# Chapter 1
# Introduction

This *Draft Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* identifies reasonable alternatives and potential impacts associated with the proposed action to enhance the U.S. Department of Energy's existing nuclear facility infrastructure for: (1) the production of isotopes for medical, research, and industrial uses, (2) the production of plutonium-238 for use in advanced radioisotope power systems for future space missions, and (3) supporting the Nation's nuclear research and development needs.

## 1.1 BACKGROUND

Under the authority of the Atomic Energy Act of 1954, as amended, the U.S. Department of Energy (DOE) is responsible for ensuring the availability of isotopes for medical, industrial, and research applications; meeting the nuclear material needs of other Federal agencies; and undertaking research and development activities related to development of nuclear power for civilian use.

To meet these responsibilities, DOE maintains nuclear infrastructure capabilities that support various missions in areas such as nuclear materials production and testing, and research and development activities related to civilian applications of nuclear power. These infrastructure capabilities include research and test facilities such as research reactors and accelerators used for steady-state neutron irradiation of materials to produce radionuclides, as well as shielded "hot cell" and glovebox facilities used to prepare materials for testing and/or to handle postirradiation materials. An additional component of this infrastructure is the highly trained workforce that specializes in performing complex tasks that have been learned and mastered over the life of these facilities.

Over the years, DOE's nuclear facility infrastructure has diminished because of the shutdown of aging facilities; recent examples are the High Flux Beam Reactor at Brookhaven National Laboratory, New York, and the Cyclotron Facility at Oak Ridge National Laboratory (ORNL), Tennessee. This, in turn, has hampered DOE's ability to satisfy increasing demands in various mission areas. To continue to maintain sufficient irradiation facilities to meet its obligations under the Atomic Energy Act, DOE must assess the need for expansion of its existing nuclear infrastructure in light of its commitments to ongoing programs, its commitments to other agencies for nuclear materials support, and its role in supporting nuclear research and development programs to maintain the viability of civilian nuclear power as one of the major energy sources available to the United States. The proposed expansion of nuclear infrastructure capabilities is in response to the programmatic needs of DOE's Office of Nuclear Energy, Science and Technology and does not include programmatic needs of other program offices within DOE, including those of the Office of Science.

## 1.2 PURPOSE AND NEED FOR AGENCY ACTION

The Nuclear Energy Research Advisory Committee (NERAC) was established in 1998 by DOE in accordance with the Federal Advisory Committee Act to provide independent, expert advice on complex science and technical issues that arise in the planning, management, and implementation of DOE's civilian nuclear energy research programs. The chairman of NERAC has informed the Secretary of Energy that:

- "There is an urgent sense that the nation must rapidly restore an adequate investment in basic and applied research in nuclear energy if it is to sustain a viable United States capability in the 21st Century"

- "[T]he most important role for DOE [Office of Nuclear Energy, Science and Technology] in the nuclear energy area at the present time is to ensure that the education system and its facility infrastructure are in good shape."

- "Of particular need over the longer term are dependable sources of research isotopes and reactor facilities providing high volume flux irradiation for nuclear fuels and materials testing" (NERAC 2000a).

Under the guidance of NERAC, DOE also has completed an internal assessment of its existing nuclear facility infrastructure capabilities. This *Nuclear Science and Technology Infrastructure Roadmap* evaluates the existing DOE infrastructure and identifies gaps for meeting projected demands (DOE 2000a). The basic finding of this assessment also concluded that the capabilities of currently operating DOE facilities will not meet projected U.S. needs for nuclear materials production and testing or research and development.

Consistent with these findings, DOE recognizes that adequate nuclear research reactor, accelerator, and associated support facilities must be available to implement and maintain a successful nuclear energy program. As demand continues to increase for steady-state neutron sources needed for isotope production and nuclear research and development, DOE's nuclear infrastructure capabilities to support this demand have not improved. To continue meeting its responsibilities under the Atomic Energy Act and to satisfy projected increases in the future demand for isotope products and irradiation services, DOE proposes to enhance its existing nuclear facility infrastructure to provide for: (1) production of isotopes for medical, research, and industrial uses, (2) production of plutonium-238 for use in advanced radioactive isotope (radioisotope) power systems for future National Aeronautics and Space Administration (NASA) space exploration missions, and (3) support of the Nation's nuclear research and development needs for civilian applications.

To evaluate the potential environmental impacts associated with this proposed enhancement, DOE has prepared this *Draft Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (*Nuclear Infrastructure Programmatic Environmental Impact Statement* [NI PEIS]). For analysis purposes, this NI PEIS evaluates impacts from facility construction, modification, startup, and 35 years of operation, followed by decommissioning when applicable. The 35-year operating period is based upon the estimated length of time existing DOE irradiation facilities would continue operating if used for accommodating these missions. This timeframe also accommodates current projections that indicate the demand for radioisotopes and nuclear research and development requiring these enhancements will extend for at least the next 20 years (Wagner et al. 1998; NERAC 2000b; DOE 2000a).

### 1.2.1 Medical and Industrial Isotope Production

Over the past few decades, isotopes have become vital tools for use in medicine, industry, and scientific research. Isotopes, including both radioisotopes and stable isotopes, play a particularly important role in medical diagnosis, treatment, and research. Currently, more than 12 million nuclear medicine procedures are performed each year in the United States, and approximately one-third of all patients admitted to U.S. hospitals undergo at least one medical procedure that employs the use of medical isotopes (NERAC 2000b). Many medical isotopes are produced in the United States by DOE in nuclear reactors and particle accelerators. In limited cases, some medical isotopes can also be produced by extracting them from existing radioactive materials. Radioisotopes are used for both diagnosis and therapy. Diagnostic radioisotopes are used for imaging internal organs. Unlike conventional radiology, imaging with radioisotopes reveals organ function and structure, which provides additional data for a more accurate diagnosis, and assists in the early detection of abnormalities. In ongoing clinical testing, therapeutic isotopes have proven effective in treating cancer and other illnesses by cell-directed localized radiation therapy (i.e., deploying antibodies or carriers of radioisotopes to seek and destroy invasive cancer cells). This directed therapy can minimize adverse side effects (e.g., healthy tissue damage, nausea, hair loss), making it an effective, attractive alternative to traditional chemotherapy or radiation treatments.

For nearly 50 years, DOE has actively promoted the use of radioisotopes to improve the health and well-being of U.S. citizens. DOE's use of its unique technologies and capabilities to develop isotopes for civilian purposes has enabled the widespread application of medical and industrial isotopes seen today. DOE must provide an adequate supply of isotopes to keep pace with the growing and changing needs of the research community if it is to continue to serve this key role.

An Expert Panel convened by DOE recently reviewed several industry projections for growth in demand for medical isotopes. The Expert Panel concluded that the growth rate in medical isotope use will be significant over the next 20 years (Wagner et al. 1998). Specifically, the panel estimated that the expected growth rate of medical isotope use during the next 20 years would range between 7 to 14 percent per year for therapeutic applications and between 7 to 16 percent per year for diagnostic applications. The panel noted that these growth rates are attainable only if basic research in nuclear medicine is supported and if modern, reliable isotope production facilities are available. DOE and NERAC have adopted the following findings and recommendations provided by the Expert Panel:

- Several isotopes have proven their clinical efficacy, but supply and cost concerns could dramatically affect the use of these isotopes in the practice of nuclear medicine.

- Although commercial and research applications for certain isotopes have been or are being developed, their limited availability and high prices are inhibiting their use in clinical applications.

- Research isotopes that have shown promise as diagnostic and therapeutic materials are not being explored because of their lack of availability or high price.

- At present, there is no domestic production facility to guarantee the continued supply of many of these isotopes.

- To meet current and future needs of the biomedical sciences community, the Expert Panel recommended:

  > . . . the United States develop a capability to produce large quantities of radionuclides [radioisotopes] to maintain existing technologies and to stimulate future growth in the biomedical sciences. The successful implementation of such a program would help insure our position as an international leader in the biomedical sciences well into the twenty-first century. The panel recommends that the U.S. Government build this capability around a reactor, an accelerator, or a combination of both technologies as long as isotopes for clinical and research applications can be supplied reliably, with diversity in adequate quantity and quality.

In its recent report from the Subcommittee for Isotope Research and Production Planning, NERAC further identified that:

> It is now widely conceded that limited availability of specific radionuclides is a constraint on the progress of research. The problem is especially apparent in a number of medical research programs that have been terminated, deferred, or seriously delayed by a lack of isotope availability . . . The lack of radionuclides

> significantly inhibits progress in evaluating a host of promising diagnostic and therapeutic drugs in patients with debilitating and fatal diseases, examining fundamental basic science questions, studying human behavior and normal growth and development, and exploring the aging process and the products of transgene expression . . . the DOE long-term goal to have a reliable isotope supply system in place that would enable scientists to bring their creative ideas into practical use safely, quickly and efficiently is appropriate, be it basic science research, clinical medicine, or industrial endeavors. The discovery and dissemination of new knowledge should continue to be a core mission, and basic science and the application of basic science to clinical research discoveries to improve the diagnosis and treatment outcomes should be a crucial component of that mission. [DOE], in providing a federal system for the reliable supply of stable and radioactive isotopes for research, will be an important aspect of fulfilling the federal responsibility to support biomedical research (NERAC 2000b).

