5. ENVIRONMENTAL CONSEQUENCES

Chapter 5 describes the environmental consequences of the production of tritium in commercial light water reactors. It begins with a brief introduction, followed by an elaboration of the potential environmental consequences of tritium production at each site. Included for consideration are the radiological impacts of operations and potential facility accidents. There follows a description of the consequences of activities that, although related to the reactor sites, are generic in nature and can be treated separately—specifically, reactor licensing renewal, decontamination and decommissioning, and spent fuel storage. Discussion then turns to the impacts from elements of the proposed action that are not directly related to the reactor sites, such as the fabrication and transport of tritium-producing burnable absorber rods. Also presented is a sensitivity analysis focused on tritium-producing burnable absorber rod design and the refueling cycle; separate evaluations of the implications of programmatic No Action and the impacts of commercial light water reactor facility accidents; and a description of the cumulative impacts of the proposed actions. The chapter concludes with a look at several issues common to all sites: unavoidable, adverse environmental impacts; relationships between local, short-term uses of man's environment and the enhancement of long-term productivity; irreversible, irretrievable commitments of resources; and mitigation measures.

5.1 INTRODUCTION

This environmental impact statement (EIS) is in compliance with regulations of the Council on Environmental Quality that require the affected environment of proposed Federal actions to be "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment," (40 CFR 1508.14). It focuses in part on the environmental consequences of the U.S. Department of Energy's (DOE) production of tritium in three commercial light water reactors (CLWRs) operated by the Tennessee Valley Authority (TVA)—Watts Bar Nuclear Plant Unit 1 (Watts Bar 1) and Sequoyah Nuclear Plant Units 1 and 2 (Sequoyah 1 and 2)—from the perspective of a comparison of the incremental impacts of tritium production with continued operation without tritium production (the present status). Also examined are the environmental impacts of tritium production in one or both of TVA's partially completed reactors, Bellefonte Nuclear Plant Units 1 and 2 (Bellefonte 1 and 2), as well as impacts associated with the construction activities required for the completion and full operation of those units. The assessment results presented in this chapter constitute the analytical basis for a comparison of all proposed actions with the No Action Alternative detailed in Chapter 3.

5.1.1 Methodology

Specific assumptions associated with the impact analysis common to all sites are provided in the appendices. The environmental assessment methods used in assessing the environmental impacts for each resource and issue at each alternative reactor site are discussed in Appendix B of this EIS.

The methods for the evaluation of human health effects for: (1) normal operation of CLWR facilities, (2) CLWR facility accidents, and (3) overland transportation are presented in Appendices C, D, and E respectively. The results of these analyses are presented in this chapter.

The discussion of public and occupational health and safety considers the radiological and chemical impacts under normal operations as well as accident scenarios. The spectrum of potential accident scenarios evaluated in this EIS include: a reactor design-basis accident, a nonreactor design-basis accident, a handling accident involving the tritium-producing burnable absorber rods (TPBARs), two transportation cask handling accidents, and beyond design-basis reactor accidents involving core damage with loss of containment integrity. For operating reactors, the impacts from the accidents with tritium production are compared to operation without tritium production. The accident selection and the uncertainties are presented in Appendix D. Analysis of transportation impacts are considered for both routine transportation and transportation accidents. The conservatism of some of the assumptions used in these analyses are summarized below.

5.1.2 Assumptions

Conservative assumptions have been incorporated into the analysis method for this EIS to ensure that the health and safety impacts to the public and workers would not be underestimated. The following are examples of conservative assumptions incorporated in the analysis method.

- The models used to estimate the risk of latent cancers from radiation are known to overestimate the risk for low dose rates. The actual risk may be zero.

- The effective dose from an elemental tritium gas exposure is about 10,000 times less than the effective dose from an exposure to airborne tritium oxide. All tritium released to the environment from TPBARs during normal incident-free operation and/or during reactor, nonreactor, TPBAR handling, and transportation cask handling facility accidents is assumed to be converted to oxide form prior to release.

