1995

Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement, Volume 1, Appendix E

United States Department of Energy

Follow this and additional works at: https://digitalcommons.usu.edu/govdocs

Part of the Environmental Sciences Commons

Recommended Citation
https://digitalcommons.usu.edu/govdocs/371
Department of Energy Programmatic
Spent Nuclear Fuel Management
and
Idaho National Engineering Laboratory
Environmental Restoration and
Waste Management Programs
Final Environmental Impact Statement

Volume 1
Appendix E

Spent Nuclear Fuel Management Programs at
Other Generator/Storage Locations

April 1995

U.S. Department of Energy
Office of Environmental Management
Idaho Operations Office
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTRODUCTION</td>
<td>1-1</td>
</tr>
<tr>
<td>2. SNF MANAGEMENT AT ORIGINATING SITES</td>
<td>2-1</td>
</tr>
<tr>
<td>2.1 Overview of SNF Types, Inventories, and Generation Rates</td>
<td>2-1</td>
</tr>
<tr>
<td>2.2 Spent Nuclear Fuel Management Program Plans and Alternatives</td>
<td>2-17</td>
</tr>
<tr>
<td>2.2.1 No Action</td>
<td>2-17</td>
</tr>
<tr>
<td>2.2.2 Decentralization</td>
<td>2-20</td>
</tr>
<tr>
<td>2.2.3 1992/1993 Planning Basis</td>
<td>2-21</td>
</tr>
<tr>
<td>2.2.4 Regionalization</td>
<td>2-22</td>
</tr>
<tr>
<td>2.2.5 Centralization</td>
<td>2-22</td>
</tr>
<tr>
<td>3. AFFECTED ENVIRONMENTS</td>
<td>3-1</td>
</tr>
<tr>
<td>3.1 DOE Experimental Reactors and Small-Quantity Storage</td>
<td>3-1</td>
</tr>
<tr>
<td>3.1.1 Brookhaven National Laboratory</td>
<td>3-1</td>
</tr>
<tr>
<td>3.1.2 Los Alamos National Laboratory</td>
<td>3-8</td>
</tr>
<tr>
<td>3.1.3 Sandia National Laboratories</td>
<td>3-15</td>
</tr>
<tr>
<td>3.1.4 Argonne National Laboratory - East</td>
<td>3-23</td>
</tr>
<tr>
<td>3.2 Domestic Research Reactors</td>
<td>3-33</td>
</tr>
<tr>
<td>3.2.1 National Institute of Standards and Technology Research Reactor</td>
<td>3-34</td>
</tr>
<tr>
<td>3.2.2 Massachusetts Institute of Technology Research Reactor</td>
<td>3-37</td>
</tr>
<tr>
<td>3.2.3 University of Missouri/Columbia Research Reactor</td>
<td>3-39</td>
</tr>
<tr>
<td>3.2.4 University of Michigan Ford Nuclear Reactor</td>
<td>3-41</td>
</tr>
<tr>
<td>3.2.5 University of Texas TRIGA</td>
<td>3-43</td>
</tr>
<tr>
<td>3.3 Nuclear Power Plant Spent Nuclear Fuel</td>
<td>3-45</td>
</tr>
<tr>
<td>3.3.1 West Valley Demonstration Project</td>
<td>3-46</td>
</tr>
<tr>
<td>3.3.2 Fort St. Vrain</td>
<td>3-52</td>
</tr>
<tr>
<td>3.3.3 B&amp;W Lynchburg</td>
<td>3-58</td>
</tr>
</tbody>
</table>

## CONTENTS (Continued)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. ENVIRONMENTAL CONSEQUENCES OF SPENT NUCLEAR FUEL MANAGEMENT ACTIVITIES</td>
<td>4-1</td>
</tr>
<tr>
<td>4.1 No Action</td>
<td>4-1</td>
</tr>
<tr>
<td>4.1.1 DOE Experimental Reactors and Small-Quantity Storage</td>
<td>4-1</td>
</tr>
<tr>
<td>4.1.2 Domestic Research Reactors</td>
<td>4-4</td>
</tr>
<tr>
<td>4.1.3 Nuclear Power Plant Spent Nuclear Fuel</td>
<td>4-7</td>
</tr>
<tr>
<td>4.2 Decentralization</td>
<td>4-9</td>
</tr>
<tr>
<td>4.3 1992/1993 Planning Basis</td>
<td>4-10</td>
</tr>
<tr>
<td>4.4 Regionalization</td>
<td>4-10</td>
</tr>
<tr>
<td>4.5 Centralization</td>
<td>4-10</td>
</tr>
<tr>
<td>5. CUMULATIVE IMPACTS</td>
<td>5-1</td>
</tr>
<tr>
<td>5.1 DOE Test and Experimental Reactors</td>
<td>5-1</td>
</tr>
<tr>
<td>5.1.1 Brookhaven National Laboratory</td>
<td>5-1</td>
</tr>
<tr>
<td>5.1.2 Los Alamos National Laboratory</td>
<td>5-2</td>
</tr>
<tr>
<td>5.1.3 Sandia National Laboratories</td>
<td>5-2</td>
</tr>
<tr>
<td>5.1.4 Argonne National Laboratory - East</td>
<td>5-2</td>
</tr>
<tr>
<td>5.2 Domestic Research Reactors</td>
<td>5-2</td>
</tr>
<tr>
<td>5.2.1 National Institute of Standards and Technology</td>
<td>5-2</td>
</tr>
<tr>
<td>5.2.2 Massachusetts Institute of Technology</td>
<td>5-3</td>
</tr>
<tr>
<td>5.2.3 Conclusion</td>
<td>5-3</td>
</tr>
<tr>
<td>5.3 Nuclear Power Plant Spent Nuclear Fuel</td>
<td>5-3</td>
</tr>
<tr>
<td>6. ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED</td>
<td>6-1</td>
</tr>
<tr>
<td>6.1 DOE Test and Experimental Reactors</td>
<td>6-1</td>
</tr>
<tr>
<td>6.2 Domestic Research Reactors</td>
<td>6-1</td>
</tr>
<tr>
<td>6.3 Nuclear Power Plant Spent Nuclear Fuel</td>
<td>6-2</td>
</tr>
</tbody>
</table>
CONTENTS (Continued)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES</td>
<td>7-1 109</td>
</tr>
<tr>
<td>7.1 DOE Test and Experimental Reactors</td>
<td>7-1 109</td>
</tr>
<tr>
<td>7.2 Domestic Research Reactors</td>
<td>7-1 109</td>
</tr>
<tr>
<td>7.3 Nuclear Power Plant Spent Nuclear Fuel</td>
<td>7-2 110</td>
</tr>
</tbody>
</table>

TABLES

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1-1 Domestic non-DOE research reactors</td>
<td>2-7</td>
</tr>
<tr>
<td>2.1-2 Category 1 projected SNF inventories</td>
<td>2-12</td>
</tr>
<tr>
<td>2.1-3 Category 2 projected SNF inventories</td>
<td>2-13</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

The U.S. Department of Energy (DOE) is performing a DOE-wide programmatic evaluation of spent nuclear fuel (SNF) management alternatives in order to determine the appropriate means of managing existing and projected quantities of SNF from now until the year 2035. At the same time, the DOE is performing a site-specific assessment of the Idaho National Engineering Laboratory (INEL) in order to determine how to manage environmental restoration, waste management, and SNF at the INEL. Sites currently involved with the management of major fractions of DOE SNF (i.e., the Hanford Site, Savannah River Site, and INEL), alternative sites being analyzed for management of SNF (Oak Ridge Reservation and Nevada Test Site), and sites involved with management of SNF from Naval Reactors are addressed in separate appendices to this volume of the environmental impact statement (EIS).

This appendix addresses other DOE sites and locations which currently generate and manage small quantities of SNF. These facilities are presently storing and/or generating, in most cases, relatively small quantities of SNF which the DOE has taken title to, has possession of, or will take possession of at sometime in the future. These facilities, referred to in this document as "originating sites," include the following:

- DOE, University, and Other Research and Test Reactors

The following DOE facilities are addressed in this appendix:

- Brookhaven National Laboratories
  - High Flux Beam Reactor
  - Brookhaven Medical Research Reactor

- Los Alamos National Laboratory
  - Omega West Reactor
  - Chemistry-Metallurgy Research Facility

Sandia National Laboratories
- Manzano Storage Structures
- Annular Core Research Reactor
- Sandia Pulse Reactor II and III and Critical Assembly
- Hot Cell Facility
- Special Nuclear Materials Storage Facility

Argonne National Laboratory - East
- Alpha-Gamma Hot Cell
- Chicago Pile 5

In addition, the DOE has title to SNF from university and other domestic research reactors. These facilities are identified and data provided on both the quantity of spent fuel in storage and estimates of the future generation rate of SNF at these facilities. However, rather than address each of these university and other research reactor facilities individually, representative facilities will be used when addressing specific topics related to facilities, the SNF, or projected environmental impacts associated with the various fuel management alternatives.

Commercial Power Reactor Fuels

The DOE has possession of 125 spent nuclear fuel assemblies and 20 complete or sectioned spent nuclear fuel rods from various nuclear power plants that were to be used to support DOE-sponsored research and development programs. This SNF is currently in storage at either the West Valley Demonstration Project in West Valley, New York, or the B&W Lynchburg Technology Center in Campbell County, Virginia.

In addition, according to the terms of a three-party agreement between the Public Services Company of Colorado, General Atomics, and the Atomic Energy Commission.
the DOE has a commitment to provide dry storage at the INEL for eight segments of Fort St. Vrain spent fuel (approximately 1,920 spent fuel elements). Three segments of this SNF have been shipped to the INEL; the other five are currently being stored at the Fort St. Vrain site.

The DOE also has possession of other commercial SNF, including that from the Arkansas, Calvert Cliffs, Connecticut Yankee, Consolidated Edison, Cooper, Dresden, H. B. Robinson, Monticello, Oconee, Peach Bottom, Point Beach, Quad Cities, Saxton, Shippingport, Surry, and Three Mile Island reactors. These represent very small quantities of SNF and are currently stored at the Hanford Site, INEL, SRS, Naval Reactor Facility at the INEL or the ORR. This commercial SNF is addressed in the corresponding appendix for each of these sites and is not discussed in detail in this appendix.

Spent nuclear fuel from commercial power reactors which is currently at commercial reactor waste sites will fall under the purview of the DOE's Office of Civilian Radioactive Waste Management and is outside the scope of this EIS.

Although these facilities represent small sources of SNF, an evaluation has been conducted in order to consider the impacts at these originating sites along with the cumulative impacts of management of all DOE SNF.

Of the five SNF management alternatives being evaluated (Volume 1, Chapter 3), only the two alternatives that preclude the shipment of SNF (Alternative 1 - No Action and Alternative 2 - Decentralization) have a definable impact on the sites and facilities discussed in this appendix. Several facilities generating SNF have limited storage capacities, and/or the facility license from the U.S. Nuclear Regulatory Commission (NRC) may limit the quantity of fuel permitted to be stored onsite. Implementation of the No Action Alternative could mean that some of the facilities with limited SNF storage capacity would have to shut down. The impact on some facilities would be the need to construct additional onsite SNF storage capacity in order to continue safe operation. Expansion of SNF storage capacity is only viable provided adequate space and adequate funding are available and expansion is approved through the NRC licensing process.

In the case of the West Valley Demonstration Project, the SNF is currently being stored in accordance with the applicable DOE Orders. Extended storage of SNF at this site would require construction of a concrete pad for a dry storage facility. However, the DOE has entered into an agreement with the New York State Energy Research and Development Authority (NYSERDA and DOE 1986) to remove all SNF from the West Valley Demonstration Project. An extension to the schedule for removal of SNF has been requested by DOE and the agreement with the state is being renegotiated.

The other alternatives, which involve the shipment of the SNF from the site at which it is generated to one or more DOE SNF interim storage facilities, reflect the current mode of SNF management at the generating facilities. Even though the selection of a site where SNF may be transported and stored may be different than the current planning basis, shipment to a different location does not impact the facility or site at which the SNF is generated.

Section 2 of this appendix presents a description of SNF management at the originating sites, including an overview of the types and inventories for SNF in three major categories: DOE test and experimental reactors; domestic research reactors; and nuclear power reactor spent fuel. Section 3 presents summary descriptions of the potentially affected environments for the three categories, and Section 4 describes the environmental consequences of SNF management alternatives at these sites. Cumulative impacts are presented in Section 5, adverse impacts that cannot be avoided in Section 6, and irreversible and irretrievable commitments in Section 7.
2. SNF MANAGEMENT AT ORIGINATING SITES

2.1 Overview of SNF Types, Inventories, and Generation Rates

This appendix addresses the management of SNF at originating sites, defined as DOE test and experimental reactors, domestic research reactors, and certain nuclear power plant spent fuels now in storage. Specific discussions of the various sites are provided in following sections.

DOE experimental reactors and small-quantity storage: These reactors and SNF storage facilities are located on DOE-owned sites, such as Brookhaven National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories. These sites host a variety of research and development or production activities, which may include test or experimental reactors and storage of small quantities of SNF, in different areas of the site.

Domestic research reactors: The greatest variations in site characteristics are those associated with research reactors. Most sites are at colleges or universities. However, a few of them are sited at government and industrial facilities.

Nuclear power plant spent fuel: The SNF in this category is not located at currently operating nuclear reactor facilities. The facilities housing the subject SNF are located at the following sites: 1) the former West Valley fuel reprocessing site, 2) the shutdown Fort St. Vrain nuclear power plant site (currently undergoing decommissioning), and 3) a commercial research laboratory (B&W Lynchburg Technology Center) located on a large rural site. The DOE also has possession of other commercial SNF, including that from the Arkansas, Calvert Cliffs, Connecticut Yankee, Consol.ated Edison, Cooper, Dresden H. B. Robinson, Monticello, Oconee, Peach Bottom, Point Beach, Quad Cities, Saxton, Shippingport, Surry, and Three Mile Island reactors. These represent very small quantities of SNF and are currently stored at the Hanford Site, INEL, SRS, Naval Reactors Facility at the INEL, or the ORR. This commercial SNF is addressed in the corresponding appendix for each of these sites and is not discussed further in this appendix.

The SNFs addressed in this appendix are of varying sizes and design configurations. In general, nuclear fuel consists of an assembly of structural components, such as plates or hollow rods, containing fissionable material. The fuel may be in the form of metal or a compound (e.g., oxide, carbide, nitride) and may vary in the degree of enrichment of the uranium-235 isotope. The structural materials may be aluminum, stainless steel, zirconium alloy, or other material such as ceramics. They form a barrier isolating the fuel (and fission products) from the reactor coolant or storage facility environment as well as providing structural support for maintaining the geometry of the fuel. The components are arranged into a specific geometric configuration determined by the type of reactor and desired performance. This assembly of fuel-bearing components is referred to as a "fuel element" (also referred to in the nuclear industry as a fuel assembly).

For each of the major facility categories, the following subsections provide detail on the quantities of SNF currently in storage and the quantities of additional SNF expected to be produced by the end of the year 2035.

2.1.1 DOE Experimental Reactors and Small-Quantity Storage

The Brookhaven National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories use test and experimental reactors for research and for small-scale production of medical and other specific isotopes. In addition, small quantities of SNF are currently in storage at these sites as well as at Argonne National Laboratory-East. The amount of SNF generated by these facilities, the amount expected to be generated through the year 2035, and accommodations being undertaken at the present time to store the SNF located at these facilities are discussed in the following sections.

2.1.1.1 Brookhaven National Laboratory

2.1.1.1.1 High Flux Beam Reactor—By mid-1995 there are projected to be 937 High Flux Beam Reactor elements (0.241 MTHM) in the reactor or in onsite wet storage. A total of 5,600 additional SNF elements (1.498 MTHM) are predicted to be produced if the reactor continues operation through the year 2035 (Wichmann 1995a).
2.1.1.1.2 Brookhaven Medical Research Reactor—The Brookhaven Medical Research Reactor is operating at the present time and has 36 elements (0.0034 MTHM) in the reactor or in onsite wet storage. Thirty-two additional SNF elements (0.0028 MTHM) are expected to be produced by the year 2035 (Wichmann 1995a).

2.1.1.2 Los Alamos National Laboratory.

2.1.1.2.1 Omega West Reactor—The Omega West Reactor has been permanently shut down. This reactor is being decommissioned. There are no elements in the reactor, and all of the 86 elements (0.014 MTHM) are in temporary dry storage at the Chemistry and Metallurgy Research Complex (Wichmann 1995a).

Additional reactor sites and critical facilities that are part of the Los Alamos National Laboratory are listed below. Each contains some radioactive and fissionable materials but does not routinely produce SNF (ANS 1988):

- Big Ten Critical Assembly
- Fast Burst Reactor - GODIVA
- Fast Burst Reactor - SI/UA
- Flattop Critical Assembly
- General Purpose Critical Assembly - COMET
- General Purpose Critical Assembly - HONEYCOMB
- General Purpose Critical Assembly - PLANET
- General Purpose Critical Assembly - VENUS
- General Purpose Critical Assembly Machine
- Solution High Energy Burst Assembly

2.1.1.3 Sandia National Laboratories. The Sandia National Laboratory reactors operate as needed on a low duty cycle, so the fission product inventories remain low and the fuel loading lasts for the life of the reactor, eliminating routine generation of spent fuel. Hence, except for a few broken plates that are in storage, the SNF at Sandia National Laboratories is still in use in the reactors (DOE 1993d).

The Sandia National Laboratories contain five SNF storage facilities: the Manzano Storage Structures, the Annular Core Research Reactor Facility, the Sandia Pulse Reactor Facility, the Hot Cell Facility, and the Special Nuclear Materials storage facility (DOE 1993b).

2.1.1.3.1 Manzano Storage Structures—The Manzano Storage Structures are reinforced concrete bunkers located in the southeast portion of Kirtland Air Force Base. Until recently, when Sandia National Laboratories took responsibility for the site, the Manzano facilities were operated and maintained by the Department of Defense. The Sandia National Laboratories currently use four structures for dry storage of reactor-irradiated nuclear material (DOE 1993b). There is a total of 0.025 metric tons of heavy metal (MTHM) of SNF in storage at this facility (Wichmann 1995a).

2.1.1.3.7 Annular Core Research Reactor—The Annular Core Research Reactor is a pool-type research reactor capable of steady-state, pulse, and tailored transient operation. The Annular Core Research Reactor facility includes the reactor pool, one safe, and eight dry floor storage vaults, all located in the high-bay of Building 6588. The eight storage vaults on the high-bay floor are used to securely store irradiated experiments containing a variety of nuclear materials, but principally U-235. Materials from only three experiments containing reactor irradiated nuclear materials are stored at the Annular Core Research Reactor (DOE 1993b). There are a total of 438 elements plus uranium from three experiments (for a total of 0.04 MTHM) in use or storage at these facilities (Wichmann 1995a).

In addition, DOE is considering using the Annular Core Research Reactor for production of molybdenum-99. If the molybdenum-99 production mission is assigned to the Annular Core Research Reactor, the current reactor fuel would likely be removed and would need to be stored at the start of, or within a few years of starting, operation (SNL 1994).

2.1.1.3.3 Sandia Pulse Reactor II and III, and Critical Assembly—Three reactors are in operation at the Sandia Pulse Reactor facility: Sandia Pulse Reactor II and Sandia Pulse Reactor III are unmoderated, fast-burst reactors capable of pulsed and steady-state operation. The Critical Assembly is a small, water-moderated reactor used to perform measurements of key reactor parameters to benchmark the computer calculations and thereby refine the designs for a
planned space propulsion reactor. The yard storage holes are 19 stainless-steel types located in a corner of the Sandia Pulse Reactor compound. These tubes are surrounded by a high-density concrete monolith. The yard holes are used to securely store irradiated experiments containing a variety of nuclear materials, but principally U-235. All of the materials remain in their own containers, some of which consist of double containment. At the Special Nuclear Material dry storage facility, Sandia National Laboratories stores previously failed fuel elements from Sandia Pulse Reactor II and elements from experiments that have been exposed to short irradiation periods (DOE 1993b). There are a total of 43 elements (with a total of 0.37 MTHM) of SNF in use or storage at these facilities (Wichmann 1995a).

Future plans include bringing on-line an additional pulse reactor named Sandia Pulse Reactor IIIM. With this new reactor, a total of three pulse reactors would be located at Sandia National Laboratories’ Technical Area V.

2.1.1.3.4 Hot Cell Facility — The Hot Cell Facility at Sandia National Laboratories is a no reactor nuclear facility housed in Building 6580 in Technical Area V. Research programs at Sandia National Laboratories—material studies, fuel studies, and safety studies—require that experiments containing radioactive materials be assembled and/or disassembled, samples prepared, and microscopic and chemical analyses performed. The principal storage facility for the Hot Cell Facility is Room 108, which is a heavily shielded room used previously as a preparation room next to the irradiation room of the Sandia Engineering Reactor, which has been defueled. There are a series of 13 storage holes under the Hot Cell Facility Monorail that are available to store irradiated material coming into or out of the Hot Cell Facility. Only one of the holes is currently in use. The other areas of the Hot Cell Facility are used for storing minor amounts of material (DOE 1993b). There is a total of 0.009 MTHM of SNF in storage at this facility (Wichmann 1995a).

2.1.1.4 Argonne National Laboratory — East. The Alpha-Gamma Hot Cell Facility, operated by the Materials Science Division, consists of a concrete-shielded, low-flow inert-atmosphere complex that was designed for the examination of irradiated plutonium fuel assemblies and related hardware (DOE 1993d). There are a total of four units of Experimental Breeder Reactor fuel, one canister containing remnants of commercial SNF, and 16 SNF elements from Oak Ridge (for a total of 0.081 MTHM) in storage (Wichmann 1995a).

The Chicago Pile 5 Building houses a heavy-water, moderated reactor whose fuel has been removed and shipped off-site. Currently, the Chicago Pile 5 is in the process of being decontaminated and decommissioned and contains only two highly enriched uranium targets (i.e., converter) elements (DOE 1993d).

2.1.2 Domestic Licensed Research Reactors

Table 2.1-1 identifies 57 non-DOE facilities representing domestic, licensed, small generators of SNF (NRC 1993a; ANS 1988). They include training, research, and test reactors at universities, commercial establishments, and several government installations; but one (McClellan Air Force Base) have been licensed by the NRC. Although they are not DOE facilities, DOE has title to the SNF and has the responsibility for interim storage and ultimate disposition.

In order to assess their SNF management capabilities, these 57 facilities have been identified as belonging to one of three categories. These categories identify the key characteristics of a facility relevant to the assessment of DOE-postulated SNF alternatives. The three categories are:

- Category 1 - Facilities that have limited onsite storage capacity compared to the amount of SNF projected to be generated at their facility by the year 2035
- Category 2 - Facilities that do not routinely generate additional SNF
- Category 3 - Facilities that no longer possess SNF onsite.

The category for each facility is identified in Table 2.1-1.
Table 2.1-1. Domestic non-DOE research reactors.

<table>
<thead>
<tr>
<th>Licensee location</th>
<th>Reactor type</th>
<th>NRC Docket no.</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerotest</td>
<td>TRIGA (Indus)</td>
<td>50-228</td>
<td>2</td>
</tr>
<tr>
<td>San Ramon, CA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arkansas Tech Univ.</td>
<td>TRIGA</td>
<td>50-606</td>
<td>2</td>
</tr>
<tr>
<td>Russelville, AR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Armed Forces Radiobiology Research Institute (AFRRI)</td>
<td>TRIGA</td>
<td>50-170</td>
<td>2</td>
</tr>
<tr>
<td>Bethesda, MD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brigham Young Univ.</td>
<td>L-77</td>
<td>50-262</td>
<td>3</td>
</tr>
<tr>
<td>Provo, UT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catholic University</td>
<td>AGN-20I</td>
<td>50-77</td>
<td>3</td>
</tr>
<tr>
<td>Washington, DC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cinticem, Inc.</td>
<td>Pool</td>
<td>50-54</td>
<td>3</td>
</tr>
<tr>
<td>Tuxedo, NY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cornell University</td>
<td>TRIGA</td>
<td>50-157</td>
<td>2</td>
</tr>
<tr>
<td>Ithaca, NY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cornell University</td>
<td>ZPR</td>
<td>50-97</td>
<td>2</td>
</tr>
<tr>
<td>Ithaca, NY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dow Chemical Company</td>
<td>TRIGA</td>
<td>50-264</td>
<td>2</td>
</tr>
<tr>
<td>Midland, MI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Atomics</td>
<td>TRIGA Mark I</td>
<td>50-89</td>
<td>2</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Atomics</td>
<td>TRIGA Mark F</td>
<td>50-163</td>
<td>2</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Electric Co.</td>
<td>NTR</td>
<td>50-73</td>
<td>1</td>
</tr>
<tr>
<td>Pleasanton, CA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georgia Institute of Technology</td>
<td>Research HW</td>
<td>50-160</td>
<td>2</td>
</tr>
<tr>
<td>Atlanta, GA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idaho State University</td>
<td>AGN-20I</td>
<td>50-284</td>
<td>2</td>
</tr>
<tr>
<td>Fociello, ID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iowa State University</td>
<td>MTR-10 Pool</td>
<td>50-116</td>
<td>2</td>
</tr>
<tr>
<td>Ames, IA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kansas State University</td>
<td>TRIGA</td>
<td>50-188</td>
<td>1</td>
</tr>
<tr>
<td>Manhattan, KS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.1-1. (continued).

