3. COMMERCIAL LIGHT WATER REACTOR PROGRAM ALTERNATIVES

Chapter 3 describes the physical process used to produce tritium in a commercial light water reactor, the proposed action, the planning assumptions and basis for the environmental impact analysis, and the development of reasonable alternatives. The chapter also describes each of the candidate commercial light water reactors, explains the No Action Alternative and the Preferred Alternative, and summarizes the environmental impacts associated with the alternatives.

3.1 PRODUCTION OF TRITIUM IN A COMMERCIAL LIGHT WATER REACTOR

A commercial light water reactor (CLWR) is a nuclear reactor designed and constructed to produce electric power for commercial sale. As discussed in Section 1.3.4, tritium can be produced during the normal operation of a CLWR. The process uses tritium-producing burnable absorber rods (TPBARs), which are specially fabricated rods that replace standard burnable absorber rods in the reactor core. Burnable absorber rods absorb excess neutrons and help control the power in a reactor to ensure an even distribution of heat and extend the reactor's fuel cycle. Tritium is produced when the TPBAR is exposed to radiation during the normal operation of the CLWR.

This section provides a general description of the process of producing tritium using a CLWR. It includes: (1) a brief description of the normal process of generating electric power in a typical CLWR plant; (2) a description of the TPBARs that are inserted in the reactor and the standard burnable absorber rods that they replace; and (3) a summary of the operational differences this replacement introduces—differences that would give rise to environmental impacts in addition to those associated with the normal operation of the reactor. A more detailed description of the process of producing tritium in a CLWR and some background information on the operation of CLWRs in a tritium-producing mode are included in Appendix A.

3.1.1 Generation of Electric Power in Nuclear Power Plants

Nuclear, coal-fueled, and oil-fueled power plants all generate electricity by heating water to create steam, which is used to turn a turbine that powers a generator. The principal difference between nuclear and fossil-fueled power plants is that, instead of using a boiler to heat water for steam, a nuclear power plant heats the water with heat generated in the core of the reactor during nuclear fission.

Nuclear fission is the process of splitting fissionable atoms. When an atom is forced to split, energy is released. Some of this energy is converted to heat. In a nuclear reactor, certain types of uranium atoms are made to fission, or split, and release heat. The amount of heat generated (the power) is controlled by two types of control rods, movable and fixed. The movable control rods are used to start or stop the reactor. The fixed control rods, also called burnable absorber rods, ensure an even distribution of heat and extend the fuel cycle. The term "burnable" in this context means "capable of being consumed," rather than "flammable," the conventional definition.

Water is pumped through the reactor core to carry away the heat produced by the nuclear fission. Power reactors in the United States are called light water reactors because they are cooled by ordinary or "light" water. There are two types of light water reactors—boiling water reactors and pressurized water reactors. In boiling water reactors, the water boils to steam in the reactor vessel and goes directly to the turbine.

In pressurized water reactors, the water is pressurized to prevent it from boiling. The pressurized water (the primary coolant) is heated as it passes through the pressurized core. Next, the pressurized water is pumped to a steam generator where it passes through tubes (heat exchangers) and heats water in a "secondary" system. When this secondary water boils, steam is created. The steam then passes through the turbine, which powers the generator and produces electricity. With both types of reactor plants, the steam, after passing through the turbine, is cooled and condensed by another water system, which is usually supplied from a lake, river, or ocean. See **Figure 3–1** for a schematic drawing of a typical pressurized water reactor.

Light water reactor fuel consists of pellets of uranium dioxide stacked in approximately 12-foot long tubes called fuel rods. Fuel rods are grouped together as fuel assemblies, where they are held side-by-side at fixed distances by metal grids. Although power reactor fuel assemblies differ somewhat, depending on the design of the reactor, a typical fuel assembly for a pressurized water reactor contains 289 positions: 264 fuel rod and 25 nonfuel rod positions in a 17 x 17 array. The nonfuel positions are used for moveable control rods, instrumentation, neutron source rods, or burnable absorber rods. Pressurized water reactors are suited for the production of tritium because the TPBARs can be inserted into the nonfuel positions of the fuel assemblies to replace standard burnable absorber rods. For this reason, only pressurized water reactors have been considered for the production of tritium in CLWRs. **Figure 3–2** shows cross-sections of a fuel assembly.

3.1.2 Description of Tritium-Producing Burnable Absorber Rods

To produce tritium in a CLWR, TPBARs would be inserted into the reactor core. The TPBARs are long, thin tubes that contain lithium-6, a material that produces tritium when it is exposed to neutrons in the reactor core. The exterior dimensions of the TPBARs are similar to the burnable absorber rods (see **Table 3–1**), so that they can be installed in fuel assemblies where burnable absorber rods are normally placed. To ease the insertion and removal from fuel assemblies, the TPBARs would be attached to a base plate. See **Figures 3–3** and **3–4** for a sketch of a typical TPBAR assembly and components. In addition to producing tritium, TPBARs would fill the same role as burnable absorber rods in the operation of the reactor.

The neutron absorber material in the TPBARs would be enriched in the isotope lithium-6, instead of the boron usually used in the burnable absorber rods. When the TPBARs are inserted into the reactor core, neutrons would be absorbed by the lithium-6 isotope, thereby initiating a nuclear process that would turn it into lithium-7. The new isotope would then split to form helium 4 and tritium (see Appendix A for a more detailed discussion of this process). The tritium then would be captured in a solid metal nickel-plated zirconium material in the TPBAR called a "getter." The tritium would be chemically bound in the TPBAR "getter" until the TPBAR is removed from the reactor during refueling and transported to the proposed Tritium Extraction Facility at the U.S. Department of Energy's (DOE) Savannah River Site in South Carolina. There the tritium would be extracted by heating the TPBARs in a vacuum to temperatures in excess of 1,000°C (1,800°F). Following extraction, the tritium would be purified. More details on the design of the TPBARs are included in Appendix A.

The current DOE TPBAR design is based on the numerous studies and tests performed for an original design to be used in Washington Nuclear Plant Unit 1, a Babcock and Wilcox (now Framatome Technologies, Inc.) reactor design, as part of new production reactor efforts in the early 1990s. The characteristics of a TPBAR design, as shown in Table 3–1, show that TPBAR assemblies can be used in either a Westinghouse (Watts Bar or Sequoyah) or a Babcock and Wilcox (Bellefonte) reactor design. The TPBARs, as currently designed, are being irradiated at the Watts Bar Nuclear Plant. The final TPBAR design has been completed and is being reviewed by the U.S. Nuclear Regulatory Commission (NRC) (63 FR 43732). The analyses of environmental impacts presented in this Environmental Impact Statement (EIS) are based on design parameters for tritium production and a maximum leakage rate of tritium for each TPBAR. These parameters are independent of the type of reactor design used.

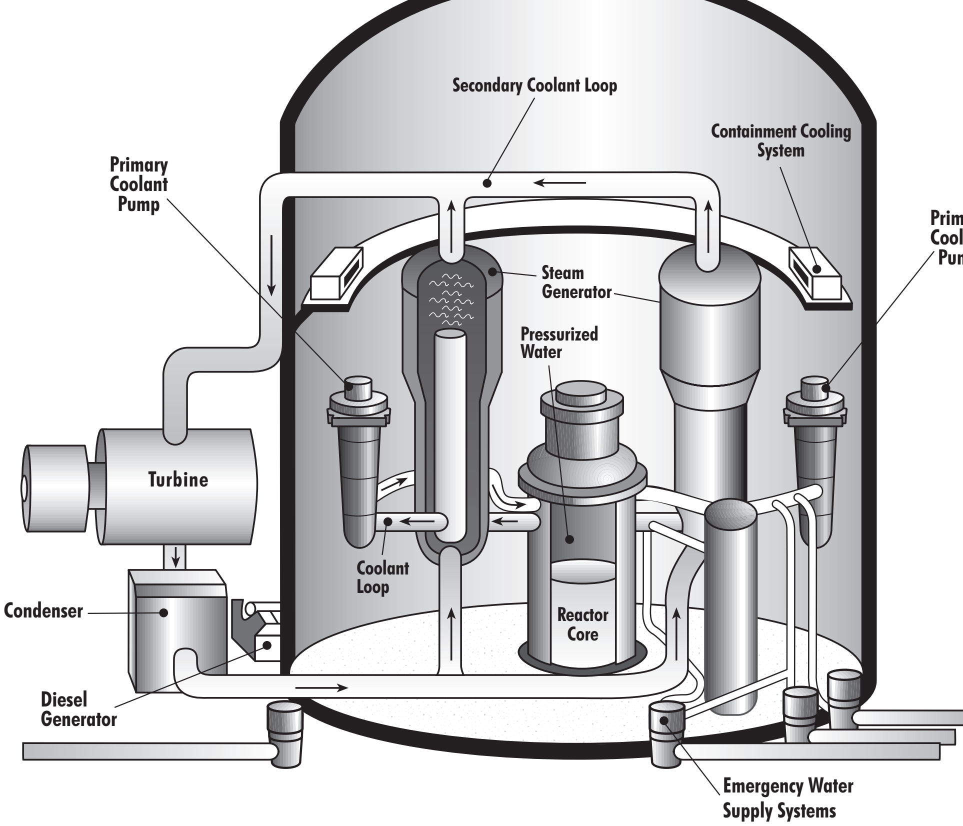

Figure 3–1 Typical Pressurized Water Reactor Schematic

The complete process of producing tritium in a CLWR can be explained in the following way. Nuclear reactors require periodic refueling. In a tritium-producing CLWR, spent fuel would be removed during periodic reactor refueling, and fresh fuel assemblies and TPBARs would be inserted in the reactor core. These new TPBARs would be transported from the TPBAR fabrication facility to the reactor site inside fresh fuel assemblies as part of the regular fresh fuel supply. During the reactor's normal operations cycle (approximately 18 months), the TPBARs would be irradiated, and the tritium generated would be chemically bound in the tritium "getter." During the subsequent refueling period, the fuel assemblies containing the TPBARs would be removed from the reactor core and transferred to the spent fuel pool, where the irradiated TPBAR assemblies would be removed from the fuel assemblies. After removal from the fuel assemblies, the TPBARs would be mechanically separated from the hold-down assembly (see Figure 3–3) and placed in a 12-foot long consolidation container. The consolidation container, which in cross-section resembles the 17 × 17 array matrix of the fuel assembly, provides 289 positions for individual TPBARs. The consolidation container with the 289 TPBARs, separated from their hold-down assemblies, would be placed in a shipping cask, sealed, placed on a truck or train, and transported to the proposed Tritium Extraction Facility at the Savannah River Site. The tritium would be extracted in a high-temperature heating/vacuum process. The base plates and any other low-level radioactive waste attributed to tritium production would be placed in a different transportation package and transported to the Barnwell disposal facility for commercial low-level