Currently, approximately 50 percent of DOE's isotope production capability is being used. Much of the remaining isotope production capability is dispersed throughout the DOE complex. This capability supports secondary missions, but cannot be effectively used due to the operating constraints associated with the facilities' primary missions (basic energy sciences or defense). Assuming a midpoint growth curve for future isotope demand and a diversity and redundancy of isotope supply, it is likely that DOE's isotope production facilities would be fully used within a 5- to 10-year timeframe if no enhancements to the existing nuclear facility infrastructure are implemented. This projection was made in the context of a worldwide market for radioisotopes. Although DOE's market share is a small fraction of the overall total, it is very significant for some radioisotopes and particularly important for a large number of radioisotopes that are used in relatively small quantities for research. These isotopes, which are used almost exclusively by researchers at universities and hospitals, are not purchased in quantities that would permit private industry to take over their production. However, DOE may need to significantly increase the production levels of these radioisotopes as world demand changes and promising research developments in their medical use are brought to commercialization.

Recent analyses indicate that the greatest challenge to meeting projected isotope market requirements over the next 20 years will be in the area of therapeutic medical isotopes, several of which are currently unavailable or are available only in limited quantities (Battelle 1999). For the purpose of analysis in this NI PEIS, a representative set of isotopes was selected on the basis of the recommendations of the Expert Panel, medical market forecasts (Frost & Sullivan 1997), reviews of medical literature, and more than 100 types of ongoing clinical trials that use radioisotopes for the treatment of cancer and other diseases. These isotopes are listed in **Table 1–1**, along with a brief description of their medical and, in some cases, industrial applications. Currently, these medical applications primarily involve the diagnosis and treatment of three major classes of disease—cancer, vascular disease, and arthritis. Although these isotopes are a representative sample of possible isotopes which could be produced, DOE expects that the actual isotopes produced as a result of the proposed action would vary from year to year in response to the focus of clinical research and the specific market needs occurring at that time.

Industrial isotope applications fall into three broad categories: nucleonic instrumentation, irradiation and radiation processing, and technologies that use radioactive tracers. Examples of nucleonic instrumentation include gauges for measuring physical parameters (e.g., detection systems for pollutants, explosives, drugs, ores, petroleum, and natural gases; nondestructive testing by gamma radiography; and smoke detectors). Irradiation and radiation processing technologies include radiation sterilization of food and medical products and the curing of plastics. Radioactive tracer applications include studies of chemical synthesis reactions; mass transfer monitoring in industrial plants; analysis of the transport and uptake of nutrients, fertilizers, herbicides,

## Table 1–1 Representative Radioisotopes

| Radioisotope | Applications |
|---|---|
| Actinium-227 | Parent of radium-223 (monoclonal antibody attachment used for cancer treatment by radioimmunotherapy) |
| Astatine-211 | Alpha-emitting radioisotope being studied for a variety of radioimmunotherapy applications |
| Gold-198 | Ovarian, prostate, and brain cancer; intracavity therapy |
| Cadmium-109 | Cancer detection; pediatric imaging; industrial detection systems for pollutants, explosives, drugs, ores, petroleum, and natural gas |
| Copper-64 | Diagnostic imaging, dosimetry studies, cerebral and myocardial blood flow, colorectal cancer therapy |
| Copper-67 | Cancer treatment/diagnostics, cancer treatment by radioimmunotherapy, planar imaging, diagnostic imaging |
| Fluorine-18 | Cancer detection/diagnostics |
| Gadolinium-153 | Osteoporosis detection, diagnostic imaging |
| Germanium-68 | Diagnostic imaging calibration, potential antibody labeling |
| Holmium-166 | Treatment of rheumatoid arthritis, radiolabeling, and monoclonal antibody techniques |
| Indium-111 | Cancer treatment/diagnostics |
| Iodine-123 | Alzheimer's Disease and Schizophrenia diagnostic, breast cancer imaging, cardiac imaging, radioimmunotherapy of Parkinson's Disease |
| Iodine-125 | Osteoporosis detection, diagnostic imaging, tracer drugs, monoclonal antibodies, brain cancer treatment (iodine-131 replacement), radiolabeling, tumor imaging, mapping of receptors in the brain, interstitial radiation therapy, brachytherapy for treatment of prostate cancer, determination of glomerular filtration rate, determination of plasma volume, detection of deep vein thrombosis of the legs |
| Iodine-131 | Lymphoid tissue tumor/hyperthyroidism treatment; antibody labeling; brain biochemistry in mental illness; diagnosis of thyroid disorders by gamma camera imaging or counting; radioimmunotherapy; imaging; cellular dosimetry; adrenal medulla scintigraphy; treatment of Grave's disease, goiters, prostate cancer, hepatocellular carcinoma, neuroblastoma and malignant pheochromocytoma, thyroid carcinoma, and melanoma; locating metastatic lesions; internal (systemic) radiation therapy; study of kidney functions; construction of renogram; adrenal cortex imaging; investigations of hepatobillary function; determination of plasma volume |
| Iridium-192 | Brachytherapy, brain and spinal cord tumor treatment, heart disease treatment (restenosis therapy), seed implants for breast and prostate tumors, industrial nondestructive testing by gamma radiography |
| Krypton-81m | Cardiac imaging |
| Lutetium-177 | Heart disease treatment (restenosis therapy), cancer treatment by radioimmunotherapy |
| Molybdenum-99 | Parent for technetium-99m generator used for brain, liver, lungs, heart imaging |
| Osmium-194 | Monoclonal antibody attachment used for cancer treatment by radioimmunotherapy |
| Phosphorus-32 | Polycythemia rubra vera (blood cell disease) and leukemia treatment, bone disease diagnosis/treatment, diagnostic imaging of tumors, pancreatic and liver cancer treatment, radiolabeling, labeling nucleic acids for in vitro research, diagnosis of superficial tumors, heart disease treatment (restenosis therapy), intracavity therapy |
| Phosphorus-33 | Leukemia treatment, bone disease diagnosis/treatment, diagnostic imaging of tumors, radiolabeling, heart disease treatment (restenosis therapy) |
| Palladium-103 | Prostate cancer treatment |
| Platinum-195m | Noninvasive monitoring of drug biodistribution and metabolism, studies with intra-arterial platinum-195m-cisplatin |
| Rhenium-186 | Cancer treatment/diagnostics, monoclonal antibodies, bone cancer pain relief, treatment of rheumatoid arthritis, treatment of prostate cancer |
| Scandium-47 | Bone cancer pain relief, cancer treatment by radioimmunotherapy |
| Selenium-75 | Radiotracer used in brain studies, imaging of adrenal cortex by gamma-scintigraphy, lateral locations of steroid secreting tumors, pancreatic scanning, detection of hyperactive parathyroid glands, measuring the rate of bile acid loss from the endogenous pool |
| Samarium-145 | Treatment of ocular cancer |
| Samarium-153 | Cancer treatment/diagnostics, bone cancer pain relief, treatment of leukemia |
| Strontium-85 | Detection of bone lesions, brain scans |
| Strontium-89 | Bone cancer pain relief, treatment of prostate cancer, treatment of multiple myeloma, osteoblastic therapy, potential agent for treatment of bone metastases from prostate and breast cancer |
| Thorium-228 | Cancer treatment by radioimmunotherapy, monoclonal antibodies, parent of bismuth-212 |
| Thorium-229 | Grandparent of bismuth-213 (alpha-emitter used in cancer treatment by radioimmunotherapy), parent of actinium-225 |

**Table 1–1 Representative Radioisotopes (Continued)**

| Radioisotope | Applications |
|---|---|
| Tin-117m | Bone cancer pain relief |
| Tungsten-188 | Cancer treatment by radioimmunotherapy, parent for rhenium-188 generator |
| Xenon-127 | Neuroimaging for brain disorders, research on variety of neuropsychiatric disorders (especially schizophrenia and dementia), higher resolution diagnostic studies with lower patient dose, lung imaging evaluation of pulmonary ventilation, indicator for measurement of local cerebral blood flow |
| Yttrium-91 | Cancer treatment by radioimmunotherapy, cellular dosimetry |
| Zinc-62 | Parent for copper-64 generator used for diagnostic imaging |

**Source:** Battelle 1999.

and waste materials in plants, soils, and groundwater; and laboratory-based studies of the properties of materials.

In proposing to enhance radioisotope production missions, DOE intends to continue to complement the commercial availability of these radioisotopes. Consistent with current isotope production activities, DOE will continue to make its facilities available to the private sector to support the production and sale of isotopes.