- When an accident frequency was estimated to be in a range, accident risk estimates were based on the high end of the range.

- The analyses assumed that 1 Curie of tritium from each TPBAR could permeate through the cladding and be released to the environment over a period of a year although, as discussed in Sections 1.3.4 and 3.1.2, the performance of the tritium "getter" is such that there is virtually no tritium available in a form that could permeate through the cladding.

- The analyses involving abnormal events assumed that 2 TPBARs could fail in a given core load of 3,400 TPBARs, and the entire inventory of tritium could be released to the reactor coolant and then to the environment. This is an extremely conservative assumption, considering the historic failure rate of standard burnable absorber rods, as discussed in Section 1.9.

- The analyses assumed that during the reactor design-basis accident all TPBARs would be breached and their tritium contents released to the reactor coolant system. Uncertainty exists on the actual percentage of TPBARs that would be breached during this accident.

- The analyses assumed an average tritium production of 1 gram per TPBAR per 18-month fuel cycle. This would overestimate the available tritium by about 15 percent, considering an estimated average tritium production rate of about 0.84 gram per TPBAR per cycle (WEC 1997).

- The analyses assumed that during a nonreactor design-basis accident about 10 percent of the tritium that was released to the reactor coolant system during normal operation would be released to the atmosphere.

- The analyses assumed that during a TPBAR handling accident the entire tritium inventory of 24 breached TPBARs would be released into the fuel pool and eventually to the environment. The analyses took no credit for mitigating actions that would be taken to limit the release of tritium into the fuel pool.

5.2 Environmental Consequences

Environmental consequences of the No Action Alternative and tritium production are evaluated in the following sections for Watts Bar 1, Sequoyah 1 and 2, and Bellefonte 1 and 2. The evaluation of tritium production impacts considers a tritium production reactor core with a nominal 1,000 TPBARs and a core with the maximum number of 3,400 TPBARs. Both the 1,000 and 3,400 TPBAR core configurations assume an 18-month reactor operating cycle. The impacts are evaluated for both individual and combined units at each site as applicable. In some cases the combined effects of two units at a site would be less than twice the impact of the individual units. Sensitivity analyses are performed in Section 5.2.9 to assess the changes in impacts due to TPBAR design modifications to increase tritium production per TPBAR, thereby reducing the core reload cycle to 15.5 or 12 months and reducing the number of TPBARs in the core to 100.

5.2.1 Watts Bar Nuclear Plant Unit 1

5.2.1.1 Land Resources

The land resources analysis addresses land use and visual resources for the region of influence. The region of influence for land use includes land within 3.2 kilometers (2 miles) of the Watts Bar site. The region of influence for visual resources includes those lands and waters from which the site is visible (the viewshed).

Land Use

No Action

No land use impacts are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

No additional property would be required for tritium production at the Watts Bar site. Land use would remain unchanged from its current industrial use. The 716-hectare (1,770-acre) site contains ample area for a dry cask spent nuclear fuel storage facility, if constructed. A description of a generic dry cask independent spent fuel storage installation (ISFSI) and its impacts is presented in Section 5.2.6.

Visual Resources

No Action

No visual impacts are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

There would be no change in the visual character of the Watts Bar site as a result of tritium production. The major visual elements of the plant already exist, including the cooling towers and the transmission lines. As described in Section 4.2.1.1, views of the Watts Bar Nuclear Plant from passing river traffic on the Tennessee River are partially screened by the wooded area east of the plant. Distant glimpses of the plant site can be had from locations along the river and various roads in the area.

5.2.1.2 Noise

No Action

No noise impacts are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Noise levels should not change as a result of tritium production at the Watts Bar site. No construction would occur at the Watts Bar site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

5.2.1.3 Air Quality

NONRADIOACTIVE GASEOUS EMISSIONS

No Action

No air quality impacts are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action (see Section 4.2.1.3, Table 4–1).