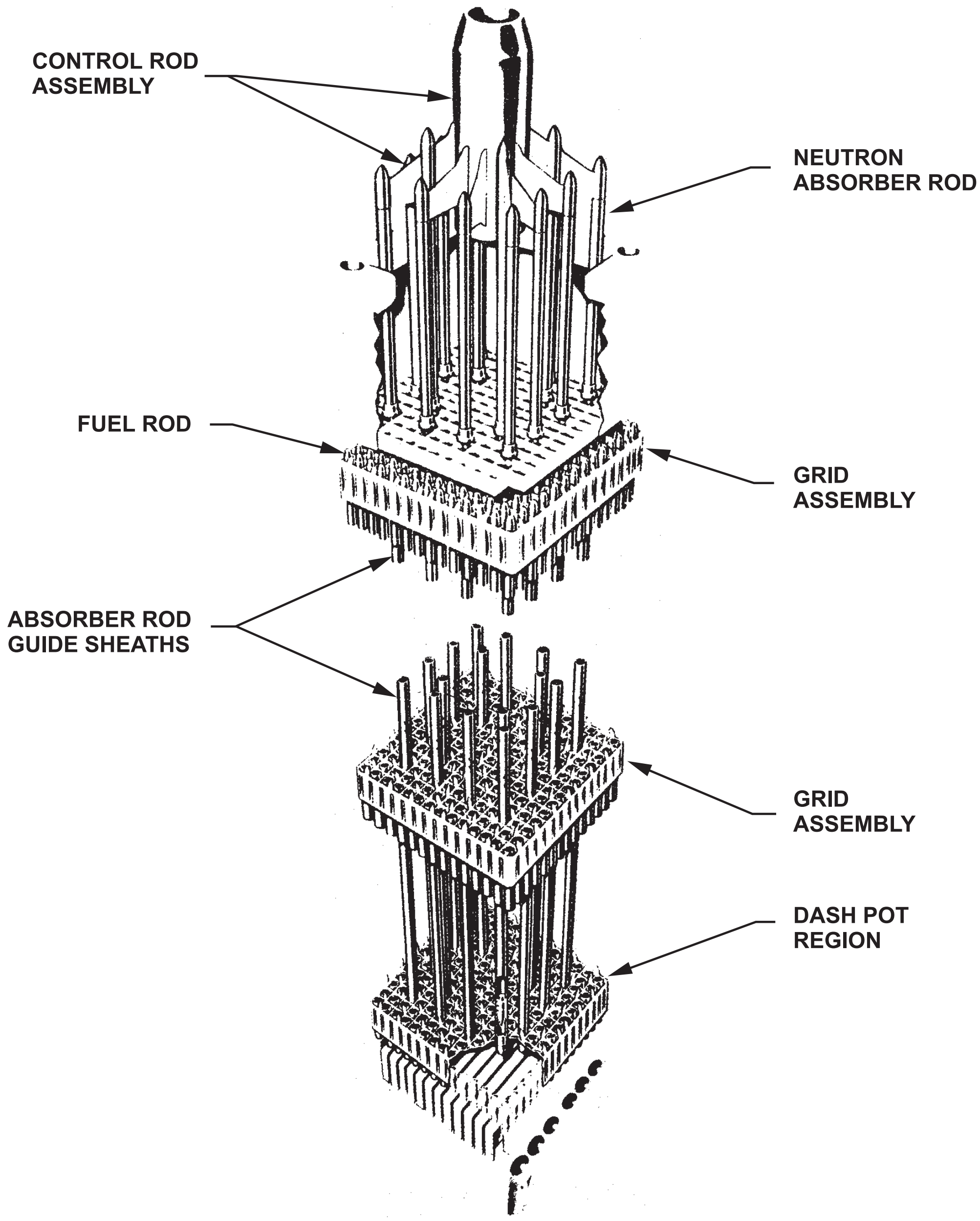

Figure 3–2 Typical Fuel Assembly Cross-Sections

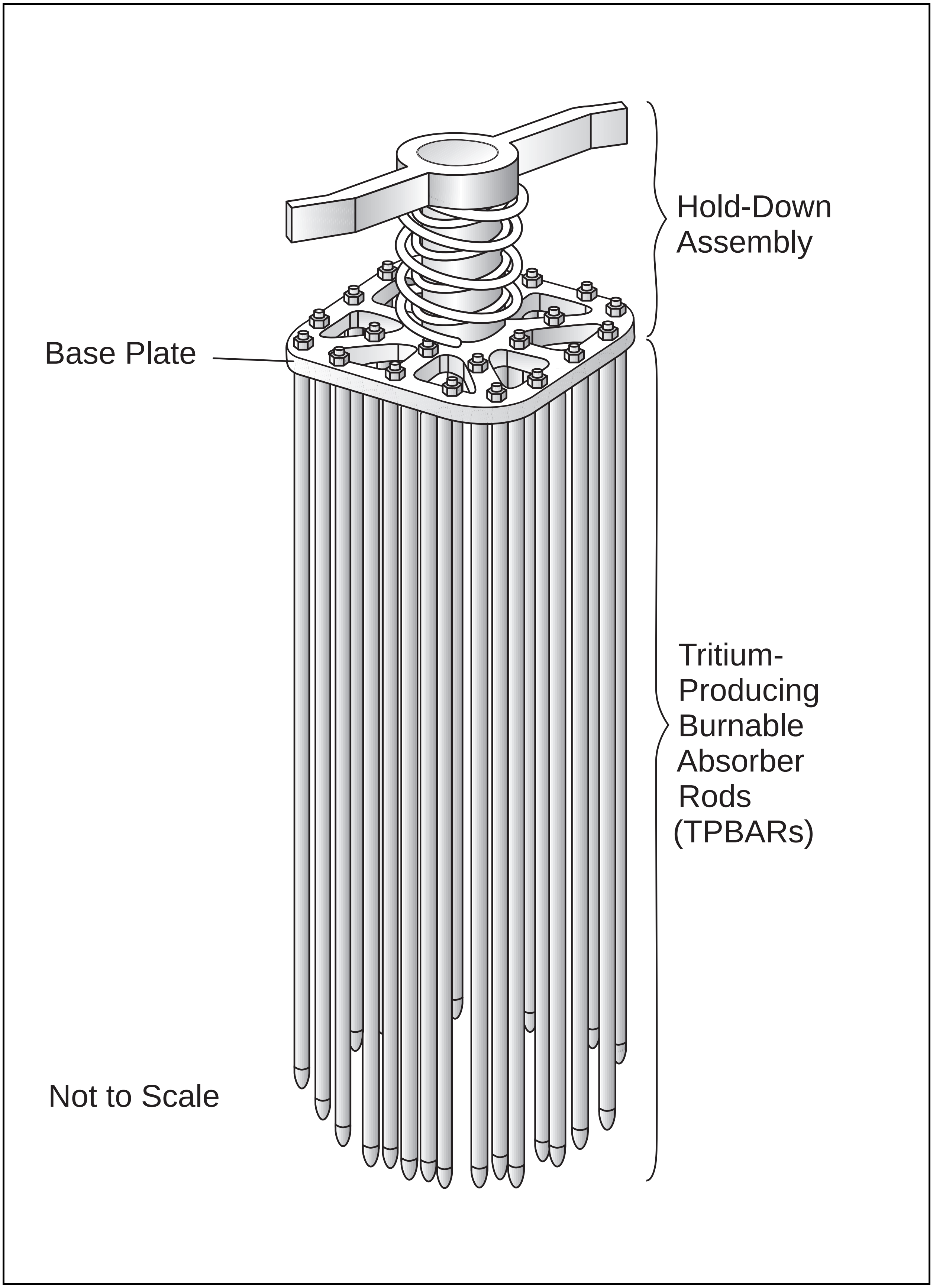

Figure 3–3 Typical TPBAR Assembly

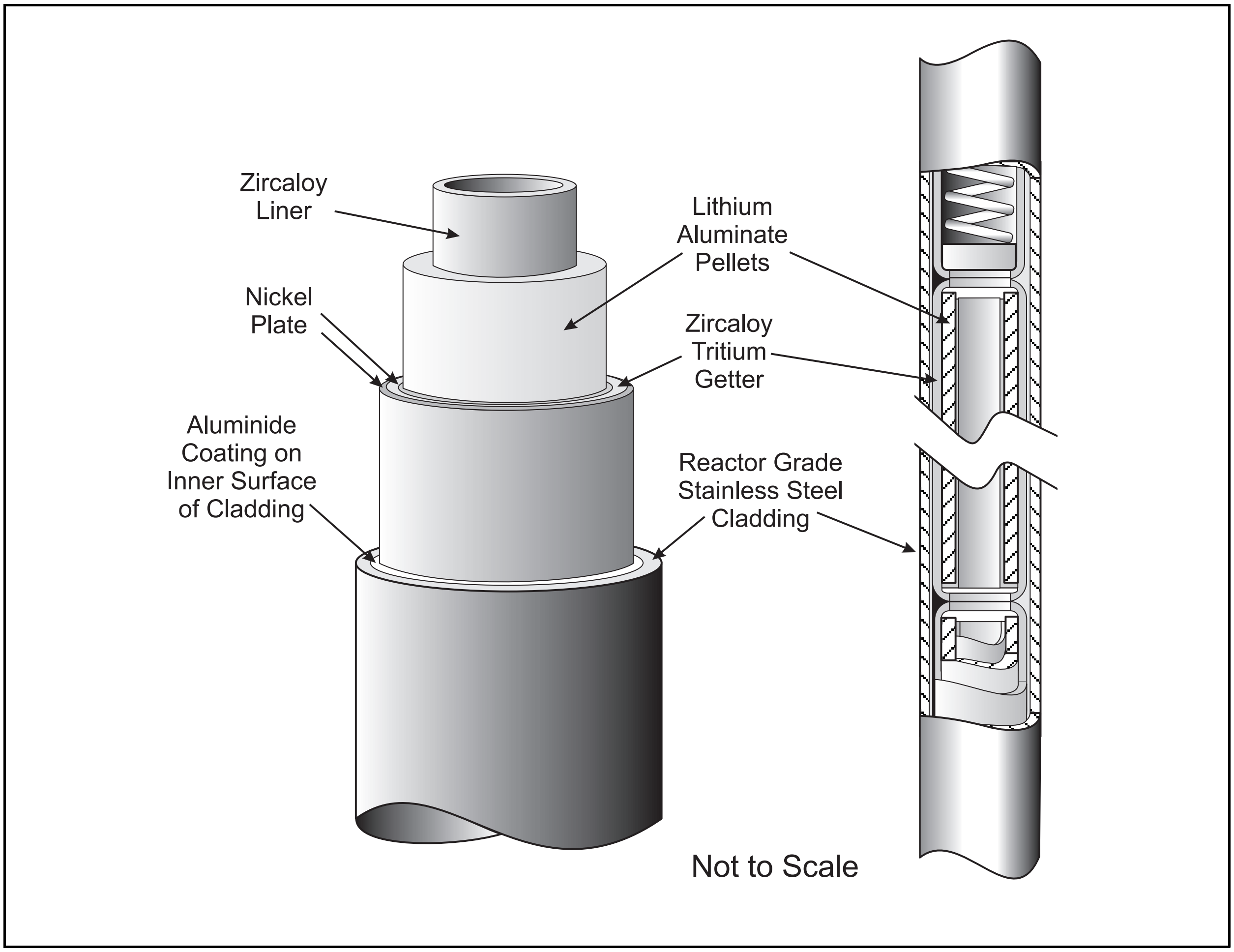

Figure 3–4 Sketch of TPBAR Components

radioactive waste or the Savannah River Site's low-level radioactive waste facility, both in South Carolina. The cycle from TPBAR fabrication and assembly through reactor irradiation and shipment to the Savannah River Site's proposed Tritium Extraction Facility is depicted in Figure 1–1.

Table 3–1 Comparison of TPBAR with Typical Burnable Absorber Rod Characteristics

Parameter	*Burnable Absorber Rod 17×17 Fuel Assembly*	*TPBAR 17×17 Fuel Assembly*
Overall length (inches)	152	152
Total weight (pounds)	1.8	2.26
Absorber length (inches)	142	~142
Absorber outside diameter (inches) Thickness (inches)	[ ][a] [ ][a]	0.303 0.040
Absorber material	Silicon-boron oxides (SiO_2-B_2O_3)	Lithium aluminate ($LiAlO_2$)
Outer cladding outside diameter (inches)	0.381	0.381
Cladding material	Stainless steel type 304SS	Stainless steel type 316SS

[a] Denotes proprietary data of burnable absorber rod vendor.
Source: PNNL 1997a.

3.1.3 Impacts of Tritium Production on Reactor Operations

The replacement of burnable absorber rods with TPBARs should have few impacts on the normal operation of the reactor. The normal power distribution within the core and reactor coolant flow and its distribution within the core would remain within existing technical specification limits. Some tritium is expected to permeate through the TPBARs during normal operation, which would increase the quantity of tritium in the reactor's coolant water system. Since tritium is a type, or isotope, of the hydrogen atom, once the tritium is in the reactor's coolant water system, it could combine with oxygen to become part of a water molecule and could eventually be released to the environment.

The operational differences between a tritium production reactor and a nuclear power plant without tritium production were determined by evaluating each environmental resource area and identifying the operational parameters that would change in a typical CLWR as a result of operating in a tritium production mode. The summarized operational differences are:

- Accident conditions—The physical changes to the reactor core would involve replacing some burnable absorber rods with TPBARs. This change would increase the estimated quantity of radionuclides assumed to be released in the analysis.

- Personnel—Additional TPBAR handling and shipping activities would create new jobs and possibly require the hiring of extra personnel at the CLWR sites.

- Effluent—The tritium content in the liquid effluent and gaseous emissions is expected to increase as a result of the presence of TPBARs in the reactor.

- Waste—Additional activities associated with handling, processing, and shipping TPBAR assemblies are expected to increase low-level radioactive waste generation rates.

- Spent fuel—Additional spent fuel could be generated when a reactor operates in a tritium-producing mode. Depending on existing spent fuel capacity, additional storage for spent fuel could be required.

- Public and worker exposure—The increased levels of tritium in the reactor coolant and the additional activities required in the handling and processing of TPBARs would result in increased radiation exposure for the public, operations workers, and maintenance personnel.

- Transportation and handling—Irradiated TPBAR assemblies would be packaged and transported from the CLWR sites to the Savannah River Site for tritium extraction and purification. Some additional risks of an accident en route would be expected. In addition, low-level radioactive waste associated with the TPBARs would be packaged and transported for disposal at the Barnwell disposal facility or the Savannah River Site.

The environmental impacts associated with these operational differences are evaluated in Chapter 5 of the CLWR EIS as they affect each environmental resource area (e.g., land resources, air resources, water resources, socioeconomics). In addition, this EIS evaluates the environmental impacts associated with any construction necessary to complete the currently unfinished Bellefonte 1 and 2.

3.2 DEVELOPMENT OF ALTERNATIVES

3.2.1 Planning Assumptions and Basis for Analysis

The *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (Final Programmatic EIS) (DOE 1995b) identified two options for producing tritium in a CLWR: (1) DOE purchase of an existing operating or partially completed CLWR and conversion of the facility to tritium production for defense purposes; and (2) DOE purchase of irradiation services from an operating CLWR to produce tritium using DOE-supplied TPBARs. Pursuing these options, on June 3, 1997, DOE issued a request for proposal (DOE 1997a) to all pressurized water reactor operators in the United States, delineating the technical requirements and financial conditions necessary for implementing these options.

Under this EIS, DOE proposes to produce, in one or more CLWRs, the tritium needed to maintain the nation's nuclear stockpile. The CLWRs were identified through a procurement process. The procurement process discussed in Section 1.1.4 identified the following CLWRs where tritium could be produced: the Watts Bar Nuclear Power Plant Unit 1 (Watts Bar 1); the Sequoyah Nuclear Power Plant Units 1 and/or 2 (Sequoyah 1 and/or 2); and the Bellefonte Nuclear Power Plant Units 1 and/or 2 (Bellefonte 1 and/or 2). All of these reactor units are owned and operated by the U.S. government. Watts Bar 1 and Sequoyah 1 and 2 are currently operating units, while Bellefonte 1 and 2 are partially completed units that would have to be completed before tritium could be produced. Based on the procurement process, DOE considers this set of five TVA reactor units to be suitable alternatives for tritium production. Descriptions of these reactor plants are included in Section 3.2.5.

This EIS evaluates the direct, indirect, and cumulative impacts associated with fabrication of the TPBARs, the irradiation and handling of the TPBARs at the reactor facility, and the transportation of all nonirradiated and irradiated materials (including wastes associated with tritium production) to and from the appropriate facilities. The planning assumptions and considerations that form the basis of the analyses and impact assessments presented in this EIS are listed below:

- The purpose of DOE's action is to produce tritium in a CLWR. Tritium is needed to maintain the nation's nuclear weapons stockpile. For the purposes of analysis in this EIS, DOE assumed that the CLWR program would be designed to produce up to 3 kilograms of tritium per year. Three kilograms of tritium represent a production goal applicable if the tritium reserve, which is maintained for emergencies and contingencies, were ever lost or used (see Figure 2-1). Considering the current design of the TPBARs and the efficiency of the tritium extraction process, this would involve the irradiation of up to 6,000 TPBARs (DOE 1996c) in an 18-month refueling cycle (4,000 TPBARs per year). The maximum number of TPBARs that could be irradiated at each reactor unit without significantly disturbing the normal electricity-producing mode of reactor operation is approximately 3,400 TPBARs; the exact number depends on the specific design of the reactor. Steady-state tritium requirements, which are classified and would vary depending upon the specific requirements of the Nuclear Weapons Stockpile Plan, are less than 3 kilograms of tritium per year. This EIS evaluates the impacts at each reactor site by considering a range of 1,000 to 3,400 TPBARs. A sensitivity analysis of the irradiation of fewer than 1,000 TPBARs is included in Section 5.2.9.

  Producing 3 kilograms of tritium per year likely would be a short-term objective to reconstitute the tritium reserve. In such a case, it is technically feasible to produce larger quantities of tritium in a single reactor by changing some of the design parameters of the TPBARs and/or some technical parameters of the host reactor core, including shortening the refueling cycle. DOE does not foresee the implementation of this mode of production in any of the reactor units considered in this CLWR EIS. For the purpose of completeness, however, the sensitivity analysis in Section 5.2.9 also addresses the environmental impacts of changing the existing design parameters of the TPBARs and some of the operating parameters of the host reactors to maximize tritium production.

- For alternatives involving currently operating reactor units, this EIS assesses the environmental impacts of the changes to existing operations resulting from the insertion of the TPBARs into the reactors. These environmental impact changes would be additional to the normal environmental impacts of the ongoing operation of the reactors. For alternatives involving partially completed reactors, the EIS assesses the impacts resulting from construction to complete the reactors and from operation of the reactors.

- The EIS addresses the impacts of the No Action Alternative for each of the reactor units by assuming the continuation of the current status and current activities at each site. Because the TVA units are the only potential CLWR units considered as a result of the procurement process, the No Action Alternative means that no tritium would be produced in any CLWR. For this reason, this EIS, consistent with the Record of Decision on the Final Programmatic EIS (60 FR 63878), summarizes the impacts of producing tritium in a linear accelerator. The impacts of constructing and operating the accelerator are described in detail in the *Environmental Impact Statement, Accelerator Production of Tritium at the Savannah River Site* (APT EIS) (DOE 1997e, DOE 1999a) (see Section 5.2.11).

- The EIS assesses the environmental impacts of tritium production in CLWRs for a period of 40 years, starting with the delivery of irradiated TPBARs at the Tritium Extraction Facility in approximately the year 2005. For alternatives involving the partially completed reactor(s), it is assumed that any construction activities needed for the completion of Bellefonte 1 (and any other startup tests and activities) would take place during the time period between 1999 and 2004, at which time the completed reactor would be fully operational. In the event Bellefonte 2 was also selected for completion, Bellefonte 1 would come on line in approximately 2005, while Bellefonte 2 would begin operation in approximately 2007.

- CLWRs are licensed by the NRC to operate for 40 years. Currently operating reactors are not in a position to continue operation beyond 40 years without NRC approval for "life extension." Some of the environmental impacts associated with life extension activities would be attributable to tritium production. The NRC has addressed the generic impacts of life extension in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NRC 1996a). The life extension impacts associated with alternatives involving the currently operating units are based on this publication and are discussed in Section 5.2.4 of this EIS. Tritium production is not expected to affect relicensing. Life extension impacts for a partially completed reactor would not be an issue, since it would be expected to operate for 40 years after its completion.

- Tritium production in a currently operating reactor would not be expected to affect the radiological condition of the reactor at the end of its life. Therefore, environmental impacts associated with decommissioning and decontamination activities would be attributed to the normal operation of the reactor as an electricity-producing unit. For alternatives involving a partially completed reactor, the impacts from decommissioning and decontamination activities are evaluated in this EIS. Decommissioning and decontamination impacts are discussed in Section 5.2.5 of the EIS and are based on the generic EIS issued by the NRC entitled *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NRC 1988).

- Fabrication of the TPBARs would take place in a commercial facility that normally fabricates and assembles the components for the fresh fuel used in the CLWRs. A description of the fabrication process and any differences between fabricating standard burnable absorber rods versus TPBARs and material resources are included in Section 5.2.7. Impacts of the transportation of the nonirradiated TPBARs to the reactor facilities are evaluated in this EIS by considering a number of possible commercial fabrication and assembly facilities.