<table>
<thead>
<tr>
<th>Licensee location</th>
<th>Reactor type</th>
<th>NRC Docket no.</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>McClellan Air Force Base</td>
<td>TRIGA</td>
<td>50-199</td>
<td>2</td>
</tr>
<tr>
<td>McClellan, CA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manhattan College</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverdale, NY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Massachusetts Institute of Technology</td>
<td>Research HW</td>
<td>50-20</td>
<td>1</td>
</tr>
<tr>
<td>Cambridge, MA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N.S. Savannah</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mount Pleasant, SC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NASA Plum Brook</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandusky, OH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Institute of Standards and Technology (NIST)</td>
<td>Test</td>
<td>50-184</td>
<td>1</td>
</tr>
<tr>
<td>Gaithersburg, MD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Carolina State U.</td>
<td>Pulstar</td>
<td>50-196</td>
<td>2</td>
</tr>
<tr>
<td>Raleigh, NC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohio State University</td>
<td>Pool</td>
<td>50-150</td>
<td>2</td>
</tr>
<tr>
<td>Columbus, OH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oregon State University</td>
<td>TRIGA</td>
<td>50-243</td>
<td>2</td>
</tr>
<tr>
<td>Corvallis, OR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penn State University</td>
<td>TRIGA</td>
<td>50-5</td>
<td>2</td>
</tr>
<tr>
<td>University Park, PA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purdue University</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Lafayette, IN</td>
<td>Lockheed</td>
<td>50-182</td>
<td>2</td>
</tr>
<tr>
<td>Reed College</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portland, OR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rensselaer Polytechnic Institute</td>
<td>Critical Assembly</td>
<td>50-225</td>
<td>2</td>
</tr>
<tr>
<td>Troy, NY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhode Island Atomic Energy Commission</td>
<td>Pool</td>
<td>50-193</td>
<td>1</td>
</tr>
<tr>
<td>Narragansett, RI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State Univ. of New York</td>
<td>Pulstar</td>
<td>50-57</td>
<td>1</td>
</tr>
<tr>
<td>Buffalo, NY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texas A&amp;M University</td>
<td>AGN-201</td>
<td>50-59</td>
<td>2</td>
</tr>
<tr>
<td>College Station, TX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Licensee location</td>
<td>Reactor type</td>
<td>NRC Docket no.</td>
<td>Category</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------</td>
<td>----------------</td>
<td>----------</td>
</tr>
<tr>
<td>Texas A&amp;M University College Station, TX</td>
<td>TRIGA</td>
<td>50-128</td>
<td>1</td>
</tr>
<tr>
<td>U.S. Geological Survey Denver, CO</td>
<td>TRIGA</td>
<td>50-274</td>
<td>1</td>
</tr>
<tr>
<td>University of Arizona Tucson, AZ</td>
<td>TRIGA</td>
<td>50-113</td>
<td>2</td>
</tr>
<tr>
<td>University of California at Berkeley Berkeley, CA</td>
<td>TRIGA</td>
<td>50-224</td>
<td>3</td>
</tr>
<tr>
<td>University of California at Irvine Irvine, CA</td>
<td>TRIGA</td>
<td>50-326</td>
<td>2</td>
</tr>
<tr>
<td>University of California at Los Angeles Los Angeles, CA</td>
<td>Educator</td>
<td>50-142</td>
<td>3</td>
</tr>
<tr>
<td>University of Florida Gainesville, FL</td>
<td>Argonaut</td>
<td>50-83</td>
<td>2</td>
</tr>
<tr>
<td>University of Illinois Urbana, IL</td>
<td>LOPRA</td>
<td>50-356</td>
<td>1</td>
</tr>
<tr>
<td>University of Kansas Lawrence, KS</td>
<td>Lockheed</td>
<td>50-148</td>
<td>3</td>
</tr>
<tr>
<td>University of Maryland College Park, MD</td>
<td>TRIGA</td>
<td>50-166</td>
<td>2</td>
</tr>
<tr>
<td>University of Mass. at Lowell Lowell, MA</td>
<td>GE Pool</td>
<td>50-223</td>
<td>2</td>
</tr>
<tr>
<td>University of Michigan Ann Arbor, MI</td>
<td>Pool</td>
<td>50-2</td>
<td>1</td>
</tr>
<tr>
<td>University of Missouri Columbia Columbia, MO</td>
<td>Tank</td>
<td>50-186</td>
<td>1</td>
</tr>
<tr>
<td>University of Missouri Rolla Rolla, MO</td>
<td>Pool</td>
<td>50-123</td>
<td>2</td>
</tr>
<tr>
<td>University of New Mexico Albuquerque, NM</td>
<td>AGN-201</td>
<td>50-252</td>
<td>2</td>
</tr>
<tr>
<td>University of Texas Austin, TX</td>
<td>TRIGA-Mark II</td>
<td>50-602</td>
<td>2</td>
</tr>
</tbody>
</table>
2.1.2.1 Reactors with Limited Storage Capacity. The sites in Category I have limited storage capacity when compared to the amount of SNF that is projected to be generated by 2035. Table 2.1-2 lists the projected inventory as of June 1, 1995 with the corresponding MTHM at each of the Category I sites. Assuming continuing operation of each reactor, the projected amount of additional SNF that would be generated through 2035 is also provided in Table 2.1-2.

To reduce the risk of theft or diversion of highly enriched uranium fuel and the consequences to public health, safety, and the environment from such theft or diversion, the NRC has imposed limitations on the use of highly enriched uranium fuel in domestic non-power reactors. Unless the NRC has determined that the non-power reactor has a unique purpose requiring the use of high enriched uranium fuel, each licensee will replace all highly enriched uranium fuel in its possession with available low enriched uranium fuel acceptable to the Commission. If federal government funding for conversion is not available, the conversion from high enriched uranium fuel to low enriched uranium fuel may be deferred on an annual basis. A number of domestic research reactors are in the process of converting from highly enriched uranium fuel to low enriched uranium fuel.

2.1.2.2 Reactors with Sufficient Storage Capacity. Licensed domestic research reactor sites with sufficient SNF storage capacity are listed in Table 2.1-3. These Category 2 sites include operating facilities with low fuel burnup rates, where the amount of SNF generated is not expected to exceed the current onsite storage capacity. Some Category 2 sites are also converting from highly enriched uranium fuel to low enriched uranium fuel but have sufficient capacity to store this additional SNF onsite.

The projected inventory at each reactor site as of June 1, 1995 and the corresponding MTHM are presented in Table 2.1-3. The amount of SNF that is projected to be generated through the year 2035 is also listed in Table 2.1-3.

2.1.2.3 Reactors without SNF Onsite. The licensed domestic research reactors that are no longer operating and have shipped all SNF offsite are identified as Category 3 in Table 2.1-1. These sites either have been decommissioned or are in the process of decommissioning. Some of the facilities have been decontaminated, although they may not have been completely dismantled.

<table>
<thead>
<tr>
<th>Licensee location</th>
<th>Inventory as of June 1, 1995</th>
<th>Future increases through 2035</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elements</td>
<td>MTHM</td>
</tr>
<tr>
<td>Kansas State University Manhattan, KS</td>
<td>107</td>
<td>0.020</td>
</tr>
<tr>
<td>Massachusetts Institute of Technology Cambridge, MA</td>
<td>66</td>
<td>0.021</td>
</tr>
<tr>
<td>National Institute of Standards and Technology Gaithersburg, MD</td>
<td>186</td>
<td>0.04</td>
</tr>
<tr>
<td>Rhode Island Atomic Energy Commission Narragansett, RI</td>
<td>57</td>
<td>0.030</td>
</tr>
<tr>
<td>State University of New York - Buffalo Buffalo, NY</td>
<td>25</td>
<td>0.493</td>
</tr>
<tr>
<td>Texas A&amp;M (TRIGA) College Station, TX</td>
<td>156</td>
<td>0.030</td>
</tr>
<tr>
<td>University of Illinois Urbana, IL</td>
<td>161</td>
<td>0.032</td>
</tr>
<tr>
<td>University of Michigan Ann Arbor, MI</td>
<td>198</td>
<td>0.037</td>
</tr>
<tr>
<td>University of Missouri Columbia, MO</td>
<td>103</td>
<td>0.072</td>
</tr>
<tr>
<td>University of Virginia Charlottesville, VA</td>
<td>82</td>
<td>0.055</td>
</tr>
<tr>
<td>University of Virginia and the National Institute of Standards and Technology</td>
<td>65</td>
<td>0.066</td>
</tr>
</tbody>
</table>

Note: Projected inventory as of June 1, 1995 is 0.896 MTHM. Projected additional SNF generated through 2035 is 2.769 MTHM.
<table>
<thead>
<tr>
<th>Licensee location</th>
<th>Inventory as of June 1, 1995</th>
<th>Future increase through 2035</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elements</td>
<td>MTHM</td>
</tr>
<tr>
<td>Aeroeis</td>
<td>91</td>
<td>0.015</td>
</tr>
<tr>
<td>San Ramon, CA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Arkansas Tech. Univ.</td>
<td>95</td>
<td>0.018</td>
</tr>
<tr>
<td>Russellville, AR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Armed Forces Radiobiology</td>
<td>123</td>
<td>0.023</td>
</tr>
<tr>
<td>Research Institute Bethesda, MD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cornell University (TRIGA)</td>
<td>283</td>
<td>0.058</td>
</tr>
<tr>
<td>Ithaca, NY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cornell University (ZPR)</td>
<td>504</td>
<td>1.7*</td>
</tr>
<tr>
<td>Ithaca, NY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dow Chemical Company</td>
<td>78</td>
<td>0.014</td>
</tr>
<tr>
<td>Midland, MI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Atomics*</td>
<td>263</td>
<td>0.008</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GE Nuclear Test Reactor</td>
<td>8</td>
<td>0.001</td>
</tr>
<tr>
<td>Pleasanton, CA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georgia Institute of Technology Atlanta, GA</td>
<td>59</td>
<td>0.030</td>
</tr>
<tr>
<td>Idaho State University</td>
<td>19</td>
<td>0.011</td>
</tr>
<tr>
<td>Pocatello, ID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iowa State University Ames, IA</td>
<td>27</td>
<td>0.024</td>
</tr>
<tr>
<td>McClellan Air Force Base McClellan, CA</td>
<td>90</td>
<td>0.015</td>
</tr>
<tr>
<td>Manhattan College Riverdale, NY</td>
<td>17*</td>
<td>0.016</td>
</tr>
<tr>
<td>North Carolina State U. Raleigh, NC</td>
<td>34</td>
<td>0.428</td>
</tr>
<tr>
<td>Ohio State University Columbus, OH and 630P</td>
<td>24</td>
<td>0.021</td>
</tr>
<tr>
<td>Oregon State University Corvallis, OR</td>
<td>96</td>
<td>0.017</td>
</tr>
<tr>
<td>Pennsylvania State Univ. University Park, PA</td>
<td>175</td>
<td>0.041</td>
</tr>
<tr>
<td>Purdue University West Lafayette, IN</td>
<td>13</td>
<td>0.002</td>
</tr>
<tr>
<td>Reed College</td>
<td>67</td>
<td>0.013</td>
</tr>
<tr>
<td>Rensselaer Polytechnic Institute* Troy, NY</td>
<td>596*</td>
<td>0.388</td>
</tr>
</tbody>
</table>

Note: The projected inventory as of June 1, 1995 is expected to be 1,323 MTHM and the approximate total for the additional SNF projected to be generated through 2035 is 1,054 MTHM. Numbers may not sum due to rounding.
The SNF that originated at these sites has either been reprocessed or is stored and accounted for at DOE storage facilities.

2.1.3 Nuclear Power Plant Spent Nuclear Fuel

This subsection addresses spent nuclear power plant fuel that DOE has possession of or will take possession of sometime in the future. Currently this fuel is in storage at one of three sites:

- the West Valley Demonstration Project, the Fort St. Vrain nuclear power plant site, and the B&W Lynchburg Technology Center in Lynchburg, Virginia. In all cases, no new additional SNF is being or will be added to existing SNF inventories.

2.1.3.1 West Valley Demonstration Project. The West Valley Demonstration Project is located on the site of the first U.S. commercial nuclear fuel reprocessing plant, which was operated by Nuclear Fuel Services, Inc., until 1972 (WVNS 1994).

Nuclear Fuel Services, Inc., shut down the reprocessing facility in 1972 in order to implement modifications for the purpose of increasing the facility's capacity. From 1973 to 1975 Nuclear Fuel Services, Inc., continued to accepted a total of 750 SNF elements. However, in 1976, it withdrew from the reprocessing business (WVNS 1994).

In 1980 Congress enacted Public Law 96-368, the West Valley Demonstration Project Act. The act directed the DOE to develop and demonstrate the technology for solidifying high-level waste in storage at the West Valley Demonstration Project so that this waste would be suitable for transportation to and long-term disposal in a federal repository (WVNS 1994).

The owners of the 750 SNF elements still in storage at the West Valley facility fuel storage pool were informed in 1981 that they would have to take back their SNF. By 1986, 625 of the elements had been returned to their respective owners; then, however, DOE took possession of the remaining 125 SNF elements (26.65 MTHM) under an agreement with Nuclear Fuel Services, Inc. The DOE was to use these 125 elements to demonstrate the safe transportation and long-term storage of SNF in a dual-purpose cask. These 125 SNF elements are included in this EIS (Wichmann 1995a).

2.1.3.2 Fort St. Vrain. Fort St. Vrain, a 330 MWe (Megawat, electric) high-temperature gas-cooled reactor power plant went into operation in January 1979 and terminated commercial operation in August 1989. It is currently undergoing decommissioning (FSV 1990a; NRC 1991a).

Prior to August 1989 a three-party agreement was reached between the Public Services Company of Colorado (the owner of Fort St. Vrain), General Atomics (the reactor developer), and the DOE that called for the DOE to take possession of eight segments of approximately 240 SNF elements each of SNF from the Fort St. Vrain for dry storage at the INEL. SNF from the Fort St. Vrain had been shipped to the INEL when a court action was initiated by the state of Idaho to stop any additional shipment of SNF to INEL.

In an effort to facilitate the continued decommissioning of the Fort St. Vrain station, the Public Services Company of Colorado has decided to store the Fort St. Vrain's SNF in a modular vault dry storage system, which is a reinforced concrete and sheathed steel frame building located on the Fort St. Vrain site immediately adjacent to but outside the fence around the Fort St. Vrain site. The modular vault dry storage system, designed to house 1,482 high-temperature, gas-cooled reactor SNF elements, 6 neutron source elements, and 37 keyed top reflector elements, became operational in late 1991 (FSV 1990a). There are 1,464 elements (16 MTHM) currently in storage in the modular vault dry storage system (Wichmann 1995a).

2.1.3.3 B&W Lynchburg. The B&W facility in Lynchburg, Virginia, is engaged in research and development on uranium fuels and the overall fuel cycle, and in the examination and testing of irradiated fuels (NRC 1987).

B&W Lynchburg currently has in storage at its facility 0.044 MTHM of SNF stored in 15 canisters (Wichmann 1995a) consisting of 3 full-length fuel rods, 17 sectioned fuel rods, and a small quantity of fuel debris from Three Mile Island 2. All of this SNF material is in the possession of the DOE and was provided to B&W under a DOE contract for Fuel Performance Improvements Programs. None of the activities ongoing at B&W Lynchburg could result in the generation of additional SNF for which the DOE has responsibility, since the facility's three reactors have been decommissioned (Wright 1993; ANS 1988).
2.2 Spent Nuclear Fuel Management Program Plans and Alternatives

The plans for management of SNF at originating sites, including generating and storage sites, or facilities generating small annual quantities of SNF, were determined by conducting a survey of the NRC licensees and others operating these sites. These plans, as they are projected to be affected by the alternatives being assessed in this EIS, are presented in this section.

Availability of onsite SNF storage capacity is the primary consequence of DOE SNF management decisions for all originating sites. Of the five DOE SNF management alternatives, only Alternative 1 (No Action - no SNF transportation) may not have been addressed under the NRC licensing process for an individual SNF originating site. DOE management plans for the alternatives which involve SNF transportation would not affect the originating sites. The management plans at the DOE facilities to which the SNF may be shipped are described in the sections of this EIS dealing with those DOE facilities. The alternate plans with regard to transportation are analyzed in Appendix I to Volume 1. Accordingly, the next few subsections will focus primarily on the No Action Alternative and describe general information on SNF produced at the originating sites, including non-DOE facilities storing SNF.

2.2.1 No Action

The No Action Alternative is intended to evaluate the impact of storage of SNF at the current storage and originating sites. This means that all facilities which are generating or storing SNF and intend to ship SNF to a DOE facility will maintain their SNF onsite. If the SNF-originating site has adequate storage capacity, operations at the site would continue without change of plans. If SNF storage capacity is inadequate, new plans, including expansion of storage capacity or decreasing the rate of fuel burn-up, would have to be considered. Possible SNF management plans are discussed more specifically in the following subsections.

Of the total of approximately 2,700 MTHM of SNF estimated as the total DOE inventory by 2035, approximately 51 MTHM of SNF is associated with the facilities addressed in this appendix (Wichmann 1995a).

2.2.1.1 DOE Experimental Reactors and Small Quantity Storage. There is insufficient onsite storage capacity at the High Flux Beam Reactor at Brookhaven National Laboratory to store all of the SNF projected to be generated through the year 2035. If SNF shipments are not made to another DOE storage facility, at the current rate of generation the remaining onsite storage space would be depleted in January 1996. There is a plan to install a storage rack in the existing wet storage facility that would add space for 162 elements. Even with this rack, storage space would be depleted in 1998. If SNF could not be shipped by that time, the arrangement of existing racks could be modified to provide additional space. There are no plans to shut down the reactor in the near future (Carelli 1993).

2.2.1.2 Domestic Research Reactors. Based on current projections, the onsite storage capacity of 11 of the 45 domestic research reactors would be exhausted before the year 2035 if the No Action Alternative were to be implemented. All 11 of these facilities have been identified as Category 1.

Several of the facilities in Category 1 have indicated that they would consider various options of increasing storage capacity if the No Action Alternative were to be implemented. Five would consider reracking, one would consider expanding dry storage within the reactor building, three would consider expanding wet storage within the reactor building, and one would consider adding 200 square feet (18.6 square meters) of wet storage area outside the reactor building.

Any previously planned expansion of onsite SNF storage capacity at an individual originating facility is addressed in site-specific NRC environmental assessments and thus is not considered to be a consequence of the proposed actions under this EIS. The facilities that are already planning to expand their SNF storage capacity include the Massachusetts Institute of Technology and the National Institute of Standards and Technology.

At one of these facilities the expanded storage capacity is projected to be adequate through the year 2005. However, without SNF transportation through the year 2035, none of the facilities would have adequate storage capacity. One of the facilities in Category 1 has offloaded its highly enriched uranium fuel and would consider reracking but might elect to shut down in 2001 because of a lack of wet storage capacity (Jentz 1993).
All 34 facilities identified as Category 2 have sufficient SNF storage capacity onsite to accommodate any of the DOE SNF alternatives. Two facilities may elect to shut down before the year 2005: one because it may not renew its license; the other because, without transferring SNF offsite, it might not meet licensing limits on possession of uranium-235 after conversion from highly enriched uranium fuel to low enriched uranium fuel. One facility, which expects to convert from highly enriched uranium fuel to low enriched uranium fuel, might elect to shut down in the year 2005 if no offsite transportation were available, unless it can expand its SNF wet storage capacity. A few facilities have indicated that they will appeal the NRC-required conversion of highly enriched uranium fuel to low enriched uranium fuel if no offsite transportation is allowed. Although several Category 2 facilities can operate practically indefinitely without refueling, it is questionable how many of them would operate as planned if there were no SNF transportation through the year 2035. Many research reactors operate with variable core loadings, storing, and reusing partially depleted fuel elements as well as adding new fuel to the reactor (Jentz 1993).

2.2.2.3 Nuclear Power Plant Spent Nuclear Fuel. The No Action Alternative necessitating extended interim onsite storage of SNF would require a revision of the SNF management program at the West Valley Demonstration Project. The need to revise this program is a result of the following (DOE 1993b):

- The West Valley fuel pool is almost 30 years old and does not meet current DOE design criteria.
- The pool is single-walled, unlined, and lacks the capability for leak detection, thus presenting the potential for an undetected release to the environment.
- Continued storage of fuel onsite would interfere with and for some areas prevent the ongoing decontamination and decommissioning activities at the West Valley Demonstration Project facility from proceeding as planned.

The management of SNF at the West Valley Demonstration Project is to continue the use of the existing spent fuel pool with no modifications.

Loss of access to the INEL for storage of its SNF has already resulted in the construction of new onsite SNF storage at Fort St. Vrain. However, under this alternative Public Service Company of Colorado would not achieve its goal of becoming free of radioactive materials by 1998 under this option.

Adequate storage capacity exists and the storage facilities are in adequate condition at the B&W Lynchburg Technology Center (DOE 1993b).

2.2.2 Decentralization

Alternative 2. Decentralization, is similar to the No Action Alternative except that limited offsite shipments are permitted as required to allow continued operation of the given facility. Decentralization is not expected to impose additional requirements for storing SNF at the facilities included in this appendix above those already identified under the No Action Alternative. Planning at the sites receiving SNF shipments that would be allowed under this alternative is addressed in Appendixes A, B, and C. Intersite transportation impacts are analyzed in Appendix I to Volume 1.

2.2.2.1 DOE Experimental Reactors and Small Quantity Storage. Compared to the restrictions imposed under the No Action Alternative, Decentralization does not change the management plans at these DOE experimental reactors and small-quantity storage facilities.

2.2.2.2 Domestic Research Reactors. The Decentralization Alternative is similar to the No Action Alternative, except that limited offsite shipments are permitted as required to allow continued operation of the given facility. Under this alternative, the domestic research reactors are allowed to return to DOE any SNF in excess of their current onsite storage capacity. Additional storage capacity would not be required at these originating facilities. Therefore, decentralization does not affect existing SNF management plans at university research reactors or other facilities in the domestic research reactor group except for possible rerouting of SNF shipments to INEL or Savannah River Site.

2.2.2.3 Nuclear Power Plant Spent Nuclear Fuel. The Decentralization Alternative is similar to the No Action Alternative, except that limited offsite shipments are permitted as
2.2.3 1992/1993 Planning Basis

Alternative 3, 1992/1993 Planning Basis, would not be expected to change any existing SNF management plans at the sites included in this appendix. Alternative 3 would permit the timely shipment of SNF from the originating sites to DOE interim storage facilities at INEL or Savannah River Site. Planning at these SNF-receiving sites is addressed in Appendixes A, B, and C. Interstate transportation impacts are analyzed in Appendix 1 to Volume 1.

2.2.3.1 DOE Experimental Reactors and Small Quantity Storage. Implementation of this alternative could require a transition period of several years. Therefore, limited onsite construction of temporary SNF storage facilities or acquisition of SNF transportation containers, suitable for use as temporary dry storage containers, may be necessary until shipment to a DOE interim storage site(s) is accomplished.

2.2.3.2 Domestic Research Reactors. Alternative 3 does not affect the existing SNF management plans at domestic research reactor facilities. Management of SNF at these reactors would continue to follow the same plans as in the past.

2.2.3.3 Nuclear Power Plant Spent Nuclear Fuel. Under Alternative 3, DOE plans to ship the SNF currently in storage at the West Valley Demonstration Project to INEL Test Area North for storage. Implementation of this alternative would therefore preclude the need for any additional action at the West Valley Demonstration Project related to providing a new onsite SNF storage facility.

If Public Service Company of Colorado shipped the remaining fuel segments, the Fort St. Vrain Site would be free of radioactive materials by 1998.

This alternative would have no impact on the management of the SNF material in storage at the B&W Lynchburg Technology Center.

2.2.4 Regionalization

Alternative 4, Regionalization, would not be expected to change any existing SNF management plans at the sites included in this appendix. Alternative 4 would permit the shipment of SNF from the originating sites to regional DOE interim storage facilities. Planning at the SNF-receiving sites is addressed in Appendixes A, B, C, and F. Interstate transportation impacts are analyzed in Appendix 1 to Volume 1.

2.2.4.1 DOE Experimental Reactors and Small Quantity Storage. Implementation of this alternative could require a transition period of several years. Therefore, limited onsite construction of temporary SNF storage facilities or acquisition of SNF transportation containers, suitable for use as temporary dry storage containers, may be necessary until shipment to a DOE interim storage site(s) is accomplished.

2.2.4.2 Domestic Research Reactors. Regionalization does not affect the existing SNF management plans at domestic research reactor facilities, except for possible rerouting of SNF shipments.

2.2.4.3 Nuclear Power Plant Spent Nuclear Fuel. The Regionalization Alternative for SNF addressed in this appendix is the same as the 1992/1993 Planning Basis Alternative except that the SNF would be sent to other locations. With the exception of INEL facilities are not presently available for SNF storage at receiving sites considered under regionalization for SNF from West Valley Demonstration Project and Fort St. Vrain. The SNF would remain in storage at West Valley Demonstration Project and Fort St. Vrain until facilities are available for receipt at the selected regional SNF management sites.