Tritium Production

Air quality should not change as a result of the production of tritium at the Watts Bar site. No construction would occur at Watts Bar unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

RADIOACTIVE GASEOUS EMISSIONS

No Action

Under the No Action Alternative, the radioactive gaseous emissions at Watts Bar 1 should continue at the levels described in Section 4.2.1.3, Table 4–2, assuming that no significant operational deviations would occur.

Tritium Production

A design objective of the TPBARs is to retain as much tritium as possible within the TPBAR. The performance of the tritium "getter" is such that there is virtually no tritium available in a form that could permeate through the TPBAR cladding. However, for the purposes of this EIS it was conservatively assumed that an average of 1 Curie of tritium per TPBAR per year could permeate to the reactor coolant (PNNL 1997b, PNNL 1999). It also was assumed that 10 percent of this tritium could be released to the environment as gaseous emission. Because of this assumption the radioactive gaseous emissions from Watts Bar 1 would increase. **Table 5–1** shows the annual radioactive gaseous emissions during tritium production at Watts Bar 1 with 0, 1,000, and 3,400 TPBARs. The method and assumptions used for the calculations are provided in Appendix C, Section C.3.4. Radiological exposures of the public and workers from radioactive emissions are presented in Section 5.2.1.9. The impacts on plants and animals are described in Section 5.2.1.6.

Table 5–1 Annual Radioactive Gaseous Emissions at Watts Bar 1

	No Action (0 TPBARs)	*Tritium Production*	
		1,000 TPBARs	*3,400 TPBARs*
Tritium release (Curies)	5.6	105.6	345.6
Other radioactive release (Curies)	283[a]	283	283
Total release (Curies)	288.6	388.6	628.6

[a] The isotopic distribution of this release is presented in Appendix C, Table C-9.
Source: TVA 1998e, TVA 1999.

5.2.1.4 Water Resources

SURFACE WATER

No Action

No surface water impacts are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Impacts on surface water from nonradiological discharges at the Watts Bar site should not change as a result of tritium production. No construction would occur at the Watts Bar site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

GROUNDWATER

No Action

No groundwater impacts are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Impacts on groundwater at the Watts Bar site should not change as a result of tritium production. No construction would occur at the Watts Bar site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

RADIOACTIVE LIQUID EFFLUENT

No Action

Under the No Action Alternative, the liquid radioactive effluent at Watts Bar 1 should continue at the levels described in Section 4.2.1.4, Table 4–4, assuming that no significant operational deviations would occur.

Tritium Production

Based on the assumption that an average of 1 Curie of tritium per TPBAR per year could permeate to the reactor coolant and that 90 percent of this tritium could be released as liquid effluent, radioactive liquid effluent from Watts Bar 1 would increase. **Table 5–2** shows the annual radioactive releases in liquid effluent during tritium production at Watts Bar 1 with 0, 1,000, and 3,400 TPBARs. The method and assumptions used for the calculations are included in Appendix C, Section C.3. Radiological exposures of the public and workers from radioactive emissions are presented in Section 5.2.1.9. The impacts on plants and animals are described in Section 5.2.1.6.

In accordance with the Safe Drinking Water Act requirements promulgated by the Environmental Protection Agency (EPA) in 40 CFR Parts 100-149, a tritium concentration of 20,000 picocuries per liter has been established as a limit for drinking water. In view of this regulatory limit, an analysis was performed to estimate tritium concentrations in the Tennessee River that could result from tritium production at Watts Bar 1. The average expected tritium concentrations in the river were calculated using the Cornell Mixing Zone Expert System (CORMIX) (Cornell 1996). **Table 5–3** presents the potential tritium concentrations from the incident-free irradiation of 1,000 and 3,400 TPBARs at two points: (1) the edge of the near-field and (2) the nearest drinking water intake. "Near-field" in CORMIX is the area surrounding the discharge point of the effluent where initial mixing is taking place. The edge of the near-field typically extends to a few meters away from the point of discharge. Table 5–3 also presents potential tritium concentrations in the unlikely event of 2 TPBAR failures during a given 18-month operating cycle. The results indicate that tritium concentrations would remain well below the 20,000 picocuries per liter limit, and at the drinking water intake the tritium concentration would be below or close to the lower detection limit for tritium which is approximately 300 picocuries per liter. Tritium production is not expected to affect the requirements in the Watts Bar 1 National Pollution Discharge Elimination System (NPDES) Permit.