- An analysis of the environmental impacts of the transportation of nonirradiated and irradiated materials is presented in Section 5.2.8. The analysis for the transportation impacts assumes that 4,000 irradiated TPBARs per year are transported from the tritium production sites to the Savannah River Site. This EIS assumes that the transportation of irradiated TPBARs would be made by truck-sized casks of the type used to transport spent nuclear fuel in the United States. In addition to the transportation of irradiated TPBARs, the CLWR EIS considers the transportation of the irradiated TPBAR hardware, which would be separated from the rods at the reactor site, and other low-level radioactive waste directly attributed to tritium production. The CLWR EIS assumes that this low-level radioactive waste is transported in separate packages to either the Savannah River Site, where it would be disposed at the low-level radioactive waste facility, or the Barnwell disposal facility, where the low-level radioactive waste of the TVA reactor facilities is normally transported and disposed. Both truck routes and rail routes are evaluated. Details on the assumptions, method, and consequences of the transportation of TPBARs and low-level radioactive waste are presented in Appendix E.

- The radiological exposures from normal operation and accident conditions are evaluated for the general public and the workers at the reactor sites. For alternatives involving currently operating reactors, the CLWR EIS assesses the exposures from any additional radioactive releases that would result from the irradiation and consolidation of the TPBARs at the reactor. [Note: Consolidation occurs when the TPBARs from several fuel assemblies are inserted into a container for shipment off site in a transportation cask.] For alternatives involving a partially completed reactor, in addition to irradiation and consolidation of TPBARs, this EIS also assesses the exposures from all radioactive releases that could result from both normal operation and accident conditions. Details on the assumptions used for radiological releases are included in Appendix C for normal operation and in Appendix D for accidents.

- Production of tritium in a CLWR would increase the generation rate of spent fuel if more than approximately 2,000 TPBARs are irradiated in a fuel cycle (WEC 1999). Normally (i.e., during normal operation with no tritium production), fuel assemblies are used in more than one cycle. However, in order to maximize tritium production, TPBARs would be inserted in fresh fuel assemblies. In accordance with the Nuclear Waste Policy Act of 1982, DOE is planning to manage all spent nuclear fuel at a national repository. Siting and development of a repository is ongoing, and the location and opening date for a suitable repository has not yet been determined. Accordingly, for the purposes of this EIS, the initial management of any additional spent nuclear fuel that may be generated as a result of tritium production is assumed to be stored on site in a generic dry cask independent spent fuel storage installation (ISFSI) pending the availability of a suitable repository. The environmental impacts from the construction and operation of an ISFSI are addressed in Section 5.2.6. However, no decision will be made to either construct or operate an ISFSI as a result of this EIS. Appropriate National Environmental Policy Act (NEPA) documentation would be prepared prior to the construction of an ISFSI.

- The methodology used to assess the environmental impacts of tritium production in CLWRs is described in Appendix B.

3.2.2 Reactor Options Considered

Currently, there are 105 CLWRs licensed to operate in the United States, of which 72 are pressurized water reactors. Only pressurized water reactors are suitable for producing tritium with the current TPBAR design. There are also a number of pressurized water reactors for which construction activities have stopped. Construction work on all of the partially completed reactors has been canceled, with the exception of three: Bellefonte 1, Bellefonte 2, and Watts Bar Nuclear Plant Unit 2 (Watts Bar 2). For these, construction has been deferred indefinitely.

DOE issued a request for proposals for the CLWR production of tritium. DOE stated in the request for proposals its intent to select one or both of two approaches: (1) the acquisition of CLWR irradiation services for tritium production, or (2) the purchase of an operating CLWR by DOE for production of tritium. As discussed in Section 1.1.4, the only qualified response to DOE's solicitation came from TVA, the operator of Watts Bar 1 and Sequoyah 1 and 2. TVA also maintains the partially completed units of Watts Bar 2 and Bellefonte 1 and 2.

As a result of DOE's procurement process, all CLWRs except five of the pressurized water reactor units operated by TVA were eliminated from consideration as reasonable alternative reactor options. A sixth TVA reactor, Watts Bar 2, was considered but eliminated because, compared to the other five TVA reactor units that have a design suitable for tritium production, utilizing Watts Bar 2 would involve significantly higher construction costs. The cost to complete Watts Bar 2 (which is 50 percent complete) has been estimated to be roughly twice the cost to complete Bellefonte 2 (which is 57 percent complete). Much of the difference in costs between finishing Watts Bar 2 and Bellefonte 2 is attributable to the resolution of design and construction issues that exist for Watts Bar 2, but not for Bellefonte 2. Moreover, construction completion plans for Watts Bar 2 have not reached the level of refinement and reliability associated with those plans for Bellefonte 1 and 2. Consequently, relative to the other five TVA reactor units whose impacts are analyzed in this EIS, Watts Bar 2 is not a reasonable alternative reactor option and has been eliminated from detailed study.

Also eliminated from detailed study was the completion and operation of Bellefonte 2 without completion and operation of Bellefonte 1. Bellefonte 1 is 90 percent complete; Bellefonte 2 is only 57 percent complete. The costs associated with completion of Bellefonte 1 include all the necessary systems and equipment that would be shared between the two units—equal to approximately 70 percent of the total cost for completion of both units. Therefore, completion of Bellefonte 2 without completion of Bellefonte 1 is economically impractical.

3.2.3 Reasonable Alternatives

The reasonable alternatives presented in the EIS are formed by the options available to DOE in implementing the project. These options include the fabrication facility options, the reactor facility options, and the transportation alternative modes, routes, and destinations.

The fabrication facility options include all commercial facilities that fabricate TPBARs and the pressurized water reactor fuel and its components for the currently operating reactor facilities. These are Framatome-Cogema Fuels, Lynchburg, Virginia; Asea Brown-Boveri/Combustion Engineering, Hematite, Missouri; BWX Technologies, Inc., Lynchburg, Virginia; Siemens Power Corporation, Richland, Washington; and Westinghouse Electric, Columbia, South Carolina. These fuel fabrication facilities could fabricate TPBARs with minimal startup time with some technology transfer on the particular TPBAR components not typically used by the nuclear industry (i.e., tritium getters and aluminized cladding), and with quality assurance standards in place and working. Another commercial facility, General Electric in Wilmington, North Carolina, would only manufacture TPBARs. Following the manufacture of TPBARs, final assembly would take place at one of the other facilities. Environmental impacts of the fabrication of TPBARs are discussed in Section 5.2.7.

To supply tritium to meet national security requirements, DOE could use one or more reactors. Considering that a maximum number of 3,400 TPBARs could be irradiated in a single reactor, at least two reactors would be needed for 6,000 TPBARs based on an 18-month refueling cycle. Considering also that additional spent nuclear fuel generation attributed to tritium production starts with the irradiation of approximately 2,000 TPBARs in a single reactor, DOE could use as many as three reactors to irradiate 6,000 TPBARs without increasing the amount of spent nuclear fuel. Mathematically, DOE has the option of selecting 1 of the 18 combinations of reactor units presented in **Table 3–2**. These 18 combinations form the reasonable alternatives of the irradiation element of the project. For the purpose of simplicity, the analysis of the environmental impacts for each reactor site is performed using conditions and assumptions that would bracket the impacts at each site. The impacts for each of the 18 irradiation alternatives would be the sum of the impacts at each of the sites involved. For example, the impacts associated with Alternative #5 in Table 3–2 would be the sum of the impacts of the operation of Watts Bar 1 and the impacts of the operation of Sequoyah 1. The environmental impacts by reactor site are discussed in Section 5.2 and summarized in Section 3.2.6.

Table 3–2 CLWR Tritium Production Program Reasonable Alternatives

Alternative	*Watts Bar 1 Operation*	*Sequoyah 1 Operation*	*Sequoyah 2 Operation*	*Bellefonte 1 Complete Construction and Operation*	*Bellefonte 2 Complete Construction and Operation*[a]
One Reactor[b]					
1	●				
2		●			
3			●		
4				●	
Two Reactor Combinations					
5	●	●			
6	●		●		
7	●			●	
8		●	●		
9		●		●	
10			●	●	
11				●	●
Three Reactor Combinations					
12	●	●	●		
13	●	●		●	
14	●		●	●	
15	●			●	●
16		●	●	●	
17		●		●	●
18			●	●	●

[a] Construction on Bellefonte 2 may be completed only if Bellefonte 1 is completed and operating.
[b] The one-reactor alternative could not produce 3 kilograms of tritium per year on an 18-month refueling cycle.

The transportation of nonirradiated and irradiated TPBARs presents options in transportation modes (truck versus rail), alternative transportation routes between facilities, alternative fabrication locations, and alternative low-level radioactive waste destinations. The full development of the various transportation options and the associated environmental impacts from these options are discussed in Section 5.2.8 and Appendix E. Transportation impacts are summarized in Section 3.2.6.2.

3.2.4 No Action Alternative

On December 22, 1998, Secretary of Energy Bill Richardson announced that CLWRs would be the primary tritium supply technology and that the accelerator would be developed, but not constructed, as a backup to CLWR tritium production (DOE 1998f). Based on this announcement, if tritium is not produced in a CLWR, it will be produced in an accelerator. Accordingly, for purposes of analysis in this EIS, the No Action Alternative assumes the continued operation of Watts Bar 1 and Sequoyah 1 and 2 for the generation of electricity and the deferral of construction activities necessary for completion of Bellefonte 1 and 2 as nuclear units. Consequently, this No Action alternative entails the production of tritium in an accelerator. A summary of the environmental impacts associated with the production of tritium in an accelerator is contained in Section 5.2.11 of the CLWR EIS. That summary is based on the APT EIS. A comparison between the environmental impacts of the CLWR EIS reactor alternatives and those for accelerator production is presented in **Table 3-14**. Since the APT EIS was developed in parallel with the CLWR EIS, the impacts in Table 3-14 represent the conclusions of the APT Draft EIS. These impacts are not expected to change in the APT Final EIS.

3.2.5 Reactor Options

3.2.5.1 Watts Bar Nuclear Plant Unit 1

Watts Bar 1 is located on a 716-hectare (1,770-acre) site in Rhea County, Tennessee, on the Tennessee River at Tennessee River Mile 528, approximately 80 kilometers (50 miles) northeast of Chattanooga, Tennessee (TVA 1976, TVA 1995c). A second, partially completed unit, Watts Bar 2, also is located at this site. Watts Bar 2 was considered and dismissed as an alternative for tritium production in the CLWR EIS, as described in Section 3.2.2. The main land-use activities of the surrounding area are described in Section 4.2.1.1. The general arrangement of the Watts Bar Nuclear Plant is shown in **Figure 3–5**.

Watts Bar 1 began commercial power operation in May 1996 (NRC 1997a). The Watts Bar 1 structures include a reactor containment building, a turbine building, an auxiliary building, a service building, a water pumping station for circulating water in the condenser, a diesel generator building, a river intake pumping station, a natural-draft cooling tower, a transformer yard, a 500-kilovolt switchyard and a 161-kilovolt switchyard, a spent nuclear fuel storage facility, and sewage treatment facilities (TVA 1976). The reactor containment building houses a pressurized water reactor designed and manufactured by the Westinghouse Electric Corporation. No modifications are expected to be necessary for Watts Bar 1 to irradiate TPBARs. Design equipment and facilities are sufficient to load and unload the TPBAR assemblies. During normal operation with tritium production, the plant could employ a few more workers (less than 10) in addition to the 809 presently employed (TVA 1998a). The spent nuclear fuel storage capacity is not sufficient for 40 years of operation with or without TPBARs. This EIS evaluates the impacts of a generic dry cask spent nuclear fuel storage facility in Section 5.2.6.

The general design specifications of the unit are provided in **Table 3–3.**

Table 3–3 General Design Specifications of Watts Bar Nuclear Plant Unit 1

Criteria	*Quantity*
Core thermal power level (megawatts-thermal)	3,411
Plant capacity factor	0.80
Total steam flow rate (pounds per hour)	1.51×10^{7}
Electrical generation (net) (megawatts-electric)	1,160
Normal operating cycle (months)	18
Size of full core fuel load	193 fuel assemblies (89.5 metric tons of uranium)

Sources: TVA 1976, TVA 1995d.

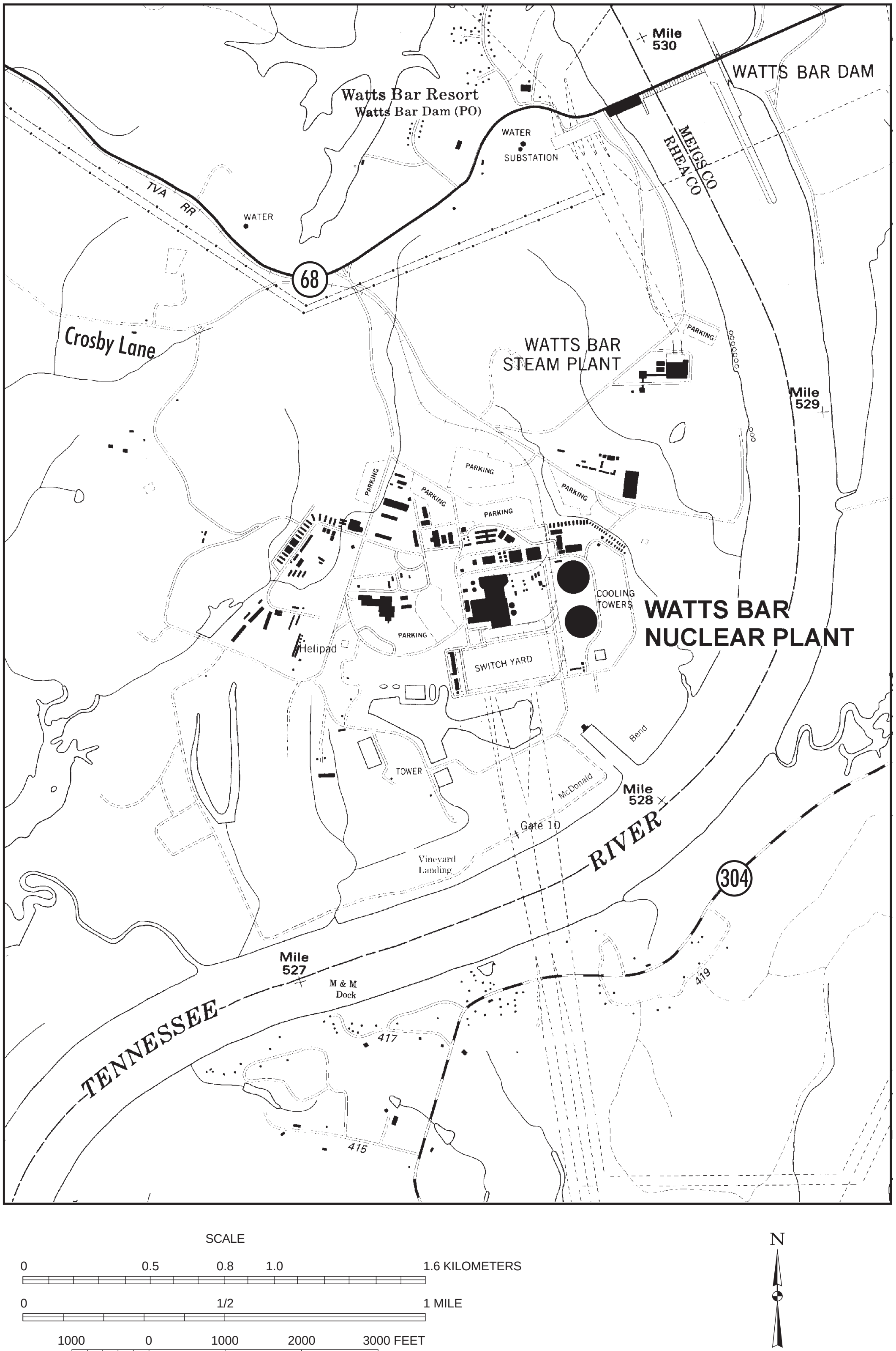

Figure 3–5 Watts Bar Nuclear Plant

In a tritium-producing mode of operation, up to 3,400 TPBARs could be placed in the core, occupying the same fuel assembly locations as the burnable absorber rods now in use. The TPBARs would be irradiated on an 18-month refueling-cycle schedule. During operation, heat released from the fissioning fuel is transported by the reactor cooling water to the steam generators. The overall thermal efficiency of the plant is about 34 percent (TVA 1995c). After passing through the turbine, the steam is condensed by moving through a condenser cooled with recirculated water. This recirculated condenser water is then cooled by passing it through a natural-draft (without fans), evaporative cooling tower. Although the cooling system is of the so-called "closed type," makeup water from the Tennessee River is needed to replace water losses due to evaporation, drift, and blowdown. Blowdown is a process to remove excess dissolved solids.