2.2.5 Centralization

Alternative 5, Centralization, would not be expected to change any existing SNF management plans at the sites included in this appendix. Alternative 5 would permit the
shipment of SNF from the originating sites to centralized DOE interim storage facilities. Planning at the SNF-receiving sites is addressed in Appendices A, B, C, and F. Intersite transportation plans are analyzed in Appendix I to Volume I.

2.2.5.1 DOE Experimental Reactors and Small Quantity Storage. Implementation of this alternative could require a transition period of several years. Therefore, limited onsite construction of temporary SNF storage facilities or acquisition of SNF transportation containers, suitable for use as temporary dry storage containers, may be necessary until shipment to a DOE interim storage site(s) is accomplished.

2.2.5.2 Domestic Research Reactors. Centralization does not affect the existing SNF management plans of domestic research reactor facilities except for rerouting of SNF shipments.

2.2.5.3 Nuclear Power Plant Spent Nuclear Fuel. The Centralization Alternative for SNF being addressed in this appendix is described as being the same as the 1992/1993 Planning Basis Alternative except that the SNF would be sent to other locations. With the exception of INEL facilities are not presently available for SNF storage at receiving sites considered under centralization for SNF from West Valley Demonstration Project and Fort St. Vrain. The SNF would remain in storage at West Valley Demonstration Project and Fort St. Vrain until facilities are available for receipt of the SNF at the selected central SNF management site.

3. AFFECTED ENVIRONMENTS

Descriptions of those facilities generating and/or storing small quantities of spent nuclear fuel for which DOE has accepted responsibility are presented in this section. The following subsections present environmental information for each of the three categories of originating sites: DOE Test and Experimental Reactors, Domestic Research Reactors, and Nuclear Power Plant Spent Nuclear Fuel Storage Sites.

The wide variety of facilities and installations included in this category precludes the definition of their affected environments in a consistent and uniform manner. The information available in existing facility documents used as the bases for this analysis varies widely with the nature of the installation and the requirements of the overseeing or regulatory agencies.

3.1 DOE Experimental Reactors and Small-Quantity Storage

The DOE experimental reactors and small-quantity SNF storage facilities included in this category are located at the Brookhaven National Laboratory, Los Alamos National Laboratory, Sandia National Laboratory, and Argonne National Laboratory - East. The facilities, sites, and their environments are described in this section. Only those DOE sites at which spent nuclear fuel is currently generated and/or stored are discussed. Information on environmental factors that are not uniformly available in existing National Environmental Policy Act documentation for all four sites (including aesthetic and scenic resources, noise, traffic and transportation, and utilities and energy) is not provided in this document.

3.1.1 Brookhaven National Laboratory

There are two reactors at the Brookhaven National Laboratory which generate SNF potentially affected by actions analyzed in this EIS: the 60 MW High Flux Beam Reactor and the 5 MW Brookhaven Medical Research Reactor (ANS 1988).

3.1.1.1 High Flux Beam Reactor. The 60 MW High Flux Beam Reactor is a heavy water moderated and cooled research reactor which replaces an earlier 40 MW reactor. The High Flux
Beam Reactor began operation in 1965. The High Flux Beam Reactor facility is composed of five buildings located on the 5.265-acre (2.131-hectare) site of the Brookhaven National Laboratory. The distance from the reactor to the nearest site boundary is to the south at 3700 feet (1288 meters). The spent nuclear fuel is stored in an 8-foot-wide, 43-foot-long, 20-foot-deep canal (2.4 meters wide, 13.2 meters long, 6.1 meters deep). Within the canal, the fuel is located in storage racks, either in a 30-cell rack or in a long-term storage rack (Carelli 1993).

3.1.1.2 Brookhaven Medical Research Reactor. The Brookhaven Medical Research Reactor is a 5 MW heterogeneous, thermal, tank type reactor which is light water moderated and cooled. The reactor, used for research, became fully operational in 1959. The Brookhaven Medical Research Reactor is located in one building at the Brookhaven National Laboratory approximately 0.25 mile (0.4 kilometer) south of the High Flux Beam Reactor site. Fuel storage at the Brookhaven Medical Research Reactor consists of a shelf, lined with boral sheets, in the upper part of the reactor vessel above the active core region. The shelf is located under 8 feet (2.5 meters) of water and is considered critically safe when fully loaded. Like the High Flux Beam Reactor, there is no facility for dry storage at the Brookhaven Medical Research Reactor (Carelli 1993).

3.1.1.3 Affected Environment at Brookhaven National Laboratory.

3.1.1.3.1 Land Use—The Brookhaven National Laboratory is located approximately 60.1 miles (97 kilometers) east of New York City on Long Island, New York. The site is located in a primarily suburban area. Land on the 5.265-acre (2.131-hectare) site is divided between undeveloped natural areas and the developed areas that support the laboratory's scientific research (BNL 1992c).

Regional land use includes a variety of residential, commercial, industrial, agricultural, institutional, recreational, and public uses. Although agricultural and undeveloped forest land have been the dominant land uses in the region, development pressures for residential and commercial land uses have increased steadily in recent years (BNL 1992c).

3.1.1.3.2 Socioeconomics—The Brookhaven National Laboratory is located in central Suffolk County just at the fringe of developed areas, in an area of rapidly growing population. About 1.32 million persons reside in Suffolk County and about 410,000 persons reside in Brookhaven Township, within which the Laboratory is situated. Between 1995 and 2040, population in Suffolk County is expected to increase 14.6 percent (DOC 1991a). Approximately 8,000 persons reside within a half mile (0.8 kilometer) of the laboratory boundary (BNL 1992b).

The population of Suffolk County is approximately 96 percent urban and has a substantially higher median family income than the rest of the state (DOC 1991c). Between 1970 and 1990, total employment in Suffolk County increased 103.8 percent (DOC 1992).

Dominant industries in the area include government, manufacturing, retail and services, with approximately 20 percent of earnings in Suffolk County coming from government spending (DOC 1992).

The Brookhaven National Laboratory is composed of a total staff of 3449 regular employees (BNL 1993a).

As reported in 1988, there were a total of 69 personnel working at the reactors (ANS 1988). This number included operators, experimenting scientists, and support personnel. While not their main occupation, part of the duties of the operators and some support personnel include tasks associated with refueling, storing, inventorying, packaging, and shipping SNF.

3.1.1.3.3 Cultural Resources—The Brookhaven National Laboratory has no properties designated as National Historic Landmarks.

The Old Reactor Building (Building 701) and the Old Cyclotron Enclosure (Building 902) are eligible for inclusion on the National Register of Historic Places (NRHP). Camp Upton training trenches from World War I are also eligible for inclusion on the NRHP.
2.1.1.3.4 Geology—The Brookhaven National Laboratory site is in the upper part of the Peconic River Valley, which is bordered by two lines of low hills. These extend east and west beyond the limits of the valley nearly the full length of Long Island and form its most prominent topographic features (ERDA 1977).

A maximum horizontal ground surface acceleration of 0.19 g at Brookhaven National Laboratory is estimated to result from an earthquake that could occur once every 2000 years (DOE 1994a). The seismic hazard information presented in this EIS is for general seismic hazard comparisons across DOE sites. Potential seismic hazards for existing and new facilities should be evaluated on a facility specific basis consistent with DOE orders and standards and site specific procedures.

No earthquake has yet been recorded in the Brookhaven National Laboratory area with a Modified Mercalli intensity in excess of III. Long Island lies in the Uniform Building Code Zone 2A (moderate) seismic hazard area. No active earthquake producing faults are known in the Long Island area (ERDA 1977).

2.1.1.3.5 Air Resources—In terms of meteorology, the laboratory can be characterized, like most Eastern Seaboard areas, as a well-ventilated site. The prevailing ground-level winds are from the southwest during the summer, from the northwest during the winter, and about equally from these two directions during the spring and fall (BNL 1992b).

The mean annual temperature for the site during 1991 was 52.8°F (11.6°C), with temperatures ranging from 21.2°F (-6.6°C) to 83.8°F (28.8°C). The annual precipitation during 1991 was 45.3 inches (115 centimeters), which is about 3.6 inches (9.0 centimeters) below the 40-year annual precipitation average of 48.4 inches (123 centimeters) (BNL 1992b).

The State of New York has adopted ambient air quality standards that specify maximum permissible short- and long-term concentrations for various contaminants. These standards are generally the same as the national standards for criteria pollutants (NYSDEC 1977). Suffolk County, in which the site is located, is classified as being in nonattainment of the standards for the criteria pollutant ozone. The county is in attainment of standards for carbon monoxide, particulates, sulfur dioxide, nitrogen dioxide, and lead (NYSDEC 1993).

2.1.1.3.6 Water Resources—The Brookhaven National Laboratory site lies on the western rim of the shallow Peconic River watershed. The marshy areas in the north and eastern sections of the site are a portion of the Peconic River headwaters. The Peconic River both recharges and receives water from the groundwater aquifer, depending on the hydrogeological potential. In times of drought the river water typically recharges to groundwater, while in times of normal to above normal precipitation, the river receives water from the aquifer (BNL 1992b).

Groundwater flow in the vicinity of Brookhaven National Laboratory is controlled by many factors. The main groundwater divide lies 1.25 to 5 miles (2 to 8 kilometers) south of Long Island Sound parallel to the Sound. This divide is known to shift 0.6 to 1.25 miles (1 to 2 kilometers), north to south. East of Brookhaven National Laboratory is a secondary groundwater divide that defines the southern boundary of the area contributing groundwater to the Peconic River. The exact location of the triple-point intersection of these two divides is not known and may be under Brookhaven National Laboratory. South of these divides, the groundwater moves southward to Great South Bay and to Moriches streams. In general, the groundwater from the area between the two branches of the divide moves out eastward to the Peconic River. North of the divide, groundwater moves northward to Long Island Sound. Pressure of a higher water table to the west of the Brookhaven National Laboratory area generally inhibits movement toward the west. Variability in the direction of flow in the Brookhaven National Laboratory site is a function of the hydraulic potential and is further complicated by the presence of clay deposits that accumulate perched water at several places plus the pumping/recharge of groundwater that are part of Brookhaven National Laboratory daily operations. In general, groundwater in the northeast and northwest sections of the site flows toward the Peconic River. On the western portion of the site, groundwater flow tends to be toward the south, while along the southern and southeastern sections of the site it tends to be toward the south to southeast (BNL 1992b).

In all areas of the site, horizontal groundwater velocity is estimated to range from 12 to 18 inches (30 to 45 centimeters) a day. The site occupied by Brookhaven National Laboratory has
been identified by the Long Island Regional Planning Board and Suffolk County as being over a deep recharge zone for Long Island. This implies the precipitation and surface water which recharges within this zone has the potential to replenish the lower aquifer systems (Magothy and/or Lloyd) which exist below the Upper Glacial Aquifer. The extent to which the Brookhaven National laboratory site contributes to deep flow recharge is currently under evaluation. However, it is estimated that up to two-fifths of the recharge from rainfall moves into the deeper aquifers. These lower aquifers discharge to the Atlantic Ocean (BNL 1992b).

The three aquifers (Upper Glacial, Magothy and Lloyd) underlying the Brookhaven National Laboratory comprise the Nassau/Suffolk Aquifer System, which has been designated as a sole source aquifer by the U.S. Environmental Protection Agency. More detailed aquifer characterization information can be found in the Brookhaven National Laboratory Site Baseline Report (SAIC 1992).

3.1.1.2 Ecological Resources—Approximately 75 percent of Brookhaven National Laboratory is primarily woodland. Terrestrial habitats include pine plantations, moderately mature pitch pine/oak forest, predominantly deciduous forest, early successional shrub/sapling community, pine barrens shrub/sapling wetlands, and lawn areas (BNL 1993a).

The isolation of the Brookhaven National Laboratory site and its variety of wildlife habitats have made it a refuge for a surprisingly diverse animal population. Thirty species of mammals have been recorded on site or within a 10-mile (16-kilometer) radius. All of these are year-round residents except for five summer-resident and two migrant species of bats (BNL 1992c).

About 400 non-extinct species of birds have been recorded on all of Long Island since records have been kept, and at least 180 of these have been recorded on site. Thirty-three species are found throughout the year and all except six of these breed on site. Forty-nine other species are summer residents. All except nine nest on site, four others probably do, and the rest nest elsewhere on Long Island, most nearby (BNL 1993).

In September 1990, the U.S. Fish and Wildlife Service confirmed that no Federal or State endangered species occur in the vicinity of Brookhaven National Laboratory. However, the State endangered tiger salamander breeds in a pond in the southeast corner of the site (BNL 1992c).

3.1.1.3.8 Public Health and Safety—The calculated effective dose equivalent associated with effluent releases from the most recent reports for a 5-year period are presented below (BNL 1993b, 1992a, 1992b, 1990, 1989). The annual doses for each year are only a fraction of the DOE Public Dose Limit of 100 millirem per year. The data are from all laboratory operations, including storage of SNF.

<table>
<thead>
<tr>
<th>Year</th>
<th>Airborne effluents (maximum site boundary)</th>
<th>Liquid effluents (maximum individual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>0.113 millirem</td>
<td>0.15 millirem</td>
</tr>
<tr>
<td>1989</td>
<td>0.120 millirem</td>
<td>0.96 millirem</td>
</tr>
<tr>
<td>1990</td>
<td>0.067 millirem</td>
<td>0.85 millirem</td>
</tr>
<tr>
<td>1991</td>
<td>0.170 millirem</td>
<td>0.74 millirem</td>
</tr>
<tr>
<td>1992</td>
<td>0.097 millirem</td>
<td>0.91 millirem</td>
</tr>
</tbody>
</table>

The collective (population) dose equivalent (total population dose) beyond the site boundary, within a radius of 50 miles (80 kilometers), attributed to laboratory operations from reports for a 5-year period is presented below (BNL 1993b, 1992a, 1992b, 1990, 1989). The data are from all laboratory operations, including storage of SNF.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total population dose (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>2.5 person-rem</td>
</tr>
<tr>
<td>1989</td>
<td>3.2 person-rem</td>
</tr>
<tr>
<td>1990</td>
<td>1.8 person-rem</td>
</tr>
<tr>
<td>1991</td>
<td>3.6 person-rem</td>
</tr>
<tr>
<td>1992</td>
<td>3.2 person-rem</td>
</tr>
</tbody>
</table>
3.1.1.3.9 Waste Management—Brookhaven National Laboratory generates low-level, low-level mixed and hazardous wastes, in conjunction with its activities as a scientific research center. In 1992, the site generated approximately 508 tons (461 metric tons) of solid waste and 19.6 cubic yards (15 cubic meters) of liquid waste (DOE 1994b).

Brookhaven National Laboratory currently stores about 110 cubic yards (84 cubic meters) of low-level mixed waste and has no current or planned onsite treatment facilities. All waste streams are currently shipped to Hanford. These waste streams include organic liquids, acid and alkaline solutions, uranium hydride, cleaning/degreasing solvents, chromic acid cleaning solutions, and lead- and mercury-contaminated equipment (DOE 1993g).

In 1989, EPA listed BNH on the National Priorities Lists and in 1992 an Interagency Agreement was signed among DOE, EPA Region II, and the New York State Department of Environmental Conservation. Seven operable units have been identified for remedial investigation/feasibility studies and evaluated for suitable remedial action. The operable units consist of various groupings (generally by area) of buildings and sumps, underground pipes and tanks, the sewage runoff and discharge areas, trichloroethylene and reactor spill areas and groundwater. Some contamination at the site was the result of U.S. Army practices from 1917 to 1947 (DOE 1993g).

3.1.2 Los Alamos National Laboratory

The Omega West Reactor, operated by the Los Alamos National Laboratory, is a thermal, heterogeneous, closed-tank research reactor normally functioning at a power level of 8 MW. The Omega West Reactor was operational from 1956 until December 1992, when it was shut down. This reactor is permanently shut down and is being decommissioned. All spent nuclear fuel, consisting of 86 fuel elements, is in temporary storage at the Chemistry and Metallurgy Research Complex in Wing 9. They are being stored in old "Rover Project" casks which were once certified for transport of spent nuclear fuel. LANL has no permit for long-term storage of spent fuel.

3.1.2.1 Land Use. Los Alamos National Laboratory is located approximately 60 miles (96 kilometers) north-northeast of Albuquerque, New Mexico. Los Alamos occupies an area of about 28,000 acres (11,000 hectares) located primarily in Los Alamos County in northern New Mexico, about 24 miles (39 kilometers) northwest of Santa Fe. The County of Los Alamos has zoned the entire area of the lab Federal Land. Los Alamos National Laboratory has developed nine land use classifications for its operations. There are no prime farmlands on the Los Alamos National Laboratory, although portions are designated as a National Environmental Research Park (DOE 1993a).

3.1.2.2 Socioeconomics. The civilian labor force in the region of interest grew 144 percent, increasing from 34,467 in 1970 to 84,107 in 1990. Total employment increased from 31,155 to 79,846 between 1970 and 1990, an annual growth rate of 5 percent. The unemployment rates for 1970 and 1990 were 9.6 percent and 5.1 percent, respectively. For the same years, personal income increased from approximately $324.7 million to $2.3 billion (an annual average of 10 percent), and per capita income increased from $3,396 to $15,348 (DOE 1993a).

Between 1975 and 1990, employment at Los Alamos National Laboratory increased from 5,094 to 7,622, representing 10 percent of the region of interest employment in 1990. As of September 1992, employment at Los Alamos National Laboratory had increased to 7,450. The prepared Fiscal Year 1994 budget projects a reduction in expenditures at the site resulting in reduced employment (DOE 1993a).

In 1991, more than half of the Los Alamos National Laboratory workforce resided in the unincorporated communities of Los Alamos and White Rock in Los Alamos County. Between 1970 and 1990, the population in the region of interest increased 61 percent to 151,408. During the same period, the New Mexico population increased 49 percent. The population in the three-county region of interest is projected to increase from an estimated 169,000 in 2000 to 191,000 by 2020, an annual rate of less than 1 percent (DOE 1993a).
Employmen associated with SNF management such as routine operations of the facility including care and periodic inventories of the SNF amounts to about 1.3 person-years per year (Cruz 1995).

3.1.2.3 Cultural Resources. The prehistoric chronology for the Los Alamos National Laboratory area consists of six broad time periods: Paleolalndian (10,000-4000 B.C.), Archaic (5500 B.C.-A.D. 600), Early Developmental (A.D. 600-900), Late Developmental (A.D. 900-1100) Coalition (A.D. 1110-1325), and Classic (A.D. 1325-1600). Prehistoric site types identified in the vicinity of Los Alamos National Laboratory include large multioroom pueblos, pithouse villages, field houses, talus houses, cave kivas, shrines, towers, rockshelters, animal traps, hunting blinds, water control features, agricultural fields and terraces, quarries, rock art, trails, campsites, windbreaks, rock rings, and limited activity sites. Approximately 75 percent of Los Alamos National Laboratory has been inventoried for cultural resources. Coverage for some inventories has been less than 100 percent; however, about 60 percent of Los Alamos National Laboratory has received 100 percent coverage. Over 975 prehistoric sites have been recorded; about 95 percent of these sites are considered eligible or potentially eligible for the National Register of Historic Places (DOE 1993a).

Native Americans in this area include those living in the San Ildefonso, San Juan, Santa Clara, Nambe, Tesuque. Pojueque pueblos east of Los Alamos, and the Jemez and Cochiti pueblos. Native American resources on Los Alamos National Laboratory may consist of prehistoric sites with ceremonial features such as kivas, village shrines, petroglyphs, or burials; all of these site types or features would be of concern to local groups (DOE 1993a).

3.1.2.4 Geology. Los Alamos National Laboratory is located on the Pajarito Plateau. The surface of the plateau is dissected by deep, southeast-trending canyons separated by long, narrow mesas (DOE 1993a).

Los Alamos National Laboratory lies in the Uniform Building Code Zone 2B seismic hazard area. The strongest earthquake in the last 100 years within a 50-mile (80-kilometer) radius was estimated to have a magnitude of 5.5 to 6 and a Modified Mercalli Intensity of VII. Studies suggest that several faults have produced seismic events with a magnitude of 6.5 to 7.8 in the last 500,000 years. Los Alamos National Laboratory operates a seismic hazards program which monitors seismicity through a seismic network and conducts studies in paleoseismology. These studies have determined the presence of three faults in the area that are considered active as defined by 10 CFR 100, Appendix A. These form the Pajarito fault system, which includes the Pajarito, Water Canyon, and Guaje Mountain faults. The Guaje Mountain fault had movement on it between 4,000 and 6,000 years ago. There is no evidence of movement along the Pajarito fault system during historical times. The 100-year earthquake at Los Alamos is regarded as having a magnitude of 5, with an event of magnitude 7 being the maximum reasonably foreseeable earthquake. These values are currently used in design considerations at Los Alamos (DOE 1993a).

Maximum horizontal ground surface accelerations ranging from 0.17 to 0.25g at Los Alamos National Laboratory are estimated to result from an earthquake that could occur once every 2000 years (DOE 1994a). The seismic hazard information presented in this EIS is for general seismic hazard comparisons across DOE sites. Potential seismic hazards for existing and new facilities should be evaluated on a facility specific basis consistent with DOE orders and standards and site specific procedures.

Geological concerns associated with the Los Alamos National Laboratory area include potential downslope movements in association with regional seismic activity. Although isolated rockfalls commonly occur from the canyon rims, landslides are an unlikely hazard (DOE 1993a).

3.1.2.5 Air Resources. The climate at Los Alamos National Laboratory and in the surrounding region is characterized as a semiarid tropical and subtropical steppe. Mountain barriers deplete a large portion of the moisture from the maritime air masses from the Pacific Ocean, a condition that contributes to the semiaridness. The annual average temperature in the area is 56.2°F (13.4°C); average daily temperatures range from 22.3°F (-5.4°C) in January to 92.8°F (33.8°C) in July. The average annual precipitation in the area is 8.1 inches (20.6 centimeters). The average monthly precipitation ranges from 0.38 inch (0.97 centimeter) in November to 1.51 inches (3.84 centimeters) in August (DOE 1993a).
3.1.2.6 Water Resources. The major surface water body in the immediate vicinity of Los Alamos National Laboratory is the Rio Grande east of the site. The primary surface water features near Los Alamos National Laboratory are intermittent streams. Sixteen drainage areas pass through or start in the Los Alamos National Laboratory site. Most Los Alamos National Laboratory facilities are located well above the streambeds. Only those Technical Areas located within canyons would be within the 500-year floodplain (DOE 1993a).

No surface water is withdrawn at Los Alamos National Laboratory for either drinking water or facility operations. The water supply system for Los Alamos is based on a series of groundwater supply wells and springs (DOE 1993a).

Los Alamos, Sandia, and Mortandad canyons currently receive treated industrial or sanitary effluent. Acid-Pueblo Canyon does not receive Los Alamos National Laboratory effluents. Surface waters in these canyons are not a source of municipal, industrial, or agricultural water supply. Only during periods of heavy precipitation or snow melt would waters from Acid-Pueblo, Los Alamos, or Sandia Canyons extend beyond Los Alamos National Laboratory boundaries and reach the Rio Grande. In Mortandad Canyon, there has been no surface runoff to the laboratory's boundary since studies were initiated in 1960 (DOE 1993a).

The main aquifer consists mainly of sediments of the Santa Fe Group. Nearly all groundwater at Los Alamos National Laboratory is obtained from deep wells that produce water from this aquifer. The Bandelier Tuff, a volcanic unit that lies above the Santa Fe Group, contains fractures that yield small amounts of water to springs. A minor amount of groundwater at Los Alamos National Laboratory is obtained from springs. The aquifers that lie beneath Los Alamos National Laboratory are considered Class II aquifers, having current sources of drinking water and water with other beneficial uses (DOE 1993a).

The water in the main aquifer moves slowly from the major recharge area in the west to discharge springs in White Rock Canyon along the Rio Grande. The depth to the aquifer ranges from about 1,200 feet (365 meters) on the west to about 600 feet (183 meters) on the east. The total saturated thickness penetrated by production wells ranges up to at least 1,700 feet (518 meters) (DOE 1993a).

3.1.2.7 Ecological Resources. Terrestrial habitats within undeveloped areas of Los Alamos National Laboratory support six major vegetative communities: juniper-grassland, pinyon pine-juniper, ponderosa pine, mixed conifer, spruce-fir, and subalpine grassland. Undeveloped areas within Los Alamos National Laboratory provide habitat for a diversity of terrestrial wildlife. Los Alamos National Laboratory was designated a National Environmental Research Park in 1976 (DOE 1993a).

National Wetland Inventory maps indicate that wetlands within Los Alamos National Laboratory are restricted to several canyons containing the Rio Grande or its tributaries. Most of the wetlands shown on the National Wetland Inventory maps have been designated as temporary or seasonal (DOE 1993a).

Aquatic habitats on Los Alamos National Laboratory are limited to the Rio Grande and several springs and intermittent streams in the canyons. These habitats currently receive National Pollutant Discharge Elimination System-permitted wastewater discharges. Fourteen species of fish are known to inhabit the roughly 6-mile (10-kilometer) reach of the Rio Grande between Los Alamos National Laboratory and Chochiti Lake. The springs and streams on the site support limited, if any, aquatic life (DOE 1993a).