Table 5–2 Annual Radioactive Liquid Effluents at Watts Bar 1

	No Action (0 TPBARs)	*Tritium Production*	
		1,000 TPBARs	*3,400 TPBARs*
Tritium release (Curies)	639	1,539	3,699
Other radionuclides released (Curies)	1.3	1.3	1.3
Total release (Curies)	640.3	1,540.3	3,700.3

Source: TVA 1998e.

Table 5–3 Tritium Concentration in the Tennessee River from Tritium Production at Watts Bar 1

		Incident-Free Tritium Production		
	No Action (0 TPBARs) (picocuries per liter)	*1,000 TPBARs (picocuries per liter)*	*3,400 TPBARs (picocuries per liter)*	*2 TPBAR Failures[a] (picocuries per liter)*
Edge of near-field	280	674	1,620	6,109
At nearest drinking water intake	22	52	126	475

[a] See Appendix C, Table C-8 for tritium release.

5.2.1.5 Geology and Soils

No Action

No impacts on geology and soils are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Impacts on geology and soils at the Watts Bar site should not change as a result of tritium production. No construction would occur at the Watts Bar site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

5.2.1.6 Ecological Resources

No Action

No impacts on land use, air quality, or water quality are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action. Therefore, no impacts on ecological resources are expected under this alternative.

Tritium Production

Operation of Watts Bar 1 during tritium production would not change the terrestrial or aquatic habitat at the site. Thermal and nonradioactive chemical discharges that could affect the ecology at the site would remain the same. No construction would occur at Watts Bar unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

Tritium production could increase radiological releases in gaseous emissions and liquid effluents, as presented in Sections 5.2.1.3 and 5.2.1.4. When tritium is inhaled or ingested by an organism, incorporation into bodily fluids is very efficient. However, long-term accumulation in the organism is limited by its rapid elimination by exhalation, excretion in body water, and tritium's short half-life. The biological properties of tritium are discussed in Appendix C.

According to an International Atomic Energy Agency (IAEA) publication (IAEA 1992), a dose rate of 100 millirem per year to the most exposed human will lead to dose rates to plants and animals of less than 0.1 rad per day. The IAEA concluded that a dose rate of 0.1 rad per day or less for animals and 1 rad per day or less for plants would not affect these populations. Doses to the public and workers from potential releases at Watts Bar 1 are estimated and presented in Section 5.2.1.9. Tritium production could increase the annual dose to the maximally exposed individual from 0.29 millirem per year (No Action) to approximately 0.34 millirem per year (3,400 TPBARs). This cumulative exposure rate is well below the IAEA benchmarks. Therefore, the increase in tritium releases due to tritium production would have no effect on plants and animals at the Watts Bar site. TVA has notified the U.S. Fish and Wildlife Service of DOE's proposed action at Watts Bar and has provided the States of Tennessee and South Carolina and the U.S. Fish and Wildlife Service with copies of the *Draft Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor (*CLWR EIS). Copies of the CLWR Final EIS also will be provided to these agencies. The U.S. Fish and Wildlife Service was consulted initially concerning the identification of threatened or endangered species that should be evaluated in this EIS (DOI 1998b). TVA evaluated those species and concluded, that since small increases in tritium releases in gaseous emissions and liquid effluents are the only operational differences for the Watts Bar plant, no threatened or endangered species should be affected.

In its response to the CLWR Draft EIS, the U.S. Fish and Wildlife Service concluded that adverse effects to listed species potentially occurring at the site from the proposed action are not anticipated (DOI 1998d). TVA and DOE will continue to comply with the requirements of the Endangered Species Act and interact with the U.S. Fish and Wildlife Service, as appropriate. TVA is committed to conducting an environmental monitoring program during tritium production operations. Should the monitoring program indicate any adverse impacts to listed species, consultation with the U.S. Fish and Wildlife Service would be initiated immediately to address those impacts.