At full power, the temperature of the water flowing through the condenser is raised by approximately 20°C (36°F) (TVA 1995c). To replace water lost through evaporation, minor leaks, and blowdown (mainly associated with cooling tower operation), approximately 156,332 liters per minute (41,300 gallons per minute) (TVA 1976) is withdrawn from the Tennessee River. Blowdown from the natural-draft cooling tower is discharged into the Tennessee River at a normal rate of 106,593 liters per minute (28,160 gallons per minute) (TVA 1976). A diffuser system disperses the blowdown into the river water, thus limiting the rise in temperature to less than 3°C (5°F) (TVA 1976). This water is discharged under a National Pollutant Discharge Elimination System (NPDES) Permit (TN DEC 1993b).

The operation of Watts Bar 1 produces radioactive fission products and activates corrosion products in the reactor coolant system. Small amounts of these radioactive products enter the cooling system water. Radionuclides are removed from the cooling water through a chemical water treatment system. The gases and liquids are processed, stored, and monitored within the facility to minimize the radioactive nuclides that could be released to the atmosphere and into the Tennessee River. Radioactive waste is generated in this treatment system. The Watts Bar 1 liquid contaminant releases to the environment during normal operations are identified in **Table 3–4.**

Table 3–4 Annual Liquid Releases to the Environment from Operation of Watts Bar 1

Materials	*Quantity*
Chemicals (kilograms)	1,098,040 [a]
Tritium (Curies)	639 [b]
Other Radionuclides (Curies)	1.32 [b]

[a] TVA 1995a.
[b] TVA 1998e.

Radioactive gaseous emission releases are controlled by using a ventilation system consisting of gas decay tanks, filter components, and related piping, ductwork, valves, and fans. The main sources of gaseous radioactive emissions are generated in conjunction with degassing of the primary coolant during letdown depressurization of the reactor cooling water into the various process equipment and tanks associated with the makeup water and purification systems. Gases from the reactor are trapped in holding tanks to allow short-lived radioactive gases to decay before they are released to the shield building vent at a controlled rate through high efficiency particulate air filters and charcoal absorbers. Another source of radioactive gaseous emissions is the purging of the reactor containment building, which is also routed through high efficiency particulate air filters and charcoal absorbers prior to release.

Nonradiological criteria and hazardous air pollutant emissions are based on the operation of equipment at Watts Bar 1 at full power. Air pollutant sources include five diesel generators, one diesel generator used for security power, one diesel pump for firefighting, two auxiliary boilers fired with No. 2 fuel oil (0.5 percent sulfur), two natural-draft cooling towers, the lube oil system, two fixed-roof tanks for storing No. 2 fuel oil, the paint shop, and the sandblast shop. Emission factors for both nonradiological criteria and hazardous air pollutants are based on the U.S. Environmental Protection Agency's (EPA) *Supplement B to Compilation of Air Pollutant Emission Factors, AP-42* (EPA 1996b).

The gaseous waste releases from Watts Bar 1 during normal operations are summarized in **Table 3–5.**

Table 3–5 Summary of Annual Watts Bar 1 Gaseous Emissions

Constituents	*Quantity*
Particulate matter (kilograms)	20,366 [a]
Carbon monoxide (kilograms)	21,802 [a]
Sulfur dioxide (kilograms)	77,634 [a]
Nitrogen dioxide (kilograms)	84,584 [a]
Volatile organic compounds (kilograms)	41,602 [a]
Hazardous air pollutants (kilograms)	126 [a]
Tritium (Curies)	5.6 [b]
Other radionuclides (Curies)	283 [b]

[a] TVA 1998a.
[b] TVA 1998e.

Several hazardous substances and chemicals are used on a regular basis in the operation of Watts Bar 1. This results in the generation of hazardous waste that is controlled, stored, and managed in accordance with the Resource Conservation and Recovery Act (40 CFR 260). This waste is disposed of off site at Resource Conservation and Recovery Act-permitted treatment and disposal facilities. Solid waste such as noncontaminated clothing, rags, office paper, boxes, and noncontaminated filters is also generated on a regular basis and is disposed of as solid waste.

The waste and spent fuel generation volumes for Watts Bar 1 during normal operation are summarized in **Table 3–6.**

Table 3–6 Summary of Annual Watts Bar 1 Waste and Spent Fuel Generation Rates

Waste Type	*Volume or Mass*
Hazardous waste (cubic meters)	1.025
Nonhazardous solid waste (kilograms)	853,438
Low-level radioactive waste (cubic meters)	40
Mixed low-level radioactive waste (cubic meters)	< 1
Spent fuel assemblies (per 18-month operating cycle)	80

Sources: TVA 1976, TVA 1995a, TVA 1995c.

The reactor is shut down for refueling and maintenance as part of a normal fuel cycle of 18 months. During this shutdown period, the irradiated TPBARs/spent fuel assemblies would be removed from the reactor and placed in the spent fuel pool for cooling. After approximately one to two months, the TPBARs would be removed from the fuel assemblies, loaded into transportation casks, and sent to the proposed Tritium Extraction Facility at the Savannah River Site for tritium extraction and purification.

3.2.5.2 Sequoyah Nuclear Plant Units 1 and 2

Sequoyah 1 and 2 are operating, pressurized CLWR nuclear power plants. The units are located on a 212-hectare (525-acre) site in Hamilton County, Tennessee, on the Tennessee River at Tennessee River Mile 484.5, approximately 12 kilometers (7.5 miles) northeast of the nearest city limit of Chattanooga, Tennessee (TVA 1974a, TVA 1996b). The main land use activities of the surrounding area are described in Section 4.2.2.1. The general arrangement of the Sequoyah Nuclear Plant is shown in **Figure 3–6**.

Sequoyah 1 began commercial operation in July 1981, and Sequoyah 2 began commercial operation in June 1982 (TVA 1996b). The nuclear steam supply systems, designed and manufactured by the Westinghouse Electric Corporation, include the reactor vessel, steam generators, and associated piping and pumps. These are housed in two reactor containment buildings. The balance of the nuclear power plant includes: a turbine building, an auxiliary building, a service and office building, a control building, a condenser circulating water pumping station, a diesel generator building, a river intake pumping station, two natural-draft cooling towers, a transformer yard, a 500-kilovolt switchyard and a 161-kilovolt switchyard, spent nuclear fuel storage facilities, and sewage treatment facilities (TVA 1974a). No modifications are expected to be needed for Sequoyah 1 and 2 to irradiate TPBARs. Equipment and facilities are sufficient to load and unload the TPBAR assemblies. Tritium production could require the addition of a few more employees (fewer than 10 per unit) to the 1,120 employees currently employed at the two-unit site (TVA 1998a). The general design specifications of the plant are provided in **Table 3–7**. The spent nuclear fuel storage capacity is not sufficient for 40 years of operation with or without TPBARs. This EIS evaluates the impacts of a generic dry cask spent fuel storage facility in Section 5.2.6.

Table 3–7 General Design Specifications of Sequoyah 1 or Sequoyah 2

Criteria	*Quantity*
Core thermal power level (megawatts-thermal)	3,411
Plant capacity factor	0.80
Total steam flow rate (pounds per hour)	1.492×10^7
Net electrical generation (net) (megawatts-electric)	1,183
Normal operating cycle (months)	18
Size of full core fuel load	193 Fuel Assemblies (89.5 metric tons of uranium)

Source: TVA 1974a, TVA 1996b.

In a tritium-producing mode of operation, approximately 3,400 TPBARs could be placed in the reactor core(s) of Sequoyah 1 and/or 2 in the same fuel assembly guide tube locations that now accommodate standard burnable absorber rods. The TPBARs would be irradiated on an 18-month refueling cycle.

During current operations at Sequoyah 1 or Sequoyah 2, heat released from the fissioning fuel is transported by the reactor cooling water to the steam generators. After passing through the turbines, the steam is condensed by moving it through a condenser. The overall thermal efficiency of each unit is about 35 percent (TVA 1996b). The condenser is in turn cooled by a direct open cooling system (or mode) using diffusers supplemented by a helper or closed system (or mode) that uses natural-draft, evaporative cooling towers (TVA 1996b). However, the cooling towers have only been used for approximately 2 percent of the plant's operating time (TVA 1998a) to meet thermal discharge limits. The direct open cooling system uses a diffuser system which discharges cooling water to the Tennessee River from diffuser pipes. One diffuser pipe is

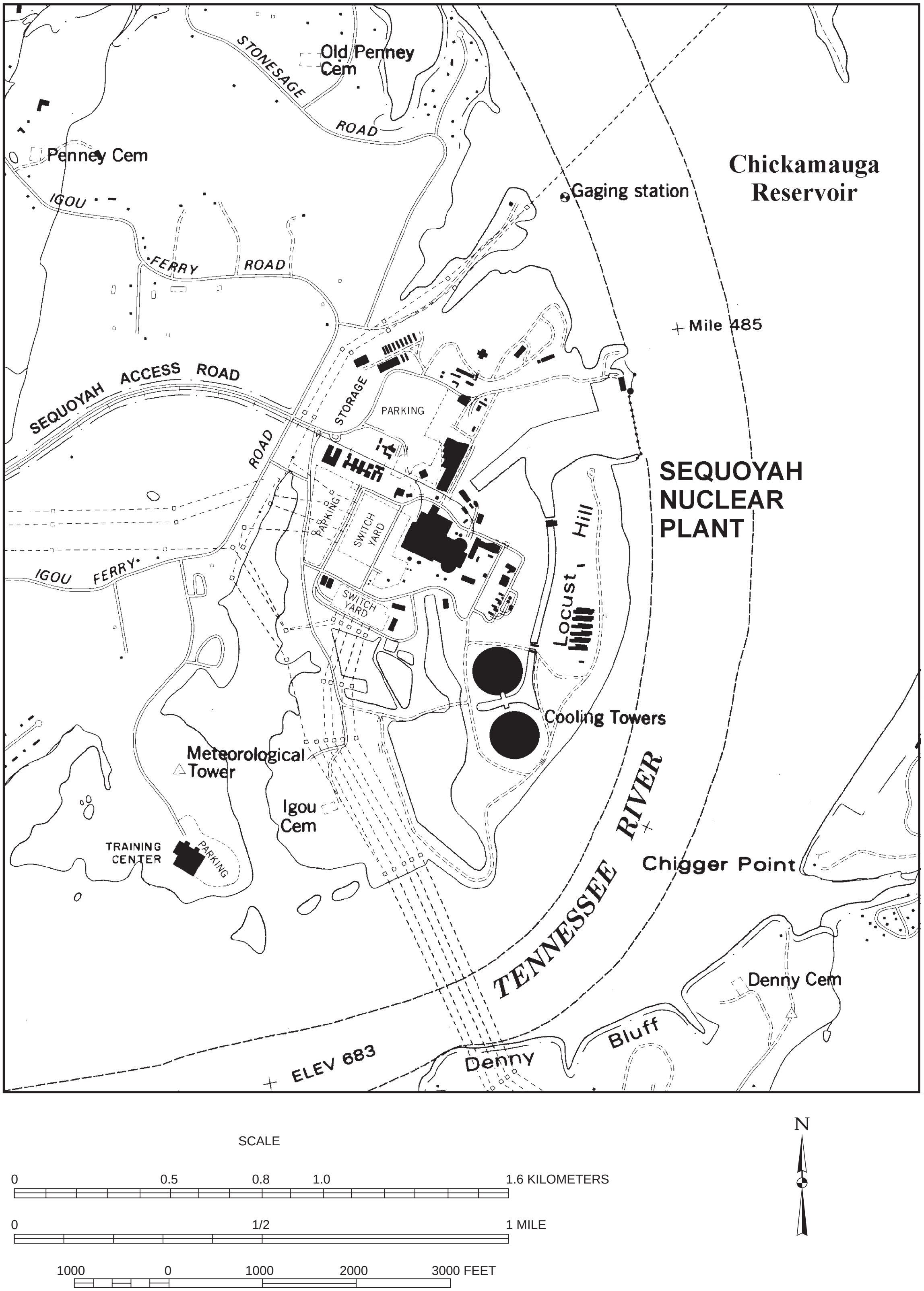

Figure 3–6 Sequoyah Nuclear Plant

4.9 meters (16 feet) in diameter and extends 107 meters (350 feet), while the other diffuser pipe is 5.2 meters (17 feet) in diameter and extends 213 meters (700 feet). These two pipes are perforated with about twelve thousand 5-centimeter (2-inch) ports through which water is discharged into the river for maximum thermal mixing. This reduces the average river water temperature rise to less than 5.6°C (10°F) (TVA 1996c).

Cooling towers can be used in the helper mode, in which they discharge water through the diffuser pipes into the river, or in the closed mode. When the supplemental cooling tower system is used in the closed mode of operation, makeup water from the Tennessee River is needed to replace water losses from evaporation, drift, and blowdown. When the cooling towers are used in the closed mode, cooling is accomplished in the same manner as described for Watts Bar 1 in Section 3.2.5.1.

When the reactor is at full power, the temperature of the water flowing through each condenser is raised by approximately 17°C (30°F) (TVA 1996b). The open cooling mode using the diffuser pipes withdraws and returns 4,250,000 liters per minute (1,222,000 gallons per minute) with two units operating (TVA 1974a). In the cooling tower closed- cycle cooling mode, water lost through evaporation, small leaks, drift, and blowdown is made up by withdrawing approximately 249,745 liters per minute (65,978 gallons per minute) (TVA 1974a) from the Tennessee River. Blowdown from a natural-draft cooling tower is discharged into the Tennessee River at a normal rate of 120,000 liters per minute (31,700 gallons per minute) (TVA 1974a). Diffusers are used to mix the blowdown with river water, thus limiting the temperature rise after mixing to less than 5.6°C (10°F) (TVA 1996c). This water is discharged under a NPDES Permit (TN DEC 1993a). Tritium production would not affect the thermal discharge characteristics of the plant.

Operation of the plant produces radioactive fission products and activates corrosion products in the reactor coolant system. Small amounts of these radioactive products enter the plant cooling water. Radionuclides are removed from the cooling water through a chemical water treatment system. The gases and liquids are processed and monitored within the facility to minimize the radioactive nuclides released to the atmosphere and into the Tennessee River. Radioactive waste is produced in this treatment system. The total Sequoyah 1 or Sequoyah 2 liquid contaminant release to the environment during normal operation is identified in **Table 3–8**.

Table 3–8 Annual Liquid Releases to the Environment from Operating Sequoyah 1 or Sequoyah 2

Materials	***Quantity***
Chemicals (kilograms)	294,012 [a]
Tritium (Curies)	714 [b]
Other Radionuclides (Curies)	1.15 [b]

[a] TVA 1996b.
[b] TVA 1998e, TVA 1999.

Gaseous wastes are managed in the same manner as described for Watts Bar 1 in Section 3.2.5.1. Gaseous emissions from the plant are summarized in **Table 3–9**.

Table 3–9 Summary of Annual Sequoyah 1 or Sequoyah 2 Gaseous Emissions

Constituent	*Quantity*
Particulate matter (kilograms)	26,225 [a]
Carbon monoxide (kilograms)	22,194 [a]
Sulfur dioxide (kilograms)	11,335 [a]
Nitrogen dioxide (kilograms)	86,928 [a]
Volatile organic compounds (kilograms)	2,377 [a]
Hazardous air pollutants (kilograms)	171 [a]
Tritium (Curies)	25 [b]
Other radionuclides (Curies)	120 [b]

[a] TVA 1998a.
[b] TVA 1998e, TVA 1999.

Several hazardous substances and chemicals are used regularly during plant operation. This results in the generation of hazardous waste, which is controlled, stored, and managed in accordance with Resource Conservation and Recovery Act guidelines. This waste is disposed of off site at Resource Conservation and Recovery Act-permitted treatment and disposal facilities. Solid waste such as noncontaminated clothing, rags, waste paper, boxes, and uncontaminated filters is also generated regularly and disposed of as solid waste. The waste generation volumes for Sequoyah 1 or Sequoyah 2 during normal operation are summarized in **Table 3–10**.