Seventeen federally listed or New Mexico-listed threatened, endangered, or candidate species potentially occur in the vicinity of Los Alamos National Laboratory. Four of these species have been observed on Los Alamos National Laboratory, including the bald eagle (Haliaeetus leucocephalus) (a federally listed endangered species that roosts along the Rio Grande); the peregrine falcon (Falco peregrinus) (a federally listed endangered species that historically nests in the northeast corner of Los Alamos National Laboratory); the northern goshawk (Accipiter gentilis) (A Federal candidate Category 2 species that forages in the northwest corner of Los Alamos National Laboratory); and the giant helleborine orchid (Epipactis gigantea) (a state-listed endangered species that occurs near springs in White Rock Canyon). Five other species occur in close proximity to Los Alamos National Laboratory and are likely to exist on the site (DOE 1993a).
3.1.2.8 Public Health and Safety. The total maximum individual dose to a member of the public associated with both gaseous and liquid effluents from the most recent reports for a 5-year period is presented below (LANL 1993, 1992, 1990, 1989, 1988). The annual doses for each year are only a fraction of the DOE Public Dose Limit of 100 millirem per year. The data are from all laboratory operations, including storage of SNF.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dose (millirem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>6.1</td>
</tr>
<tr>
<td>1988</td>
<td>6.2</td>
</tr>
<tr>
<td>1989</td>
<td>3.9</td>
</tr>
<tr>
<td>1990</td>
<td>3.1</td>
</tr>
<tr>
<td>1991</td>
<td>4.4</td>
</tr>
</tbody>
</table>

The population collective effective dose equivalent attributable to laboratory operations to persons living within 50 miles (80 kilometers) of the laboratory for a 5-year period is presented below (LANL 1993, 1992, 1990, 1989, 1988). The data are from all laboratory operations, including storage of SNF.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dose (person-rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>3.5</td>
</tr>
<tr>
<td>1988</td>
<td>2.2</td>
</tr>
<tr>
<td>1989</td>
<td>3.1</td>
</tr>
<tr>
<td>1990</td>
<td>3.1</td>
</tr>
<tr>
<td>1991</td>
<td>1.1</td>
</tr>
</tbody>
</table>

3.1.2.9 Waste Management. Current low-level radioactive waste management activities at Los Alamos National Laboratory may require expansion of the existing landfill at Los Alamos National Laboratory. A portion of the proposed expansion area for the existing landfill has been contaminated by a chemical plume from the hazardous chemical disposal site, which restricts further development. DOE is considering the expansion to ensure continued operation of laboratory activities that generate low-level radioactive waste and to provide safe isolation of the wastes (DOE 1993a).

Waste minimization has been implemented by Los Alamos National Laboratory's Environmental Management Division using programmatic controls such as source reduction, inventory control, product substitution, and waste exchange programs. A Waste Minimization and Pollution Prevention Awareness Plan was completed in 1991. Major waste generating operations have been prioritized by severity of hazard and volume in order to determine which generating systems to address. Also, halogenated solvent substitution has been evaluated for a number of research processes (DOE 1993a).

3.1.3 Sandia National Laboratories

Sandia National Laboratories, headquartered in Albuquerque, New Mexico, maintain facilities in three locations: Albuquerque, New Mexico; Livermore, California; and Tonopah, Nevada. The facilities discussed in this document refer only to the Albuquerque location, located adjacent to the city of Albuquerque, New Mexico. The site is approximately 6.5 miles (10 kilometers) southeast of downtown Albuquerque. Sandia National Laboratories consist of 8,300 acres (3,360 hectares) on Kirtland Air Force Base allocated to DOE.

Sandia National Laboratories use facilities at five Technical Areas and a Test Field (DOE 1993a).

- Technical Area I—Administration, site support, technical support, component development, research, energy programs, microelectronics, defense programs, and exploratory systems.
- Technical Area II—Testing of explosive components.
- Technical Area III—Testing and simulation of a variety of natural and induced environments, including two rocket sled tracks, two centrifuges, and a radiant heat facility.
- Technical Area IV—A remote site for pulsed power sciences such as X-ray, gamma-ray, and particle beam fusion accelerators.
Structures. Concrete bunkers located in the southeast portion of Kirtland Air Force Base were when the bunkers with an earth covering. and reinforced concrete (DOE I laboratories currently use four structures for dry storage of reactor has a large central irradiation safety research. The eight storage vaults on the high-bay the core. neutron radiography facilities. The Annular Core Research Reactor facility includes the reactor pool. one safe. and eight dry storage vaults. all located in the high-bay of Building 6588. The Annular Core Research Reactor is used primarily for testing electronics and for reactor safety research. The eight storage vaults on the high-bay floor are used to securely store irradiated experiments containing a variety of nuclear materials, but principally uranium-235. Materials from only three experiments containing reactor irradiated nuclear materials are stored at the Annular Core Research Reactor (DOE 1993b).

3.1.3.1 Manzano Storage Structures. The Manzano Storage Structures are reinforced concrete bunkers located in the southeast portion of Kirtland Air Force Base. Until recently, when the Sandia National Laboratories took responsibility for the site, the Manzano facilities were operated and maintained by the Department of Defense. The Sandia National Laboratories currently use four structures for dry storage of reactor irradiated nuclear material. The two types of bunkers which Sandia National Laboratories utilize are reinforced concrete bunkers with an earth covering, and reinforced concrete bunkers bored into the mountain. The average storage space available is 1800 square feet (167 square meters). A ring road encircles the mountain and provides access to all of the bunkers. The ventilation is natural air circulation (DOE 1993b).

3.1.3.2 Annular Core Research Reactor. The Annular Core Research Reactor is a pool-type research reactor capable of steady-state, pulse, and tailored transient operation. The reactor has a large central irradiation cavity (primary experiment location) that extends through the core, two interchangeable, fuel-ringed external cavities, an unfueled external cavity and two neutron radiography facilities. The Annular Core Research Reactor facility includes the reactor pool, one safe, and eight dry storage vaults, all located in the high-bay of Building 6588. The Annular Core Research Reactor is used primarily for testing electronics and for reactor safety research. The eight storage vaults on the high-bay floor are used to securely store irradiated experiments containing a variety of nuclear materials, but principally uranium-235. Materials from only three experiments containing reactor irradiated nuclear materials are stored at the Annular Core Research Reactor (DOE 1993b).

3.1.3.3 Sandia Pulse Reactor II and III, and Critical Assembly. Three reactors are operated at the Sandia Pulse Reactor facility; Sandia Pulse Reactor II and Sandia Pulse Reactor III are unmoderated, fast-burst reactors capable of pulsed and steady-state operation. They are designed to produce a neutron energy spectrum similar to that produced from fission. The primary experiment location for each reactor is a central cavity that extends through the core. The principal use of the reactors is to irradiate electronic devices requiring high neutron fluence and/or high dose rates. The Critical Assembly is a small, water-moderated reactor used to perform measurements of key reactor parameters to benchmark the computer calculations and thereby refine the designs for a planned space propulsion reactor. The yard storage holes are 19 stainless-steel types located in a corner of the Sandia Pulse Reactor compound. These tubes are surrounded by a high-density concrete monolith. The yard holes are used to securely store irradiated experiments containing a variety of nuclear materials, but principally uranium-235. All of the materials reside in their own containers, some of which have double containment (DOE 1993b).

3.1.3.4 Hot Cell Facility. The Hot Cell Facility at Sandia National Laboratories is a nonreactor nuclear facility that is housed in Building 6580 in Technical Area V. The Hot Cell Facility includes the Hot Cell, the Glove Box Laboratory, Radiochemistry Laboratory, and support facilities in rooms 101, 104, 105, 106, 107, 108, 110, 111, 112, 113, 113A, 203, and 212A. This facility is designed to permit safe handling and experimentation with Special Nuclear Materials, both irradiated and unirradiated. Research programs at Sandia National Laboratories (material studies, fuel studies, and safety studies) require that experiments containing radioactive materials be assembled and/or disassembled, samples prepared, and microscopic and chemical analyses performed. The principal storage facility for the Hot Cell Facility is Room 108, which is a heavily shielded room used previously as a preparation room next to the irradiation room of the Sandia Engineering Reactor which has been defueled. There are a series of 13 storage holes under the Hot Cell Facility Monorail that are available to store irradiated material coming into or out of the Hot Cell Facility. Only one of the holes is currently in use. The other areas of the Hot Cell Facility are used for storing minor amounts of material (DOE 1993b).

3.1.3.5 Special Nuclear Material Storage Facility. At this dry storage facility, Sandia National Laboratories stores previously failed fuel elements from Sandia Pulse Reactor II and
elements from experiments that have been exposed to short irradiation periods. The complex
also provides for a loading area, a maintenance area, and an administrative office area. The
ventilation consists of a forced air filtered system (DOE 1993b).

3.1.3.6 Affected Environment at Sandia National Laboratories.

3.1.3.6.1 Land Use—Sandia National Laboratories are located approximately
6.5 miles (10.5 kilometers) southeast of downtown Albuquerque, New Mexico. There are no
prime farmlands on Sandia National Laboratories (DOE 1993a).

3.1.3.6.2 Socioeconomics—The civilian labor force in the region of interest grew
132 percent, increasing from 133,798 in 1970 to 310,252 in 1990. Total employment increased
from 124,605 to 293,905 between 1970 and 1990, an annual growth rate of 4 percent. The
unemployment rates for 1970 and 1990 were 6.9 percent and 5.3 percent, respectively. For the
same years, personal income increased from approximately $1.3 billion to $9.4 billion (an annual
average of 10 percent), and per capita income increased from $3,438 to $15,992 (DOE 1993a).

Between 1970 and 1990, employment levels at Sandia National Laboratories increased from
6,440 to 7,536, representing 3 percent of the region of interest employment in 1990. Changes in
mission requirements have historically led to fluctuations in employment levels over the period.
For example, employment decreased to 5,542 in 1975 and increased to 7,051 by 1985. As of
September 30, 1992, employment levels at Sandia National Laboratories had increased to 8,473.
The prepared Fiscal Year 1994 budget projects a reduction in expenditures at the site, resulting
in reduced employment. The reduction in work force associated with the budget reductions is
only estimated at this time (DOE 1993a).

Between 1970 and 1990, the population in the region of interest increased 58 percent to
589,131. During the same period, the population of New Mexico increased 49 percent. The
population in the three-county region of interest is projected to increase from an estimated
682,000 in 2000 to 771,000 by 2020, an annual rate of less than 1 percent (DOE 1993a).

As reported in 1988, there were a total of 21 personnel working at the reactors (ANS 1988).
This number included operators, experimenting scientists, and support personnel. While not
their main occupation, part of the duties of the operators and some support personnel include
tasks associated with refueling, storing, inventorying, packaging, and shipping SNF.

3.1.3.6.3 Cultural Resources—The prehistoric chronology for the Sandia National
Laboratories area consists of three broad time periods: Paleindian (10,000-5500 B.C.), Archaic
(5500 B.C.-A.D. 1), and Anasazi (A.D. 1600). Prehistoric site types include pueblos, pithouse
villages, rockshelters, hunting blinds, agricultural terraces, quarries, lithic and ceramic scatters,
lithic scatters, and hearths. About 22 percent of Sandia National Laboratories/DOE-controlled
land has been intensively inventoried for cultural resources; another 28 percent has received less
intensive surveys. Because techniques and procedures varied greatly between projects in these
areas, most surveys are not considered adequate. All five DOE Technical Areas have been
intensively surveyed; no prehistoric sites were recorded. Sixty-four prehistoric sites have been
recorded in DOE-owned or controlled lands beyond the five Technical Areas. About 88 percent
of these sites are considered eligible for the National Register of Historic Places (DOE 1993a).

Native Americans in this area include those living on the Sandia Pueblo, north of
Albuquerque, and the Isleta Pueblo, south of Kirtland Air Force Base. Native American
resources on Sandia National Laboratories/DOE-controlled lands may consist of prehistoric sites
with ceremonial features such as kivas, village shrines, petroglyphs, or burials; all of these types
or features would be of concern to local groups (DOE 1993a).

3.1.3.6.4 Geology—Sandia National Laboratories lie on a sequence of sedimentary,
igneous, and Precambrian basement rocks. The northern and western sections of Sandia
National Laboratories rest on Miocene to Quaternary gravels, sands, silts, and clays deposited in
the basin formed by uplift of the mountains to the east. The eastern portion of Sandia National
Laboratories is underlain primarily by Precambrian rocks (DOE 1993a).

The eastern portion of Sandia National Laboratories is cut by the Tijeras, Hubble Springs,
Sandia, and Manzano faults. Both the Tijeras and Sandia faults, which intersect on the site, are
considered capable faults (DOE 1993a).
Sandia National Laboratories lies in the Uniform Building Code 2B seismic hazard area. The facility is situated in a region of high seismic activity but low magnitude and intensity. Available records indicate that more than 1,100 earthquakes have occurred during the past 127 years. However, during the past century, only three have caused damage at Albuquerque. Intensities have been as high as a Modified Mercalli Intensity of VII, which can cause damage (DOE 1993a).

Possible geological concerns include potential ground shaking and rupturing associated with regional seismic activity and the two capable faults intersecting on the site. Statistical studies indicate that a nondamaging earthquake (Modified Mercalli Intensity less than III) may be expected every 2 years, with a damaging event every 100 years (DOE 1993a).

A maximum horizontal ground surface acceleration of 0.28g at Sandia National Laboratory is estimated to result from an earthquake that could occur once every 2000 years (DOE 1994a). The seismic hazard information presented in this EIS is for general seismic hazard comparisons across DOE sites. Potential seismic hazards for existing and new facilities should be evaluated on a facility specific basis consistent with DOE orders and standards and site specific procedures.

3.1.3.6.5 Air Resources—The climate at Sandia National Laboratories and in the surrounding region is characteristic of a semiarid steppe. The annual average temperature in the area is 56.2°F (13.4°C); temperatures vary from an average daily minimum of 22.3°F (-5.4°C) in January to an average daily maximum of 92.9°F (33.8°C) in July. The average annual precipitation is 8.1 inches (20.6 centimeters) (DOE 1993a).

3.1.3.6.6 Water Resources—Sandia National Laboratories are located within the Kirtland Air Force Base on the Albuquerque East Mesa. The mesa slopes gently southwest to the Rio Grande, the primary drainage channel for the area. The average flow of the Rio Grande is 1,008 cubic feet (28.5 cubic meters) per second. No perennial streams flow through the Sandia National Laboratories area. The two primary surface channels at Sandia National Laboratories are Tijeras Arroyo and the smaller Arroyo del Coyote. The Arroyo del Coyote joins the Tijeras Arroyo to discharge into the Rio Grande approximately 5 miles (8 kilometers) from the western edge of Kirtland Air Force Base. Both arroyos flow intermittently during spring snow melt or following thunderstorms. Springs in the eastern mountains provide a perennial flow in the upper reaches of Tijeras Arroyo. Most of this flow evaporates or percolates into the soil before reaching Kirtland Air Force Base (DOE 1993a).

High peak flows of short duration characterize floods in the area. High-intensity summer thunderstorms produce the greatest flows, but the probability of flooding is not considered high at Kirtland Air Force Base. The southeast corner of Technical Area IV and the east side of Technical Area II lie within the 500-year floodplain of Tijeras Arroyo (DOE 1993a).

Sandia National Laboratories lie within the north-south trending Albuquerque Basin. The principal aquifer of the Albuquerque basin is the Valley Fill aquifer. The Valley Fill consists of unconsolidated and semiconsolidated sands, gravels, silts, and clays that vary in thickness from a few feet (meters) adjacent to the mountain ranges to over 21,000 feet (6,400 meters) at a point 5 miles (8 kilometers) southwest of Kirtland Air Force Base airfield. The Valley Fill aquifer is considered a Class IIa aquifer, having a current source of drinking water and waters with other beneficial uses. (DOE 1993a)

The regional water table is separated by a fault complex that divides the area into a deep region on the west side of the complex and a shallower region on the east side. The depth to groundwater ranges from 50 to 100 feet (15 to 30 meters) on the east side of the fault complex and from 380 to 500 feet (115 to 150 meters) on the west side. Based on available data, the apparent direction of groundwater flow west of the fault complex is generally to the north and northwest. The direction of groundwater flow east of the fault complex typically is west toward the fault system (DOE 1993a).

3.1.3.6.7 Ecological Resources—Most undeveloped lands within Technical Areas I and III of Sandia National Laboratories support grassland vegetation. Terrestrial wildlife using grassland habitats on Sandia National Laboratories are typical of similar habitats in central New Mexico. The size and diversity of wildlife populations are thought to be limited by the poor availability of water. An inventory of wildlife species on Kirtland Air Force Base (including Sandia National Laboratories) has been recently updated (DOE 1993a).
No wetland inventories have been performed for Sandia National Laboratories, and no National Wetland Inventory maps have been published. Several springs exist on Kirtland Air Force base, including Sol se Mete Spring, Coyote Springs, and G Spring. These are associated with canyons and arroyos. No springs exist in Technical Areas I through V, and none are located within permitted land to which Sandia National Laboratories has access (DOE 1993a).

Potential aquatic habitat within Kirtland Air Force Base is limited to arroyos and canyons and the few springs associated with them. The nearest major perennial aquatic habitat is the Rio Grande, approximately 5 miles (8 kilometers) to the west (DOE 1993a).

No federally listed threatened or endangered species are known to occur on Sandia National Laboratories. The peregrine falcon (Falco peregrinus), a federally and state-listed endangered species, could potentially occur in the mountainous areas of Kirtland Air Force Base surrounding Sandia National Laboratories, but the likelihood is low because of the poor quality habitat for this species. The grama grass cactus (Pediocactus pappacanthus), a Federal Candidate Category 2 and state-listed endangered species, is known to occur in grasslands on Kirtland Air Force Base similar to those occurring on Sandia National Laboratories. The spotted bat (Eutelma maculatum), also a Federal Category 2 and state-endangered species, has a low probability of occurrence on Sandia National Laboratories. Sandia National Laboratories lie within the breeding range of several Federal Candidate bird species (DOE 1993a).

3.1.3.6.8 Public Health and Safety—The annual dose to a maximally exposed individual due to release of gaseous radionuclides from laboratory operations from reports for a 5-year period is presented below (SNL 1993, 1992, 1991, 1990, 1989). The data are from all laboratory operations, including storage of SNF.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dose (millirem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>0.00034</td>
</tr>
<tr>
<td>1989</td>
<td>0.00088</td>
</tr>
<tr>
<td>1990</td>
<td>0.0020</td>
</tr>
<tr>
<td>1991</td>
<td>0.0014</td>
</tr>
<tr>
<td>1992</td>
<td>0.0034</td>
</tr>
</tbody>
</table>

The estimated population dose to persons living within a 50-miles (80-kilometer) radius surrounding the laboratory due to release of gaseous radionuclides from laboratory operations from reports for a 5-year period is presented below (SNL 1993, 1992, 1991, 1990, 1989). The data are from all laboratory operations, including storage of SNF.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dose (person-rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>0.039</td>
</tr>
<tr>
<td>1989</td>
<td>0.097</td>
</tr>
<tr>
<td>1990</td>
<td>0.82</td>
</tr>
<tr>
<td>1991</td>
<td>0.052</td>
</tr>
<tr>
<td>1992</td>
<td>0.020</td>
</tr>
</tbody>
</table>

3.1.3.6.9 Waste Management—Low-level radioactive waste at Sandia National Laboratories is generated in both technical and remote test areas as a result of research and development activities. Most of the low-level radioactive waste consists of contaminated equipment and combustible decontamination materials and cleanup debris. All generated low-level radioactive waste is temporarily stored at generator sites or above ground in transportation containers at the Technical Area III disposal site. All low-level radioactive waste packages are currently onsite pending approval of transport by commercial carriers offsite for burial (DOE 1993a).

Mixed wastes include radioactively contaminated oils and solvents and radioactively contaminated or activated lead or other heavy metals. Other mixed wastes may be generated as a result of weapon tests (DOE 1993a).

3.1. Argonne National Laboratory - East

The Argonne National Laboratory - East stores reactor irradiated nuclear materials in the Alpha-Gamma Hot Cell (Building 212, Wing F), the Chicago Pile 5 Building, and analytical laboratories within Building 205. The principal mission (past and present) of the Alpha-Gamma Hot Cell is research on the behavior of materials, fuel, and structures used in nuclear reactors. Chicago Pile 5 houses a shut-down, heavy-water, moderated reactor whose fuel has been removed and shipped offsite. Currently Chicago Pile 5 is in the process of being decontaminated...
and decommissioned and contains only two highly enriched uranium target (i.e., converter) elements. Building 205 contains analytical laboratories that perform analyses on gram quantities of SNF samples coming from the Alpha-Gamma Hot Cell (DOE 1993b).

3.1.4.1 Land Use. The laboratory and support facilities occupy about a 200-acre (81-hectare) tract; 1,700 acres (688 hectares) within the site perimeter are devoted to forest and landscaped areas. The DuPage County Forest Preserve District operates 2,040-acre (826-hectare) green belt forest preserve, known as the Waterfall Glen Forest Preserve, which surrounds the site. Much of this forest preserve was formerly Argonne National Laboratory property but was deeded to the Forest Preserve District in 1973 for use as a public recreation area, nature preserve, and demonstration forest. In the past few years, a number of industrial parks have been constructed to the north and northwest of the laboratory. Also, many commercial establishments and a large number of dwelling units have been constructed within a few miles (kilometers) of Argonne National Laboratory. Before being occupied by Argonne National Laboratory, most of the site was wooded and the remaining land was used for farming (ANL-E 1993a).

3.1.4.2 Socioeconomics. Argonne National Laboratory is located within the Chicago Standard Metropolitan Statistical Area, which comprises six Illinois and two Indiana counties around the southwest corner of Lake Michigan. The population between 1970 and 1990 in the region increased 1.2 percent from 6,491,300 to 6,568,800 people. During this time total Illinois population increased 2.9 percent. Data sources for this information include U.S. Bureau of the Census, Bureau of Economic Analysis, and Department of Energy documents (DOC 1992).

The nearby areas of Will and Cook Counties have generally developed at a considerably lower rate than has the DuPage County area, except along the Illinois Waterway where industrial development has taken place. Included within a 50-mile (80-kilometer) radius are portions of Lake and Porter Counties in Indiana, and all of DuPage, Will, Cook, Kendall, and Kane Counties in Illinois (DOC 1992).

Beyond the forest preserve at Argonne National Laboratory's perimeter, the population density is low, except for a high-density residential area—over 15 units per acre (37 units per hectare) and about 4,500 residents—beginning some 650 yards (600 meters) east of the perimeter. DuPage County's growth rate has been the highest of any metropolitan Illinois county. In 1990, the total number of housing units within region equaled 2,548,736. Cook County contained the largest percentage of the region's housing units (DOC 1991b).

With its workforce of about 4,700 persons, Argonne National Laboratory is one of the three largest employers in DuPage County. Employees commute to Argonne National Laboratory from distances as far as 30 miles (50 kilometers); thus the payroll is spread over a wide area. However, nearby villages, notably Lemont and Downers Grove, do house high numbers of Argonne National Laboratory employees. About 50 percent of Argonne National Laboratory employees reside within 10 miles (16 kilometers) of the site. The laboratory also purchases much of its utilities, outside services, equipment, and supplies locally (DOC 1992).

Employment associated with SNF management such as routine operations of the facility including care and periodic inventories of the SNF amounts to about 0.5 person-years per year (Neimark 1995).

3.1.4.3 Cultural Resources. The ANL-E site has no properties designated as National Historic Landmarks or listed on the National Register of Historic Places.

In 1992, 26 archaeological properties had been recorded at ANL-E. One site has been evaluated as being potentially eligible for the National Register, 19 sites are not considered eligible, and 6 sites have not been evaluated (ANL-E 1993a).

The Illinois State Historic Preservation Agency has not evaluated the ANL-E site's potential to contain additional unidentified archaeological or architectural resources. The potential of the ANL-E site to contain traditional cultural resources of interest to Native American groups has not been evaluated (ANL-E 1993a).

3.1.4.4 Geology. The topography at ANL-E is generally gently rolling; the average elevation is 725 feet (221 meters) above sea level. Slopes of consequence are found only adjacent to streams and near the southern edge of the site, where the fall into the Des Plaines
River Valley begins (ANL-E 1993b). The geology of the Argonne National Laboratory area consists of about a 100-foot-thick (30-meter-thick) deposit of glacial till on top of dolomite bedrock. The bedrock at Argonne National Laboratory is the Niagaran and Alexandrian dolomite of Silurian age (about 400 million years old). These formations are underlain by Maquoketa shale of Ordovician age, and older dolomites and sandstones of Ordovician and Cambrian age. The beds are nearly horizontal (ANL-E 1993b).

The Niagaran and Alexandrian dolomite are about 200 feet (60 meters) thick in the Argonne National Laboratory area, and are widely used in DuPage County as a source of groundwater. The Maquoketa shale separates the upper dolomite aquifer from the underlying sandstone and dolomite aquifers. This shale retards hydraulic connection between the upper and lower aquifers; the lower aquifer has a much lower piezometric level and does not appear to be affected by pumping from the overlying Silurian bedrock (ANL-E 1993a).

A capable fault is one that has had movement at, or near, the ground surface at least once within the past 35,000 years or recurring movement within the past 500,000 years (10 CFR 100, Appendix A). A few minor earthquakes have occurred in northern Illinois, believed to have been caused by isostatic adjustments of the Earth's crust in response to glacial unloading. Several areas of seismic activity are present at moderate distances from ANL-E, including the New Madrid Fault zone in the St. Louis area of southwestern Missouri, the Wabash Valley Fault zone along the southern Illinois-Indiana border, and the Anna region of western Ohio. Ground motions induced by near and distance seismic sources are expected to be minimal at the Laboratory (ANL-E 1993a).