### 1.2.2 Plutonium-238 Production for Space Missions

As part of its charter under the Atomic Energy Act, DOE and its predecessor agencies have been developing and supplying radioisotope power systems (radioisotope thermoelectric generators and radioisotope heater units) to NASA for space exploration for more than 30 years. Previous NASA space missions that have used radioisotope power systems include the Apollo lunar scientific packages and the Pioneer, Viking, Voyager, Galileo, and Ulysses deep space probes. More recent missions include the Mars Pathfinder mission launched in 1996 and the Cassini mission launched in 1997. These radioisotope power systems have repeatedly demonstrated their performance, safety, and reliability in various NASA space missions. Without these power systems, these types of space exploration missions could not be performed by NASA.

The radioisotope used in these power systems is plutonium-238. Through a Memorandum of Understanding with NASA, DOE provides these radioisotope power systems, and the plutonium-238 that fuels them, for space missions that require or would be enhanced by their use (DOE 1991). In addition, under the National Space Policy issued by the Office of Science and Technology Policy in September 1996, and consistent with DOE's charter under the Atomic Energy Act, DOE is responsible for maintaining the capability to provide the plutonium-238 needed to support these missions. The Intersector Guidelines section of the National Space Policy states that, "The Department of Energy will maintain the necessary capability to support space missions which may require the use of space nuclear power systems." Although research to identify other potential fuel sources to support these space exploration missions has been conducted, no viable alternative to using plutonium-238 has been established. Similarly, NASA has yet to identify or demonstrate technologies that can viably replace plutonium-238-fueled radioisotope power systems for use in deep space missions (NASA 1995).

Historically, the reactors and chemical processing facilities at DOE's Savannah River Site (SRS) were used to produce plutonium-238; however, downsizing of the DOE nuclear weapons complex resulted in the shutdown of the last remaining SRS operating reactor, K-Reactor, by early 1996. Also, in 1992 then-Secretary of Energy Watkins issued a decision to phase out operations at the two chemical processing facilities (F-Canyon and H-Canyon) at SRS. In accordance with that decision, the separation facilities are planned to be shut down following completion of their current missions to stabilize and prepare for disposition Cold War legacy nuclear materials and certain spent nuclear fuel, and a determination that a new nonchemical processing technology is capable of preparing aluminum-based research reactor spent nuclear fuel for ultimate disposition.

Because the supply of plutonium-238 produced at SRS to support NASA space missions is limited, DOE signed a 5-year contract in 1992 to purchase plutonium-238 from Russia, authorizing the United States to purchase up to 40 kilograms (88.2 pounds) of plutonium-238, with the total available for purchase in any one year limited to 10 kilograms (22 pounds). Under this contract, DOE purchased approximately 9 kilograms (19.8 pounds) of plutonium-238 on an as-needed basis, an amount that also reflects the available U.S. inventory that has been reserved for space missions.[1] Larger individual quantities have not been purchased by DOE due to budget constraints. Also, purchase on an as-needed basis has avoided the costs from processing the plutonium-238 to remove the decay products that would result from storing it for an extended period of time. In 1997, DOE extended the contract for another 5 years; therefore, it is set to expire in 2002. Any further extensions to the contract would need to be negotiated.

The political and economic climate in Russia creates uncertainties that could affect its reliability as a source of plutonium-238 to satisfy future NASA space mission requirements. Moreover, information is limited concerning the extent of the Russian supply, Russian plans on how they would satisfy future demand, and the nuclear safety and nonproliferation implications of the Russian production methods. The long-term viability of pursuing additional contract extensions or entering into a new contract is unclear, whereas the current inventory of plutonium-238 for space missions is expected to be depleted by approximately 2005 if currently projected missions are implemented. In 2000, NASA provided preliminary guidance to DOE to plan for the potential use of radioisotope power systems for the Pluto/Kuiper Express mission scheduled for launch in 2004, the Europa Orbiter mission scheduled for launch in 2006, and the Solar Probe mission scheduled for launch in 2007 (NASA 2000). The Pluto/Kuiper Express mission would require approximately 7.4 kilograms (16.3 pounds) of plutonium-238, and the Europa Orbiter and Solar Probe missions would each require approximately 3 kilograms (6.6 pounds) of plutonium-238. DOE is also planning to provide radioisotope heater units for several NASA Mars Surveyor missions over the next decade, each of which would require approximately 0.3 kilograms (0.7 pounds) of plutonium-238. Although future space mission schedules over a long-term planning horizon of 20 to 35 years cannot be specified at this time, DOE anticipates that NASA space exploration missions conducted during this period will continue to require plutonium-238-fueled power systems. A plutonium-238 production rate of 2 to 5 kilograms (4.4 to 11 pounds) per year would be sufficient to meet these estimated long-term requirements.

Because it is not in the best interest of the United States to continue relying on foreign sources to provide an assured, uninterrupted supply of plutonium-238 to satisfy future NASA space exploration mission requirements, DOE proposes to re-establish a domestic capability for producing and processing this material. Since the SRS facilities previously used for plutonium-238 production are no longer available, DOE needs to evaluate other DOE irradiation and chemical processing facilities, as well as potential commercial light water reactors (CLWR), for this mission. Unless an assured domestic supply of plutonium-238 is established, DOE's ability to support future NASA space exploration missions may be lost.

### 1.2.3 Nuclear Energy Research and Development for Civilian Applications

Nuclear energy is an important contributor in reducing greenhouse gas emissions in the United States, Asia, and Europe. Globally, nuclear energy produces 17 percent of the world's electricity. In the United States, nuclear energy generated 20 percent of all electricity consumed in 1999. In view of these energy and environmental contributions, there is a renewed interest in nuclear power to meet an equivalent portion of the Nation's future expanding energy requirements.

[1] The environmental impacts of purchasing plutonium-238 from Russia are evaluated and documented in the *Environmental Assessment of the Import of Russian Plutonium-238* (DOE 1993), prepared by DOE's Office of Nuclear Energy.

In January 1997, President Clinton tasked his Committee of Advisors on Science and Technology (PCAST) to evaluate the current national energy research and development portfolio and to provide a strategy that ensures the United States has a program to address the Nation's energy and environmental needs for the next century. In its November 1997 report responding to this request, the PCAST Energy Research and Development Panel determined that restoring a viable nuclear energy option to help meet our future energy needs is important and that a properly focused research and development effort to address the potential long-term barriers to expanded use of nuclear power (e.g., nuclear waste, proliferation, safety, and economics) was appropriate. The PCAST panel further recommended that DOE reinvigorate its nuclear energy research and development activities to address these potential barriers.[2]

It is the policy of this Administration that clean, safe, reliable nuclear power has a role today and in the future for our national energy security. Recognizing this need, the Administration and Congress have initiated two new significant nuclear energy research and development programs: the Nuclear Energy Research Initiative and Nuclear Energy Power Optimization. The Nuclear Energy Research Initiative program sponsors new and innovative scientific and engineering research and development to address the potential long-term barriers identified by the PCAST panel affecting the future use of nuclear energy. The Nuclear Energy Power Optimization program, a cost-shared program with industry, sponsors applied research and development to ensure that current nuclear plants can continue to deliver adequate and affordable energy supplies up to and beyond their initial 40-year license period by resolving open issues related to plant aging and by applying new technologies to improve plant reliability, availability, and productivity.

The NERAC Subcommittee on Long-Term Planning for Nuclear Energy Research has set forth a recommended 20-year research and development plan to guide DOE's nuclear energy programs in areas of material research, nuclear fuel, and reactor technology development (NERAC 2000c). This plan stresses the need for DOE facilities to sustain the nuclear energy research mission in the years ahead. Such nuclear research and development initiatives requiring an enhanced DOE nuclear facility infrastructure fall into three basic categories: materials research, nuclear fuel research, and advanced reactor development.

**Materials Research.** The high radiation fields, high temperatures, and corrosive environments in nuclear reactors (terrestrial or space) and other complex nuclear systems (e.g., accelerator transmutation of waste [ATW] systems) can accelerate the degradation of pressure vessels and structural material, component materials, material interfaces, and joints between materials (e.g., welds). Radiation effects in materials can cause a loss of mechanical integrity (fracture toughness and ductility) by embrittlement, dimensional changes (creep and swelling), and fatigue and cracking (irradiation-assisted stress corrosion cracking). Acquiring a fundamental understanding of radiation effects in current and future reactor materials (engineered steel alloys, ceramics, composites, and refractory metals), as well as the experimental validation of analytical models and computational methods, would require material irradiation testing over a range of neutron energies (thermal and fast flux) and doses. Material testing under simulated reactor conditions would be required to ensure the compatibility of advanced materials with the various moderators/coolants of future reactor concepts. In addition, the thermophysical properties and behaviors of liquid metal coolants being considered for advanced reactor (terrestrial or space) and ATW systems would require further irradiation testing. One key area of materials research that is important to plant safety and the license renewal of existing nuclear power plants is the accelerated aging of materials to simulate radiation effects over a plant lifetime. Researchers from the United States and many foreign countries use DOE's high-flux research reactors for materials testing and experimentation. These facilities have the capability to maintain a high density of neutrons in a given test

[2] DOE's Office of Nuclear Energy, Science and Technology has considered the PCAST recommendations in the development of this NI PEIS. This NI PEIS does not evaluate programmatic needs of other DOE program offices, including the Office of Science.

volume for materials testing; shorten the time needed for such testing; tailor the neutron flux to simulate the different reactor types and conditions; and instrument the core for close monitoring of the test conditions.