Table 3–10 Summary of Annual Sequoyah 1 or Sequoyah 2 Waste and Spent Fuel Generation Rates

Waste Type	*Volume or Mass*
Hazardous waste (cubic meters)	1.196
Nonhazardous solid waste (kilograms)	1,301,966
Low-level radioactive waste (cubic meters)	383
Mixed low-level radioactive waste (cubic meters)	less than 1
Spent fuel assemblies (per 18-month operating cycle)	80

Sources: TVA 1974a, TVA 1996b.

The reactors are shut down for refueling and maintenance as part of a normal fuel cycle of 18 months. During this shutdown period, the irradiated TPBARs/spent fuel assemblies would be removed from the reactors and placed in the spent fuel pool for cooling. After approximately one to two months, these TPBARs would be removed from the fuel assemblies, loaded into transportation casks, and sent to the proposed Tritium Extraction Facility at the Savannah River Site for tritium extraction and purification.

3.2.5.3 Bellefonte Nuclear Plant Units 1 and 2

Bellefonte 1 and 2 are partially completed pressurized water reactors. They are situated on approximately 607 hectares (1,500 acres) (TVA 1997f) on a peninsula at Tennessee River Mile 392, on the west shore of Guntersville Reservoir, about 11.3 kilometers (7 miles) northeast of Scottsboro, Alabama (TVA 1991). The main land uses of the surrounding area are forestry and agriculture; however, urban-industrial development has grown over the past several years around the plant along the Guntersville Reservoir. The affected environment at the Bellefonte Nuclear Plant site is described in Section 4.2.3. The general arrangement of the Bellefonte Nuclear Plant is shown in **Figure 3–7**.

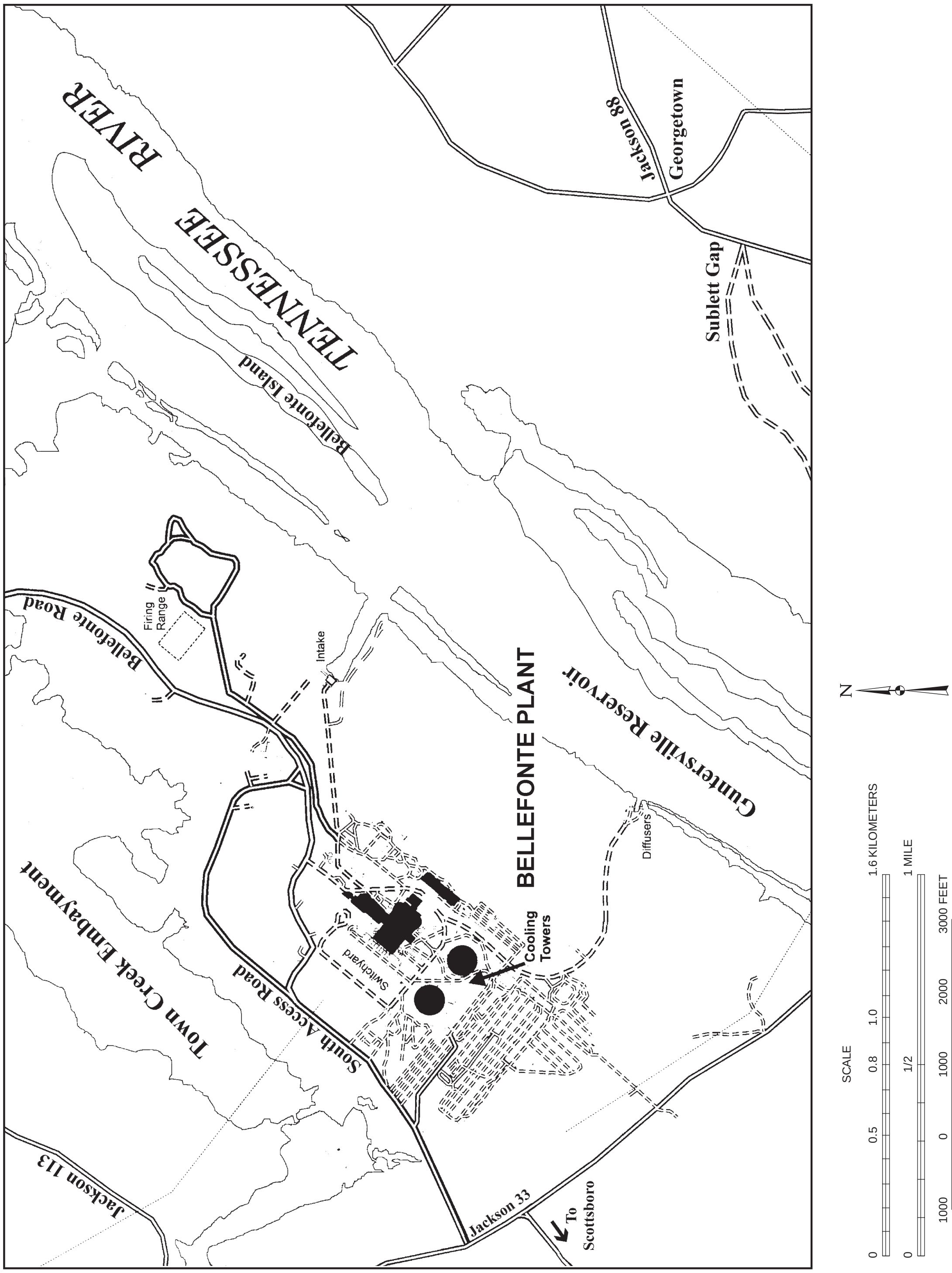

Figure 3–7 Bellefonte Nuclear Plant

The U.S. Atomic Energy Commission (now the NRC) issued the construction permit for the Bellefonte Nuclear Plant in December 1974 (NRC 1990), and construction started in February 1975. On July 29, 1988, TVA notified the NRC that Bellefonte was being deferred as a result of a lower load forecast for the near future (TVA 1988). After three years of extensive study, TVA notified the NRC on March 23, 1993, of its plans to complete Bellefonte 1 and 2 (TVA 1994a). In December 1994, TVA announced that Bellefonte would not be completed as a nuclear plant without a partner and put further activities on hold until a comprehensive evaluation of TVA's power needs was completed. On April 29, 1996, TVA issued a Notice of Intent to prepare an EIS for the proposed conversion of the Bellefonte Nuclear Plant to a fossil fuel facility. The *Final Environmental Impact Statement for the Bellefonte Conversion Project*, which analyzed alternatives for such a conversion, was issued in October 1997 (TVA 1997f). A Record of Decision for that EIS will not be made until it is determined whether Bellefonte 1 or both Bellefonte 1 and 2 will be used for tritium production.

The plant structures presently consist of two reactor containment buildings; a control building; a turbine building; an auxiliary building; a service building; a condenser circulating water pumping station; two diesel generator buildings; a river intake pumping station; two natural-draft cooling towers; a transformer yard; a 500-kilovolt switchyard and a 161-kilovolt switchyard; a spent nuclear fuel storage pool; and sewage treatment facilities (TVA 1991). Additionally, there are office buildings to house engineering and other department personnel. Entrance roads, parking lots, railroad spurs, and a helicopter landing pad are in place and are capable of supporting a construction project.

No modifications to the original design should be necessary to complete Bellefonte 1 or Bellefonte 2 for operation, with or without TPBARs.

The plant systems and structures are maintained through active layup and preservation. Program activities include the following:

- Each unit's main turbine generators are rotated every other week.
- The diesel fire pumps are maintained in an operational status and are run monthly.
- The shell and tube sides of the main condensers (heat exchangers) are kept dry, and the tube side is maintained with a flow of warm, dehumidified air.
- The reactor coolant system is kept dry using a flow of warm, dehumidified air.

A workforce of approximately 80 personnel supports layup and preservation of the plant. Of that number, 38 are involved in operations and maintenance (TVA 1998e).

To complete Bellefonte 1 or both Bellefonte 1 and 2, additional engineering and construction activities would be required (TVA 1998a). These activities are summarized in the following paragraphs.

Engineering

Engineering for the original Bellefonte Nuclear Plant design is substantially complete. The additional engineering effort consists of completing analysis and design modifications that were not completed prior to deferral to update the design-basis documentation to current industry standards, as well as supporting construction, startup, and licensing of the plant. More specifically, the remaining engineering effort for Bellefonte 1 and 2 includes, but is not limited to, the following:

- Issuing detailed design modifications for certain mechanical and electrical systems to meet current requirements

- Updating the main control room drawings into computer-aided design electronic format
- Reviewing the control room design and upgrading the simulator and plant computers
- Reanalyzing piping and pipe supports
- Resolving industry issues (e.g., fire protection, electrical equipment qualification, station blackout, site security, communications, motor-operated valves) that were either not completed prior to deferral in 1988 or have arisen since deferral
- Developing fuel assembly and fuel cycle designs to facilitate the production of tritium
- Supporting submittals of the Final Safety Analysis Report and completing previous NRC position papers
- Supporting field change requests by the constructor

Construction

Construction activities required to complete Bellefonte 1 and 2 include, but are not limited to, the following:

- Completing the application of protective coatings to structures, piping, and components and the installation of piping insulation
- Installing the Bellefonte 2 reactor coolant pump internals and motors [Some (less than 10 percent) of Bellefonte 1 reactor coolant instrumentation and pipe supports would have to be installed.]
- Installing limited major piping and components in the balance of the plant for Bellefonte 2
- Installing the steam piping for Bellefonte 2
- Installing and energizing a limited amount of the electric power equipment within the plant [The 161-kilovolt and 500-kilovolt offsite transmission lines are terminated in the switchyard, which is complete and energized.]
- Completing the Bellefonte 2 main control room [Substantial work would be required because the Bellefonte 1 main control room, although not complete, is functional and manned to monitor the ongoing preservation activities. The recommendations of the Control Room Design review would be factored into efforts to complete construction of both control rooms.]
- Preparing the intake structure for operation by desilting the intake water pump
- Constructing some new support buildings and installing additional equipment

In addition to the engineering and construction activities, completion and operation of Bellefonte 1 or both Bellefonte 1 and 2 would require NRC licensing, startup testing, and operations staffing and training.

Estimates of the resources required to complete Bellefonte 1 and both Bellefonte 1 and 2 are provided in **Table 3–11**. Bellefonte 2 would require fewer resources than Bellefonte 1 because some facilities constructed for Bellefonte 1 are in common with Bellefonte 2.

Table 3–11 Summary of Resources Required to Complete Construction of Bellefonte 1 or Bellefonte 1 and 2

Resources	*Bellefonte 1*	*Bellefonte 1 and 2*
Employment, peak year	4,500	4,500
Length of time (years)	5	6.5
Electricity (megawatt-hours)	575,000	1,075,000
Water (cubic meters)	280,000	440,000
Concrete (cubic meters)	2,190	3,981
Steel (metric tons)	353	451
Fuel (liters)	9.7×10^6	1.4×10^7
Industrial gases (cubic meters)	500	1,800

Source: TVA 1995b.

For tritium production, approximately 3,400 TPBARs could be placed in the reactor core(s) of Bellefonte 1 or both Bellefonte 1 and 2, occupying the same fuel assembly guide tube locations that would otherwise have held standard burnable absorber rods.

During normal operation, one unit would employ approximately 800; both units would employ 1,000 (TVA 1998a). Less than 10 additional employees per unit would be needed for normal operations with tritium production. If either or both units were completed, each reactor containment building would house a pressurized water reactor designed and manufactured by Framatome Technologies, Inc. The general design specifications of the plant are provided in **Table 3–12**.

Table 3–12 General Design Specifications of Bellefonte 1 or Bellefonte 2

Criteria	*Quantity*
Core thermal power level (megawatts-thermal)	3,600
Plant capacity factor	0.80
Total steam flow (pounds per hour)	1.609×10^7
Electrical generation (megawatts-electric)	1,212
Normal operating cycle (months)	18
Size of full core fuel load	205 fuel assemblies (93.5 metric tons of uranium)

Source: TVA 1991.

During operation, heat released from the fissioning fuel would be transported by the reactor cooling water to the steam generators. After passing through the turbines, the steam would be condensed by moving it through a condenser cooled by recirculated water. The overall thermal efficiency of an operation unit is expected to be about 34 percent (TVA 1991). This water would in turn be cooled by passing through a natural-draft evaporative cooling tower. Although the cooling system would be of the (so-called) closed type, makeup water from the Tennessee River (Guntersville Reservoir) would be needed to replace water losses due to evaporation, drift, and blowdown. Cooling would be accomplished in the same manner as described for Watts Bar 1 in Section 3.2.5.1.

At full power, the temperature of the water flowing through a condenser would be raised by approximately 20°C (36°F) (ADEM 1992). In the cooling tower closed-cycle cooling mode, water lost (from both units) through evaporation, small leaks, drift, and blowdown would be made up by withdrawing approximately 252,000 liters per minute (66,600 gallons per minute) from the Guntersville Reservoir (TVA 1978).

Blowdown from the natural-draft cooling towers would be discharged into the Guntersville Reservoir at a normal rate of 2.1 cubic meters per second (74 cubic feet per second) (TVA 1974b). A diffuser would be used to mix the blowdown with reservoir water and thus limit the temperature rise after mixing to less than 3°C (5°F) (TVA 1978). This water would be discharged under a NPDES Permit (ADEM 1992).

Operation of the plant would produce radioactive fission products and activate corrosion products in the reactor coolant system. Small amounts of these radioactive products would enter the cooling water of the plant. Radionuclides would be removed from the cooling water through a chemical water treatment system. The gases and liquids would be processed and monitored within the facility to minimize the radioactive nuclides released to the atmosphere and into the Guntersville Reservoir. Radioactive waste would be generated in this treatment system.

The gaseous emissions would be managed in the same manner as described for Watts Bar 1 in Section 3.2.5.1. The projected nonradiological gaseous releases at Bellefonte 1 and 2, with the units at full power, would be similar to those for Watts Bar 1 and Sequoyah 1 and 2.

Several hazardous substances and chemicals would be used regularly in the operation of the plant. This is expected to result in the generation of hazardous waste that will be controlled, stored, and managed in accordance with the Resource Conservation and Recovery Act and disposed of off site at Resource Conservation and Recovery Act-permitted treatment and disposal facilities. Solid waste such as noncontaminated clothing, rags, waste paper, boxes, and uncontaminated filters should also be generated regularly and disposed of as solid waste.

The reactors would be shut down for refueling and maintenance after operating for approximately 18 months. During this shutdown period, the irradiated TPBARs would be removed from the reactor and placed in the spent fuel pool for cooling. After one to two months, the TPBARs separated from the hold-down assemblies would be loaded into transportation casks and sent to the proposed Tritium Extraction Facility at the Savannah River Site for tritium extraction and purification.

3.2.6 Comparison of Alternatives

To aid the reader in understanding the differences among the various alternatives, this section presents a comparison of the environmental impacts associated with tritium production at each of the reactor plants. The comparisons concentrate on those resources that would most likely be impacted.

The information in this section is based on the environmental consequences described in Chapter 5 of this EIS. For the five TVA reactors being considered for tritium production (Watts Bar 1, Sequoyah 1, Sequoyah 2, Bellefonte 1, and Bellefonte 2), impacts are presented for the bounding case (i.e., the maximum number of TPBARs that could be irradiated in a reactor). For those cases in which impacts would be significantly different for a lesser number of TPBARs, an explanation is provided. The impacts of using more than one CLWR for tritium production can be determined by adding the impacts of each individual CLWR together. The impacts of not producing tritium at any of these five reactors (the No Action Alternative) are presented first as a baseline against which to compare the impacts of producing tritium. A summary of the environmental consequences is presented in **Table 3–13** at the end of this chapter. In addition, **Table 3–14** contains a comparison of the environmental impacts between tritium production in a CLWR and the accelerator at the Savannah River Site.

3.2.6.1 No Action Alternative Impacts

Construction

Watts Bar 1 and Sequoyah 1 and 2. Under the No Action Alternative, Watts Bar 1 and Sequoyah 1 and 2 would continue to produce electricity, and no construction impacts would occur.

