding unit for the collective dose to a population (the sum of the doses to members of the population, or the product of the number of exposed individuals and their average dose) is the person-rem.

The potential impacts of exposure to hazardous chemicals released to the atmosphere were also evaluated for routine operations associated with the alternatives analyzed in the NI PEIS. The receptors considered in these evaluations are the public. Impacts of exposures to hazardous chemicals for workers directly involved in the treatment process were not quantitatively evaluated because workers use personal protective equipment and engineering process controls that limit their exposure to levels within applicable limits. The health effect endpoints evaluated in this analysis include excess incidences of latent cancers for carcinogenic chemicals, and a spectrum of chemical-specific noncancer health effects expressed in terms of a hazard index. This index is a measure of the likelihood of noncancer health effects, such as headache, membrane irritation, neurotoxicity, immunotoxicity, liver toxicity, kidney toxicity, developmental toxicity, reproductive toxicity, and genetic toxicity for noncarcinogens.

Public and Occupational Health and Safety—Facility Accidents

The accidents considered in the NI PEIS for both the irradiation facilities and the processing facilities are based on a spectrum of accidents ranging from high-probability low-consequence events to extremely unlikely higher consequence events. All the facilities have been treated comparably with regard to accident evaluation, while incorporating facility-specific differences in design and mitigation features.

For each evaluated accident, radiological dose consequences are provided for the maximally exposed individual. The maximally exposed individual is typically defined as a hypothetical individual who resides at the nearest site boundary in the direction that would result in the highest dose, assuming an accident occurs. Since major highways pass through some of the sites and these are well traveled, the NI PEIS also included an evaluation of individuals assumed to be located on a highway within the site. Accident doses to individuals at the nearest site boundary and on highways within the site were evaluated and the hypothetical individual receiving the highest dose was designated as the maximally exposed individual. For the hazardous chemical accident analysis, consequences are determined by comparing estimated airborne chemical concentrations to emergency response guidelines. Hazardous chemical impact information is presented for both individuals.

While it is possible that an individual member of the public could be closer to a facility than either the site boundary or the nearest onsite highway, such individuals would be present only occasionally and for brief periods (a few hours or more). Therefore, the annual probability that an individual would be close to a facility is relatively low, and the associated risk to that individual would be bounded by the maximally exposed individual at the site boundary or nearest onsite highway.

In addition to the maximally exposed individual, accident consequence information is also provided for a noninvolved worker. For the NI PEIS accident analysis, the noninvolved worker is a hypothetical individual located 640 meters (0.4 miles) from the affected facility. The noninvolved worker impacts are provided for each facility except the CLWR. CLWR accidents selected for analysis in the NI PEIS are severe accidents that are intended to envelop the accident risk. Due to the nature and timing of these accidents, there is sufficient time prior to a radioactive release to initiate site emergency procedures. The NI PEIS accident analysis assumes that noninvolved workers, trained in emergency procedures, would have sufficient time to evacuate without suffering any consequences.

Radiological accident impacts are also provided for the offsite population within an 80 kilometer (50 mile) radius of each facility. Additional accident analyses include the evaluation of involved worker impacts and industrial accidents. Because of the large uncertainties associated with involved worker impacts, the consequences are presented qualitatively.

Public and Occupational Health and Safety—Transportation

The transportation of any commodity involves a risk to both transportation crew members and members of the public. This risk results directly from transportation-related accidents and indirectly from the increased levels of pollution from vehicle emissions, regardless of the cargo. The transportation of certain materials, such as hazardous or radioactive substances, can pose an additional risk due to the unique nature of the material itself. To permit a complete appraisal of the environmental impacts of the proposed action and alternatives, the human health risks associated with the overland transportation of neptunium- and plutonium-bearing material are analyzed in the NI PEIS. For each alternative, radiological risks (i.e., those risks that result from the radioactive nature of the neptunium and plutonium) are assessed for both incident-free (i.e., normal) and accident transportation conditions. The radiological risk associated with incident-free transportation conditions would result from the potential exposure of people to external radiation in the vicinity of a loaded shipment. The radiological risk from transportation accidents would come from the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of people. All radiological impacts are calculated in terms of committed dose and associated health effects in the exposed populations.

In addition to the radiological risks posed by overland transportation activities, vehicle-related risks are also assessed for nonradiological causes (i.e., causes related to the transport vehicles and not the radioactive cargo) for the same transportation routes. The nonradiological transportation risks, which would be incurred for similar shipments of any commodity, are assessed for both incident-free and accident conditions. The nonradiological risks during incident-free transportation conditions would be caused by potential exposure to increased vehicle exhaust emissions. The nonradiological accident risk refers to the potential occurrence of transportation accidents that directly result in fatalities unrelated to the shipment of cargo. National transportation fatality rates are used in the assessment. Nonradiological risks are presented in terms of estimated fatalities.

Environmental Justice

The NI PEIS provides an assessment of the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations from the implementation of each alternative. Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts to human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority population or low-income population is significant and exceeds the risk or exposure rate for the general population or, where available, for another appropriate comparison group. A disproportionately high and adverse environmental impact refers to an impact (or risk of an impact) in a low-income or minority community that is significant and exceeds the adverse environmental impact on the larger community. In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed or minority low-income populations are considered. Potentially affected areas examined in the NI PEIS include areas defined by an 80-kilometer (50-mile) radius centered on candidate facilities for plutonium-238 production, radioisotope production, or processing activities located at INEEL, ORR, and Hanford. Potentially affected areas used in the analysis of environmental justice are the same as those used in the analysis of radiological health effects. Potentially affected areas for the other resource areas are included in the potentially affected areas used for the analysis of radiological health effects.

Waste Management

The construction and operation of the proposed facilities, as well as the permanent deactivation of FFTF and decontamination and decommissioning of one or two accelerators, research reactor, and support facility, would generate several types of waste, depending on the alternative. Such waste may include high-level radioactive waste, transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, hazardous waste and nonhazardous waste. The alternatives could have an impact on existing site facilities devoted to the treatment, storage, and disposal of these categories of waste. Impacts were assessed by comparing the projected waste stream volumes generated from the proposed activities at each site with that site's waste management capacities and generation rates. Only the impacts relative to the capacities of waste management facilities were considered; other environmental impacts of waste management facility operations (e.g., human health effects) are evaluated in other sections of the NI PEIS, or in other facility-specific or sitewide NEPA documents. Projected waste generation rates for the proposed activities were compared with site processing rates and capacities of those treatment, storage, and disposal facilities likely to be involved in managing the additional waste. Projected waste stream volumes could not be compared to site waste management capacities and generation rates for the alternatives involving the use of a generic DOE site or a CLWR site because a specific location was not identified.

Cumulative Impacts

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The cumulative impact analysis for the NI PEIS involved combining the impacts of the alternatives (including No Action) with the impacts of other present and reasonably foreseeable activities in the regions of influence. The regions of influence for different resources can vary widely in extent. In general, cumulative impacts were calculated by adding the values for the baseline affected environment (i.e., conditions attributable to present actions by DOE and other public and private entities), the proposed action (or no action), and other future actions. This cumulative value was then weighed against the appropriate impact indicators (e.g., standards) to determine the potential for impact. For this cumulative impact assessment, it was conservatively assumed that all facilities would operate concurrently at the DOE sites. Decontamination and decommissioning of the proposed facilities was not addressed in the cumulative impact estimates. Given the uncertainty regarding the timing of decontamination and decommissioning, any impact estimate at this time would be highly speculative. A detailed evaluation of decontamination and decommissioning will be provided in follow-on NEPA documentation closer to the actual time of those actions.