A maximum horizontal ground surface acceleration of 0.15g at Argonne National Laboratory - East is estimated to result from an earthquake that could occur once every 2000 years (DOE 1994a). The seismic hazard information presented in this EIS is for general seismic hazard comparisons across DOE sites. Potential seismic hazards for existing and new facilities should be evaluated on a facility specific basis consistent with DOE orders and standards and site specific procedures.

No active volcanoes are considered to be in the ANL-E region (Keller 1979). Therefore, the potential for damage from volcanic activity is minimal.

The major soil type present at ANL-E is Morley silt loam. This soil covers approximately 70 percent of the site. Stream valley soils, including the Askum, Peotone, and Sawmill silt loams, cover approximately 15 percent of the site, urban land soils approximately 10 percent, and other minor soils the remaining 5 percent (Mapes 1979).

3.1.4.5 Air Resources. The regional climate around Argonne National Laboratory is characterized as being continental, with relatively cold winters and hot summers. The area is subject to frequently changing weather as storm systems move from the Great Plains toward the east. The weather is slightly modified by Lake Michigan, which is about 22 miles (35 kilometers) east-northeast of the Laboratory (ANL-E 1993a).

Meteorological data presented here were compiled from the National Weather Service Station at the O'Hare International Airport in Chicago and from the meteorological tower operated at ANL-E. The prevailing winds for the airport are from the south and southwest with a northeast component. The frequency of calm winds, defined as those less than 2 miles per hour (1 meter per second), was approximately 4 percent. The 1992 average wind rose for the ANL-E site is very similar to this pattern, with prevailing winds from the west to south, but with a more significant northeast component. In 1992, the percentage of calm winds at ANL-E was approximately 3 percent (ANL-E 1993a).

The amount of rainfall recorded in 1992, 31.5 inches (80.01 centimeters), was nearly identical to the site's historical average of 31.48 inches (79.95 centimeter). The temperatures recorded during 1992 were also similar to the site's long-term averages. The coldest months during 1992 were January and December, with monthly averages of 27.9°F (-2.3°C) and 28.0°F (-2.2°C), respectively. The warmest months were July and August, with monthly averages of 68.5°F (20.3°C) and 66.9°F (19.4°C), respectively (ANL-E 1993a).

The area experiences about 40 thunderstorms annually. Occasionally, these storms are accompanied by hail, damaging winds, or tornadoes. From 1957 to 1969 there were 371
Theoretical probability of a tornado strike at Argonne is 8.54 x 10^-6 each year, or a recurrence interval of 1 tornado every 1,200 years. The Argonne National Laboratory site was struck by tornadoes in 1976 and 1978, with minor damage to power lines, roofs, and trees.

The State of Illinois has adopted ambient air quality standards that specify maximum permissible short- and long-term concentrations of various contaminants (State of Illinois Rules and Regulations 1992). These standards are the same as the National Ambient Air Quality Standards for criteria pollutants (NAAQS: 40 CFR 50). In addition to standards for criteria pollutants, the Illinois Environmental Protection Agency has made applicable all regulations promulgated by the EPA relating to National Emission Standards for Hazardous Air Pollutants (NESHAP), under Section 112 of the Clean Air Act (40 USC 7412, 7601a). The ANL-E site and the surrounding counties are classified by the EPA as severe nonattainment areas for the criteria pollutant ozone (O₃). All other surrounding counties and areas are in attainment of the remaining National Ambient Air Quality Standards criteria pollutants: nitrogen dioxide (NO₂), sodium dioxide (SO₂), lead (Pb), particulate matter less than 10 microns in diameter (PM₁₀) and carbon monoxide (CO) (with the exception of the Lyons Township in southeast Chicago, which is listed as a moderate nonattainment area for PM₁₀) (ANL-E 1993b).

3.1.4.6 Water Resources.

Surface Water - The ANL-E is in the Des Plaines River drainage basin 24 miles (39 kilometers) west of Lake Michigan and is on the northern margin of the Des Plaines River valley. The largest onsite stream is Sawmill Creek, which originates north of the site and enters the Des Plaines River about 1.25 miles (2.01 kilometers) southeast from the center of the site. Two small streams originate onsite and combine to form Freund Brook, which discharges into a Sawmill Creek. Most of ANL-E is drained by Freund Brook. The Des Plaines River flows southwest about 30 miles (48 kilometers) until it joins with the Kankakee River to form the Illinois River (ANL-E 1993a). As noted in National Wild and Scenic Rivers System, December 1992 (USGS, 1992) the ANL-E region has no federally designated wild and scenic rivers.

Flow in Sawmill Creek, upstream from the ANL-E wastewater outfall, averaged 6.3 cubic feet (0.18 cubic meters) per second in 1992. Flow in the Des Plaines River near the site is approximately 900 feet³ (25.5 meters) per second (ANL-E, 1991). In addition, ANL-E facilities are not in the 500-year floodplain. The floodplain areas are largely confined to areas within 200 feet (61 meters) of the surface streams (ANL-E 1993a).

The potable and site water supplies are obtained from groundwater (ANL-E 1993b). The first downstream location where surface water is used for drinking is at Alton, on the Mississippi River, about 370 miles (595 kilometers) from ANL-E. The first downstream location where surface water is used for drinking is at Alton, on the Mississippi River, about 370 miles (595 kilometers) from ANL-E (ANL-E 1993b).

The ANL-E has nine National Pollutant Discharge Elimination System permitted outfalls, most of which discharge directly or indirectly to Sawmill Creek (ANL-E 1991).

In addition to this outfall monitoring, surface water bodies in the region are routinely monitored for radioactive and nonradioactive parameters. In 1990, measurable levels of americium-241, californium-249, californium-252, cesium-137, curium-242, curium-244, neptunium-237, plutonium-238, plutonium-239, strontium-90, and tritium were detected in Sawmill Creek downstream from the only small fraction of the DOE-derived concentration guides for water (DOE Order 5400.5). Dilution in the Des Plaines River reduced the concentration of the measured radionuclides to levels below their respective detection limits. Streams sediments in the ANL-E region are routinely sampled for radionuclides at 3 onsite and 10 offshore locations. These samples are not routinely analyzed for chemical constituents (ANL-E 1991).

Groundwater - The ANL-E vicinity uses two principal aquifers for its water supply. The upper aquifer is the Niagara and Alexandria dolomite, which is about 200 feet (61 meters) thick in the region and has a potentiometric surface between 500 and 100 feet (152 and 30 meters) below ground (ANL-E 1993b). Water flows through this unit in a southern direction (ANL-E 1991). No aquifers in the region are considered sole source aquifers under the Safe Drinking Water Act regulations (EPA 1994).
The ANL-E receives its potable water supply from four wells in the Niagara dolomite aquifer. These wells are approximately 300 feet (91 meters) deep and provide hard water that requires treatment before use (ANL-E 1993b). Treated sanitary and laboratory wastewater from ANL-E are combined and discharged into Sawmill Creek. This effluent averaged 0.83 million gallons (3.1 million liters) per day (ANL-E 1993a).

Groundwater is monitored for radioactive and nonradioactive parameters at 32 ANL-E locations. Groundwater in the four onsite drinking water wells is also monitored for radioactive and nonradioactive parameters, as required by the Safe Drinking Water Act. In 1990, all results were less than the limits established by the Safe Drinking Water Act except for elevated levels of total dissolved solids and turbidity. The average concentration of tritium was approximately 1 percent of the EPA Primary Drinking Water Standard of 20,000 picocuries per liter. One well was removed from service in 1990 (ANL-E 1991).

3.1.4.7 Ecological Resources. The Argonne National Laboratory site lies within the Prairie Peninsula Section of the Oak-Hickory Forest Region. The Prairie Peninsula is a mosaic of oak forest, oak openings, and tall-grass prairie occurring on glaciated parts of Illinois, northwest Indiana, southern Wisconsin, and parts of other states. Forests in the Argonne National Laboratory-East region are predominantly oak hickory. Other forested areas consist of sugar maple, red oak, and basswood (ANL-E 1993a).

The mixture of vegetational communities (open fields, deciduous forests, pine plantations, wetlands, and mowed rights-of-way), coupled with a large degree of protection from human intrusion, makes the Argonne National Laboratory site an effective refuge for many species of animals. These animals are characteristically found in open fields, forests, and forest-edge communities in the Midwest. Also other bird species use the Argonne National Laboratory site as a stopover during spring and fall migrations. By far, the most numerous animals on the site are the small invertebrates (ANL-E 1993b).

The site is inhabited by fallow deer, (Dama dama), eastern cottontail rabbit, opossum, raccoon and squirrels. Although fallow deer have several color varieties, only the white variety occurs at Argonne. Invertebrate fauna consist primarily of dipteran larvae, crayfish, caddisfly larvae, and midge larvae. Few fish are present due to the low summer flows and high temperatures. Wetlands include a cattail marsh and wooded swamp habitat (ANL-E 1993b).

An opinion rendered by the U.S. Fish and Wildlife Service indicated that the only federally listed endangered or threatened vertebrate species likely to be present in the vicinity of the Argonne National Laboratory site is the Indiana bat (Myotis sodalis). An unconfirmed capture of an Indiana bat in nearby waterfall Glen Forest Preserves indicates that the bat may occur on the ANL-E site. In addition, a September 1980 updated of the “Red Book” for the North-Central Region lists the federally endangered bald eagle (Haliaeetus leucocephalus) as wintering in nearby Will County. Both American and Arctic subspecies of the peregrine falcon (Falco peregrinus anatum and F. p. tundrius) and Kirtland’s warbler (Dendroica kirtlandii) migrate through northeastern Illinois and thus might occasionally be found on or near the Argonne National Laboratory site. All three of these bird taxa are on the Federal endangered species list (ANL-E 1993b).

At least two plant species proposed for Federal endangered/threatened designation are known to occur in counties near the Argonne National Laboratory site and therefore might be present here. These are Thesium americana, found on wet prairies in Cook County; and Plantago cordata, a plant of wet woodlands recorded in Will County (ANL-E 1993b).

3.1.4.8 Public Health and Safety. The highest annual dose received by an offsite resident from a combination of the separate airborne and direct exposure pathways from the most recent reports for a 5-year period is presented below (ANL-E 1993a, 1992, 1991, 1990, 1989). The annual doses are only a fraction of the DOE Public Dose Limit of 100 millirem per year. The data are from all laboratory operations, including storage of SNF.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dose (millirem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>0.66</td>
</tr>
<tr>
<td>1989</td>
<td>0.49</td>
</tr>
<tr>
<td>1990</td>
<td>0.41</td>
</tr>
<tr>
<td>1991</td>
<td>0.29</td>
</tr>
<tr>
<td>1992</td>
<td>0.34</td>
</tr>
</tbody>
</table>
The total annual population dose to the entire area within a 50-mile (80-kilometer) radius of the laboratory for a 5-year period is presented below (ANL-E 1993a, 1992, 1991, 1990, 1989). The data are from all laboratory operations, including storage of SNF.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>25 person-rem</td>
</tr>
<tr>
<td>1989</td>
<td>17 person-rem</td>
</tr>
<tr>
<td>1990</td>
<td>15 person-rem</td>
</tr>
<tr>
<td>1991</td>
<td>15 person-rem</td>
</tr>
<tr>
<td>1992</td>
<td>17 person-rem</td>
</tr>
</tbody>
</table>

**3.1.4.9 Waste Management.** Activities conducted at ANL-E generate a variety of radioactive and hazardous waste streams (DOE 1994b).

The ANL-E reports 10 mixed waste streams in the inventory of operations waste. Of these, eight are low-level mixed waste streams and two are mixed transuranic waste streams. The ANL-E currently stores about 2.5 cubic yards (1.9 cubic meters) of mixed transuranic waste and projects that 2.1 yards (1.6 meters) of additional transuranic wastes will be generated through the end of 1997. This waste will be processed as necessary (characterized, repackaged, immobilized) to meet the waste acceptance criteria of the Waste Isolation Pilot Plant (DOE 1993e).

The ANL-E has no facilities for treating low-level mixed waste and transuranic waste. ANL-E currently stores about 125 cubic yards (96 meters³) of low-level transuranic waste, which includes low-level waste and transuranic waste reclassified as low-level transuranic waste. Roughly 30 meters³ (39 cubic yards) of low-level transuranic waste are projected to be generated through the end of 1997 (DOE 1993e).

Two major, unused facilities at ANL-E are undergoing environmental restoration. The Laboratory expects to complete removal of the Experimental Boiling Water Reactor vessel by the end of Fiscal Year 1995 and to complete the conversion of the CP-5 reactor building to an interim safe storage condition during Fiscal Year 1994 (DOE 1993f).

**3.2 Domestic Research Reactors**

The environments of domestic research reactors that may be affected by SNF activities are described in this section. Representative environments of sites generating and storing SNF are described as a basis for assessing the 57 reactor sites identified in Subsection 2.1.2. This approach was selected to permit enveloping the characteristics of the large number of sites covered. Additionally, it is recognized that the programmatic SNF analyses in this EIS are not intended to be site specific. Site-specific environmental information has already been presented to the NRC and analyzed as part of the facility licensing process.

Domestic research reactors are located in a wide variety of environmental settings, ranging from relatively densely populated urban areas to rural/semirural university campuses and industrial parks. To provide reasonably representative descriptions of potentially affected environments for these diverse installations, environmental information has been provided for 5 of the 11 Category 1 reactor sites. These five reactor sites encompass the diverse range of reactor types and power level as well as diverse environmental setting.

As reported in 1988, there were a total of 268 personnel working at the 11 Category 1 reactors (ANS 1988). This number included operators, experimenting scientists, and support personnel. While not their main occupation, part of the duties of the operators and some support personnel include tasks associated with refueling, storing, inventorying, packaging, and shipping SNF.

Environmental information is provided for those facilities whose ability to store SNF is limited when compared to their fuel burnup rate. For those operating facilities possessing adequate storage for their SNF, projected to be generated through 2035, there would be no incremental impacts on the surrounding environment. Accordingly, no environmental analyses have been performed and no information is provided in this section.

The environmental information for each of these reactors has been presented as part of their license applications to the NRC and has been assessed by that agency as part of the licensing process for each facility. The environmental impacts of expanded storage of SNF at
these facilities are expected to be minimal (although other effects on the institutions themselves may be extensive). Information on environmental factors that are not affected by the activities of storing SNF at these sites (including cultural resources, aesthetic and scenic resources, ecological resources, noise, traffic and transportation, utilities and energy, materials and waste management) is not provided in this document.

Data on the calculated doses to the general public resulting from effluents from NRC licensed research reactors is not available, since their license and reporting requirements were not the same as those for DOE facilities. At the time of the reports (1987-1993), the effluent release limits in 10 CFR 20 (specified as maximum permissible concentrations) were based on a dose limit of 500 millirem per year to a hypothetical member of the public. The conservative assumptions made in calculating the 10 CFR 20 concentration limits were that the person only drank the water and breathed the air released from the licensed facility. The licensed research reactors proved to the NRC that the dose limit of 500 millirem per year for the general public was being met by maintaining the release concentrations at the site boundary below the maximum permissible concentration limits specified in 10 CFR 20. In reality, the actual dose received by any member of the public was well below the prescribed limit of 500 millirem per year because 1) no individual drinks the water discharged in the sewer systems from these facilities, 2) no individual stands at the closest downwind location for 24 hours a day, 365 days a year, and 3) the radioactivity concentrations at the site boundary are well below the concentration limits.

As of 1993, licensed research reactors are required to meet the dose limits specified by the EPA in 40 CFR 61 of 10 millirem per year to the maximum exposed individual from airborne effluents. In addition, as of 1994, the licensed research reactors are required to comply with the new 10 CFR 20, in which exposure to any member of the public from all pathways is limited to 100 millirem per year.

3.2.1 National Institute of Standards and Technology Research Reactor

The National Institute of Standards and Technology research reactor, formerly known as the National Bureau of Standards Reactor, is a highly enriched, heavy-water-cooled and moderated vessel-type reactor. The National Institute of Standards and Technology reactor received an Atomic Energy Commission provisional license in 1967 to operate at 10 MW. On May 16, 1984, the NRC upgraded the National Institute of Standards and Technology research reactor license to operate for 20 years at up to 20 MW (NRC 1983).

The spent fuel storage pool, located in the basement of the confinement building, is used to store spent fuel under filtered, demineralized water until the fuel is shipped offsite. A spent-fuel storage pool cooling system is installed to dissipate the decay heat from elements stored in the pool. Storage racks are provided to store both full fuel elements and cut fuel pieces in a defined geometry. Boron or stainless steel spacers are placed between elements as required to control criticality. The storage rack arrangement ensures that the fuel in the pool remains subcritical (NRC 1983).

The National Institute of Standards and Technology site is a 576-acre tract of land in upper Montgomery County, Maryland, approximately 1 mile (1.6 kilometers) southwest of the City of Gaithersburg, Maryland. According to the 1990 census, the population of Gaithersburg was 39,542 (Rand 1992). The general area is a combination of residential and rural. The nearest population centers are Gaithersburg, adjacent to the site, and Rockville, 5 miles (8 kilometers) southeast of the site. The National Institute of Standards and Technology site is located approximately 20 miles (32 kilometers) northwest of the center of the District of Columbia. The National Institute of Standards and Technology campus is bounded on the east by a major interstate highway (I-270), on the north and west by Maryland Route 124, and on the southeast by Muddy Branch Road. The area adjacent to the reactor building is occupied by a parking lot, the reactor cooling tower, and roads. Thus, the area within a 500-foot (152-meter) radius of the reactor building stack is not readily available for the construction of new buildings, and planning for future development of the National Institute of Standards and Technology site does not include any new buildings within 500 feet (152 meters) of the reactor stack. The site boundary nearest to the National Institute of Standards and Technology reactor is approximately 0.25 mile (0.4 kilometers) southwest of the reactor. The nearest offsite residential or commercial housing is about 1.500 feet (457 meters) to the southeast of the reactor (NRC 1983).
During the period 1955-1967, 28 tornadoes were reported in a 2 degree latitude-longitude square containing the site. The computed recurrence interval for a tornado at the National Institute of Standards and Technology site is about 2000 years. Numerous tropical storms, tornadoes and hurricanes have affected the area. In the period from 1871 to 1978, about 20 tornadoes or hurricanes have passed within 100 miles (160 kilometers) of the site (NRC 1983).

There is no known major fault in the site vicinity (Seismic Zone 1). There is no known relationship between mapped faults and the moderate seismicity in the region. The maximum potential earthquake for the area was estimated to result in a maximum ground acceleration of 0.07 g at the reactor site. The effects of stresses developed by 0.1 g earthquake loadings have been evaluated, and it was demonstrated that the confinement building and reactor equipment would remain intact and maintain their capability (NRC 1983).

A summary of the radioactive material released in airborne and liquid effluents from the National Institute of Standards and Technology from the most recent reports for a 5-year period is presented below (NIST 1993, 1992, 1991, 1990, 1989).

<table>
<thead>
<tr>
<th>Year</th>
<th>Airborne effluents</th>
<th>Liquid effluents into sanitary sewer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Argon-41 Tritium</td>
<td>Tritium Other beta-gamma emitters</td>
</tr>
<tr>
<td>1988</td>
<td>900 Ci 393 Ci</td>
<td>5.1 Ci 0.0026 Ci</td>
</tr>
<tr>
<td>1989</td>
<td>328 Ci 461 Ci</td>
<td>2.9 Ci 0.0039 Ci</td>
</tr>
<tr>
<td>1990</td>
<td>687 Ci 309 Ci</td>
<td>2.2 Ci 0.0011 Ci</td>
</tr>
<tr>
<td>1991</td>
<td>971 Ci 251 Ci</td>
<td>1.8 Ci 0.0016 Ci</td>
</tr>
<tr>
<td>1992</td>
<td>665 Ci 351 Ci</td>
<td>1.5 Ci 0.0004 Ci</td>
</tr>
</tbody>
</table>

3.2.2 Massachusetts Institute of Technology Research Reactor

The Massachusetts Institute of Technology Reactor is a tank-type, light-water cooled and moderated, heavy-water reflected, plate fuel, research and training reactor. The Massachusetts Institute of Technology Reactor received its 5 MW operating license June 9, 1958 and originally was designed to have a heavy-water moderated and cooled core utilizing curved plate-type fuel elements, highly enriched in uranium-235. The major revision of the core design occurred in 1970 (MIT 1981, 1970).

The reactor building is a steel, gas-tight, 70-foot (21.3-meter) internal diameter, 50-foot (15.2-meter) high, domed right cylinder with 2-foot (0.6-meter) thick concrete shielding walls on the inside. The reactor building basement contains an 8-foot (2.4-meter) diameter, 20-foot-deep (6-meter-deep) spent fuel storage tank of demineralized water. The containment building has an air conditioning and multiple filter ventilation system which exhausts to a 150-foot (46-meter) stack.

Irradiated fuel elements can be stored in any of the following locations:

a) In the reactor core
b) In the cadmium-lined fuel storage ring (holds 27 SNF elements) attached to the flow shroud, or briefly in a three-element rack in the core tank used during transfers of spent fuel out of the core tank
c) In 22 steel-lined dry storage holes, 5 inches (13 centimeters) in diameter, on the reactor top biological shield
d) In the spent fuel storage tank in the basement of the reactor building
e) In the fuel element transfer flask or other proper shield within the controlled area.
The Massachusetts Institute of Technology Reactor is located a few blocks northwest of the main Massachusetts Institute of Technology campus in Cambridge, Massachusetts and less than 2,000 feet (610 meters) from the Charles River, which separates Cambridge from Boston. According to the 1990 census, Cambridge had a population of 95,802 (Rand 1992). The MIT Reactor is located in the midst of a heavily industrialized section of Cambridge. The site measures approximately 280 feet in length by 150 feet in width (85 meters by 46 meters). Boston and Albany Railroad tracks, used exclusively for freight traffic, run parallel to the back of the reactor exclusion area. Although the site boundary comes nearest to the reactor on the side facing the railroad tracks, the closest point of normal public occupancy near the site boundary is on the Albany Street side at approximately 120 feet (37 meters). (MIT 1970)

The Massachusetts Institute of Technology Meteorology Department has stated that conditions for the reactor site should vary only slightly from those at Logan Airport in east Boston. The area atmospheric conditions vary from highly stable situations with light winds to unstable periods with strong winds in excess of 47 miles (75.6 kilometers) per hour. Water drainage from the reactor site is into the Charles River and on into Boston Harbor and Massachusetts Bay. The drainage in this section of Cambridge is such that after a record-breaking 20 inches (0.5 meter) of rain fell in 48 hours, the Charles River did not overflow its banks, nor was the area inundated (MIT 1970).

The Cambridge area lies in the Boston Basin which has been relatively free of earthquakes in the past 150 years but had several earthquakes in the preceding centuries. The region is located in Seismic Zone 2. The most severe shock with a probable epicenter near Cambridge occurred in 1755 with a Rossi-Forel intensity of 9 (equivalent to Modified Mercalli Intensity IX or X). Partial or total destruction of some buildings occurred. Since 1817, no earthquake with a Rossi-Forel intensity of more than 5 (equivalent to Modified Mercalli Intensity VI) has been reported near Boston (MIT 1970).

A summary of the radioactive material released in airborne and liquid effluents from the Massachusetts Institute of Technology Research Reactor from the most recent reports for a 5-year period is presented below (MIT 1992, 1991, 1990, 1989, 1988). Liquid radioactive wastes generated at the Massachusetts Institute of Technology Research Reactor facility are discharged only to the sanitary sewer serving the facility. All releases were in accordance with Technical Specifications 3.8-1 and 10 CFR 20. All activities were substantially below the limits specified in 10 CFR 20.303. Gaseous radioactivity is discharged to the atmosphere from the containment building exhaust stack. All gaseous releases were in accordance with the Technical Specifications and all nuclides were below the limits of 10 CFR 20. The information is reported by fiscal year, from July 1 of the previous year to June 30 of the current year.

<table>
<thead>
<tr>
<th>Year</th>
<th>Airborne effluents</th>
<th>Liquid effluents into sanitary sewer</th>
<th>Other beta-gamma emitters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Argon-41</td>
<td>Tritium</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>2627 Ci</td>
<td>0.071 Ci</td>
<td>0.0011 Ci</td>
</tr>
<tr>
<td>1989</td>
<td>1529 Ci</td>
<td>0.107 Ci</td>
<td>0.0034 Ci</td>
</tr>
<tr>
<td>1990</td>
<td>543 Ci</td>
<td>0.059 Ci</td>
<td>0.0220 Ci</td>
</tr>
<tr>
<td>1991</td>
<td>684 Ci</td>
<td>0.115 Ci</td>
<td>0.0071 Ci</td>
</tr>
<tr>
<td>1992</td>
<td>728 Ci</td>
<td>0.023 Ci</td>
<td>0.0137 Ci</td>
</tr>
</tbody>
</table>

3.2.3 University of Missouri/Columbia Research Reactor

The University of Missouri/Columbia Research Reactor is a 10 MW tank in pool light water moderated and cooled research reactor. The reactor uses plate-type fuel containing 93 percent enriched uranium-235. The core forms an annular fuel region which is pressurized and cooled by forced convection. The University of Missouri/Columbia Research Reactor received its operating license October 11, 1966 and initially operated at 5 MW. The reactor power was increased to 10 MW in 1974 (UMC 1965; NRC 1991b).