Bellefonte 1 and 2. Under the No Action Alternative, Bellefonte 1 and 2 would remain in deferred status, and no construction impacts would occur. TVA could also convert Bellefonte 1 and 2 to a fossil fuel plant, as described in the *Final Environmental Impact Statement for the Bellefonte Conversion Project* (TVA 1997f) (see Section 1.5.2.4). Such conversion would be independent of this EIS and would not occur until a decision is made regarding the role of Bellefonte 1 and 2 in tritium production.

Operation

Watts Bar 1 and Sequoyah 1 and 2. Under the No Action Alternative, Watts Bar 1 and Sequoyah 1 and 2 would continue to produce electricity for the foreseeable future, and there would be no changes in the type and magnitude of environmental impacts that currently occur. In producing electricity, these reactor plants would continue to comply with all Federal, state, and local requirements. Impacts associated with the continued operation of Watts Bar 1 and Sequoyah 1 and 2 are described in the following paragraphs.

Under the No Action Alternative, water requirements at all three plants would continue to be met by existing water resources with no additional impacts, and water quality would not change, but would remain within regulatory limits. Air quality would also remain within regulatory limits. Worker employment should remain steady at each of the sites, with no major changes to the regional economic areas as a result of plant operation. Worker exposure to radiation should remain well under the regulatory limit of 5 rem per year, with the average worker dose at approximately 90 to 100 millirems per year. Radiation exposure of the public from normal operations would also remain well within regulatory limits (3 rem per year) for each of the reactor sites. At Watts Bar 1, the total dose to the population within 80 kilometers (50 miles) would be approximately 0.55 person-rem (see Chapter 10, *Glossary*, for definition) per year. Statistically, this equates to one fatal cancer approximately every 3,570 years from operation of Watts Bar 1. At Sequoyah 1 or Sequoyah 2, the total dose to the population within 80 kilometers (50 miles) would be approximately 1.6 person-rem per year. Statistically, this equates to one fatal cancer approximately every 1,250 years from the operation of Sequoyah 1 or 2. Risks of accidents would remain unchanged.

Under the No Action Alternative, all categories of wastes would continue to be generated at each of the reactor plants, and they would be managed in accordance with regulations. Low-level radioactive wastes would continue to be generated at a rate of approximately 40 (Watts Bar 1) to 383 (Sequoyah 1 or Sequoyah 2) cubic meters per year and would be disposed of at the Barnwell disposal facility. For each of the reactors, spent fuel would also continue to be generated at a rate of approximately 80 fuel assemblies per year. Spent fuel would continue to be managed at each of the reactor plants in compliance with all regulatory requirements.

Bellefonte 1 and 2. Under the No Action Alternative, Bellefonte 1 and 2 would remain uncompleted nuclear reactors, and the impacts on the environment would not change.

3.2.6.2 Impacts Associated with Tritium Production

Construction

Watts Bar 1 and Sequoyah 1 and 2. Because this EIS assumes that long-term spent fuel storage would take place at each of the reactor plants, an ISFSI eventually could be required for Watts Bar 1, Sequoyah 1, or

Sequoyah 2 to support tritium production. This could be the only construction necessary for tritium production. If such a facility were to be constructed, it would consist of three reinforced concrete slabs covering approximately 3.5 acres. Approximately 60-80 horizontal storage modules, each made of reinforced concrete, could be housed on the slabs. These horizontal storage modules would have a hollow internal cavity to accommodate a stainless steel cylindrical cask that would contain the spent nuclear fuel. Constructing such a facility would disturb approximately 5 acres and require approximately 50 construction workers. Premixed concrete would be used, and impacts to air quality, water, and biotic resources are expected to be small. Appropriate NEPA documentation would be prepared prior to the construction of a dry cask spent fuel storage facility.

Bellefonte 1 and 2. All major structures (e.g., containment buildings, cooling towers, turbine buildings, support facilities) have been constructed, so construction activities would consist largely of internal modifications to the existing facilities. No additional land would be disturbed in completing construction, and there would be no impacts on visual resources, biotic resources (including threatened and endangered species), geology and soils, and archaeological and historic resources. Because this EIS assumes that long-term spent fuel storage would take place at each of the reactor plants, a dry cask spent fuel storage facility would eventually be required at Bellefonte 1 and 2. The impacts of constructing such a spent fuel storage facility would be similar to those described above for Watts Bar 1, Sequoyah 1, or Sequoyah 2. Appropriate NEPA documentation would be prepared before the construction.

Completing construction of Bellefonte 1 would have the greatest impact on socioeconomics, with construction activities taking place between 1999 and 2004. During the peak year of construction (2002), approximately 4,500 direct jobs could be created. As many as 4,500 secondary jobs (indirect jobs) also could be created. The total new jobs (9,000) could cause the regional economic area unemployment rate to decrease to approximately 4 percent from the current rate of 8.2 percent. Public finance expenditures/revenues could increase by over 30 percent in Scottsboro and about 15 percent in Jackson County. Rental vacancies could decline to near zero, and demand for all types of housing could increase substantially. Rents and housing prices could increase at double-digit percentage levels.

If Bellefonte 2 were also selected for completion, construction activities for both units would be drawn out, taking place between 1999 and 2005. The peak year of construction would shift, but the total number of direct and indirect jobs would be the same. The effects, therefore, on unemployment, public finance, rents, and housing prices would be the same as for the construction completion of Bellefonte 1.

Operation

Watts Bar 1 and Sequoyah 1 and 2. In a tritium production mode, these operating reactors would continue to comply with all Federal, state, and local requirements. Tritium production would have little or no effect on land use, visual resources, water use and quality, air quality, archaeological and historic resources, biotic resources (including threatened and endangered species), and socioeconomics. It could, however, have some incremental impacts in the following areas: radiation exposure (worker and public), spent fuel generation, and low-level radioactive waste generation. Tritium production could also change the accident and transportation risks associated with these reactors. Each of these areas is discussed below.

Radiation Exposure Tritium production could increase average annual worker radiation exposure by approximately 0.82–1.1 millirem per year. The resultant dose would be well within regulatory limits. Radiation exposure to the public from normal operations could also increase, but still would remain well within regulatory limits at each of the reactor sites. At either Watts Bar 1, Sequoyah 1, or Sequoyah 2, the total dose to the population within 80 kilometers (50 miles) could increase by a maximum of 1.9 person-rem per year. Statistically, this equates to one additional fatal cancer approximately every 1,000 years from the operation of Watts Bar 1, Sequoyah 1, or Sequoyah 2.

Spent Fuel Generation Given irradiation of 3,400 TPBARs (the maximum number of TPBARs without changing the reactor's fuel cycle), additional spent fuel would be generated at Watts Bar 1, Sequoyah 1, or Sequoyah 2. In the average 18-month fuel cycle, spent fuel generation could increase from approximately 80 spent fuel assemblies up to a maximum of 140, a 71 percent increase in spent fuel generation over the No Action Alternative. Because this EIS assumes that long-term spent fuel storage would take place at each of the reactor plants, a dry cask spent fuel storage facility eventually would be needed. Storing the additional spent fuel should have minor impacts. Radiation exposures would remain below regulatory limits for both workers and the public, and less than 4 cubic feet of low-level radioactive waste would be generated annually. The impacts of accidents associated with dry cask spent fuel storage would be small. As previously mentioned, appropriate NEPA documentation would be prepared before the construction of a dry cask spent fuel storage facility at Watts Bar 1, Sequoyah 1, or Sequoyah 2. If fewer than approximately 2,000 TPBARs were irradiated, there would be no change in the amount of spent fuel produced by the reactors.

Low-Level Radioactive Waste Generation Compared to the No Action Alternative, tritium production at Watts Bar 1, Sequoyah 1, or Sequoyah 2 would generate approximately 0.43 additional cubic meters per year of low-level radioactive waste. This would be a 0.1 (Sequoyah 1 or Sequoyah 2) to 1.0 (Watts Bar 1) percent increase in low-level radioactive waste generation over the No Action Alternative. Such an increase would amount to less than 1 percent of the low-level radioactive waste disposed of at the Barnwell disposal facility. The EIS also analyzes the impacts of this low-level radioactive waste disposal at the Savannah River Site. Disposing of 0.43 cubic meters per year of low-level radioactive waste would amount to less than 1 percent of the low-level radioactive waste disposed of at the Savannah River Site and less than 1 percent of the landfill's capacity.

Accident Risks Tritium production could change the potential risks associated with accidents at Watts Bar 1, Sequoyah 1, or Sequoyah 2. As described in the following text, these changes would be small. Potential impacts from accidents were determined using computer modeling. If a limiting design-basis accident occurred, tritium production at the 3,400-TPBAR level would increase the individual risk of a fatal cancer by 1.4×10^{-9} to an individual living within 80 kilometers (50 miles) of Watts Bar 1. Statistically, this equates to a risk to the individual of one fatal cancer approximately every 710 million years from tritium production. For an individual living within 80 kilometers (50 miles) of Sequoyah 1 or Sequoyah 2, there would be a 2.1×10^{-9} increased likelihood of a cancer fatality to an individual from a design-basis accident as a result of tritium production. Statistically, this equates to a risk to an individual of one additional fatal cancer approximately every 480 million years from tritium production. For a beyond design-basis accident (an accident that has a probability of occurring approximately once in a million years or less), tritium production would result in small changes in the consequences of an accident. This is due to the fact that the potential consequences of such an accident would be dominated by radionuclides other than tritium.

Transportation Tritium production at either Watts Bar 1, Sequoyah 1, or Sequoyah 2 would necessitate additional transportation to and from the reactor plants. Most of the additional transportation would involve nonradiological materials. Impacts would be limited to toxic vehicle emissions and traffic fatalities. At each of these reactors, the transportation risks would be less than one fatality per year. Radiological materials transportation impacts would include routine and accidental doses of radioactivity. The risks associated with radiological materials transportation would be less than one fatality per 100,000 years.

Bellefonte 1 and 2. Because neither Bellefonte 1 or Bellefonte 2 are currently operating, this EIS assesses the impacts of completing construction and operating these units for tritium production. Consequently, environmental impacts would occur in the following resources: visual resources, water use, biotic resources, socioeconomics, radiation exposure (worker and public), spent fuel generation, and low-level radioactive waste generation. Tritium production would also change the accident and transportation risks associated with these reactors.

During operations, Bellefonte 1 and 2 would produce vapor plumes from cooling towers that would be visible up to 10 miles away. These plumes could create an aesthetic impact on the towns of Pisgah, Hollywood, and Scottsboro, Alabama.

During operation, Bellefonte 1 and 2 each would use less than 0.5 percent of the river flow from Guntersville Reservoir and would not have any adverse impacts on other users. Discharges from the plants would be treated and monitored before release and would comply with NPDES permits. Impacts on water quality would be minimal, and no standards would be exceeded. Operation of either Bellefonte 1 or both Bellefonte 1 and 2 for tritium production would have some effects on ecological resources typical to the operation of a nuclear power plant, regardless of tritium production. Impacts on ecological resources from the operation of Bellefonte 1 or both Bellefonte 1 and 2 would result from radioactive and nonradioactive emissions of air pollutants to the atmosphere; thermal, chemical, and radioactive effluent releases to surface waters; increases in human activity; and increases in noise levels. These impacts would be small, considering that the units would operate in compliance with all Federal, state, and local requirements specifically promulgated to protect environmental resources. The estimated radiological doses to terrestrial and aquatic organisms are well below levels that could have any impact on plants or terrestrial and aquatic animals at the site. Other possible environmental impacts on the aquatic ecosystem of Guntersville Reservoir due to operation of the Bellefonte units would include fish losses at the cooling water intake screens, almost total loss of unscreened entrained organisms, and effects of thermal and chemical discharges. The effects of both thermal and chemical discharges would be small, as these discharges would comply with NPDES limitations.

Socioeconomics During operations, approximately 800 direct jobs would be created at Bellefonte 1, along with approximately an equal number of indirect jobs. The total new jobs (approximately 1,600) would cause the regional economic area unemployment rate to decrease to approximately 6.2 percent. Public finance expenditures/revenues would decline from the levels achieved during construction, but would remain 10 to 15 percent higher than they would be otherwise at Scottsboro and 5 to 10 percent higher in Jackson County. Housing prices would decline and could fall below the precompletion prices, depending on how much new construction of permanent housing took place during the completion period and how many construction workers chose to remain in the area once construction was completed. If Bellefonte 2 were also completed, a total of approximately 1,000 direct jobs would be created along with approximately 1,000 indirect jobs.

Radiation Exposure Reactor operations to produce tritium would cause worker radiation exposure to increase from 0 to approximately 105 millirem per year. This resultant dose would be well within regulatory limits of 5,000 millirem per year. Radiation exposure to the maximally exposed individual from normal operations would increase from 0 to 0.28 millirem. The total dose to the population within 80 kilometers (50 miles) would increase from approximately 0 to approximately 2.3 person-rem per year for Bellefonte 1. If Bellefonte 2 also were operating, this dose would be approximately 4.6 person-rem per year. Statistically, this equates to one fatal cancer approximately every 435 years from the operation of Bellefonte 1 and 2.

Spent Fuel Generation Given production of the maximum amount of tritium in the average 18-month fuel cycle, spent fuel generation would increase from 0 up to a maximum of 141 spent fuel assemblies (i.e., 69 fuel assemblies over the normal refueling size). Because this EIS assumes that long-term spent fuel storage would take place at each of the reactor plants, a dry cask spent fuel storage facility could eventually be needed to store the additional assemblies. The impacts of storing the spent fuel in a dry cask spent fuel storage facility are described above for the existing operating reactor plants. As previously mentioned, appropriate NEPA documentation would be prepared before the construction of a dry cask spent fuel storage facility.

Low-Level Radioactive Waste Generation Compared to the No Action Alternative, reactor operation to produce tritium at Bellefonte 1 or Bellefonte 2 would generate approximately 40 cubic meters (80 cubic meters for both units) of low-level radioactive waste. This quantity would be a small fraction of the landfill capacity at the Barnwell disposal facility or the Savannah River Site's low-level radioactive waste disposal facility.

Accident Risks Compared to the No Action Alternative, there is a significant change in potential risks from tritium production. Risks due to accidents would increase during the construction and operation of Bellefonte 1 and 2, and during the operation of these units for production of tritium. Similar to Watts Bar 1 and Sequoyah 1 and 2, the potential impacts from the accidents at Bellefonte 1 or Bellefonte 2 were determined using computer modeling. If a limiting design-basis accident occurred, tritium production would increase the individual risk of a fatal cancer by 8.0×10^{-10} additional fatal cancers to an individual living within 80 kilometers (50 miles) of the units. Statistically this means that, for one individual, one fatal cancer would occur approximately every 1.3 billion years from tritium production at Bellefonte. If a beyond design-basis accident occurred (an accident that has a probability of occurring approximately once in a million years or less), tritium production would increase the risk of a fatal cancer by 0.00010 additional fatal cancers to an individual living within 80 kilometers (50 miles) of the Bellefonte Nuclear Plant.

Transportation Tritium production at either Bellefonte 1 or 2 would necessitate transportation of workers, construction material, and radiological and nonradiological material to and from the reactor plants. Most of the additional transportation would involve nonradiological materials. Impacts of this transportation are limited to toxic vehicle emissions and traffic fatalities. For Bellefonte 1 or 2, the transportation risks would be significantly lower than one fatality per year. Radiological materials transportation impacts would occur as a result of routine and accidental doses. In all instances the risks associated with radiological materials transportation would be less than one fatality per 100,000 years.

3.2.7 Preferred Alternative

The Council on Environmental Quality regulations require that an agency identify its Preferred Alternative(s) in the Final EIS (40 CFR 1502.14e). The Preferred Alternative is defined as the alternative that the agency believes would fulfill its statutory mission, giving consideration to environmental, economic, technical, and other factors. This EIS provides information on the environmental impacts. Cost, schedule, and technical analyses will be discussed in the Record of Decision for the EIS. DOE has identified the purchase of irradiation services from the Watts Bar and Sequoyah reactor facilities as the Preferred Alternative for the production of tritium in a CLWR. Under the Preferred Alternative, no more than 3,400 TPBARs would be irradiated in a single reactor per each refueling cycle. In implementing the Preferred Alternative, DOE and TVA would minimize, to the extent practicable, the generation of additional spent nuclear fuel.