5.2.1.7 Archaeological and Historic Resources

No Action

No impacts on land use are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action. As a result, no impacts on historic and archaeological resources are expected.

Tritium Production

Since no additional land would be required for tritium production, there would be no impacts on archaeological and historic resources at the Watts Bar site. It should be noted that the Tennessee State Historic Preservation Office reviewed the CLWR Draft EIS for compliance with Section 106 of the National Historic Preservation Act and determined that tritium production at Watts Bar would have no effect upon properties listed or eligible for listing by the National Register of Historic Places (TN DEC 1998b). No construction would occur at Watts Bar unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

5.2.1.8 Socioeconomics

No Action

Under the No Action Alternative, no socioeconomic impacts are expected in the region of influence of the Watts Bar plant beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

As Watts Bar 1 is an operating facility, only the socioeconomic impacts associated with incremental tritium-related changes to plant operations have been considered. The primary costs of operating a CLWR for tritium production could relate to operations and maintenance, supplemental fuel procurement or fuel enrichment, storage of additional spent fuel, replacement power, capital upgrades or replacements, and fees to the utility. Of these costs, only operations and maintenance would have the potential for material socioeconomic impacts within the region of influence. All the other expenses would relate to nonplant functions that generate corporate income, though not local income (e.g., fees from DOE) or procurements (e.g., potential spent fuel storage casks, fuel elements, TPBARs) in other parts of the country. Minor regional costs (e.g., potential maintenance of the spent fuel storage casks) would have no measurable socioeconomic impacts.

Operation of Watts Bar 1 for tritium production should require less than 10 full-time equivalent workers in addition to normal plant operations staff. The addition of 10 full-time equivalent workers to the normal operations staff would increase local socioeconomic factors such as income, housing requirements, and indirect employment by about 1 percent compared to normal plant operations for power production. Regional income would increase by slightly more than $1 million per year.

The potential increase in spent fuel storage requirements due to tritium production would involve some additional costs, but the overall socioeconomic impacts would be small. These requirements would be met via dry cask storage (see Section 5.2.6) using casks procured from outside the region. Annual costs for additional fuel transfers, spent fuel storage cask maintenance, spent fuel cask pad expansion, and the transfer of spent fuel to shipping casks would be a maximum of $2 million.

Life extension of Watts Bar 1 as a result of tritium production (see Section 5.2.4) would have substantial regional socioeconomic benefits. An extension of normal plant operations would allow regional earnings to continue at about $100 million per year.

The transportation impacts of tritium production would be minimal and would be limited to commuter traffic by the personnel assigned to the site. The impact of 50 additional construction workers and associated construction vehicles, assuming the potential construction of a dry cask ISFSI, would be temporary and minor, and the traffic impact of 10 additional tritium production operations workers would not be noticeable. Additional truck traffic during tritium operations would include a total of 16 shipments of TPBARs to and from the plant per year.

5.2.1.9 Public and Occupational Health and Safety

This section describes the impacts of radiological and hazardous chemical releases resulting from normal operation, abnormal conditions, and accidents due to tritium production at Watts Bar 1.

5.2.1.9.1 Normal Operation

RADIOLOGICAL IMPACTS

During normal operation, there would be incremental radiological releases of tritium to the environment, as well as additional in-plant exposures. The resulting doses and potential health effects on the general public and workers are described below. There would be no immediate construction of new facilities to support tritium production operations at Watts Bar 1; therefore, there would be no associated impacts on the public or workers. Impacts from construction of a dry cask ISFSI are presented in Section 5.2.6.

The annual increase in gaseous radioactive emissions and liquid radioactive effluents from the production of tritium at Watts Bar 1 are presented in Sections 5.2.1.3 and 5.2.1.4, respectively. The radiological impacts of both gaseous and liquid radioactive releases are presented in **Table 5–4** for the maximally exposed offsite individual and the general public living within 80 kilometers (50 miles) of Watts Bar 1 in the year 2025. **Table 5–5** reflects the radiological impacts on the facility workers. A facility worker is defined as any "monitored" reactor plant employee. Doses to these workers would be kept to minimal levels through programs to ensure worker doses are as low as reasonably achievable. The tables also include the impacts of the No Action Alternative.