The reactor is housed in a five-level, poured-concrete, gas-tight containment building which is in the center of the Research Reactor Facility, a one-level building of poured-concrete, block and brick construction. The reactor vessel is located eccentrically within an open pool 10 feet (3 meters) in diameter and 30 feet (9 meters) deep. Permanent SNF storage is provided within the biological shield, in a pool separated from the reactor by a massive submerged concrete weir (UMC 1965).
The University of Missouri/Columbia Research Reactor currently has 44 fuel elements in the core. 20 SNF elements in wet storage and none in dry storage. Without offsite shipment of SNF, the University of Missouri/Columbia Research Reactor's storage capacity of 120 elements would be filled by June 1996. Before this could occur, NRC approval would be required to raise the reactor's uranium-235 possession limit above 165 pounds (75 kilograms). Increased SNF storage capacity could be achieved by reracking and building a new wet-storage area within the reactor building. However, there are no plans to expand the current SNF storage capacity (Jentz 1993).

The University of Missouri/Columbia Research Reactor Facility is located within the 85-acre (0.344-square-kilometer) Research Park about 1 mile (1.6 kilometers) southwest of the main campus of the University of Missouri, south of the main business district of the city of Columbia, Boone County, Missouri. According to the 1990 census, the population of Columbia was 69,101 (Rand 1992). The nearest permanent residence is approximately 1,000 feet (305 meters) from the reactor. There are a number of small industrial activities in the area, but for the county, agriculture is the leading activity.

Wind speeds up to 50 miles (80 kilometers) per hour are not uncommon at Columbia. Ninety-four-mile-per-hour (151-kilometer-per-hour) winds have an average recurrence interval of 100 years; winds of 105 miles (169 kilometers) per hour have an average recurrence interval of 200 years. The frequency of tornadoes is so low that it is difficult to estimate the probability of the event. In most of the Midwest, there are an average 2.5 tornadoes per year in a 10,000 square-mile (25,900-square-kilometer) area. Surface drainage from the site moves south to enter Hinkson Creek, which drains to Perche Creek and then to the Missouri River (UMC 1961).

Columbia's position within the stable area of Missouri (Seismic Zone 1) and the seismic history of the area indicate that the probability of seismic damage to the area is extremely low.

A summary of the radioactive material released in airborne and liquid effluents from the University of Missouri/Columbia Research Reactor from the most recent reports for a 5-year period is presented below (UMC 1992, 1991, 1990, 1989, 1988). The information is reported by fiscal year, from July 1 of the previous year to June 30 of the current year.

<table>
<thead>
<tr>
<th>Year</th>
<th>Airborne effluents</th>
<th>Liquid effluents into sanitary sewer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Argon-41 Tritium</td>
<td>Tritium Other beta-gamma emitters</td>
</tr>
<tr>
<td>1988</td>
<td>813 Ci 14.5 Ci</td>
<td>0.077 Ci 0.0080 Ci</td>
</tr>
<tr>
<td>1989</td>
<td>920 Ci 2.8 Ci</td>
<td>0.0352 Ci 0.0085 Ci</td>
</tr>
<tr>
<td>1990</td>
<td>590 Ci 2.3 Ci</td>
<td>0.555 Ci 0.0385 Ci</td>
</tr>
<tr>
<td>1991</td>
<td>520 Ci 15.0 Ci</td>
<td>0.1600 Ci 0.0250 Ci</td>
</tr>
<tr>
<td>1992</td>
<td>440 Ci 0.73 Ci</td>
<td>0.2094 Ci 0.0488 Ci</td>
</tr>
</tbody>
</table>

3.2.4 University of Michigan Ford Nuclear Reactor

The University of Michigan's Ford Nuclear Reactor is a pool-type heterogeneous 2-megawatt-thermal reactor that is light-water cooled and moderated. The Ford Nuclear Reactor has been operated since 1957 and received a 20-year license renewal from the NRC on July 29, 1985 (NRC 1985c). Its principal function is for teaching, research, activation, and experiments (NRC 1985d).

The reactor is located in a windowless, four-story reinforced concrete building that is approximately a 70-foot (21.3-meter) cube. The reactor room, designed to restrict leakage, is equipped with its own ventilation system and exhaust stack (NRC 1985d).

The Ford Nuclear Reactor site situated on the North Campus, which is about 1.75 miles (2.8 kilometers) northeast of the old University of Michigan campus. The North Campus is a tract of nearly 900 acres (3.64 square kilometers), approximately 1.5 miles (2.4 kilometers) northeast of the center of Ann Arbor. According to the 1990 census, the population of the city of Ann Arbor was 109,592 (Rand 1992). The University of Michigan controls all the land within 1500 feet (457 meters) of the reactor site, with the exception of a small portion of the highway right-of-way along Glacier Way to the southeast and the Arborcrest Cemetery, located 800 feet...
The heaviest recorded 24-hour period of rainfall was approximately 5 inches (13 centimeters). Hourly intensities as high as 1.2 inches (3 centimeters), occur with a frequency of once every 2 years. Average annual snowfall is 30.2 inches (76.7 centimeters). Annual totals have ranged from 13 to 54 inches (33 to 137 centimeters). The heaviest recorded snowfall for a single day was 6.2 inches (15.7 centimeters). The highest wind velocity recorded in the Ann Arbor area was 60 miles per hour (27 meters per second). Michigan lies at the northeastern edge of the nation’s maximum frequency belt for tornadoes. For the past decade, Michigan has averaged nine tornadoes per year, 90 percent of which have been in the southern half of the lower peninsula (NRC 1985d).

The University of Michigan Ann Arbor site, within the Central Stable Region, is characterized by a relatively low level of seismic activity (Seismic Zone 1). Recent interpretations of geophysical investigations suggest that different areas of the Central Stable Region exhibit different levels of seismic activity. For instance, Barstow et al. developed an earthquake frequency map for the eastern United States that places Ann Arbor in a zone where 8-15 earthquakes per 4500 square miles (11,660 square kilometers), with Modified Mercalli Intensities of III or greater, have occurred during the time period 1800-1977. The Anna, Ohio, location experienced a frequency of 32-63 earthquakes per 4500 square miles (11,660 square kilometers) with Modified Mercalli Intensity III or greater for the same time period. The Michigan Basin area, in general, is considered to have had no more than 0-3 earthquakes per 4,500 square miles (11,660 square kilometers) of Modified Mercalli Intensity III or greater. A seismicity map developed by the Geological Survey of the State of Michigan shows that for the time period from 1872-1967, only 34 earthquakes were felt (reported) in the entire State of Michigan. A U.S. Geological Survey seismicity map of the State of Michigan shows a total of 83 earthquakes in the state since 1872. The nearest of these to Ann Arbor (March 13, 1978; Modified Mercalli Intensity IV) was about 30 miles (48 kilometers) away. Only six earthquakes have been reported within 60 miles (96 kilometers) of Ann Arbor. The risk of damage from earthquakes to well-designed structures is relatively low for the Ann Arbor area. In addition, the earthquake intensity/magnitude potential is relatively low for the Michigan region, and there are no known structures in the Ann Arbor area capable of causing earthquakes (NRC 1985d).


<table>
<thead>
<tr>
<th>Year</th>
<th>Airborne effluents</th>
<th>Liquid effluents into sanitary sewer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Argon-41</td>
<td>Tritium</td>
</tr>
<tr>
<td>1989</td>
<td>31 Ci</td>
<td>0.051 Ci</td>
</tr>
<tr>
<td>1990</td>
<td>35 Ci</td>
<td>0.069 Ci</td>
</tr>
<tr>
<td>1991</td>
<td>41 Ci</td>
<td>0.079 Ci</td>
</tr>
<tr>
<td>1992</td>
<td>39 Ci</td>
<td>No discharges</td>
</tr>
<tr>
<td>1993</td>
<td>39 Ci</td>
<td>No discharges</td>
</tr>
</tbody>
</table>

3.2.5 University of Texas TRIGA

The University of Texas General Atomic TRIGA Mk-II Reactor replaces an earlier TRIGA Mk-I reactor which had been in operation on the main campus in Austin, Texas since 1963. The TRIGA Mk-II is a 1.1 MW heterogeneous, pool-type reactor incorporating solid uranium-zirconium hydride fuel-moderator elements with an enrichment of 19.7 percent uranium-235.
The University of Texas TRIGA core is similar to most other TRIGA reactors operated throughout the world as well as the United States. It received its NRC operating license on January 17, 1992 (NRC 1985a, 1992).

The University of Texas TRIGA Mk-II Reactor facility is housed in the Nuclear Engineering Teaching Laboratory on the east tract of the Balcones Research Center about 7 miles (11.3 kilometers) north of the University of Texas main campus, in the City of Austin, Travis County. According to the 1990 census, the City of Austin had a population of 465,622 (Rand 1992). Residential areas are located from 0.8 to 1.3 miles (1.3 to 2.1 kilometers) from the reactor facility. Most areas adjacent to the research center are developed for mixed commercial and industrial activities. Major activities in the area are from the University of Texas main campus at Austin and the State of Texas government and the business district of the City of Austin (NRC 1985a).

Destructive wind and damaging hailstorms are infrequent. On rare occasions, dissipating tropical storms affect the city with strong winds and heavy rains. Tornado activity at the site is roughly one event per year per 1000 square miles (2,600 square kilometers), or 4 x 10^4 per year for an area of 333 square feet (30.8 square meters), which is roughly equal to the general site area. Water drainage at the immediate site is primarily related to the potential but temporary occurrence of extreme rainfall rates. Surface water runoff from the Balcones Research Center site is drained into the Shoal Creek Watershed except for the extreme northeast region of the site, which drains into the Walnut Creek watershed. The facility is located in the northeast site region with drainage into the Walnut Creek watershed. It is situated at an elevation well above the local area flood plain, and is located nearly equidistant 0.5 mile (0.8 kilometer) from the drainage easements of both watersheds. Thus no significant general site area flooding is anticipated (NRC 1985a).

The University of Texas TRIGA reactor site is located in a zone where no damage from earthquakes is expected (Seismic Zone 1). This does not mean, however, that the area is

ascismic. The Austin region has experienced three (recorded) earthquakes within a 50-mile (92.6-kilometer) radius since the late nineteenth century:

- May 1, 1873--Manor earthquake with epicentral Modified Mercalli Intensity III-IV
- January 5, 1887--Paige earthquake with epicentral Modified Mercalli Intensity V
- October 9, 1902--Creedmore earthquake with epicentral Modified Mercalli Intensity IV-V.

Other regions in central and east Texas have experienced earthquakes of epicentral Modified Mercalli Intensity V and possibly VI. Damage from an Modified Mercalli Intensity VI earthquake is limited to cracked plaster and damage to chimneys. Structures of good design do not begin to experience damage from intensities below Modified Mercalli Intensity VII. Therefore, when state-of-the-art engineering practices for general structures of common design are adhered to, seismic excitations from earthquakes of Modified Mercalli Intensities V or VI are not expected to affect the integrity of the reactor (NRC 1985a).

The University of Texas TRIGA reactor recently became operational, with its first criticality occurring in March 1992. There is no history of releases and exposure for this reactor.

### 3.3 Nuclear Power Plant Spent Nuclear Fuel

In this section, the environments of three facilities housing power reactor SNF to be managed by DOE are described. These facilities are the West Valley Demonstration Project in New York State; the Fort St. Vrain SNF Storage Facility in Colorado; and the B&W Research Technology Center in Virginia. General environmental concerns related to these facilities and their operation have been addressed either during their initial licensing/permitting activities or during a subsequent amendment process. Information on environmental factors that are not uniformly available in existing NEPA documentation for all three sites (noise, traffic, utilities and energy, and waste management) are not provided in this document.
3.3.1 West Valley Demonstration Project

The West Valley Demonstration Project consists of numerous structures and facilities. The Fuel Receiving & Storage facility, located adjacent to the original fuel reprocessing plant, is where SNF management activities at the West Valley Demonstration Project are currently performed. The Fuel Receiving & Storage facility consists of the following buildings and systems (WVNS 1993).

- Fuel Receiving & Storage Building - This building contains the spent fuel pool, cask unloading pool, cask decontamination area, cask and fuel handling equipment, and the spent fuel pool water treatment system.

- The water treatment system maintains a water quality that ensures visual clarity for underwater operations and that degradation of the SNF is minimized.

- The spent fuel pool provides shielding from irradiated fuel and ensures that stored assemblies are maintained in a critically safe geometry. The pool is about 30 years old and was not designed with a liner or a leak detection system, nor were the fuel racks designed to withstand a design-basis earthquake.

- Radwaste Process Building - This building houses the equipment for the Radwaste Treatment System, including the high integrity containers used to store spent resins and filter media, as well as shields for those containers.

- Recirculation Ventilation Building - This building houses the ventilation equipment for the Fuel Receiving & Storage building including fans, filters, heaters, chiller, and controls.

The Western New York Nuclear Service Center is located in the town of Ashford, Cattaraugus County, in rural western New York State, approximately 31 miles (50 kilometers) south of Buffalo and 24.5 miles (40 kilometers) inland (east) of Lake Erie. The West Valley Demonstration Project site consists of a 220-acre (88-hectare) tract which is located in the center of the 3,345-acre (1,341-hectare) Western New York Nuclear Service Center, (WVNS 1992a).

3.3.1.1 Land Use. Regional land use is predominantly agricultural, with some scattered residential areas. The communities of West Valley, Riceville, Ashford, Hollow, and the village of Springville are located within 5 miles (8 kilometers) of the West Valley Demonstration Project. The proximity of the city of Buffalo, Lake Erie, and Lake Ontario influence land use patterns in the region (WVNS 1992a).

3.3.1.2 Socioeconomics. The West Valley Demonstration Project comprises Cattaraugus and Erie Counties in the State of New York. These counties collectively account for 96 percent of the site's employee residential distribution. Most West Valley Demonstration Project employees live in Erie County. Total employment in the region increased 14.4 percent between 1970 and 1990. During the same period, total population in the region decreased 12.2 percent. Personal income in 1990 for Cattaraugus and Erie County residents was $13,698 and $18,305, respectively (DOC 1992). The total number of housing units within the region is 438,970.

The number of regular employees working at West Valley Demonstration Project is 1050 personnel. Employment associated with SNF management at West Valley amounts to 9 person-years per year (Connors 1995).

3.3.1.3 Cultural Resources. The cultural resources of 360 acres (145 hectares) that may be affected by future West Valley Demonstration Project Plans and/or West Valley Demonstration Project completion and Western New York Nuclear Service Center closure have been investigated. No recorded extant historic structures are located within or adjacent to the study area, but seven recorded prehistoric sites are within a 1.5-mile (2.4-kilometer) radius of the study area described below. There are no structures or prehistoric sites within the study area nor within the town of Ashford that are listed on the New York State Register of Historic Places or the National Register of Historic Places (WVNS 1994).

3.3.1.4 Aesthetic and Scenic Resources. The natural landscape in the area consists of rolling wooded hillsides, a mix of actively used agricultural fields, inactive farm fields reverting to...
brush, and rural homesites. Large portions of the Western New York Nuclear Service Center are relatively undisturbed and consist of a mixture of abandoned agricultural areas in various stages of ecological succession, forested tracts, and wetlands joined by transitional ecotones. The terrain in the area of the Western New York Nuclear Service Center is not unique in terms of landforms, vegetation, expanses of water, or land use (WVNS 1993).

3.3.1.5 Geology. The West Valley Demonstration Project is located within the Cattaraugus highlands, which is a transitional zone between the Appalachian Plateau Province and the Great Lakes Plain (WVNS 1993).

No fold or fault of any consequence is recognized within the site. The Clarendon-Linden Structure is the closest active "capable" earthquake (fault)-producing feature known to exist in the region. It is approximately 23 miles (37 kilometers) from the site (WVNS 1993). The site has experienced a moderate amount of relatively minor seismic activity. During historical times, ground motion at the site probably has not exceeded a Modified Mercalli Intensity of IV or a horizontal acceleration of 0.05g. It is estimated that the maximum earthquake on the Claredon-Linden Structure would produce an earthquake of Modified Mercalli Intensity of VI to VII and a maximum horizontal acceleration of approximately 0.12g at the site. The Claredon-Linden Fault Zone is located approximately 18 miles (29 kilometers) east of the West Valley Demonstration Project (WVNS 1993).

The West Valley Demonstration Project region has no active volcanoes (Keller 1979). The major soil types at the West Valley Demonstration Project include the well-drained Chenango gravelly loam, the poorly drained Erie silt loam, and the poorly drained Mahoning silt loam.

3.3.1.6 Air Resources. A 200 feet (60-meter) onsite meteorological tower is operated by DOE at the West Valley Demonstration Project. A review of the West Valley Demonstration Project tower's 1992 data indicates that the prevailing wind was from the south-southeast with a mean wind speed of 5.4 miles per hour (2.4 meters per second). The precipitation for 1992 was 7.1 inches (18 centimeters) above the annual average of 40.9 inches (104 centimeters). The onsite 1992 wind data and National Weather Service wind data collected at Buffalo airport did not compare well, thereby indicating that Buffalo airport is not representative for predicting conditions at the West Valley Demonstration Project.

The state of New York has adopted national ambient air quality standards. The West Valley Demonstration Project is in a Class II Prevention of Significant Deterioration area. The nearest Class I Prevention of Significant Deterioration area is the Edwin B. Forsyth National Wildlife Refuge, approximately 300 miles (483 kilometers) southeast of the site.

3.3.1.7 Water Resources. The West Valley Demonstration Project is located in the Cattaraugus Creek drainage basin, which is part of the Great Lakes – St. Lawrence watershed. All surface drainage from the West Valley Demonstration Project is to Buttermilk Creek, which flows into Cattaraugus Creek and ultimately into Lake Erie (WVNS 1992a). Cattaraugus Creek is used for swimming, canoeing, and fishing. Although limited irrigation water for nearby golf course greens and tree farms is taken from Cattaraugus Creek, no public water supply is drawn from the creek downstream of the site. The West Valley Demonstration Project has three National Pollutant Discharge Elimination System permitted outfalls that discharge to Erdman Brook (WVNS 1992a).

The West Valley Demonstration Project site has two aquifers, but neither is considered highly permeable. The Cattaraugus Creek Basin aquifer system is a sole source aquifer under Safe Drinking Water Act regulations (EPA 1994). Groundwater beneath the West Valley Demonstration Project is not used for process or drinking water. The site receives all of its water supply from surface water. Offsite water supplies north of the site and south of Cattaraugus Creek derive mainly from springs and shallow dug wells (WVNS 1992a).

More detailed aquifer characterization information can be found in the West Valley Demonstration Project Safety Analysis Report for Project Overview and General Information, WVNS-SAR-001 (WVNS 1993).

3.3.1.8 Ecological Resources. The West Valley Demonstration Project lies within the Humid Temperature Domain, Warm Continental Division (Bailey 1994). The West Valley Demonstration Project is in a transitional zone between the Appalachian Plateau to the south...
and east and the Great Lakes Plain to the north and west (WVNS 1992b). The West Valley Demonstration Project is equally divided between forest land and abandoned farm fields (WVNS 1993).

Native vegetation, removed by previous agricultural activity, is becoming reestablished and, if left undisturbed, will slowly revert by successional stages to a climax hardwood community (WVNS 1992b).

Terrestrial wildlife is abundant within the Western New York Nuclear Services Center and surrounding areas because of the mixture of open areas and forested lands as well as the Center’s protected nature (WVNS 1992b). Fifty-four species of mammals potentially occur on the site (22 have been recorded onsite). The most common mammal is the white-tailed deer (Odocoileus virginianus), which is also the most abundant game species in the region. However, hunting is prohibited. Other common game and fur bearer species include raccoon (Procyon lotor), muskrat (Ondatra zibethica), red fox (Vulpes fulva), gray fox (Urocyon cinereoargenteus), woodchuck (Marmota monax), mink (Mustela vison), beaver (Castor canadensis), eastern cottontail (Sylvilagus floridanus), red squirrel (Tamiasciurus hudsonicus), and gray squirrel (Sciurus carolinensis) (WVNS 1992b).

The various old-field, deciduous, and coniferous woodlands, marshes, reservoirs, and streams within the Western New York Nuclear Services Center provide a diversity of habitats used by a wide variety of birds. Bird species at the West Valley Demonstration Project include permanent and summer residents, migrants, and visitants. The abundance of upland meadow ecosystem within the Western New York Nuclear Services Center provides a unique habitat for several New York protected birds (WVNS 1992b).

Aquatic communities at the Western New York Nuclear Services Center include common shiners, eastern blacknose dace, common white sucker, and bluegill sunfish (WVNS 1992b).

Total wetland area is approximately 35 acres (14 hectares). The general types of wetlands on the West Valley Demonstration Project can be described as palustrine, emergent, shrub/scrub, and forested (WVNS 1993a).

A riparian area on Cattaraugus Creek is recognized by New York State as Habitat Significant for Wildlife (WVNS 1992b; WVNS 1993). Canada geese and other waterfowl have been observed periodically using the onsite reservoirs during migration (WVNS 1992b).

### 3.3.1.9 Transportation

Transportation in the Western New York Nuclear Service Center vicinity is primarily by highway system. Roads in Cattaraugus County are considered rural roads, except for those in Olean and Salamanca, located 38 miles (61 kilometers) and 26 miles (42 kilometers), respectively, south of the Western New York Nuclear Service Center. New York State classifies rural roads as interstate, principal arterial, minor arterial, major collector, minor collector, and local. Rock Springs Road, next to the Western New York Nuclear Service Center on the west, is a local road that services as the site-access road and connects with U.S. Route 219 about 2.5 miles (4 kilometers) west of the Western New York Nuclear Service Center. Route 219 connects with Interstate 90 (the New York State Thruway) approximately 25 miles (40 kilometers) north and with Interstate 17 (the Southern Tier Expressway) approximately 29 miles (46 kilometers) south of the Western New York Nuclear Service Center (WVNS 1993a).

Rail service to the Western New York Nuclear Service Center is provided by the Buffalo & Pittsburgh Division of the CSX Railroad, located 0.6 mile (1 kilometer) east of the Western New York Nuclear Service Center. A rail spur connects the West Valley Demonstration Project to the CSX (WVNS 1993a).

The Buffalo International Airport is located approximately 31 miles (50 kilometers) north. A general aviation airport, Olean Municipal Airport, is approximately 20 miles (32 kilometers) southeast of the Western New York Nuclear Service Center (WVNS 1993a).

### 3.3.1.10 Public Health and Safety

Nuclear Fuel Services, Inc. developed an environmental surveillance program in March 1963 before beginning fuel reprocessing. The program was intended to establish onsite background levels of gross radiological activity in surface water and air. The West Valley Demonstration Project began groundwater monitoring in 1982 (WVNS 1994).
Fallout data show the environmental levels of deposition at West Valley to have been within the nationwide normal range of the Radiation Alert Network measurements. Gross beta measurements in air taken at West Valley also were within the normal range of such readings taken throughout the United States. Levels of airborne particulates and deposition beyond the Western New York Nuclear Service Center perimeter have consistently been indistinguishable from the natural background.

The calculated total dose associated with airborne and liquid effluents released from West Valley Demonstration Project for a 6-year period are presented below (WVNS, 1994). The annual doses for each year are only a fraction of the DOE public dose limit of 100 millirem per year.

<table>
<thead>
<tr>
<th>Year</th>
<th>Maximum Individual at Site Boundary EDE</th>
<th>Collective Dose Within 50-Miles (80-km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>0.11 millirem</td>
<td>0.031 person·rem</td>
</tr>
<tr>
<td>1989</td>
<td>0.08 millirem</td>
<td>0.065 person·rem</td>
</tr>
<tr>
<td>1990</td>
<td>0.25 millirem</td>
<td>0.058 person·rem</td>
</tr>
<tr>
<td>1991</td>
<td>0.06 millirem</td>
<td>0.015 person·rem</td>
</tr>
<tr>
<td>1992</td>
<td>0.05 millirem</td>
<td>0.011 person·rem</td>
</tr>
<tr>
<td>1993</td>
<td>0.03 millirem</td>
<td>0.072 person·rem</td>
</tr>
</tbody>
</table>

3.3.2 Fort St. Vrain

Between 1979 and 1989 a high temperature gas-cooled reactor was in operation at the Fort St. Vrain site. In 1989, the Fort St. Vrain reactor was permanently shut down. At that time the Public Services Company of Colorado, the owner of Fort St. Vrain, proceeded with plans to decommission the Fort St. Vrain powerplant. To facilitate the decommissioning, the SNF had to be removed from the reactor. However, implementation of an agreement between the DOE and the Public Services Company of Colorado which would have provided for the storage of Fort St. Vrain SNF at the INEL was blocked, requiring the Public Services Company of Colorado to provide storage for the SNF from the Fort St. Vrain reactor. The SNF from the Fort St. Vrain is being stored in an independent spent fuel storage installation located on the Fort St. Vrain site (FSV 1990b).

The Fort St. Vrain site is located in Weld County in northeastern Colorado, approximately 3.5 miles (5.6 kilometers) northwest of the town of Platteville, 0.5 mile (0.8 kilometer) west of the South Platte River, and 35 miles (56 kilometers) north of Denver. The Fort St. Vrain site consists of 2,798 acres (1,132 hectares). About 1 mile (1.6 kilometers) north of the northern portion of the site is the confluence of the South Platte River and St. Vrain Creek. St. Vrain Creek flows in a northerly direction and passes within approximately 0.75 mile (1.2 kilometers) west of the site at its nearest approach (NRC 1991c; PSC 1994).