Table 3–13 Summary of Environmental Consequences for the CLWR Reactor Alternatives

Resource/Material Categories	***Watts Bar 1***	***Sequoyah 1 or Sequoyah 2***	***Bellefonte 1 or Bellefonte 2***
No Action			
All Resource/Material Categories	No construction or operational changes. Reactor unit continues to produce electricity. No change in environmental impacts.	No construction or operational changes. Reactor units continue to produce electricity. No change in environmental impacts.	No construction or operational changes. Reactor units remain uncompleted. No change in environmental impacts.
Annual Tritium Production			
Land Resources			
Land Use	*Construction:* Potential land disturbance - 5.3 acres for dry cask ISFSI if constructed. *Operation:* Potential permanent land requirement - 3.1 acres for ISFSI if constructed.	*Construction:* Potential land disturbance - 5.47 acres for ISFSI if constructed. *Operation:* Potential permanent land requirement - 3.2 acres for ISFSI if constructed.	*Construction:* Potential land disturbance - 4.9 acres for ISFSI if constructed and additional land for support buildings. *Operation:* Potential permanent land requirement - 3.4 acres for ISFSI if constructed and additional land for support buildings.
Visual Resources	*Construction and Operation:* No additional impact to visual resources.	*Construction and Operation:* No additional impact to visual resources.	*Construction:* No additional impact to visual resources. *Operation:* Cooling tower vapor plumes would be visible up to 10 miles away.
Noise	*Construction:* No change from current levels. Small impacts if an ISFSI is constructed. *Operation:* No change from current levels.	*Construction:* No change from current levels. Small impacts if an ISFSI is constructed. *Operation:* No change from current levels.	*Construction:* No change from current levels except for construction vehicle traffic. Small impacts if an ISFSI is constructed. *Operation:* Increase in noise levels from 50 dBA (decibels A-weighted) to 51 dBA at nearest receptor. Increase in traffic noise on onsite access roads from 50 dBA to 57 dBA due to commuter traffic and truck deliveries.

Resource/Material Categories	*Watts Bar 1*	*Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 2*
Air Quality Nonradioactive Emissions	*Construction:* No change from current air quality conditions. Small impacts if an ISFSI is constructed. *Operation:* No change from current air quality conditions.	*Construction:* No change from current air quality conditions. Small impacts if an ISFSI is constructed. *Operation:* No change from current air quality conditions.	*Construction:* Potential temporary dust emissions during construction. Small impacts if an ISFSI is constructed. *Operation:* The increase in nonradioactive air pollutant concentrations would be well within established standards.
Air Quality Radioactive Emissions	*Construction:* No radioactive emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 100 Curies; given 3,400 TPBARs, 340 Curies.	*Construction:* No radioactive emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 100 Curies; given 3,400 TPBARs, 340 Curies.	*Construction:* No radioactive emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 106 Curies; given 3,400 TPBARs, 346 Curies, of which 5.6 Curies would be from normal operation without tritium production. The release of other radioactive emissions would be 283 Curies.
Water Resources Surface Water	*Construction:* No change to current surface water requirements, discharge, or water quality conditions. Small impacts if an ISFSI is constructed. *Operation:* No change to current surface water requirements.	*Construction:* No change to current surface water requirements, discharge, or water quality conditions. Small impacts if an ISFSI is constructed. *Operation:* No change to current surface water requirements.	*Construction:* Potential for increased stormwater runoff. Small amount of surface water requirements. Small impacts if an ISFSI is constructed. *Operation:* Increased surface water requirements and discharge. Water usage less than 1 percent of Tennessee River flow per year. All water quality parameters within established limits.

Resource/Material Categories	*Watts Bar 1*	*Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 2*
Water Resources (cont'd) Radioactive Effluent	*Construction:* No radioactive effluents. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive tritium effluents would be 900 Curies; given 3,400 TPBARs, 3,060 Curies. Tritium concentration will remain well below the EPA limit of 20,000 picocuries per liter.	*Construction:* No radioactive effluents. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive tritium effluents would be 900 Curies; given 3,400 TPBARs, 3,060 Curies. Tritium concentration will remain well below the EPA limit of 20,000 picocuries per liter.	*Construction:* No radioactive effluents. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive tritium effluents would be 1,539 Curies; given 3,400 TPBARs, 3,699 Curies, of which 639 Curies would be from normal operation without tritium production. The release of other radioactive effluents would be 1.32 Curies. Tritium concentration will remain well below the EPA limit of 20,000 picocuries per liter.
Groundwater	*Construction:* No groundwater requirements or additional impacts to groundwater quality conditions. *Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.	*Construction:* No groundwater requirements or additional impacts to groundwater quality conditions. *Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.	*Construction:* Groundwater would not be used during construction. *Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.
Ecological Resources	*Construction*: No additional impacts on ecological resources. Small impacts if an ISFSI is constructed. *Operation*: Small or no impacts to ecological resources from additional tritium releases.	*Construction*: No additional impacts on ecological resources. Small impacts if an ISFSI is constructed. *Operation*: Small or no impacts to ecological resources from additional tritium release.	*Construction:* Potential impacts to ecological resources due to the small amount of land disturbance. Small impacts if an ISFSI is constructed. *Operation:* Additional impacts on ecological resources, including fish impingement and entrainment of aquatic biota during normal plant operation. Small impacts to ecological resources from tritium and other radioactive releases during normal plant operations.

Resource/Material Categories	***Watts Bar 1***	***Sequoyah 1 or Sequoyah 2***	***Bellefonte 1 or Bellefonte 2***
Socioeconomics	*Construction:* No measurable impact. *Operation:* <1 percent impact on regional economy.	*Construction:* No measurable impact. *Operation:* <1 percent impact on regional economy.	*Construction:* 4,500 peak new direct jobs due to plant completion. Short-term increased costs and traffic for local jurisdictions. *Operation:* 800 to 1,000 workers per day. Increase in payment-in-lieu of taxes to state and local jurisdictions (approximately $5.5 to $8 million annually), decrease in the unemployment rate (from 8.2 percent to approximately 6.2 percent), and minor impacts to school resources.
Public and Occupational Health and Safety Normal Operation	Annual dose for 1,000 TPBARs: *Workers:* Average dose increase by 0.33 millirem. *Maximally Exposed Individual:* Dose increase by 0.013 millirem. *50-mile population:* Dose increase by 0.34 person-rem. Annual dose for 3,400 TPBARs: *Workers:* Average dose increase by 1.1 millirem. *Maximally Exposed Individual:* Dose increase by 0.05 millirem. *50-mile population:* Dose increase by 1.2 person-rem.	Annual dose for 1,000 TPBARs: *Workers:* Average dose increase by 0.24 millirem. *Maximally Exposed Individual:* Dose increase by 0.017 millirem. *50-mile population:* Dose increase by 0.57 person-rem. Annual dose for 3,400 TPBARs: *Workers:* Average dose increase by 0.82 millirem. *Maximally Exposed Individual:* Dose increase by 0.057 millirem. *50-mile population:* Dose increase by 1.9 person-rem.	Annual dose for 1,000 TPBARs: *Workers:* Average dose increase by 104.33 millirem, of which 104 millirem would be from normal operations without tritium production. *Maximally Exposed Individual:* Dose increase by 0.263 millirem, of which 0.26 millirem would be from normal operations without tritium production. *50-mile population:* Dose increase by 1.6 person-rem, of which 1.4 person-rem would be from normal operations without tritium production. Annual dose for 3,400 TPBARs: *Workers:* Average dose increase by 105.1 millirem, of which 104 millirem would be from normal operations without tritium production. *Maximally Exposed Individual:* Dose increase by 0.28 millirem. *50-mile population:* Dose increase by 2.3 person-rem.

Resource/Material Categories	Watts Bar 1	Sequoyah 1 or Sequoyah 2	Bellefonte 1 or Bellefonte 2
Design-Basis Accident Risks	Increased likelihood of a cancer fatality per year due to tritium production: For 1,000 TPBARs: *Maximally Exposed Individual:* 3.4×10^{-8} (1 fatality in 29 million years). *Average individual in population:* 4.0×10^{-10} (1 fatality in 2.5 billion years). *Exposed population*: 0.000074 (1 fatality in 13 thousand years). *Noninvolved worker:* 4.2×10^{-10} (1 fatality in 2.4 billion years).	Increased likelihood of a cancer fatality per year due to tritium production: For 1,000 TPBARs: *Maximally Exposed Individual:* 7.9×10^{-9} (1 fatality in 130 million years). *Average individual in population:* 6.1×10^{-10} (1 fatality in 1.6 billion years). *Exposed population*: 0.00015 (1 fatality in 6.6 thousand years). *Noninvolved worker:* 1.3×10^{-10} (1 fatality in 7.7 billion years).	Increased likelihood of a cancer fatality per year due to tritium production: For 1,000 TPBARs: *Maximally Exposed Individual:* 3.5×10^{-7} (1 fatality in 2.9 million years). *Average individual in population:* 2.6×10^{-10} (1 fatality in 3.8 billion years). *Exposed population*: 0.000070 (1 fatality in 14 thousand years). *Noninvolved worker:* 1.2×10^{-12} (1 fatality in 830 billion years).
	Involved worker, reactor design-basis accident: In the highly unlikely event the workers are in containment at the time of the accident they will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible. *Involved worker, nonreactor design-basis accident:* In the highly unlikely event that involved workers are in the immediate area of a rupture of the gas decay tank or associated piping, they could be injured by debris or the stream of gas from the rupture. In addition, involved workers could receive a radiation dose while evacuating the area. If the accident is initiated by a valve failure or human error, the release will be vented out of the auxiliary building stack. The involved worker is not at risk of injury or an additional radiation dose.	*Involved worker, reactor design-basis accident:* In the highly unlikely event the workers are in containment at the time of the accident they will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible. *Involved worker, nonreactor design-basis accident:* In the highly unlikely event that involved workers are in the immediate area of a rupture of the gas decay tank or associated piping, they could be injured by debris or the stream of gas from the rupture. In addition, involved workers could receive a radiation dose while evacuating the area. If the accident is initiated by a valve failure or human error, the release will be vented out of the auxiliary building stack. The involved worker is not at risk of injury or an additional radiation dose.	*Involved worker, reactor design-basis accident:* In the highly unlikely event the workers are in containment at the time of the accident they will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible. *Involved worker, nonreactor design-basis accident:* In the highly unlikely event that involved workers are in the immediate area of a rupture of the gas decay tank or associated piping, they could be injured by debris or the stream of gas from the rupture. In addition, involved workers could receive a radiation dose while evacuating the area. If the accident is initiated by a valve failure or human error, the release will be vented out of the auxiliary building stack. The involved worker is not at risk of injury or an additional radiation dose.

Resource/Material Categories	***Watts Bar 1***	***Sequoyah 1 or Sequoyah 2***	***Bellefonte 1 or Bellefonte 2***
	For 3,400 TPBARs: *Maximally Exposed Individual:* 1.1×10^{-7} (1 fatality in 9.1 million years). *Average individual in population:* 1.4×10^{-9} (1 fatality in 710 million years). *Exposed population*: 0.00026 (1 fatality in 3.8 thousand years). *Noninvolved worker:* 1.5×10^{-9} (1 fatality in 670 million years).	For 3,400 TPBARs: *Maximally Exposed Individual :* 2.7×10^{-8} (1 fatality in 37 million years). *Average individual in population:* 2.1×10^{-9} (1 fatality in 480 million years). *Exposed population*: 0.00052 (1 fatality in 1.9 thousand years). *Noninvolved worker:* 4.5×10^{-10} (1 fatality in 2.2 billion years).	For 3,400 TPBARs: *Maximally Exposed Individual:* 3.6×10^{-7} (1 fatality in 2.8 million years). *Average individual in population:* 8.0×10^{-10} (1 fatality in 1.3 billion years). *Exposed population*: 0.00022 (1 fatality in 4.6 thousand years). *Noninvolved worker:* 4.3×10^{-12} (1 fatality in 230 billion years).
	Involved worker: Same as above for 1,000 TPBARs. *Involved worker: Same as above for 1,000 TPBARs.*	*Involved worker: Same as above for 1,000 TPBARs.* *Involved worker: Same as above for 1,000 TPBARs.*	*Involved worker: Same as above for 1,000 TPBARs.* *Involved worker: Same as above for 1,000 TPBARs.*
Beyond Design-Basis Accident Risks	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Average individual in population:* Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Exposed population*: Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production.	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual :* Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Average individual in population:* Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Exposed population*: Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production.	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* 3.3×10^{-8} (1 fatality in 30 million years). *Average individual in population:* 1.4×10^{-10} (1 fatality in 7.1 billion years). *Exposed population*: 0.00017 (1 fatality in 5.8 thousand years).

Resource/Material Categories	Watts Bar 1	Sequoyah 1 or Sequoyah 2	Bellefonte 1 or Bellefonte 2
	Noninvolved worker: Not applicable. Noninvolved worker has evacuated the plant before a release. Evacuation warning to noninvolved worker is at least one hour before a release. *Involved worker:* Most of the postulated accident sequences have adequate time for workers to evacuate the containment before there is a radioactive release to the containment. If the accident sequence is initiated by a large break loss-of-coolant accident or another high energy release mechanism, workers in containment will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible during a high energy steam release accident scenario.	*Noninvolved worker:* Not applicable. Noninvolved worker has evacuated the plant before a release. Evacuation warning to noninvolved worker is at least one hour before a release. *Involved worker:* Most of the postulated accident sequences have adequate time for workers to evacuate the containment before there is a radioactive release to the containment. If the accident sequence is initiated by a large break loss-of-coolant accident or another high energy release mechanism, workers in containment will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible during a high energy steam release accident scenario.	*Noninvolved worker:* Not applicable. Noninvolved worker has evacuated the plant before a release. Evacuation warning to noninvolved worker is at least one hour before a release. *Involved worker:* Most of the postulated accident sequences have adequate time for workers to evacuate the containment before there is a radioactive release to the containment. If the accident sequence is initiated by a large break loss-of-coolant accident or another high energy release mechanism, workers in containment will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible during a high energy steam release accident scenario.
	For 3,400 TPBARs: *Maximally Exposed Individual:* 1.0×10^{-10} (1 fatality in 10 billion years). *Average individual in population:* 1.0×10^{-11} (1 fatality in 100 billion years). *Exposed population*: 0.000011 (1 fatality in 88 thousand years).	For 3,400 TPBARs: *Maximally Exposed Individual :* 1.0×10^{-10} (1 fatality in 10 billion years). *Average individual in population:* 1.1×10^{-10} (1 fatality in 9.1 billion years). *Exposed population*: 0.00014 (1 fatality in 7.1 thousand years).	For 3,400 TPBARs: *Maximally Exposed Individual:* 3.3×10^{-8} (1 fatality in 30 million years). *Average individual in population:* 1.5×10^{-10} (1 fatality in 6.6 billion years). *Exposed population*: 0.00018 (1 fatality in 5.5 thousand years).
	Noninvolved worker: Same as for 1,000 TPBARs. *Involved worker:* Same as for 1,000 TPBARs.	*Noninvolved worker*: Same as for 1,000 TPBARs. *Involved worker:* Same as for 1,000 TPBARs.	*Noninvolved worker:* Same as for 1,000 TPBARs. *Involved worker:* Same as for 1,000 TPBARs.