Background information on the effects of radiation on human health and safety is included in Appendix C. The method and assumptions used for calculating the impacts on public health and safety at Watts Bar 1 are presented in Appendix C, Section C.3.

Table 5–4 Annual Radiological Impacts to the Public from Incident-Free Tritium Production Operations at Watts Bar 1

Tritium Production	*Release Media*	*Maximally Exposed Offsite Individual*		*Population Within 80 kilometers (50 miles) for the Year 2025*	
		Dose (millirem)	*Latent Fatal Cancer Risk*	*Annual Dose (person-rem)*	*Latent Fatal Cancers*
No Action[a] (0 TPBARs)	Air	0.036	1.8×10^{-8}	0.071	0.000036
	Liquid	0.25	1.3×10^{-7}	0.48	0.00024
	Total	0.29	1.5×10^{-7}	0.55	0.00028
Incremental dose for 1,000 TPBARs	Air	0.012	6.0×10^{-9}	0.15	0.000075
	Liquid	0.0014	7.0×10^{-10}	0.19	0.000095
Total dose for 1,000 TPBARs	Air	0.048	2.4×10^{-8}	0.22	0.00011
	Liquid	0.25	1.3×10^{-7}	0.67	0.00034
	Total	0.30	1.5×10^{-7}	0.89	0.00045
Incremental dose for 3,400 TPBARs	Air	0.042	2.1×10^{-8}	0.50	0.00025
	Liquid	0.0050	2.5×10^{-9}	0.69	0.00035
Total dose for 3,400 TPBARs	Air	0.078	3.9×10^{-8}	0.57	0.00029
	Liquid	0.26	1.3×10^{-7}	1.2	0.00060
	Total	0.34	1.7×10^{-7}	1.8	0.00090

[a] Doses based on actual measurements during plant operation in 1997 with population exposure adjusted to reflect population growth to the year 2025.

Table 5–5 Annual Radiological Impacts to Workers from Incident-Free Tritium Production Operations at Watts Bar 1

Impact	*No Action*	*1,000 TPBARs*	*Total With 1,000 TPBARs*	*3,400 TPBARs*	*Total With 3,400 TPBARs*
Average worker dose (millirem)[a]	104	0.33	104.33	1.1	105.1
Latent fatal cancer risk	4.2×10^{-5}	1.6×10^{-7}	4.2×10^{-5}	4.5×10^{-7}	4.2×10^{-5}
Total worker dose (person-rem)	112	0.35	112.35	1.2	113.2
Latent fatal cancers	0.045	0.00014	0.045	0.00048	0.045

[a] Based on 1,073 badged workers in 1997.
Source: TVA 1998d, TVA 1998e.

No Action

Under the No Action Alternative, the health and safety risk of members of the public and facility workers at Watts Bar 1, assuming that the operating conditions did not change from those expected, would remain at the levels presented in Section 4.2.1.9. As shown in Tables 5–4 and 5–5:

- The annual dose to the maximally exposed offsite individual would remain at 0.29 millirem per year, with an associated 1.5×10^{-7} risk of a latent cancer fatality per year of operation.
- The collective dose to the population within 80 kilometers (50 miles) of Watts Bar 1 would remain at 0.55 person-rem per year, with an associated 0.00028 latent cancer fatality per year of operation.

- The collective dose to the facility workers on average would remain at 112 person-rem per year, with an associated 0.045 latent cancer fatality per year of operation.

Tritium Production

In the tritium production mode, the health and safety risk of the public and facility workers would increase due to the estimated releases of tritium in gaseous emissions and liquid effluent. As shown in Tables 5–4 and 5–5, for 3,400 TPBARs in the reactor core:

- The annual dose to the maximally exposed offsite individual would be 0.34 millirem per year, with an associated 1.7×10^{-7} risk of a latent cancer fatality per year of operation. This dose is 1.4 percent of the annual total dose limit of 25 millirem set by regulations in 40 CFR 190.