3.3.2.1 Land Use. Most of the land in the immediate area of the Fort St. Vrain site is disturbed, agricultural land. Its agricultural value is enhanced by a number of irrigation ditches fed by surface water diversions from the South Platte River and St. Vrain Creek. The predominant use of the land, surface water, and groundwater is agricultural (NRC 1991c).

3.3.2.2 Socioeconomics. The immediate area surrounding the Fort St. Vrain Nuclear Generating Station site is rural, with many communities within commuting distance. The nearest community is Platteville. Larger cities in the vicinity include Boulder, Denver, Estes Park, Fort Collins, Greeley, Longmont, Loveland, and Lyons (NRC 1991a).

The population density in the vicinity of the Fort St. Vrain Nuclear Generating Station is low. The nearest residence is more than 2,600 feet (0.8 kilometer) north-northwest of the site. The number of residents living within 1 mile (1.6 kilometer) of the Independent Spent Fuel Storage Installation site (based on projections from 1980 census data) is 39; the projected figure for the year 2012 is 46. However, 1990 figures indicate populations are changing at a similarly low rate, less than 1 percent per year, and consequently the projections will not change significantly (NRC 1991a).

Based on the 1980 census, the population within a 5-mile (8-kilometer) radius of the site at that time was 3,148, with 1,662 residing in the town of Platteville. The projected population for
the year 2012 (through the 20-year license) for this same area is 4.526, with 3,040 residing in Platteville (FSV 1990a).

At the present time there are approximately 230 personnel working at the Fort St. Vrain site. Of these approximately 16 full time equivalent personnel work on the Fort St. Vrain SNF storage facility (Holmes 1995).

3.3.2.3 Cultural Resources. There are no known archaeological, cultural, or historical resources within, adjacent to, or in the immediate vicinity of the Independent Spent Fuel Storage Installation site. The nearest landmarks fitting any of these designations are more than 2 miles (3.2 kilometers) from the site. They include (NRC 1991a):

- The Dent site, an archaeological excavation with mammoth remains left by prehistoric Indians, situated about 4.5 miles (7.2 kilometers) northeast of Fort St. Vrain
- The original Fort St. Vrain, located 2.5 miles (4 kilometers) northeast of the Independent Spent Fuel Storage Installation site
- Fort Vasquez, located 4 miles (6.4 kilometers) southeast of the Independent Spent Fuel Storage Installation, and listed on the National Register of Historic Places
- Fort Jackson, situated 8 miles (12.8 kilometers) southeast of the Independent Spent Fuel Storage Installation site.

3.3.2.4 Aesthetic and Scenic Resources. The topography at the Independent Spent Fuel Storage Installation site is flat. It is situated on the high plains, overlooked by the foothills of the Front Range, which rise about 20 miles (32 kilometers) to the west, and by the Front Range crest, which rises to 14,255 feet (4,345 meters) (Longs Peak) about 45 miles (72 kilometers) to the west. The Front Range crest due west of the Independent Spent Fuel Storage Installation site is the most easterly section of the continental divide in the Rocky Mountains. The divide runs along ridges at an altitude of approximately 12,000 feet (3,650 meters) to a high point of 13,327 feet (4,062 meters) (McHenry's Peak) (NRC 1991a).

3.3.2.5 Geology. The Fort St. Vrain site is located on the east flank of the Colorado Front Range, a complexly faulted anticlinal arch. Numerous faults and smaller folds are superimposed on the arch and are related to the uplift of the Front Range which began in the Late Cretaceous and continued into the Tertiary. In addition to the axes of the superimposed folds, two groups of high angle faults have been recognized: a series of faults along the mountain front that extend in a generally northwest-southeast direction from the Precambrian into the Paleozoic-Mesozoic sediments, and northeast-southwest-oriented faults observed primarily in coal mines located east of Boulder (NRC 1991a).

The Fort St. Vrain site has not experienced any observed earthquake activity (Seismic Zone 1). A field examination and photo interpretation of the area provided no evidence of recent movement along any of the known faults. The closest area of recent activity is about 25 miles (40 kilometers) south of the site. Between April 1962 and May 1967, there were approximately 1,130 earthquake events in this area with magnitudes ranging from 1.0 to 5.0 on the Richter Scale. The 5.0 earthquake produced ground accelerations in the Vrain Valley of 0.002 ± 0.001 g. An earthquake with a Modified Mercalli intensity of VII (slight to moderate damage to structures) occurred on November 7, 1882, and was felt throughout Colorado and Southern Wyoming. Due to the sparse population in the epicentral region, the assigned intensity may in actuality be an underestimate. A reasonable guess for its Richter magnitude is 6.5, implying that most of the strain energy released by earthquakes of Colorado in the last century was released in this one earthquake (NRC 1991a).

3.3.2.6 Air Resources. The general climate around the Fort St. Vrain site is typical of the Colorado eastern-slope plains region. The weather is generally mild. Most seasons are characterized by low humidity and sunny days, with occasional brief storms bringing precipitation to the area. Thermal radiation losses resulting from lack of cloud cover provide considerable variation in temperature from night to day. In this semiarid region, the precipitation averages 10 to 15 inches (25 to 38 centimeters) a year, mostly from thunderstorms in late spring and summer. Snowfall is significant; however, the snow cover is usually melted in a few days. Relative humidity averages about 40 percent during the day and 45 percent at night (NRC 1991a).
Meteorological conditions in the local area include a preponderance of stable meteorological conditions and rather low wind speeds. Wind speeds generally range from 1 to 7 miles per hour (0.45 to 3.2 meters per second) 80 percent of the time. Wind directions are rather evenly distributed, although there is a preponderance of winds from the southwest and northeast quadrants. Seasonally, winds tend to be strongest in the late winter and spring, the season with high chinook frequency, and again in the summer, when thunderstorms occur frequently. Strong winds, especially under chinook conditions, have been observed on various occasions in eastern Colorado. The chinook winds are strongest immediately to the east of the mountain ridge and diminish rapidly over the plains with increasing distance from the mountains (NRC 1991a).

The region typically experiences five tornadoes per year per 10,000 square miles (25,900 square kilometers), with peak tornado activity occurring during the month of June. According to the National Weather Service, Weld County has had 117 tornadoes during the period 1950-1987. A study of tornadoes in the area concluded that 100 mile (160 kilometer) per hour winds should constitute maximum forces to be expected at Fort St. Vrain (NRC 1991a).

Northeastern Colorado has moderate thunderstorm activity. The region near Fort St. Vrain averages 50 days a year in which thunder and lightning occur. The majority of these thunderstorms are present from late spring through the summer (NRC 1991a).

3.3.2.7 Water Resources. The topography in the immediate vicinity of the site is relatively flat and water use is primarily agricultural. Its distribution is through the use of irrigation ditches. The nearest major surface water features are the South Platte River, about 0.5 mile (0.8 kilometer) east of the site, and the St. Vrain Creek, about 0.75 mile (1.2 kilometers) west of the site. Local surface water diversions from these rivers, which feed irrigation ditches to support agriculture, are somewhat closer, about 0.33 mile (0.5 kilometer) east and west of the site, and about 0.4 mile (0.64 kilometer) to the north. The net local topography, which controls the direction of surface runoff, slopes slightly to the northeast toward the South Platte River. This trend is interrupted by the irrigation ditches. There are no liquid discharges from the dry storage facility (NRC 1991a).

3.3.2.8 Ecological Resources. Wildlife indigenous to the area include several species of ducks and geese, the mourning dove, cottontail rabbit, fox squirrel, and to a lesser extent bobwhite quail, ring-necked pheasant, deer, and antelope. The most abundant fish species include the white sucker, carp, notropis, creek chub, and, to a lesser extent, several types of perch (NRC 1991a).

With most of the land dominated by agriculture, natural vegetation is minimal. Most of the trees found along roads, in hedgerows, and around farm houses are cottonwood. Trees found in the river area are primarily cottonwoods, willows, and Russian olives. Typical grasses and weeds found in river bottom areas include gnat heads, golden weed, snake weed, Smith grass, Indian grass, foxtail and big bluestem. The site does not have readily visible evidence of recent farming but is now overrun with plants which are typically indigenous to disturbed land; plant species include Russian thistle, cocklebur, Canada thistle, dandelion, and poor-man’s pepper grass (NRC 1991a).

The only threatened or endangered animal species known to occur within the area of the project are the bald eagle and the peregrine falcon. However, this land has not been identified as a critical habitat for these or any other species. The black-footed ferret, also endangered, may be found as a transient within the region, but requires a permanent habitat which is occupied by prairie dogs. Prairie dogs are not present at the site (NRC 1991a).

3.3.2.9 Transportation. There are no airports within the immediate vicinity of the Independent Spent Fuel Storage Installation site. Stapleton International is about 30 miles (48 kilometers) south of the site. County roads with their associated rights-of-way are adjacent the exclusion area boundary or provide access to the generating station (County Roads 21, and 19 1/2, respectively). A railroad spur connects the site to the Union Pacific Railroad main line located about 2 miles (3.2 kilometers) to the west (NRC 1991a).

3.3.2.10 Public Health and Safety. Results from an Independent Spent Fuel Storage Installation Site Background Radiation Study, completed by Colorado State University in October 1990, including the mean integral exposure rate of 0.34 mR per day, were consistent with data acquired for the area during previous years of sampling by the Fort St. Vrain Radiological
Environmental Monitoring Program. With the exception of cesium-137, whose average surface activity concentration of 0.18 pCi/l is consistent with regional levels due to global fallout, no statistically significant concentrations of activation or fission products were detected (NRC 1991a).

The design of the modular vault dry store system is such that its operation does not result in any water or other liquid discharges, generate any chemical, sanitary, or solid wastes, or release any radioactive materials in solid, gaseous, or liquid form during normal operations. The primary radiological exposure pathway associated with the Independent Spent Fuel Storage Installation operation is direct irradiation of nearby residents and site workers. The highest dose to the nearest resident for any year is about 0.1 mrem. The highest collective dose commitment for any year to the population within 5 miles (8 kilometers) of the Independent Spent Fuel Storage Installation will not exceed 0.45 person-rem (NRC 1991a).

3.3.3 B&W Lynchburg

B&W Lynchburg maintains a large nuclear fuels research facility at its Mount Athos site. This site is about 925 acres (374 hectares) in area with the research facility within a 4-acre (1.6-hectare) fenced area. Numerous support facilities are located outside and adjacent to this fenced area. The research facility is in Campbell County, Virginia near the James River, approximately 4 miles (6.4 kilometers) east of the city of Lynchburg (NRC 1987).

Building A was constructed in 1956 and housed the Lynchburg pool reactor and the Critical Experiment Facility. This facility has been decommissioned (NRC 1987).

Building B contains a hot cell facility with its associated operations area, cask handling area, transfer canal and storage pool, and various laboratories associated with the examination of radioactive materials. It also houses a demineralizer for the cleanup of the pool water (NRC 1987).

Building C was used as a plutonium fuels development laboratory and for research and development of processes for other nuclear fuels. It is undergoing decommissioning (NRC 1987).

Building J and its Annex are used for solid waste storage. High, intermediate, and low-level wastes may be stored here. Irradiated fuel wastes are being stored until they are accepted by the DOE in accordance with the provisions in the Nuclear Waste Policy Act of 1982 (NRC 1987).

3.3.3.1 Land Use. Land use in Campbell and Amherst counties is dominated by farming and forestry. Although the site lies in an agricultural region, very few of the important agricultural characteristics attributed to the region occur within 5 miles (8 kilometers) of the site because of unfavorable terrain. The region is characterized by mixed land use consisting of small areas of farmland (crop and pasture) interspersed within large tracts of forested area (NRC 1986).

3.3.3.2 Socioeconomics. The Lynchburg Research Center and the nearby City of Lynchburg are centrally located within the area of Amherst, Appomattox, Bedford, and Campbell counties. The combined population of these counties and Lynchburg is about 180,000 (NRC 1986).

The Lynchburg area's commercial and industrial interests provide a large percentage of the employment in the four-county area. Although farming and forestry activities dominate the land use in the region, they provide less than 1 percent of the economic activity and very little permanent employment. Other principal commercial, industrial, and population centers that may influence the four-county area or may be slightly influenced by B&W operations are Roanoke, Charlottesville, Richmond, and Danville (NRC 1986).

The Lynchburg Research Center has about 180 employees, and the other facilities on the B&W site employ about 2,200. The total employment on the B&W site is only about 3 percent of the 69,000 persons employed in the Lynchburg Standard Metropolitan Statistical Area. The B&W operation is an important, although not critical, source of employment in the Lynchburg region (NRC 1986).

3.3.3.3 Cultural Resources. A review of the Federal Register reveals that the only historic site on the National Register of Historic Places located within 5 miles (8 kilometers) of the B&W facilities is the 19th-century Mt. Athos Plantation, which is across the road to the east of the site.
There are numerous historic places between 5 and 25 miles (8 kilometers and 40 kilometers) from the B&W site, particularly in Bedford County and Lynchburg to the west. The best known historic site is the Appomattox Court House National Historic Park, about 15 miles (24 kilometers) to the east (NRC 1986).

3.3.3.4 Aesthetic and Scenic Resources. The topography of the plant site is generally rolling with gentle slopes. The nominal river elevation is 470 feet (143 meters) above mean sea level. The dominant topographic feature of the site is a hill located approximately at the center of the property, the crest of which rises to 693 feet (211 meters) above mean sea level. The site includes a large area of relatively flat floodplain adjacent to the river. The highest point in the vicinity of the site is the top of Mt. Athos, where the elevation is 890 feet (271 meters) above mean sea level (NRC 1986).

3.3.3.5 Geology. The James River Basin of Virginia includes portions of four physiographic provinces characterized by distinct land forms and physical features. These provinces, located west to east, are Valley and Ridge, Blue Ridge, Piedmont, and Coastal Plain. Western or inner Piedmont, where the B&W property lies, is an upland characterized by scattered hills, some of mountainous dimensions, lying eastward from the foot of the Blue Ridge (NRC 1986).

No important mineral resources have been identified at the B&W site, and U.S. Geological Survey topographic maps do not indicate any significant surface or underground mining activities within 5 miles (8 kilometers) of the site (NRC 1986).

The B&W site is located in a western part of the central Virginia cluster region which is classified as Zone 2 on the Seismic Risk Map of the United States. This zone corresponds to an intensity of VII according to the Modified Mercalli scale, which implies building damages to the extent of fallen chimneys and cracked walls. During the period 1758 through 1968, 121 earthquakes with epicenters in Virginia were reported. The largest earthquake was in 1897, with a probable epicenter in Giles County, approximately 100 miles (160 kilometers) west of the plant site. A maximum intensity of VIII was estimated in the epicentral region, but an intensity of only V-VI was estimated at the plant site. The second largest earthquake was in 1875, with a maximum epicentral intensity of VII more than 50 miles (80 kilometers) east or northeast of the site. The estimated intensity at the site was V. No other quakes have been recorded with intensities at the site greater than the 1875 or 1897 occurrences (NRC 1986).

3.3.3.6 Air Resources. The climate of the Lynchburg area is influenced by cold and dry polar continental air masses in the winter and warm and humid gulf maritime air masses in the summer. Extremes in weather conditions in the area are rare. The mean temperature is about 56.7°F (13.7°C), with normal average temperatures ranging from 76.3°F (24.6°C) in July to 38.5°F (3.6°C) in December. Rainfall amounts at Lynchburg can be expected to reach 40.3 inches (102.4 centimeters) in any given year. The monthly rates are nearly uniform except for a slightly higher rate during the summer months. Snowfall in the Lynchburg area generally occurs between the months of December and March. The mean yearly snowfall total is 19.4 inches (49.3 centimeters). Winds at Lynchburg are predominant from the southwest with a mean speed of 8 miles per hour (3.6 meters per second). Mean relative humidity values in Lynchburg at 7:00 am, 1:00 pm, and 7:00 pm are 78, 51, and 62 percent, respectively. Heavy fog (visibility of less than 1,320 feet or 400 meters) can be expected to occur at the site on the average of 40 days per year (NRC 1986).

Severe weather at the Lynchburg Research Center is generally limited to thunderstorms, with a low probability of tornadoes. Climatological data show that the mean number of thunderstorms occurring at Lynchburg is 22 per year. According to methods for estimating tornado occurrence presented by Thom, the probability of a tornado's actually striking the site is 3.0 x 10⁻³ per year, with a recurrence interval of 3,333 years (NRC 1986).

The B&W Lynchburg Research Center is located in the Central Virginia Air Quality Control Region, where the air is classified by the Environmental Protection Agency as "better than national standards" for total suspended particulates and sulfur dioxide. The City of Lynchburg also meets the national standards for total suspended particulates and sulfur dioxide. For carbon monoxide, nitrogen dioxide, ozone, and hydrocarbons, the Air Quality Control Region cannot be classified because data are not available (NRC 1986).
3.3.3.7 Water Resources. A relatively large forested floodplain exists between the normal elevation of the James River and the estimated highest flood state at the site. Since no Lynchburg Research Center structures are located in the floodplain, plant operation does not impact floodplain features (NRC 1986).

The James River is formed about 96 miles (154 kilometers) upstream of the site by the confluence of the Jackson and Cowpasture Rivers. The James River flows generally south-southeast from the Valley and Ridge Province to the Atlantic Ocean through the Hampton Roads and Chesapeake Bay. On the basis of records for two U.S. Geological Survey gaging stations, one about 20 miles (32 kilometers) upstream and the other about 21 miles (34 kilometers) downstream of the site, the annual average flow rate of the river at the plant is estimated to be about 3920 cubic feet per second (110 cubic meters per second). The estimated water surface elevation at the site at the average now rate is approximately 470 feet (143 meters) above mean sea level (NRC 1986).

Eleven great floods of the James River occurred at the plant site in 1771, 1795, 1870, 1877, 1887, 1899, 1913, 1930, 1936, 1969, and 1985. The 1795 flood had the highest flood state, which was 535 feet or 163 meters above mean sea level at Lynchburg and 494 feet (151 meters) above mean sea level at the site (estimated). The largest recent flood occurred in November 1985 and had a flood state of 534 feet (163 meters) above mean sea level at Lynchburg (NRC 1986).

The Standard Project Flood determined by the U.S. Army Corps of Engineers for the James River would produce a discharge rate of 10,705 m³/s (378,000 cfs) and a flood state of 502 feet (153 meters) above mean sea level at the site (NRC 1986).

Because the elevation of the plant floors at the Lynchburg Research Center is 389 feet (180 meters) above mean sea level, which is 95 feet (29 meters) above the maximum historical flood state or 37 feet (26 meters) above the Standard Project Flood elevation, James River floods would not affect the research and development facility at the Lynchburg Research Center (NRC 1986).

Measurements in potable wells located in the river floodplain near the B&W Commercial Nuclear Fuel Plant in the northeast corner of the site indicate that the groundwater elevation ranges between 440 and 460 feet (134 and 140 meters) above mean sea level, which is 10 feet (3 meters) below surface elevation at the annual average flow rate. Because of the relative impermeability of the silt and clay soils, neither the water in surface soils nor river flood water has a major effect on the groundwater supply or quality. B&W obtains about 100,000 gallons per day (380 cubic meters per day) from the above-mentioned wells for drinking and industrial uses. An average of 19,300 gallons per day (73 cubic meters per day) is used at the Lynchburg Research Center. Continuous pumping tests on these wells indicates a plentiful supply of groundwater. Therefore, it is not likely that the performance at nearby residential wells would be affected by B&W's operations (NRC 1986).

3.3.3.8 Ecological Resources. Natural climax vegetation in the region is classified as oak-hickory-pine (Quercus-Carya-Pinus) forest. Dominants include white (Q. alba), post oak (Q. stellata), hickory (Carya spp.), shortleaf pine (P. echinata) and loblolly pine (P. taeda). Other common species include tulip poplar (Liriodendron tulipifera), sweetgum (Liquidambar styraciflua), dogwood (Cornus florida), and several other species of oak, hickory, and pine (NRC 1986).

The great diversity of plants and vegetative communities in the site vicinity provide a wide variety of habitats for wildlife. There are approximately 24 species of mammals, 160 species of birds, 19 species of reptiles, and 17 species of amphibians expected to occur in the Lynchburg area. Species in the vicinity of the site that are economically important include game mammals, e.g., white-tailed deer (Odocoileus virginianus) and black bear (Ursus americanus), otter (Lutra canadensis), red fox (Vulpes vulpes), and beaver (Castor canadensis); and mourning dove (Zenaida macroura) and several species of water fowl (NRC 1986).

The aquatic biota of the James River in the vicinity of the Lynchburg Research Center is generally characteristic of that of a moderately polluted river. Examination of photoplankton communities downstream of the site at Cartersville shows reasonably diverse communities consisting of green, yellow-green (diatoms) and blue-green algae during the late summer.
Phytoplankton communities during the fall, winter, and early summer consisted almost entirely of a few species of yellow-green algae (NRC 1986).

Most of the fish in the James River in the vicinity of the Lynchburg Research Center are primarily members of the minnow, sucker, sunfish, perch, and catfish families. Species in these families range from common to uncommon. There is no commercial fishery in the vicinity of the Lynchburg Research Center site (NRC 1986).

Federally and state-listed threatened and endangered animal species whose present or former geographic ranges include central Virginia and the B&W site are the bald eagle (*Haliaeetus leucocephalus*), American peregrine falcon (*Falco peregrinus*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Virginia big-eared bat (*Plecotus townsendii virginianus*), and eastern cougar (*Felis concolor cougar*). There have been no reports of these species being observed on the site or its vicinity (NRC 1986).

There are no species of rare or endangered fish or mollusks known to occur in the James River in the vicinity of the site (NRC 1986).

**3.3.3.9 Transportation.** The site is bounded on three sides by the James River and on the fourth side by Virginia State Route 726. The site is serviced by a spur of the CSX Railroad, which runs through the B&W property. The site is also conveniently located for truck and automobile access, because only about 2 miles (3.2 kilometers) from the plant, State Route 726 connects with U.S. Highway 460, a major link between Roanoke and Richmond (NRC 1986).

**3.3.3.10 Public Health and Safety.** The total-body dose rate for the vicinity of Lynchburg is approximately 107 millirem per year. This dose rate includes 43 millirem per year from cosmic rays, 45.6 millirem per year from terrestrial sources, and 18 millirem per year from internal emitters (NRC 1986).
4. ENVIRONMENTAL CONSEQUENCES OF SPENT NUCLEAR FUEL MANAGEMENT ACTIVITIES

This section presents the projected impacts of implementing the programmatic alternatives for management of SNF for which DOE has accepted present or future responsibility. The SNF management activities evaluated in this section only include those actions identified by the originating sites to be implemented should the No Action Alternative be adopted, as described in Section 2. SNF management activities planned independently of this EIS are addressed only if they are directly affected or altered as a result of the programmatic SNF alternatives considered in this EIS. Only Alternative 1, No Action, has any potential for affecting some of the facilities addressed in this Appendix. Thus only the environmental consequences of SNF management activities at originating sites under Alternative 1 will be discussed here. For the other DOE alternatives, the environmental consequences of SNF transportation from originating sites are analyzed in Appendix I to Volume 1. The environmental consequences at the DOE facilities that receive the SNF originating from any facilities in this Appendix are addressed in Appendices A, B, C and F.

4.1 No Action

4.1.1 DOE Experimental Reactors and Small-Quantity Storage

The DOE's reactors at the Brookhaven National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories would not be affected by the No Action Alternative through the year 2005. Between 2006 and 2035, however, implementation of this alternative might require modifications of SNF management activities at the reactor facilities.

4.1.1.1 Brookhaven National Laboratory. The High Flux Beam Reactor at the Brookhaven National Laboratory is planned to continue to operate for the foreseeable future. The presently planned installation of a storage rack in the existing wet storage facility, providing 162 additional storage locations, will be depleted in 1998. It is expected that the arrangement of the existing racks will be modified to provide additional storage capacity in the existing pool if SNF cannot be shipped at that time (Carelli 1993).

Fuel storage capacities at the Brookhaven National Laboratory High Flux Beam Reactor would be severely taxed if the No Action Alternative were selected. Selection of the No Action Alternative could result in the eventual shutdown of the High Flux Beam Reactor as a result of filling the existing SNF storage capacity. Implementation of the No Action Alternative would be expected to have no operational impact on the Brookhaven Medical Research Reactor (Carelli 1993).

There is no safety analysis or technical specification limit on the number of elements stored, so the proposed addition of a new storage rack should be accompanied by a new criticality analysis (DOE 1993c).

The fuel canal is unlined and there is no continuous and accurate way of measuring leak detection. However, alarms for high and low water level are in the control room and the water level is regularly monitored. Records are maintained for canal water additions, and thus any increased amounts of canal makeup water can be detected. The canal has been sealed against evaporation about every 5 years to measure leakage, and no leakage problems have ever been detected. Also, there are groundwater monitoring wells near the High Flux Beam Reactor that are sampled twice per year, and no significant amounts of radionuclides have ever been detected. No known damaged fuel is presently stored in the fuel canal (DOE 1993c).