**Nuclear Fuel Research.** Increasing demands are being placed on nuclear fuel and cladding material performance as the fuel burnup limits are extended in existing light water reactors to maximize plant performance and economic benefits. New fuel types and forms are being investigated that offer potential benefits such as enhanced proliferation resistance (uranium-thorium fuel), higher burnup, and improved waste forms for the new reactor concepts being researched and developed by DOE. In addition, plutonium-based mixed oxide fuels are being developed for the disposition of surplus weapons material, and high temperature, long-life fuels may be required for space reactors. Each of the various fuel and cladding types, forms, and material compositions would require research and irradiation testing under prototypical reactor conditions to fully understand fuel performance, cladding performance, cladding/fuel interaction, and cladding/coolant material compatibility. Fuel research includes a variety of thermal and fast spectrum power reactor fuel forms (ceramic, metal, hybrids such as cermet) and various fuel types (oxides, nitrides, carbides, and metallics). Irradiation experiments to characterize fuel performance would require the capability to test fuel pellets, pins, and fuel assemblies under steady-state and transient conditions in the higher temperature environments expected in future reactor designs. Reactor physics and criticality safety data for benchmarking computational codes and analytical methods used in fuel design and performance analysis would also be required.

**Advanced Reactor Development.** Certification and licensing of advanced reactor and complex nuclear systems would require the demonstration and validation of reactor and safety system thermal and fluid dynamic properties under steady-state and transient conditions. Typically, nonnuclear test loops are used to perform this research. However, because of the unique nature of some proposed advanced reactor concepts, test loop operation under prototypical temperature and neutron flux conditions would be necessary to adequately test and demonstrate coolant/moderator physics and thermal properties, heat transfer, fluid flow, and fuel-moderator performance.

## 1.3 DECISIONS TO BE MADE

In reaching programmatic decisions regarding potential enhancements to its existing nuclear facility infrastructure, DOE will factor the analytical results of this NI PEIS together with the findings presented in the companion NI Cost Report and NI Nonproliferation Impacts Assessment[3] (both expected to be available for information in August 2000), the *Nuclear Science and Technology Infrastructure Roadmap* (which will be updated periodically), recommendations of NERAC and its various subcommittees, public input, and other DOE policy and programmatic considerations.

With the benefit of this broad base of information, DOE intends to make the following decisions:

- Whether to enhance its current nuclear facility infrastructure to meet projected requirements for future medical and industrial isotope production, plutonium-238 production, and nuclear research and development.

- If a decision is made to enhance DOE's existing nuclear facility infrastructure, whether to construct new facilities (one or two accelerators or a research reactor).

[3] The DOE Office of Arms Control and Nonproliferation is analyzing the nonproliferation policy impacts of FFTF's restart, and of the other alternatives and their various options, and will be reporting its findings in the *Nonproliferation Impacts Assessment for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (Nuclear Infrastructure Nonproliferation Impacts Assessment).

- Whether to restart the Fast Flux Test Facility (FFTF) at the Hanford Site in Richland, Washington, as part of a nuclear infrastructure enhancement program and, if not, whether to remove FFTF from standby mode and permanently deactivate it in preparation for its eventual decontamination and decommissioning.

- If DOE's existing nuclear facility infrastructure is not enhanced, select from existing operating facilities those needed to support the proposed plutonium-238 mission, or decide whether to continue purchasing plutonium-238 from Russia to support future NASA space missions. Existing operating facilities performing medical, research, and/or industrial isotope production missions and/or nuclear research and development missions would continue to support existing missions at current levels.

- Whether DOE inventories of neptunium-237 should be relocated and stored for future plutonium-238 production needs.

The programmatic decisions reached in association with this NI PEIS will address isotope production and civilian nuclear energy research and development missions which are the responsibility of the DOE Office of Nuclear Energy, Science and Technology. In addition to the range of reasonable programmatic alternatives evaluated in this NI PEIS, DOE could choose to combine components of several alternatives in selecting the most appropriate strategy. For example, DOE could select a low-energy accelerator to produce medical, research, and industrial isotopes, and an existing operating reactor to produce plutonium-238 and conduct nuclear research and development. If alternatives were selected involving the siting, construction, and operation of one or two new accelerators or a new research reactor, appropriate site- and project-specific NEPA documentation, tiered from this NI PEIS, would be prepared.

## 1.4 ISSUES IDENTIFIED DURING THE SCOPING PROCESS

On October 5, 1998, DOE published in the Federal Register (63 FR 53398) a Notice of Intent to prepare an environmental impact statement on the proposed production of plutonium-238 for use in advanced radioisotope power systems for future space missions. With that announcement, DOE began preparing the *Environmental Impact Statement for the Proposed Production of Plutonium-238 for Use in Advanced Radioisotope Power Systems for Future Space Missions* (*Plutonium-238 Production EIS*). The scope of the *Plutonium-238 Production EIS* was established through a public scoping process conducted from October 5, 1998, through January 4, 1999. As part of the scoping process for that draft, DOE announced that FFTF would not be considered a reasonable alternative for the plutonium-238 production mission unless restart of the facility were proposed for other reasons.

Since then, the Secretary of Energy announced on August 18, 1999 that DOE would prepare the NI PEIS. Because plutonium-238 production would be among the missions considered, the scope of the *Plutonium-238 Production EIS* in its entirety was incorporated within the scope of this NI PEIS, and preparation of the *Plutonium-238 Production EIS* as a separate National Environmental Policy Act (NEPA) review was terminated.

On September 15, 1999, DOE published in the Federal Register a Notice of Intent to prepare the NI PEIS (64 FR 50064). In the Notice, DOE invited the public to comment on the proposed actions during the 45-day NI PEIS scoping period that ended October 31, 1999. During this period, DOE held public scoping meetings at seven locations: Oak Ridge, Tennessee; Idaho Falls, Idaho; Richland and Seattle, Washington; Hood River and Portland, Oregon; and Washington, D.C. The written and oral comments, and the additional comments received via U.S. mail, electronic mail, and toll-free faxes and telephone calls, were reviewed and considered by DOE in preparing this NI PEIS. Similarly, DOE reviewed and considered all comments and input originally received from the public during the *Plutonium-238 Production EIS* scoping period in the preparation of this NI PEIS.

For the *Plutonium-238 Production EIS*, approximately 750 scoping comments were received by DOE. At the scoping meetings, the following general issues and concerns were raised:

- Additional irradiation service alternatives, such as CLWRs and accelerators
- Additional storage, target fabrication, and target processing alternatives, such as Argonne National Laboratory–West's Hot Fuels Examination Facility and the SRS H-Canyon and HB-Line
- Generation of additional waste streams
- Costs of implementing the various alternatives

In general, the people who attended the meetings in Idaho and Tennessee were supportive of DOE's proposed plans to produce plutonium-238 domestically for future space missions. However, in Richland, Washington, the meeting was attended by several stakeholder and environmental groups who voiced considerable opposition to DOE's consideration of FFTF for plutonium-238 production.

At the meeting in Richland, Washington, the main concern was that DOE should not consider restarting FFTF; that DOE has worked hard over the years to change Hanford's mission from "production" to "cleanup"; and that DOE should continue to honor its commitment to cleanup. There were concerns about the generation of additional waste streams at the site and the operational safety of FFTF. There was strong opposition to restart of FFTF for any mission.

For this NI PEIS, approximately 7,000 comments were received by DOE. At the scoping meetings, the most prevalent concerns were:

- Status of and commitment to cleanup at Hanford and the impact of FFTF's restart on the existing waste cleanup at Hanford
- Lack of justification for the identified missions
- Costs of implementing the various alternatives
- Need for an additional alternative calling for the permanent deactivation of FFTF coupled with the No Action Alternative elements; that is, no plutonium-238 production and no additional research and development or medical isotope production beyond existing operating levels

The number of people who commented at the scoping meetings conducted in Oak Ridge, Tennessee; Idaho Falls, Idaho; and Washington, D.C., was smaller in comparison to the meetings held in the Pacific Northwest. At the scoping meeting in Oak Ridge, Tennessee, a commentor was concerned with the relationship of this NI PEIS to other DOE programs and the relative merits of accelerator and reactor performance. The commentor stated that the NI PEIS should include an explanation of mixed oxide fuel disposition. In addition, the commentor supported medical isotope production in Oak Ridge because it is near a transportation hub and some medical isotopes are short-lived; therefore, transportation is key.