Resource/Material Categories	Watts Bar 1	Sequoyah 1 or Sequoyah 2	Bellefonte 1 or Bellefonte 2
Waste Management	*Construction:* Potential nonhazardous waste if an ISFSI is constructed. *Operation:* Low-level radioactive waste increase by approximately 0.43 cubic meters per year. Other waste types would be unaffected by tritium production.	*Construction:* Potential nonhazardous waste if an ISFSI is constructed. *Operation:* Low-level radioactive waste increase by approximately 0.43 cubic meters per unit per year. Other waste types would be unaffected by tritium production.	*Construction:* Minor amounts of nonhazardous construction material waste generated during the completion of the plant. Potential nonhazardous waste if an ISFSI is constructed. *Operation:* Low-level radioactive waste increase by approximately 41 cubic meters per unit per year, of which 40 cubic meters would be from normal operations without tritium production.
Spent Nuclear Fuel Management	*Operation:* No increase if less than 2,000 TPBARs are irradiated. If 3,400 TPBARs are irradiated, the amount of spent fuel generated would increase by a maximum of 56 fuel assemblies per fuel cycle.	*Operation:* No increase if less than 2,000 TPBARs are irradiated. If 3,400 TPBARs are irradiated, the amount of spent fuel generated would increase by a maximum of 60 fuel assemblies per fuel cycle.	*Operation:* The amount of spent fuel would increase from 0 to approximately 72 spent fuel assemblies for less than 2,000 TPBARs. For 3,400 TPBARs, the amount of spent fuel generation could increase from 0 to a maximum of 141 spent fuel assemblies per fuel cycle, of which 72 would be from normal operation without tritium production.
Transportation	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years.	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years.	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years. Traffic volumes on local roads could increase during construction and operations.
Fuel Fabrication	Not applicable for the reactor site.	Not applicable for the reactor site.	Not applicable for the reactor site.
Decontamination and Decommissioning	Decontamination and decommissioning would be required but not because of tritium production.	Decontamination and decommissioning would be required but not because of tritium production.	Decontamination and decommissioning would be required. For a generic discussion on impacts from decontamination and decommissioning, see Section 5.2.5.

Resource/Material Categories	***Watts Bar 1***	***Sequoyah 1 or Sequoyah 2***	***Bellefonte 1 or Bellefonte 2***
License Renewal	Licensing renewal would be required. For a generic discussion on impacts from licensing renewal, see Section 5.2.4.	Licensing renewal would be required. For a generic discussion on impacts from licensing renewal, see Section 5.2.4.	Licensing renewal would not be required.

MEI = Maximally Exposed Offsite Individual.
ISFSI = Independent Spent Fuel Storage Installation.

Table 3–14 Summary Comparison of Environmental Impacts Between CLWR Reactor Alternatives and the APT

Resource/Material Categories	*Watts Bar 1 or Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 1 and Bellefonte 2*	*CLWR No Action (APT at the Savannah River Site)*[a]
Land Resources			
Land Use	*Construction:* Potential land requirement—5.3 acres (Watts Bar) or 5.47 acres (Sequoyah) of previously disturbed industrial land for a dry cask ISFSI if constructed. *Operation:* Potential permanent land requirement - 3.1 to 3.2 acres, respectively, of previously disturbed industrial land for an ISFSI if constructed.	*Construction:* Potential land requirement—4.9 acres of previously disturbed industrial land for an ISFSI, if constructed, and additional small amounts of land for support buildings. *Operation:* Potential permanent land requirement - 3.4 acres of previously disturbed industrial land for an ISFSI, if constructed, and additional small amounts of land for support buildings.	*Construction and Operation:* 250 acres of land converted to industrial use. Additional lands for new roads, bridge upgrades, rail lines, and construction landfill. Additional 12 acres required for modular design, if selected. Additional land required for electric power generating facility, if constructed (e.g., 110 acres for a natural gas-fired facility and 290 acres for a coal-fired facility).
Visual Resources	*Construction and Operation:* No additional impact to visual resources.	*Construction:* No additional impact to visual resources. *Operation:* Vapor plumes under certain meteorological conditions would be visible up to 10 miles away.	*Construction:* No additional impact to visual resources. *Operation:* Vapor plumes under certain meteorological conditions would be visible.
Noise	*Construction:* No change from current levels. Small impacts if an ISFSI is constructed. *Operation:* No change from current levels.	*Construction:* No change from current levels except for construction vehicle traffic. Small impacts if an ISFSI is constructed. *Operation:* Increase in noise emissions from the plant from 50 dBA to 51 dBA at nearest receptor. Increase in traffic noise on site access roads from 50 dBA to 57 dBA due to commuter traffic and truck deliveries.	*Construction:* No change from current levels except for construction vehicle traffic. *Operation:* Increase in noise emissions from the new APT facility, electric power generating facility (if constructed), and support facilities.
Air Quality			
Non-radiological Emissions	*Construction:* No change from current air quality conditions. Small impacts if an ISFSI is constructed. *Operation:* No change from current air quality conditions.	*Construction:* Potential temporary dust emissions during construction. Small impacts if an ISFSI is constructed. *Operation:* The increase in nonradioactive emissions would be within established standards.	*Construction:* Potential temporary dust emissions during construction. *Operation:* The increase in nonradiological emissions would be within standards. Large increase in carbon dioxide emissions from any electric power generating facility.

Resource/Material Categories	Watts Bar 1 or Sequoyah 1 or Sequoyah 2	Bellefonte 1 or Bellefonte 1 and Bellefonte 2	CLWR No Action (APT at the Savannah River Site)[a]
Radioactive Emissions	*Construction:* No radiological emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 100 Curies; given 3,400 TPBARs, 340 Curies.	*Construction:* No radiological emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 106 Curies; given 3,400 TPBARs, 346 Curies, of which 5.6 Curies would be from normal operation without tritium production. The release of other radioactive emissions would be 283 Curies.	*Construction:* No radiological emissions. *Operation:* The maximum potential increase in annual radioactive emissions of tritium would be 30,000 Curies in oxide form and 8,600 Curies in elemental form. The release of other radioactive emissions would be 2,250 Curies. Potential for an additional 2,000 Curies from electric power generating facility if power is acquired through market transaction (APT Final EIS p. C-46 & Draft EIS p. 4-80).
Water Resources Surface Water	*Construction:* No change to current surface water requirements, discharge, or water quality conditions. Small impacts if an ISFSI is constructed. *Operation:* No change to current surface water requirements, discharge, or water quality conditions.	*Construction:* Potential for increased storm water runoff. Small amount of surface water requirements. Small impacts if an ISFSI is constructed. *Operation:* Increased surface water requirements and discharge. Water usage less than 1 percent of Tennessee River flow per year. All water quality parameters within established limits.	*Construction:* Increased storm water runoff and impacts from dewatering. Surface water requirements. *Operation:* Increased surface water requirements and discharge. Potential for additional water requirements from an electric power generating facility, if constructed—4.7 billion gallons per day (coal-fired) and 1.4 billion gallons per day (natural gas-fired). All water quality parameters within established limits (APT Draft EIS p. 4-81).
Water Resources Radioactive Effluent	*Construction:* No radiological effluent. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 900 Curies; given 3,400 TPBARs, 3,060 Curies.	*Construction:* No radiological effluent. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 1,539 Curies; given 3,400 TPBARs 3,699 Curies, of which 639 Curies from normal operation without tritium production. The release of other radioactive effluents would be 1.32 Curies.	*Construction:* No radiological effluent. *Operation:* The maximum potential increase in annual radioactive tritium effluents would be 3,000 Curies and 0.0031 Curies from other radioactive emissions. Potential for an additional 19,000 Curies from the electric power generating facility if power is acquired through market transaction (APT Final EIS p. C-43 & Draft EIS 4-80).
Groundwater	*Construction and Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.	*Construction:* Groundwater would not be used during construction. *Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.	*Construction:* Due to below-ground construction of the APT, groundwater would be withdrawn and discharged to surface water. *Operation:* Potential for a 6,000 gallons per minute withdrawal of groundwater for APT cooling water (APT Draft EIS p. 4-3).

Resource/Material Categories	Watts Bar 1 or Sequoyah 1 or Sequoyah 2	Bellefonte 1 or Bellefonte 1 and Bellefonte 2	CLWR No Action (APT at the Savannah River Site)[a]
Ecological Resources	*Construction:* No additional impacts on ecological resources. Small impacts if an ISFSI is constructed. *Operation:* Small or no impacts to ecological resources from tritium production.	*Construction:* Potential impacts to ecological resources due to the small amount of land disturbance. Small impacts if an ISFSI is constructed. *Operation:* Impacts on ecological resources, including fish impingement and entrainment of aquatic biota during normal plant operation. Small impacts to ecological resources from tritium and other radioactive releases during normal plant operations.	*Construction:* Potential impacts to ecological resources due to land disturbance. *Operation:* Impacts on ecological resources, including fish impingement and entrainment of aquatic biota during normal plant operation. Small impacts to ecological resources from tritium and other radioactive releases during normal operations. Potential additional impacts on ecological resources from electric power generating plant, if constructed.
Socioeconomics	*Construction:* No measurable impact. *Operation:* less than 1 percent impact on regional economy.	*Construction:* 4,500 peak new direct jobs due to plant completion. Short-term increased costs and traffic for local jurisdictions. *Operation:* 800 to 1,000 workers per day. Increase in payment-in-lieu of taxes to state and local jurisdictions (approximately $5.5 to $8 million annually), decrease in the unemployment rate (from 8.2 percent in 1997 to approximately 6.2 percent), and minor impacts to school resources.	*Construction:* 1,400 peak new direct jobs. Short-term increased costs and traffic for local jurisdictions. Additional 1,100 peak jobs associated with new electric power generating facility, if constructed (APT Draft EIS p. 4-80). *Operation:* 500 workers per day. Increase in payment-in-lieu of taxes to state and local jurisdictions, decrease in the unemployment rate, and minor impacts to school resources. Additional 200 jobs associated with new electric power generating facility, if constructed (APT Draft EIS p. 4-80).

Resource/Material Categories	*Watts Bar 1 or Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 1 and Bellefonte 2*	*CLWR No Action (APT at the Savannah River Site)*[a]
Public and Occupational Health and Safety Normal Operation	Annual dose for 1,000 TPBARs: *Workers*: Total dose - 112.35 person-rem (Watts Bar) and 132.35 person-rem (Sequoyah). *Maximally Exposed Individual*: Dose increase by 0.013 millirem (Watts Bar) and 0.017 millirem (Sequoyah). *50-mile population*: Dose increase by 0.34 person-rem (Watts Bar) and 0.60 person-rem (Sequoyah). Annual dose for 3,400 TPBARs: *Workers*: Total dose 113.2 person-rem (Watts Bar) and 133.2 person-rem (Sequoyah). *Maximally Exposed Individual*: Dose increase by 0.05 millirem (Watts Bar) and 0.057 millirem (Sequoyah). *50-mile population*: Dose increase by 1.2 person-rem (Watts Bar) and 1.9 person-rem (Sequoyah).	Annual dose for 1,000 TPBARs: *Workers*: Total dose—112.35 person-rem per unit; 112 person-rem per unit from normal operations without tritium production. *Maximally Exposed Individual*: Dose increase by 0.263 millirem per unit, of which 0.26 millirem per unit would be from normal operation without tritium production. *50-mile population*: Dose increase by 1.6 person-rem per unit, of which 1.4 person-rem per unit would be from normal operation without tritium production. Annual dose for 3,400 TPBARs: *Workers*: Total dose—113.2 person-rem; 112 person-rem from per unit normal operations without tritium production. *Maximally Exposed Individual*: Dose increase by 0.28 millirem per unit, of which 0.26 millirem per unit would be from normal operation without tritium production. *50-mile population*: Dose increase by 2.3 person-rem per unit, of which 1.4 person-rem per unit would be from normal operation without tritium production.	Annual dose *Workers*: Total dose - 72 person-rem (APT Draft EIS p. 4-39). *Maximally Exposed Individual*: Dose increase by 0.053 millirem (APT Final EIS p. C-52). *50-mile population*: Dose increase by 3.1 person-rem (APT Final EIS p. C-52).

Resource/Material Categories	***Watts Bar 1 or Sequoyah 1 or Sequoyah 2***	***Bellefonte 1 or Bellefonte 1 and Bellefonte 2***	***CLWR No Action (APT at the Savannah River Site)[a]***
Design-Basis Accident Risks	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* 3.4×10^{-8} (1 fatality in 29 million years - Watts Bar) and 7.9×10^{-9} (1 fatality in 130 million years - Sequoyah). *Average individual in population:* 4.0×10^{-10} (1 fatality in 2.5 billion years - Watts Bar) and 6.1×10^{-10} (1 fatality in 1.6 billion years - Sequoyah). *Exposed population:* 0.000074 (1 fatality in 13 thousand years - Watts Bar) and 0.00015 (1 fatality in 6.6 thousand years). *Noninvolved worker:* 4.2×10^{-10} (1 fatality in 2.4 billion years - Watts Bar) and 1.3×10^{-10} (1 fatality in 7.7 billion years - Sequoyah). For 3,400 TPBARs: *Maximally Exposed Individual:* 1.1×10^{-7} (1 fatality in 9.1 million years - Watts Bar) and 2.7×10^{-8} (1 fatality in 37 million years - Sequoyah). *Average individual in population:* 1.4×10^{-9} (1 fatality in 710 million years - Watts Bar) and 2.1×10^{-9} (1 fatality in 480 million years - Sequoyah). *Exposed population:* 0.00026 (1 fatality in 3.8 thousand years - Watts Bar) and 0.00052 (1 fatality in 1.9 thousand years). *Noninvolved worker:* 1.5×10^{-9} (1 fatality in 670 million years - Watts Bar) and 4.5×10^{-10} (1 fatality in 2.2 billion years - Sequoyah).	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* 3.5×10^{-7} (1 fatality in 2.9 million years). *Average individual in population:* 2.6×10^{-10} (1 fatality in 3.8 billion years). *Exposed population:* 0.000070 (1 fatality in 14 thousand years). *Noninvolved worker:* 1.2×10^{-12} (1 fatality in 830 billion years). For 3,400 TPBARs: *Maximally Exposed Individual:* 3.6×10^{-7} (1 fatality in 2.8 million years). *Average individual in population:* 8.0×10^{-10} (1 fatality in 1.3 billion years). *Exposed population:* 0.00022 (1 fatality in 4.6 thousand years). *Noninvolved worker:* 4.3×10^{-12} (1 fatality in 230 billion years).	Increased likelihood of a cancer fatality per year due to tritium production. Design-basis seismic event: 2.6 fatalities every 2,000 years.

Resource/Material Categories	*Watts Bar 1 or Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 1 and Bellefonte 2*	*CLWR No Action (APT at the Savannah River Site)*[a]
Waste Management	*Construction:* Potential nonhazardous waste if an ISFSI is constructed. *Operation*: Low-level radioactive waste increase by approximately 0.43 cubic meters per unit per year. Other waste types would be unaffected by tritium production.	*Construction:* Minor amounts of nonhazardous construction material waste generated during the completion of the plant. Potential for additional nonhazardous waste material generated if an ISFSI is constructed. *Operation*: Low-level radioactive waste increase by approximately 41 cubic meters per unit per year, of which 40 cubic meters would be from normal operation without tritium production. Other waste types would also be generated due to tritium production.	*Construction:* 30,000 cubic meters of construction material generated and deposited in onsite landfill. Potential for additional nonhazardous waste material generated if new electric power generating facility is constructed. *Operation:* Low-level radioactive waste increase by approximately 1,400 cubic meters per year. Potential for additional 10,000 units of nuclear solid waste if power is acquired through market transaction (APT Draft EIS p. 4-80). Other waste types would also be generated due to tritium production and electric power generation (APT Draft EIS p. 4-26).
Spent Nuclear Fuel Management	*Operation:* No increase if less than 2,000 TPBARs are radiated. If 3,400 TPBARs are irradiated, the amount of spent fuel generated would increase by a maximum of 60 (Sequoyah), and 56 (Watts Bar) fuel assemblies per fuel cycle.	*Operation:* The amount of spent fuel would increase from 0 to approximately 72 spent fuel assemblies for less than 2,000 TPBARs. For 3,400 TPBARs, the amount of spent fuel generation could increase from zero to a maximum of 141 spent fuel assemblies per fuel cycle, of which 72 would be from normal operation without tritium production.	*Operation:* Spent nuclear fuel would be generated under the market transaction/existing capacity alternative for electric power generation.
Transportation	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years.	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years. Traffic volumes on local roads could increase during construction and operations.	Transportation within the Savannah River Site only.
Fuel Fabrication	Not applicable for reactor site.	Not applicable for reactor site.	Not applicable for APT facility. Yes for electric-generating facility.
Decontamination and Decommissioning	Decontamination and decommissioning would be required but not because of tritium production.	Decontamination and decommissioning would be required. For a generic discussion on impacts from decontamination and decommissioning, see Section 5.2.5.	Decontamination and decommissioning would be required.
License Renewal	Licensing renewal would be required. For a generic discussion on impacts from licensing renewal, see Section 5.2.4.	Licensing renewal would not be required.	Licensing renewal is not applicable.

[a] Based on tritium production of 3 kilograms of tritium per year.