The fuel canal water monitoring program is adequate to control corrosion and to minimize the release of fusion products. In addition, corrosion surveillance coupon samples have been photographed and evaluated yearly since stored in the canal in 1977. These photographs have shown no corrosion damage (DOE 1993c).

In view of the absence of any substantive difference in SNF management operations attributable to the No Action Alternative, effluent releases and their associated doses would be expected to be the same as those currently being experienced there.

Potential impacts on the Nassau/Suffolk Aquifer System as a result of SNF management alternatives described in this EIS are expected to be small. If the fuel canal were to leak, ground
water impacts would be expected, but monitoring measures would mitigate impacts by permitting early detection of leaks.

For the Brookhaven Medical Research Reactor, which has sufficient SNF storage capacity, the No Action Alternative would cause no environmental consequences—other than those that have already been addressed and accepted under the siting and operation approval process.

4.1.1.2 Los Alamos National Laboratory. The Omega West Reactor at Los Alamos National Laboratory is permanently shut down. It is being decommissioned. The SNF is in temporary storage at the Chemistry and Metallurgy Research complex. Although at present the stored fuel elements do not present a health or safety hazard, storage of fuel at the Chemistry and Metallurgy Research complex presents a potential radiological hazard at that facility. The Los Alamos National Laboratory does not have the capability to store, handle or monitor spent fuel for any extended length of time. The Rover casks contain no monitoring devices, and storage of spent fuel is not addressed in the current Chemistry and Metallurgy Research complex authorization. It is recommended that the fuel be relocated as soon as practical.

For the other Los Alamos National Laboratory facilities that have sufficient SNF storage capacity, the No Action Alternative would cause no environmental consequences—other than those that have already been addressed and accepted under the siting and operation approval process.

4.1.1.3 Sandia National Laboratories. Each of the reactors at Sandia National Laboratories is designed so that the uranium fuel source essentially lasts the designed life of the reactor. Consequently, none of the reactors require periodic refueling or discharge spent fuel. Therefore, the No Action Alternative would cause no environmental consequences—other than those that have already been addressed and accepted under the siting and operational approval process for these facilities at Sandia National Laboratories (DOE 1993d).

4.1.1.4 Argonne National Laboratory—East. Essentially all of the SNF at the Argonne National Laboratory site in Illinois is contained in the Alpha-Gamma Hot Cell Facility. The Alpha-Gamma Hot Cell Facility is an operating hot cell where fuel development programs have been conducted for 29 years. The SNF located there is a combination of material in process and the stored residues from past programs (DOE 1993d).

The condition of the stored SNF is generally good and would be an issue only if its physical and chemical state dictates that it must be treated before it will be acceptable at a long-term interim storage site or a final repository. Likewise, the physical condition of the facility is good, considering its 29-year age. The SNF is contained within the hot cell, which precludes its entry into the environment except under the most extremely low-probability events (DOE 1993d).

4.1.2 Domestic Research Reactors

In Section 2.2.1.2, it was noted that SNF storage facilities at 34 domestic research reactors would not be overloaded were the No Action Alternative (i.e., no off-site SNF transportation) to be implemented. For those sites, the adoption of the No Action Alternative would produce no incremental impacts on the environment.

This conclusion is supported by NRC determinations in a number of licensing actions related to requested increases in possession limits for U-235 in fuel at research reactor sites. In these licensing actions, the NRC has determined that there is no significant impact on the environment from normal operation or accidents associated with the increases in the possession limits for U-235 at those reactor sites. The possession or storage of fuel at the domestic research reactor sites is not considered by the NRC to be a significant activity as indicated by the following examples of their findings.

In 1993, the NRC performed a safety evaluation in response to the University of Missouri at Columbia request for a temporary increase in the license possession limit for U-235 from 45 to 60 kilograms. In regard to potential accidents the NRC determined: "There are no specific accidents in this type of research reactor associated with the storage of spent fuel in accordance with the Technical Specifications. The maximum hypothetical accident of complete fusion product release of four fuel plates in the reactor core is not affected by increasing the amount of stored fuel. Because the fuel will be stored in accordance with the Technical Specifications, accidents previously evaluated are not changed and no new or different kind of accident is
created. Therefore, the staff concludes that the temporary increase in the possession limit of U-235 is acceptable.

In regard to environmental considerations of this possession increase, the NRC stated: "The staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and there is no significant increase in individual or cumulative occupational radiation exposure. Accordingly, this amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no Environmental Impact Statement or Environmental Assessment need be prepared in connection with the issuance of this amendment." (NRC 1993b)

In 1991, in performing a safety evaluation in response to an earlier University of Missouri request for a temporary increase in the license possession limit for a larger amount of U-235 from 60 to 75 kilograms, the NRC reached the same determinations and conclusions as in the 1993 licensing action. (NRC 1991b)

In response to the request from the Massachusetts Institute of Technology request in 1991 to extend a temporary increase in the possession limit of U-235 of 41 kilograms until January 1, 1994, the NRC performed an evaluation and made identically the same determination as that quoted above for the University of Missouri license amendment. (NRC 1991d)

The NRC, in its Environmental Assessment for the Training and Research Reactor of the University of Lowell, stated: "Accidents ranging from the failure of experiments up to the largest core damage and fission product release considered possible result in doses that are less than 10 CFR Part 20 guidelines and are considered negligible with respect to the environment.... The staff concludes that there will be no significant environmental impact associated with the licensing of research reactors or critical facilities designed to operate at power levels of 2 MWt or lower and that no environmental impact statements are required to be written for the issuance of construction permits or operating licenses for such facilities." (NRC 1985b)

In the Environmental Impact Statement for the University of Texas, TRIGA Mark II reactor, it was stated: "Storage, processing and disposal of fuel elements is not considered a significant activity of this facility." (NRC 1984)

Of the 11 domestic research reactors that are projected to exhaust their storage capacity, a few facilities indicated that they might take measures to physically expand their SNF storage capacity within their existing structures beyond what had been planned. Only one facility has indicated that it might elect to create an 18.6-square-meter (200-square-foot) storage area outside the existing structure. An addition of this small size would be expected to have a minuscule impact on the previously disturbed environment.

A small number of these facilities could request deferral of their directed conversion from highly enriched uranium fuel to low enriched uranium fuel. The environmental consequences of such an action would derive from extending the risks of theft or diversion of highly enriched uranium fuel which the U.S. Government has tried to reduce by mandating the conversion (Jentz 1993).

An unidentified number of the research reactors may elect to discontinue operation at some time during the next 40 years. Storage of the SNF onsite at a reactor facility that is undergoing decommissioning would interfere with the radiological surveys conducted to ensure that the reactor site is returned to the pristine conditions that existed before the reactor was constructed.

The consequences of premature shutdown of any of these reactors, attributable to implementation of the No Action Alternative, would include the loss of service which the reactors were scheduled to provide. These consequences of implementing the No Action Alternative could include, for example:

- Loss of education and training for some nuclear engineers and scientists
- Loss of trace analysis capability supporting solar cell material research, monitoring of atmospheric pollutants, detection of trace metals in foods, and analysis of criminal artifacts
- Loss of specific materials research capability relating to hydrogen in met-tls, metglasses, amorphous magnetic materials, and biomolecular polymers
- Loss of specific nuclear medicine and radiation therapy.

Any changes in radioactive (or other) releases or exposures to the public or to workers would be inconsequential. More detailed analyses of radiation exposures and other impacts would be provided in site-specific NRC licensing documents before implementation of any changes in these facilities that were made necessary by an SNF transportation moratorium.

4.1.3 Nuclear Power Plant Spent Nuclear Fuel

4.1.3.1 West Valley Demonstration Project. It has been determined that continued use of the SNF storage pool in the Fuel Receiving & Storage building at the West Valley Demonstration Project is not a viable option for extended periods of time. Therefore, alternative concepts for storing West Valley Demonstration Project SNF are being evaluated by the Project. The options being considered at West Valley include dry storage, wet storage involving refurbishing of a portion of the existing spent fuel storage pool, and continued use of the present facility.

Dry storage is projected to require a maximum area of 0.003 square kilometer (0.72 acre) (i.e., a square plot of land about 54 meters [177 feet] on each side). This area would include the actual storage facility, approach pads, and perimeter fence. The largest base pad required for any of the dry storage concepts would measure 9.1 by 15.2 meters (30 by 50 feet) and be between 0.61 and 1.22 meters (2 and 4 feet) thick (WVDP 1993).

The wet storage concept and No Action Alternative assume the continued use (either modified or as is) of the existing spent fuel storage pool. These options should have no measurable impact on the West Valley Demonstration Project site. The actions taken to transfer the spent fuel from the storage pool to the on-site dry storage facilities would not differ from those taken to transfer this SNF to the INEL or any other DOE facility. Therefore, there would be no additional environmental impact resulting from these fuel transfer activities.

4.1.3.2 Fort St. Vrain. The Fort St. Vrain facility has already constructed an Independent Spent Fuel Storage Installation for interim storage (with a 40 year design basis) of the SNF from the Fort St. Vrain site. Onsite storage will have no additional impact on the Fort St. Vrain site (FSV 1990a). However, under this alternative, Public Service Company of Colorado would not achieve its goal of becoming free of radioactive materials by 1998 under this option.

Potential impacts on the Cattaraugus Creek Basin Aquifer System as a result of SNF Management alternatives described in this EIS are expected to be small.

Keeping the SNF in dry storage on-site would result in both on-site and off-site exposures that would not occur if the fuel were shipped off-site once it was removed from the storage pool. Storing the fuel dry in sealed containers would not result in the production of radioactive liquid or gaseous effluents or solid radioactive wastes. The source of the on-site and off-site radiation doses is direct radiation from the dry spent fuel storage facility. Estimates have not yet been developed for these doses, because a storage concept has not been selected.

The 125 fuel assemblies in the Fuel Receiving and Storage Facility have been in storage for over 20 years. Their total heat generation rate is less than 9 kilowatt and fission product inventory should have reached a near steady state condition. Conservative calculations in safety analysis report estimate that failure of all 125 fuel assemblies would result in an off-site dose of 42 mrem and an on-site dose of 2.1 rem (DOE 1993c).

Doses and solid waste generation volumes resulting from implementation of the No Action Alternative would remain the same as the current operation at the West Valley Demonstration Project. The calculated annual effective dose equivalent resulting from the total site operations including wet storage of SNF at the West Valley Demonstration Project are as follows: (WVNS 1994)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum individual off-site dose from</td>
<td>1.6 x 10^4 mrem/year</td>
</tr>
<tr>
<td>gaseous releases</td>
<td></td>
</tr>
<tr>
<td>Maximum individual off-site dose from</td>
<td>1.1 x 10^2 mrem/year</td>
</tr>
<tr>
<td>liquid releases</td>
<td></td>
</tr>
</tbody>
</table>

4-7 VOLUME 1, APPENDIX E
4.1.3 B&W Lynchburg Technology Center. The Lynchburg Technology Center received the SNF between 1980 and 1987 as part of a "high-burnup" research program sponsored by the DOE Office of Nuclear Energy. The experiments were completed in 1989 and the program was officially terminated in 1992. Since that time, the Lynchburg Technology Center has stored this fuel under contract to DOE (DOE 1993c).

The DOE-owned spent fuel rods that are stored in the spent fuel storage pool are intact and in good condition. Water quality is also good and is maintained by passing through particulate filters and resin beds. No chemistry controls have been needed. In addition, sludge is not present in the pool and biological contamination has not been observed (DOE 1993c).

There are no routine inspections of the condition of spent fuel rods that have been sectioned and placed in dry storage. However, some of the fuel stored in this facility was recently repackaged and moved; this fuel and its containers are known to be in good condition. Other evidence that the integrity of spent fuel storage containers has been maintained in good condition is routine monitoring of groundwater, direct radiation, and smearable contamination, all of which indicate that leakage of radionuclides is not occurring (DOE 1993c).

Groundwater and other radionuclide monitoring have not indicated any radionuclide releases from the SNF storage facilities at the B&W Lynchburg Technical Center. There is currently no reason to suspect that spent fuel storage containers will degrade in the near term in a manner that would result in a release of fission products. This facility is routinely inspected and relicensed by the NRC every 5 years. Hence, any developing storage problems would most likely be dealt with and corrected under the direction of the NRC (DOE 1993c).

4.2 Decentralization

The Decentralization Alternative is similar to the No Action Alternative except that limited off-site shipments would occur from university and domestic non-DOE research reactors. Impacts of transportation are described in Appendix I to Volume 1. Some DOE facilities would be upgraded/replaced and additional on-site storage capacity would be required at several DOE facilities. Essentially, there are no differences from the No Action Alternative, except impacts from transportation, facility upgrade, and new construction.

At Brookhaven National Laboratory High Flux Beam Reactor, some land disturbance might be anticipated from the installation of additional SNF storage capacity, whether wet or dry. However, any such disturbance is expected to occur in previously disturbed on-site areas.

4.3 1992/1993 Planning Basis

The 1992/1993 Planning Basis Alternative would permit the shipment of the SNF currently in storage or being generated at the originating sites. With the implementation of the 1993/93 Planning Basis Alternative, as in past practice, SNF would continue to be shipped from the originating sites to a DOE receiving site. The 1992/1993 Planning Basis Alternative would be expected to have essentially no incremental impact on the originating sites. Impacts of transportation are described in detail in Appendix I to Volume 1. The alternative of transporting SNF by barge from Brookhaven National Laboratory is also described in Appendix I to Volume 1.

4.4 Regionalization

The Regionalization Alternative would be the same as the 1992/1993 Planning Basis Alternative, except for the difference in destinations. Implementation of the Regionalization Alternative would permit the shipment of SNF from originating sites to regional DOE interim storage facilities. The Regionalization Alternative would be expected to have essentially no incremental impact on the originating sites. Impacts of transportation are described in detail in Appendix I to Volume 1.

4.5 Centralization

The Centralization Alternative would be the same as the 1992/1993 Planning Basis Alternative, except for the difference in destinations. Implementation of the Centralization Alternative would permit the shipment of SNF from originating sites to a central DOE interim
storage facility. The Centralization Alternative would be expected to have essentially no incremental impact on the originating sites. Impacts of transportation are described in detail in Appendix I to Volume 1.

5.0 CUMULATIVE IMPACTS

This section describes the cumulative environmental impacts of the alternatives for generating and storing SNF at the originating sites addressed in this Appendix. The emphasis is on DOE SNF Alternative I, No Action, under which all SNF would remain at the originating facility. For the individual originating facilities, the cumulative impact is defined as the sum of the incremental impacts of SNF management under the No Action Alternative and the impacts of the other operations at the facility's reactor(s) or other activities involving radioactive materials. For the other alternatives, the SNF cumulative impact at the originating facilities essentially would end with the removal of the SNF from the site. The cumulative impacts of intersite SNF transportation alternatives on transportation routes and affected communities are analyzed programmatically in Volume 1, Appendix I. The cumulative impacts at the DOE facilities receiving SNF are addressed in Appendices A, B, C and F.

5.1 DOE Test and Experimental Reactors

Under the No Action Alternative, the cumulative environmental impacts at DOE test and experimental reactors are derived from past environmental impacts as obtained from annual operating reports, and estimated future impacts based on extrapolation to the year 2035 of past impacts.

5.1.1 Brookhaven National Laboratory

It is expected that the High Flux Beam Reactor and Brookhaven Medical Research Reactor would continue to operate for all SNF management alternatives except No Action. If additional storage were to be required on-site to accommodate High Flux Beam Reactor SNF through 2035, current impacts would be somewhat increased by the impacts of building and operating an additional facility. Although the nature of that facility has not been determined, the resulting impacts are expected to be negligibly small. Should the facility propose substantial changes, appropriate NEPA documentation would be prepared in accordance with existing environmental regulations.
5.1.2 Los Alamos National Laboratory

Omega West Reactor at the Los Alamos National Laboratory is permanently shut down and is being decommissioned. The spent fuel is in temporary dry storage at the Chemistry and Metallurgy Research complex, and resulting impacts are negligible. The spent fuel is awaiting relocation. Cumulative impacts would not change under any alternative.

5.1.3 Sandia National Laboratories

The cumulative environmental impacts would not change from those currently experienced at Sandia National Laboratories from the operation of the reactors and storage of small quantities of SNF.

5.1.4 Argonne National Laboratory - East

The cumulative environmental impacts would not change from those currently experienced from the storage of small quantities of SNF.

5.2 Domestic Research Reactors

Under the No Action Alternative, the cumulative environmental impacts at domestic research reactors are a composite of past environmental impacts as obtained from annual operating reports, and estimated future impacts based on extrapolation to the year 2035 of past impacts. The following facility-specific cumulative environmental impacts have been selected as representative of all domestic research reactor facilities that could be affected by Alternative 1.

5.2.1 National Institute of Standards and Technology

Implementation of the No Action Alternative would result in the shutdown of the National Bureau of Standards Reactor in October 1996 due to the inability to store additional SNF. The environmental radiological impact of such action would be a reduction of radioactive releases and doses below those of full power operation. On-site SNF storage would meet existing facility design criteria. There would be no other change in the cumulative environmental impact except for the adverse socioeconomic impacts as a result of the loss of services and knowledge from reactor operations.

A scenario of continued operation, assuming timely reissuance of the operating license, including compliance with the National Environmental Policy Act, would bound the cumulative environmental impacts under any of the DOE-postulated SNF alternatives.

5.2.2 Massachusetts Institute of Technology

As with the National Institute of Standards and Technology, the Massachusetts Institute of Technology research reactor would be expected to shut down in response to the No Action Alternative because of limited SNF storage capacity. Thus, a scenario of continued operation, assuming timely reissuance of the operating license, would bound the cumulative environmental impacts under any of the DOE-postulated SNF alternatives.

5.2.3 Conclusion

For all domestic research reactors, the SNF management alternatives, including the No Action Alternative, would not increase the cumulative impacts of the originating sites above current values. Some of the facilities could not be able to continue normal operation under the No Action Alternative and could be forced to shut down due to the lack of SNF storage capacity. Reactors licensed by the U.S. Nuclear Regulatory Commission are not under DOE control, and additional storage space could be constructed under the No Action Alternative. However, except for the negative socioeconomic impacts attributable to the loss of services and knowledge resulting from such shutdowns, other site-specific cumulative impacts would not be increased.

5.3 Nuclear Power Plant Spent Nuclear Fuel

The implementation of any one of DOE's five SNF management alternatives would have no additional environmental consequences beyond those already evaluated for the Fort St. Vrain and B&W Lynchburg facilities.
The situation is similar for the West Valley Demonstration Project, except that the DOE has entered into an agreement with the New York State Energy Research and Development Authority which calls for the removal of SNF from the West Valley Demonstration Project. Implementation of the No Action and Decentralization Alternatives would result in SNF remaining at the West Valley Demonstration Project. If the fuel remains at the West Valley Demonstration Project, the SNF may be managed in a new dry storage facility. Once the SNF is in dry storage, there will be no releases of radioactive effluents and an indistinguishable direct radiation exposure to the environs in excess of that which would occur were the SNF to be moved as scheduled, and in the payment of storage costs by DOE to the State of New York.

6.0 ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED

Unavoidable adverse impacts addressed here are limited to those occurring as a result of DOE Alternative 1 (No Action) at the originating facilities discussed in this Appendix. All other alternatives consider normal shipment of SNF from the originating site, with only transportation routes and the receiving site possibly being subjected to unavoidable adverse impacts by transferred SNF. Any adverse impacts at the originating sites are thus precluded for all SNF transportation alternatives. Possible unavoidable adverse impacts on transportation routes are analyzed in Volume I, Appendix I. Possible unavoidable adverse impacts at the DOE facilities that receive SNF are addressed in Appendices A, B, C and F.

6.1 DOE Test and Experimental Reactors

The adverse effects that may be unavoidable caused by implementation of the No Action Alternative would be associated with the possible premature, long-term shutdown of the High Flux Beam Reactor at Brookhaven National Laboratory. The consequences of this shutdown would be cessation of site specific activities involving unique experiments. These experiments are needed for understanding material structures, biological processes, and the behavior of superconducting materials. Shutdown would also cause the loss of jobs associated with these experiments and supporting site activities.

6.2 Domestic Research Reactors

The adverse effects that may be unavoidable at domestic research reactors caused by implementation of the No Action Alternative would be associated with the possible premature, long-term shutdown of several reactors. The consequences of these shutdowns, discussed in Section 4.1.2, would be cessation of site-specific research and education activities and could result in the loss of jobs associated with these activities at these sites.
6.3 Nuclear Power Plant Spent Nuclear Fuel

Implementation of the No Action Alternative could result in adverse consequences that may be unavoidable at West Valley Demonstration Project. Should this alternative be selected, the adverse impact that may be unavoidable would be continued on-site and off-site radiation exposures beyond the scheduled fuel removal date as a result of radioactive effluents and/or direct radiation.

Since the Public Services Company of Colorado has already responded to the No Action Alternative by licensing and constructing an independent spent nuclear fuel storage installation at its Fort St. Vrain site, no additional consequences or additional adverse consequences would be incurred there.

7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The assessment of the activities undertaken at the SNF originating sites as a consequence of the implementation of all alternatives indicates that only minor irreversible and irretrievable commitments of resources would be required.

7.1 DOE Test and Experimental Reactors

If the Decentralization Alternative were to be implemented, the Brookhaven National Laboratory would expect to be required to identify some way to store the SNF generated by the High Flux Beam Reactor through the year 2035. Several scenarios are possible, but none has been decided upon at this time. One possible SNF management scenario is to install additional storage accommodations. Limited quantities of construction materials and fuel for construction equipment would be required if this scenario were selected.

Implementation of the No Action Alternative would not result in any irreversible and irretrievable commitments at the Los Alamos National Laboratory, Sandia National Laboratories or Argonne National Laboratory - East.

Implementation of any of the other proposed alternatives for SNF would not result in any additional irreversible and irretrievable commitments of resources at the DOE test and experimental reactors.

7.2 Domestic Research Reactors

There are no substantial new irreversible and irretrievable commitments of resources at the domestic research reactors with the implementation of any of the proposed SNF alternatives for generating and storing SNF. If, under the No Action Alternative, any NRC-licensed facility should elect to modify its SNF storage capabilities, a site-specific license amendment would be required. If the storage facilities were expanded, there would be a commitment of construction...
materials and fuel to operate construction equipment. The other DOE SNF alternatives would involve no commitment of resources at domestic research reactor facilities.

7.3 Nuclear Power Plant Spent Nuclear Fuel

Implementation of the Decentralization Alternative could result in irreversible and irretrievable commitments of resources at the West Valley Demonstration Project site. Should this alternative be selected, this commitment of resources would result from the construction materials and fuels used to provide alternative on-site SNF storage capability. The magnitude of these commitments cannot be quantified, however, until it is determined whether existing SNF storage capacity would be modified or a new SNF storage facility would be constructed and its type.

Implementation of any of the other proposed alternatives for SNF would not result in any additional irreversible and irretrievable commitments of resources at the commercial SNF storage facilities.

References


DOC (U.S Department of Commerce). 1991a, Region and County Projections, November.


FSV (Fort St. Vrain) 1990a, ISFSI (Independent Spent Fuel Storage Installation) Safety Analysis Report, Revision 0, Fort St. Vrain, Denver, Colorado, June 22, pp. 1.1-1 to 1.1-5; 1.2-1 to 1.2-2; 1.3-3; 2.1-1 to 2.1-2; 4.2-1; 4.2-5; 4.2-9; 5.1-1; 5.3-1; 5.4-1; 7.4-1 to 7.4-2; 7.5-1 to 7.5-2.

FSV (Fort St. Vrain) 1990b, ISFSI (Independent Spent Fuel Storage Installation) Environmental Report, Revision 0, Fort St. Vrain, Denver, Colorado, June 22, pp. 1.1-1; 1.2-1; 2.1-1; 6.1-1 to 6.1-2; 9.1-1 to 9.1-3; 9.2-1.


Jentz, T.L., 1993, Domestic Research Reactor Responses to Spent Nuclear Fuel Disposition Questionnaire, 2Y99-SNF-008, Halliburton NUS Corporation, Gaithersburg, Maryland.

Keller, 1979, Environmental Geology 2d ed, Columbus, Ohio: Charles E. Merrill Publishing Company.


LANL (Los Alamos National Laboratory), 1990, Environmental Surveillance at Los Alamos during 1989, Environmental Protection Group, Los Alamos, New Mexico, December, pp. 21-29.


LANL (Los Alamos National Laboratory), 1988, Environmental Surveillance at Los Alamos during 1987, Environmental Protection Group, Los Alamos, New Mexico, April, pp. 17-24.


Neimark, L., 1995, Argonne National Laboratory, personal communication with T. Jentz, Halliburton NUS Corporation, Gaithersburg, Maryland, regarding "Number of Personnel Involved with SNF," March 3.

New York State Department of Environmental Conservation, 1993, Division of Air Resources, New York State Air Quality Report Ambient Air Monitoring System. DAR-93-1.


State of Illinois Rules and Regulations 1992. "Title 35: Environmental Protection; Subtitle B: Air Pollution; Chapter 1: Pollution Control Board; Subchapter I: Air Quality Standards; Subpart B: Standards and Measurements", July.

SNL (Sandia National Laboratory), 1994, Medical Isotope Production Program, NEPA ID. Number: SNA-94-047, November.


UMC (University of Missouri/Columbia), 1965, University of Missouri Research Reactor Facility Hazards Summary Report, University of Missouri, Columbia, Missouri, July.