At the scoping meeting in Idaho Falls, Idaho, most commentors supported siting the new missions at the Idaho National Engineering and Environmental Laboratory (INEEL). The commentors also stated that the socioeconomic impacts of the alternatives need to be considered in this NI PEIS. A commentor stated that decisions in regard to medical isotope production should be based on the needs of the Nation as a whole and not on perceived commercial needs. The commentor also stated that incremental DOE and commercial investments in the Advanced Test Facility would be sufficient to enhance reactor radioisotope production needs and meet the requirements of the nuclear medicine industry.

At the meetings held in the states of Washington and Oregon, many of the comments either supported or opposed using FFTF to accomplish the proposed missions. The commentors who attended the meetings in Seattle, Washington; Portland, Oregon; and Hood River, Oregon, were strongly opposed to the restart of FFTF. Many commentors stated that the Hanford cleanup mission would be jeopardized, especially when DOE has not met the cleanup milestones. Most of the comments received at the Richland, Washington, meeting supported restarting FFTF, stating that the restart would not hamper Hanford's cleanup mission, and further stating that the operation of FFTF could help save many lives by producing isotopes to be used in new ways to treat cancer, heart disease, and other illnesses. Commentors were also concerned about the potential generation of radioactive and hazardous waste as a result of the proposed missions, as well as DOE's commitment to ongoing cleanup programs, particularly at Hanford.

At the scoping meeting in Washington, D.C., the commentors supported the need for medical isotope production. Several commentors were against the restart of FFTF; others stated that DOE needs to consider partnerships with private industry to generate necessary funds for the restart. Some commentors thought a cost study should be prepared to include avoiding future healthcare costs as well as cost savings to the national Medicare and Medicaid programs that could be realized by using nuclear isotopes in medical applications. Proliferation concerns were also raised as some commentors stated that: (1) the United States would be sending the wrong message by restarting FFTF; (2) a change in the U.S. nonproliferation policy would be required to import German mixed oxide fuel; and (3) the use of highly enriched uranium would be contrary to existing U.S. nonproliferation policy. Other concerns included waste generation, the Hanford cleanup, and safety at FFTF.

Comments received during the scoping periods were systematically reviewed by DOE. As a means of summarizing the issues raised during the scoping process, those comments with similar or related topics were grouped into categories to identify specific issues of public concern. After these issues were identified, they were further evaluated to determine whether they fell within or outside the proposed scope of this NI PEIS. In several instances, the original scope was expanded to accommodate additional issues resulting from the public scoping process.

Comments received that contributed to expansion of the scope included the following general areas:

- Deactivate FFTF: Alternative 5, Permanently Deactivate FFTF with no new missions at existing facilities, has been added to the scope of this NI PEIS.

- Cleanup at Hanford: although not within the scope of this NI PEIS, information is included about the cleanup mission at Hanford and land-use planning efforts.

- Environmental contamination at Hanford: information is included about the groundwater quality at the existing Hanford site.

- European regulatory/government issues: the import of German SNR–300 fuel is being addressed, and a separate "Nuclear Infrastructure Nonproliferation Impacts Assessment" report will be completed in the summer of 2000 to also address export issues.

- Transition of FFTF stewardship after it is deactivated: the appropriate transition information is included.

- Restart of FFTF and budget constraints: DOE has made a commitment that implementation of the Record of Decision will not divert or reprogram budgeted funds designated for Hanford cleanup, regardless of the alternative selected.

- Tri-Party Agreement at Hanford: information about the Tri-Party Agreement and its relationship to this NI PEIS is included.

Public comments and materials submitted during the public scoping periods for both the *Plutonium-238 Production EIS* and this NI PEIS were logged and placed in the Administrative Record for this NI PEIS. Appendix N summarizes the comments received during both public scoping periods.

## 1.5 ALTERNATIVES EVALUATED IN THIS NI PEIS

This NI PEIS analyzes the potential environmental impacts using various irradiation and processing facilities to meet the following projected DOE irradiation service mission needs for 35 years: (1) production of medical, research, and industrial isotopes; (2) production of 5 kilograms (11 pounds) per year of plutonium-238 for use in advanced radioisotope power systems for future NASA space missions; and (3) support for U.S. nuclear research and development activities. The proposed irradiation facilities include those that are currently operating, those that could be brought online, or those that could be constructed and operated to meet DOE's nuclear facility infrastructure requirements. This NI PEIS evaluates a No Action Alternative and five programmatic alternatives:

No Action Alternative
Alternative 1—Restart FFTF
Alternative 2—Use Only Existing Operational Facilities
Alternative 3—Construct New Accelerator(s)
Alternative 4—Construct New Research Reactor
Alternative 5—Permanently Deactivate FFTF (with no new missions)

Each of the alternatives in this NI PEIS would contribute to fulfilling some of the proposed missions. However, none of the alternatives can completely meet all of the projected nuclear infrastructure needs. It is possible during the Record of Decision process that a combination of the alternatives could be selected, e.g., a low power accelerator in combination with the existing reactors to optimize research isotope production, or in combination with FFTF to optimize research and therapeutic isotope production. The alternatives, their associated facility options, and their relative capabilities are described in detail in Chapter 2. **A preferred alternative has not yet been identified. In accordance with the Council on Environmental Quality regulations, DOE will identify a preferred alternative in the Final NI PEIS.**

## 1.6 RELATED NEPA REVIEWS

This section provides brief summaries of NEPA documents related to ongoing DOE programs, including documents that address other aspects of DOE's nuclear facility infrastructure, the management of various waste types across the DOE complex, and activities currently under way or planned at candidate sites that are analyzed in this NI PEIS.

The *Environmental Assessment, Shutdown of the Fast Flux Test Facility, Hanford Site, Richland, Washington,* (DOE/EA-0993, May 1995; FONSI, May 1995) analyzes the environmental impacts associated with permanent shutdown (deactivation) of FFTF and the activities required to support it. Based on the environmental assessment, DOE determined that the proposed shutdown would not result in significant environmental impacts as defined under NEPA. This NI PEIS summarizes the impacts presented in the environmental assessment for those alternatives that consider permanent deactivation of FFTF (i.e., Alternatives 2, 3, 4, and 5) (DOE 1995a).

The *Environmental Assessment of the Import of Russian Plutonium-238* (DOE/EA-0841, June 1993; FONSI, June 1993) addresses the environmental impacts of importing plutonium-238 from Russia to augment the U.S. inventory for NASA space missions. The proposed action considers shipping up to 40 kilograms (88.2 pounds) of plutonium-238 fuel from Russia to a U.S. port, transporting the plutonium-238 within the United States to either SRS or Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico, and if necessary, processing the material at SRS to remove impurities from the fuel. The impacts analyzed in the environmental assessment are summarized in this NI PEIS for those alternatives that do not consider re-establishing a domestic plutonium-238 production capability (i.e., the No Action Alternative and Alternative 5) (DOE 1993).

The *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220, October 1995) analyzes the potential environmental impacts of managing certain nuclear materials at SRS pending decisions on future use or ultimate disposition, as well as the impacts of constructing the SRS Actinide Packaging and Storage Facility. Five related Records of Decision have been issued since this Final EIS was published. On December 12, 1995, DOE issued a Record of Decision and a Notice of Preferred Alternatives (60 FR 65300) concerning interim management of several categories of nuclear materials at SRS. On February 8, 1996, DOE issued a Supplemental Record of Decision (61 FR 6633) concerning stabilization of two of the remaining categories of nuclear materials (Mark-16 and Mark-22 fuel and other aluminum-clad targets) analyzed in the Final EIS. After considering a DOE staff study and recommendation on canyon facility use, DOE issued a second Supplemental Record of Decision on September 6, 1996 (61 FR 48474), concerning stabilization of the neptunium-237 solutions, obsolete neptunium targets, and plutonium-239 solutions. On April 2, 1997, DOE issued a third Supplemental Record of Decision (62 FR 17790) related to stabilization in the F-Canyon and FB-Line facilities of the remaining Taiwan Research Reactor spent nuclear fuel. On October 31, 1997, DOE issued a fourth Supplemental Record of Decision (62 FR 61099) to add another method, processing and storage for vitrification in the Defense Waste Processing Facility, to those being used to manage plutonium and uranium stored in vaults and to amend its September 6, 1996, Supplemental Record of Decision to now enable use of the SRS H-Canyon facilities to stabilize the plutonium-239 and neptunium-237 solutions stored in H-Canyon and the obsolete neptunium-237 targets stored in K-Reactor into oxide forms. This neptunium-237 oxide serves as the target material for the plutonium-238 production mission analyzed in this NI PEIS (DOE 1995b).

The *Final Environmental Impact Statement, Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes* (DOE/EIS-249, April 1996; Record of Decision, September 1996 [61 FR 48921]) analyzes the proposed establishment of a domestic capability to produce molybdenum-99 (a short-lived isotope that decays into technetium-99, an isotope used extensively for medical imaging) and related medical isotopes such as iodine-131, xenon-133, and iodine-125. At the time of this review, the U.S. supply of molybdenum-99 depended on the production capacity of one aging reactor in Canada, so DOE proposed this action to ensure a reliable domestic source for this vital isotope. In the Record of Decision, DOE selected the Annular Core Research Reactor and the Hot Cell Facility at Sandia National Laboratory (SNL), New Mexico, for the production of molybdenum-99 and the related isotopes. Since that time, two new Canadian reactors have been built to replace the aging reactor. DOE has determined that, because the vulnerability in supplies of molybdenum-99 has sufficiently diminished, the selected SNL facilities should serve primarily defense missions, but should provide a reserve capability to support limited medical isotope production, if necessary. Any nuclear facility infrastructure enhancements analyzed in this NI PEIS would be separate from, and in addition to, the existing capabilities of these facilities (DOE 1996a).

The *Final Environmental Impact Statement, Construction and Operation of the Spallation Neutron Source* (DOE/EIS-0247, April 1999; Record of Decision, June 1999 [64 FR 35140]) analyzes the potential environmental impacts of constructing and operating a state-of-the-art spallation neutron source facility at one of four sites: ORNL (Preferred Alternative); Argonne National Laboratory–East in Argonne, Illinois;

Brookhaven National Laboratory in Upton, New York; and LANL. The spallation neutron source facility is designed to provide a high-flux, short-pulsed neutron source that would give the United States' scientific and industrial research communities a much more intense source of pulsed neutrons than is currently available. Construction of this new facility would also ensure the future availability of a state-of-the-art facility as currently existing sources reach the end of their useful operating lives. In the associated Record of Decision, DOE designated ORNL as the chosen site for construction and operation of the spallation neutron source. The spallation neutron source is currently under construction, and the facility's full capacity has been dedicated to support planned missions. The nuclear facility infrastructure enhancements analyzed in this NI PEIS would be separate from, and in addition to, the capabilities of this facility (DOE 1999a).

The *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (*Waste Management PEIS*) (DOE/EIS-0200-F, May 1997; Transuranic Waste Record of Decision, January 1998 [63 FR 3629]; Hazardous Waste Record of Decision, August 1998 [63 FR 41810]; High-Level Radioactive Waste Record of Decision, August 1999 [64 FR 46661]; Low-Level Radioactive Waste and Mixed Low-Level Radioactive Waste Record of Decision, February 2000 [65 FR 10061] examines the potential environmental and cost impacts of selected strategic alternatives for managing five types of radioactive and hazardous waste that result from nuclear defense and research activities at sites throughout the United States. The *Waste Management PEIS* provides information on the impacts of the various siting configurations DOE will use to decide where to locate additional treatment, storage, and disposal capacity for each waste configuration. In the transuranic waste Record of Decision, DOE determined that those sites that currently have or will generate transuranic waste will prepare it for storage and store it on site, except SNL, which will transfer its transuranic waste to LANL. The hazardous waste Record of Decision states that DOE will continue the use of offsite facilities to treat nonwastewater hazardous waste, with the exception that Oak Ridge Reservation (ORR) and SRS will treat some of their own nonwastewater hazardous waste on site. The high-level radioactive waste Record of Decision states that immobilized high-level radioactive waste will be stored at Hanford, INEEL, SRS, and the West Valley Demonstration Project in New York until a geologic repository is licensed by the NRC. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision states that DOE will minimally treat low-level radioactive waste at the generator sites, and that Hanford and the Nevada Test Site will be made available to all DOE sites for low-level radioactive waste disposal. As part of this decision, DOE will treat mixed low-level radioactive waste at INEEL, ORR, and SRS; dispose of mixed low-level radioactive waste at the Nevada Test Site; and both treat and dispose of mixed low-level radioactive waste at Hanford. Waste generated as part of this NI PEIS proposed action would be managed in accordance with these decisions (DOE 1997).

The *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, (DOE/EIS-0250D, July 1999) analyzes the construction, operation and monitoring, and eventual closure of a potential geologic repository at Yucca Mountain to dispose of commercial and DOE spent nuclear fuel, high-level radioactive waste, and materials that NRC determines by rule require the same degree of isolation. National transportation, Nevada transportation, and waste packaging are evaluated as part of the analysis. Three implementing design alternatives based on thermal load—low, intermediate, and high—are examined. This NI PEIS assumes for analysis purposes that Yucca Mountain is a potential geologic repository site for spent nuclear fuel produced as a result of enhancing the U.S. nuclear facility infrastructure (DOE 1999b).

The *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* (DOE/EIS-0189, August 1996; Record of Decision, February 1997 [62 FR 8693]) satisfies the DOE commitment made in the *Disposal of Hanford Defense High-Level, Transuranic and Tank Waste Final Environmental Impact Statement* (DOE/EIS-0113, December 1987; Records of Decision March and April 1988) to prepare a supplemental NEPA analysis. The *Tank Waste Remediation System EIS* was prepared in response to several important changes subsequent to the Record of Decision, including a revised strategy for managing and disposing of tank waste and encapsulated cesium and strontium. As part of the proposed action, the *Tank Waste Remediation System EIS* evaluates continued operation and management of the tank farms, waste transfer system upgrades, and retrieval and treatment of the tank waste, including construction and operation of a facility to vitrify high-level radioactive waste and to vitrify or similarly immobilize low-level radioactive waste. DOE decided to implement the Preferred Alternative for retrieval, treatment, and disposal of tank waste and to defer a decision on the disposition of cesium and strontium capsules. Two supplemental analyses were prepared for the *Tank Waste Remediation System EIS*. The first was *Proposed Upgrades to the Tank Farm Ventilation, Instrumentation, and Electrical Systems under Project W-314 in Support of Tank Farm Restoration and Safe Operations* (DOE/EIS-0189-SA1, June 1997). Based on these supplemental analyses, it was determined that upgrades or planned upgrades to the tank farm do not pose any additional potential environmental impacts and, therefore, no additional NEPA analysis is required. The second supplemental analysis was for the *Tank Waste Remediation System* (DOE/EIS-0189-SA2, May 1998). This analysis provides information on the most recent inventory of chemical and radiological constituents in the tanks and the new waste to be sent to the tanks for treatment. Based on the new data, it was concluded that there would be minimal changes from the impacts identified in the *Tank Waste Remediation System EIS* and, therefore, no additional NEPA analysis is required. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996b).

The *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE/EIS-0222-F, September 1999; Record of Decision, November, 1999 [64 FR 61615]) focuses on developing an overall strategy for future land use at Hanford and includes a proposed comprehensive land-use plan. The Preferred Alternative, which DOE selected in the Record of Decision, is to consolidate waste management operations in the Central Plateau; allow industrial development in the eastern and southern portions of the site; increase recreational access to the Columbia River; and expand Saddle Mountain National Refuge to include all of the Wahluke Slope, McGee Ranch, and Fitzner-Eberhardt Arid Lands Ecology Reserve. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1999c).

The *Hanford Reach of the Columbia River Comprehensive River Conservation Study and Environmental Impact Statement* (National Park Service June 1994; Record of Decision July 1996) evaluates impacts related to protection of the Hanford Reach of the Columbia River as a Wild and Scenic River, increased recreation access, and visitor interpretation and education. In the Record of Decision, the National Park Service recommended that Congress designate the Hanford Reach of the Columbia River, public land within one-quarter mile of the river, and all public land on the Wahluke Slope as a new National Wildlife Refuge and National Wild and Scenic River. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (NPS 1994).

The *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F, April 1995; Record of Decision, May 1995 [60 FR 28680]) is a complex-wide evaluation of the alternatives for managing the existing and projected amounts of spent nuclear fuel within the DOE inventory through 2035. The EIS contains an analysis of the impacts of transporting spent nuclear fuel, as well as sitewide alternatives for environmental restoration and waste management programs at INEEL. In the associated Record of Decision, DOE designated Hanford, INEEL, and SRS for regional spent fuel storage and management and made decisions about environmental restoration and waste management activities at INEEL. In March 1996, DOE issued an amendment to the May 1995 Record of Decision to include a decision to regionalize the management of DOE-owned spent nuclear fuel by fuel type, including spent fuel currently stored at Hanford, INEEL, and SRS. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1995c).

The *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (DOE/EIS-0218F, February 1996; Record of Decision, July 1996 [61 FR 38720]) evaluates the adoption of a joint DOE/Department of State policy to manage spent nuclear fuel from foreign research reactors, including highly enriched uranium provided by the United States to other countries for research reactors. Management alternatives include a number of implementation options for port selection, transportation, and storage at DOE sites. In the Record of Decision, DOE selected a management policy that returned spent nuclear fuel from various foreign research reactors to the United States using two designated U.S. ports and the management at INEEL and SRS. A supplement analysis (DOE/EIS-0218-SA-2, August 1998) was prepared to examine acceptance of foreign research reactor spent nuclear fuel under three scenarios not specifically examined in the EIS: (1) accepting spent nuclear fuel not included in EIS-estimated inventories, (2) accepting spent nuclear fuel from countries in quantities greater than the quantities identified in the EIS, and (3) transporting more than eight casks of spent fuel on a single oceangoing vessel. The supplement analysis concluded that the potential environmental impacts of these actions are bounded by the analysis performed in the EIS and, therefore, no supplement to the EIS is needed. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996c).

The DOE INEEL *Advanced Mixed Waste Treatment Project Final Environmental Impact Statement* (DOE/EIS-0290, January 1999; Record of Decision, April 1999 [64 FR 16948]) evaluates four alternatives: (1) a No Action Alternative under which existing waste management operations, facilities, and projects would continue; (2) the proposed action/Preferred Alternative under which BNFL, Inc., would build and operate an advanced mixed waste treatment project facility using proposed thermal and nonthermal treatment technologies for certification and shipment to the Waste Isolation Pilot Plant or to another acceptable disposal facility; (3) a nonthermal treatment alternative under which some treatment of transuranic, alpha, and low-level mixed waste would occur at an advanced mixed waste treatment project facility at the same location as the proposed action, and waste that requires thermal treatment would be repackaged for storage; and (4) a treatment and storage alternative that would include the same processes as the proposed action/Preferred Alternative, except the treated waste would be placed in Resource Conservation and Recovery Act–permitted storage units at the onsite Radioactive Waste Management Complex for long-term storage. In the Record of Decision, DOE selected the Preferred Alternative, although construction of the thermal treatment component of this alternative has been deferred pending the recommendation of a blue ribbon panel of experts assessing possible technology alternatives. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1999d).

The *Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory* (DOE/EIS-0238, January 1999; Record of Decision, September 1999 [64 FR 50797]) evaluates ongoing and projected new operations and facilities at LANL in support of DOE missions, including the storage of plutonium-238. A decision was made in the LANL Record of Decision to implement the Preferred Alternative, which includes expansion of operations as necessary, increases in existing operations to the greatest reasonably foreseeable levels, and full implementation of the mission elements assigned to LANL. Because the remaining U.S. inventory of usable plutonium-238 is stored at LANL, the NI PEIS evaluates the transport to LANL of the plutonium-238 product resulting from an enhanced nuclear facility infrastructure (DOE 1999e).

The *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE/EIS-0161, October 1995; Record of Decision, December 5, 1995 [60 FR 63878]) evaluates the siting, construction, and operation of tritium supply technology alternatives and recycling facilities at five candidate sites, as well as the use of a CLWR for producing tritium, a gaseous radioactive isotope of hydrogen considered essential to the operation of U.S. thermonuclear weapons. In the Record of Decision, DOE selected a dual-track approach. One track explores the purchase of an operating or partially complete CLWR, or the purchase of irradiation services from such a reactor. A second track would design, build, and test critical components of an accelerator system for production of tritium. The Record of Decision stated that DOE would select one of the alternatives at a later date to serve as the primary tritium source for the U.S. nuclear weapons stockpile, while the other alternative will be developed as a backup source, if feasible. The Record of Decision also stated that DOE would determine whether the operation of FFTF might be able to play any role in future tritium requirements. On December 22, 1998, the Secretary of Energy announced his selection of the CLWR as the primary tritium supply and that an accelerator would be developed but not constructed. In addition, DOE decided that FFTF would have no role in tritium supply plans. The impacts of this action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action. Since the accelerator for production of tritium would not be built, it was not considered as a reasonable alternative in the NI PEIS (DOE 1995d).

The *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240, June 1996; Record of Decision, July 1996 [61 FR 40619) addresses the disposition of a nominal 220 tons of highly enriched uranium declared surplus to the national security needs of the United States. Alternatives include several approaches to blending down the highly enriched material to make it non-weapons-usable and suitable for fabrication into fuel for commercial nuclear reactors. The Record of Decision identifies DOE's intent to blend, over time, as much material as possible (up to 85 percent) for commercial use and blending the remainder for disposal as low-level radioactive waste. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996d).

The *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE/EIS-0229, December 1996; Record of Decision, January 1997 [63 FR 43386]) analyzes the environmental impacts of alternatives considered for the long-term storage of weapons-usable fissile materials (highly enriched uranium and plutonium) and for the disposition of weapons-usable plutonium that has been declared surplus to national security needs. The Record of Decision encompasses two categories of plutonium decisions: (1) the sites and facilities for the storage of nonsurplus plutonium and the storage of surplus plutonium pending disposition; and (2) the programmatic strategy for disposition of surplus plutonium. It also announces the decision to store surplus and nonsurplus highly enriched uranium in upgraded facilities at ORR. DOE studies indicated that significant cost savings could be realized from the transfer of nonpit materials from the Rocky Flats Environmental Technology Center and Hanford earlier than indicated in the *Storage and Disposition PEIS* Record of Decision. DOE issued an amended Record of Decision (August 1998) that supports the early closure of the Rocky Flats Environmental Technology Center and the early deactivation of plutonium storage facilities at Hanford. The amended Record of Decision includes decisions to accelerate shipment of all nonpit surplus plutonium from the Rocky Flats Environmental Technology Center to SRS and the relocation of all Hanford surplus plutonium to SRS, if SRS were selected as the immobilization site. A supplement analysis to the *Storage and Disposition PEIS*, the *Supplement Analysis for Storing Plutonium in the Actinide Packaging and Storage Facility and Building 105–K at the Savannah River Site*, was issued in July 1998. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996e).

The *Surplus Plutonium Disposition Final Environmental Impact Statement* (DOE/EIS-0283, November 1999; Record of Decision, January 2000 [65 FR 1608]) was tiered from the *Storage and Disposition PEIS* and evaluated reasonable alternatives for the siting, construction, and operation of facilities required to implement DOE's disposition strategy for up to 50 metric tons of surplus plutonium. The disposition facilities analyzed in this EIS include a pit disassembly and conversion facility, a plutonium conversion and immobilization facility, and a mixed oxide fuel fabrication facility. The analyses also considered the potential impacts of fabricating a limited number of lead fuel assemblies for testing in a reactor. In the Record of Decision, DOE decided to provide for the safe, secure disposition using a hybrid approach of immobilizing approximately 17 metric tons (19 tons) and using up to 33 metric tons (36 tons) as mixed oxide fuel. DOE also decided to construct and operate each of the three disposition facilities at SRS, fabricate the lead assemblies at LANL, and conduct postirradiation examination of the lead assemblies at ORNL. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1999f).

The *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DOE/EIS-0269, April 1999; Record of Decision, August 1999 [64 FR 43358]) evaluates the environmental impacts of six alternative strategies for the long-term management of DOE-owned depleted uranium hexafluoride currently stored at the East Tennessee Technology Park in Oak Ridge, Tennessee; the Paducah Gaseous Diffusion Plant near Paducah, Kentucky; and the Portsmouth Gaseous Diffusion Plant near Piketon, Ohio. These alternatives involve cylinder technology and design; conversion of depleted uranium hexafluoride to another chemical form; and materials use, storage, disposal, and transportation. As indicated in the Record of Decision, DOE selected the Preferred Alternative—to begin conversion of the depleted uranium hexafluoride as soon as possible, either to uranium oxide, uranium metal, or a combination of both, while allowing for future use of as much of this inventory as possible. This NI PEIS analyzes the conversion of depleted uranium hexafluoride from a representative site (Portsmouth) to uranium dioxide, which would be used as feedstock for immobilization and mixed oxide fuel and lead assembly fabrication. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1999g).

The *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE/EIS-0236, September 1996; Record of Decision, December 1996 [61 FR 68014]) evaluates the potential environmental impacts resulting from activities associated with nuclear weapons research, design, development, and testing, as well as the assessment and certification of their safety and reliability. The stewardship portion of the document analyzes the development of three new facilities to provide enhanced experimental capabilities. The stockpile management portion of the EIS concerns producing, maintaining, monitoring, refurbishing, and dismantling the nuclear weapons stockpile at eight sites, including Pantex and SRS. In the Record of Decision, DOE selected to downsize a number of facilities for stockpile dismantlement and to build experimental facilities at Lawrence Livermore National Laboratory. A draft supplement analysis (DOE/EIS-0236-SA, June 1999) was prepared to examine the plausibility of a building-wide fire at LANL's plutonium facility and to examine new studies regarding seismic hazards at LANL. The draft supplement analysis was issued for public comment and a final supplemental analysis was issued on September 2, 1999. The supplement analysis concluded that there is no need to prepare a supplemental EIS. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996f).

The *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE/EIS-0306, July 2000) evaluates strategies to remove or stabilize the reactive sodium contained in a portion of DOE's spent nuclear fuel inventory to prepare the spent nuclear fuel for disposal in a geologic repository. The EIS analyzes, under the proposed action, six alternatives that employ one or more of the following technology options at nuclear fuel management facilities at SRS or INEEL: electrometallurgical treatment; the plutonium-uranium extraction process; packaging in high-integrity cans; and the melt and dilute treatment process. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 2000b).

The *Final Environmental Impact Statement (EIS) for Treating Transuranic (TRU)/Alpha Low-Level Waste at the Oak Ridge National Laboratory Oak Ridge, Tennessee* (DOE/EIS-0305, June 2000) evaluates alternatives to construct, operate, and decontaminate and decommission a transuranic waste treatment facility in Oak Ridge, Tennessee. Four types of waste would be treated at the proposed facility including remote-handled transuranic mixed waste sludge, liquid low-level radioactive waste associated with the sludge, contact-handled transuranic/alpha low-level radioactive waste solids, and remote-handled transuranic/alpha low-level radioactive waste solids. The EIS analyzes the potential environmental impacts associated with five alternatives—No Action; the Low-Temperature Drying Alternative, which is DOE's Preferred Alternative; the Vitrification Alternative; the Cementation Alternative; and the Treatment and Waste Storage at ORNL Alternative. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from this NI PEIS proposed action (DOE 2000c).

The *Environmental Assessment of Melton Valley Storage Tanks Capacity Increase Project at the Oak Ridge National Laboratory in Oak Ridge, Tennessee* (DOE/EA-1044, April 1995) evaluates the potential impacts of the construction and maintenance of additional storage capacity at ORNL in Oak Ridge, Tennessee, for liquid low-level radioactive waste. New capacity would be provided by a facility partitioned into six individual tank vaults containing one 100,000-gallon liquid low-level radioactive waste storage tank each. Alternatives considered include the No Action Alternative, ceasing generation, storage at other ORR storage facilities, source treatment, pretreatment, and storage at other DOE facilities. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1995e).

The *Environmental Assessment and FONSI for the Management of Spent Nuclear Fuel on the Oak Ridge Reservation Oak Ridge, Tennessee* (DOE/EA-1117, February 1996) evaluates the potential impacts of the management of spent nuclear fuel on the DOE Oak Ridge Reservation. Spent nuclear fuel would be retrieved from storage; transferred by truck to a hot cell facility, if segregation by fuel type and/or repackaging is required; loaded into containers/transport casks that meet regulatory requirements; and shipped via truck to offsite storage at either SRS or INEEL. The proposed action may also include construction and operation of a dry cask spent nuclear fuel storage facility on ORR to enable reactor operations to continue in the event of an interruption of offsite spent nuclear fuel shipment. In the No Action Alternative, neither construction of a dry cask storage facility nor shipment of spent nuclear fuel from ORR would occur. Spent nuclear fuel would remain at present storage locations on ORR. Due to space limitations, operations on ORR that generate spent nuclear fuel would have to cease, including operation of the High Flux Isotope Reactor. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE 1996g).

The *Environmental Assessment for Transportation of Low-Level Radioactive Waste From the Oak Ridge Reservation to Off-Site Treatment or Disposal Facilities* (DOE/EA-1315, April 2000) evaluates the potential impacts of the transportation of low-level radioactive waste from ORR in Tennessee for treatment or disposal at various locations in the United States. Low-level radioactive waste from three ORR facilities, ORNL, Oak Ridge Y–12 Plant, and East Tennessee Technology Park, is proposed to be loaded and transported to destinations representative of other DOE sites and licensed commercial nuclear waste treatment or disposal facilities. The treatment and/or disposal facilities include Envirocare of Utah, Inc.; Waste Control Specialists; commercial treatment or disposal facilities near SRS in Aiken, South Carolina; commercial facilities near ORR; commercial facilities near Hanford; and facilities at DOE sites such as the Nevada Test Site, the Hanford Reservation, and SRS. In the No Action Alternative, DOE would not ship and dispose of the existing and projected large quantities of ORR low-level radioactive waste at offsite radioactive waste disposal facilities. Relatively small volumes of ORR low-level radioactive waste would continue to be shipped to DOE or commercial disposal facilities under existing and previously approved categorical exclusions. Low-level radioactive waste would continue to be stored on the ORR site, eventually requiring additional low-level radioactive waste storage facilities. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from this NI PEIS proposed action (DOE 2000d).

The *Environmental Assessment for Selection and Operation of the Proposed Field Research Centers for the Natural and Accelerated Bioremediation Research (NABIR) Program* (DOE/EA-1196, March 2000; FONSI, April 2000) evaluates the potential impacts of adding a Field Research Center component to the existing NABIR Program. The NABIR Program is a 10-year fundamental research program designed to increase the understanding of fundamental biogeochemical processes that would allow the use of bioremediation approaches for cleaning up DOE's contaminated legacy waste sites. The Field Research Center would be integrated with the existing and future laboratory and field research and would provide a means of examining the fundamental biogeochemical processes that influence bioremediation under controlled small-scale field conditions. The environmental assessment analyzes the No Action Alternative and two alternative sites under the proposed action: ORNL/Y–12 Site, Oak Ridge, Tennessee, and Pacific Northwest National Laboratory/ DOE Hanford 100-H Area, Richland, Washington. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from this NI PEIS proposed action (DOE 2000e).

The *Idaho High-Level Waste and Facilities Disposition Draft Environmental Impact Statement* (DOE/EIS-0287D, December 1999) analyzes the potential environmental consequences of managing two waste types at INEEL. The two waste types are high-level radioactive waste in a calcine form and liquid mixed transuranic waste, historically known as sodium-bearing waste and newly generated liquid waste. The disposition of existing and proposed high-level radioactive waste facilities after their missions have been completed is also analyzed. The waste processing alternatives are No Action, Continued Current Operations, Separations, Non-Separations, and Minimum INEEL Processing. The facilities' disposition alternatives are No Action, Clean Closure, Performance-Based Closure, Closure to Landfill Standards, Performance-Based Closure with Class A Grout Disposal, and Performance-Based Closure with Class C Grout Disposal. The impacts of the proposed action are factored into the assessment of potential impacts resulting from the NI PEIS proposed action (DOE 1999h).

The *Draft Environmental Assessment for Transportation of Low-Level Radioactive Mixed Waste From the Oak Ridge Reservation to Off-Site Treatment or Disposal Facilities* (DOE/EA-1317, in preparation) evaluates the potential impacts of transportation of low-level radioactive mixed waste from Oak Ridge, Tennessee, to treatment and disposal facilities in various locations in the United States. Low-level radioactive mixed waste from three ORR facilities, East Tennessee Technology Park, ORNL, and the Y–12 Plant, is proposed to be packaged as required, loaded, and shipped to licensed, commercial nuclear waste treatment or disposal facilities. The treatment and/or disposal facilities include Envirocare of Utah, Inc.; Waste Control Specialists; Nevada Test Site; and commercial treatment or disposal facilities near SRS in Aiken, South Carolina, ORR, and the Hanford Site in Richland, Washington. The No Action Alternative of continuing to store most low-level radioactive mixed waste on site, and eventually requiring additional low-level radioactive mixed waste storage facilities is also analyzed. The impacts of the proposed action are factored into the assessment of potential cumulative impacts resulting from the NI PEIS proposed action (DOE in preparation).

## 1.7 STRUCTURE OF THIS NI PEIS

This NI PEIS contains 9 chapters and 15 appendixes. The main analyses are included in the chapters, and additional project information is provided in the appendixes. A summary of this NI PEIS is included as a separate volume.

The nine chapters provide the following information:

Chapter 1—Introduction: Background; purpose and need for agency action; decisions to be made; issues identified during the public scoping process; alternatives evaluated; and related NEPA documents

Chapter 2—Program Description and Alternatives: Program missions; candidate facilities and proposed options to enhance U.S. nuclear infrastructure and provide the capabilities needed to meet

DOE's mission requirements; operations required to implement DOE program missions and the candidate sites and facilities for these activities; transportation activities associated with the program missions; alternatives considered reasonable for detailed evaluation; alternatives and facilities considered and dismissed from evaluation; status of the Preferred Alternative; summaries of the environmental impacts, and implementation schedules associated with the alternatives evaluated

Chapter 3—Affected Environment: Aspects of the environment that could be affected by the NI PEIS alternatives

Chapter 4—Environmental Consequences: Analyses of the potential impacts of the NI PEIS alternatives on the environment

Chapter 5—Applicable Laws, Regulations, and Other Requirements: Environmental, safety, and health regulations that would apply to the alternatives of this NI PEIS, and agencies consulted for their expertise

Chapter 6—List of Preparers

Chapter 7—Distribution List

Chapter 8—Glossary

Chapter 9—Index

The 15 appendixes provide the following information:

Appendix A—Plutonium-238 Target Fabrication and Processing Operations

Appendix B—Neptunium-237 Target Irradiation Operations in Currently Operating Reactors for Plutonium-238 Production

Appendix C—Medical and Industrial Isotope Target Fabrication and Processing Operations

Appendix D—Fast Flux Test Facility Operations

Appendix E—Research Reactor Operations

Appendix F—New Accelerator(s)

Appendix G—Methods for Assessing Environmental Impacts

Appendix H—Evaluation of Human Health Effects from Normal Facility Operations

Appendix I—Evaluation of Human Health Effects from Facility Accidents

Appendix J—Evaluation of Human Health Effects of Transportation

Appendix K—Environmental Justice Analysis

Appendix L—Socioeconomics Analysis

Appendix M—Ecological Resources

Appendix N—Public Scoping Process

Appendix O—Contractor Disclosure Statement

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