- The collective dose to the population within 80 kilometers (50 miles) of Watts Bar 1 would be 1.8 person-rem per year, with an associated 0.00090 latent cancer fatality per year of operation.

- The collective dose to the facility workers on average would be 113.2 person-rem per year, with an associated 0.045 latent cancer fatality per year of operation.

In addition to the assumed normal operation release of tritium through permeation, an additional potential release scenario considered in this EIS is the failure of 1 or more TPBARs, such that the inventory of the TPBARs is released to the primary coolant. The occurrence of TPBAR failure is considered to be beyond that associated with normal operating conditions and, as discussed in Section 1.9, such an assumption is extremely conservative. The radiological consequences to the public and workers resulting from the assumption of 2 TPBAR failures in a given core load of 3,400 TPBARs at Watts Bar 1 are presented in **Tables 5–6** and **5–7**. Releases, doses, and cancer risks associated with 1 TPBAR failure can be determined by dividing the values in Tables 5–6 and 5–7 by two.

Table 5–6 Radiological Impacts to the Public from the Failure of 2 TPBARs at Watts Bar 1

Release Pathway	*Release Quantity (Curies)*	*Dose to Maximally Exposed Individual (millirem)*	*Latent Fatal Cancer Risk*	*Dose to Population Within 80 kilometers (50 miles) (person-rem)*	*Latent Fatal Cancers*
Air	2,315	0.29	1.5×10^{-7}	3.4	0.0017
Liquid	20,835	0.033	1.7×10^{-8}	4.4	0.0022

Table 5–7 Radiological Impacts to Workers from the Failure of 2 TPBARs at Watts Bar 1

Impact Type	*Impact Quantity*
Average Worker Dose (millirem)[a]	7.7
Latent Fatal Cancer Risk	3.1×10^{-6}
Total Worker Dose (person-rem)	8.2
Latent Fatal Cancers	0.0033

[a] Based on 1,073 badged workers in 1997.
Source: TVA 1998d, TVA 1998e.

HAZARDOUS CHEMICAL IMPACTS

No Action

No impacts on public and occupational health and safety from exposure to hazardous chemicals are anticipated at Watts Bar beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Tritium production would introduce no additional operations at the plant that would require the use of hazardous chemicals.

5.2.1.9.2 Facility Accidents

RADIOLOGICAL IMPACTS

The accident set selected for evaluation of the impacts of the No Action Alternative and tritium production are described in Section 5.1 and discussed in detail in Appendix D, Section D.1. The consequences of the reactor and nonreactor design-basis accidents for the No Action Alternative at the Watts Bar plant (0 TPBARs) and for maximum tritium production (3,400 TPBARs) were estimated using the Nuclear Regulatory Commission (NRC)-based licensing approach presented in the *Watts Bar Nuclear Plant Final Safety Analysis Report* (TVA 1995c). The receptors were an individual at the reactor site exclusion area boundary and an individual at the reactor site low-population zone. The margin of safety for site dose criteria associated with the same accidents and the same receptors are presented in **Table 5–8.** Data presented for the No Action Alternative were extracted directly from the *Watts Bar Nuclear Plant Final Safety Analysis Report*. As indicated in Table 5–8 the irradiation of TPBARs at the Watts Bar plant would result in a very small increase in design-basis accident consequences and thus, a reduction in the consequence margin. The accident consequences would be dominated by the effects of the nuclide releases inherent to the No Action Alternative.

Table 5–8 Design-Basis Accident Consequence Margin to Site Dose Criteria at Watts Bar 1

Accident	*Tritium Production*	*Dose Description*[a]	*Site Dose Criteria (rem)*[b]	*Individual at Area Exclusion Boundary*		*Individual at Low Population Zone*	
				Dose (rem)	*Margin (%)*[c]	*Dose (rem)*	*Margin (%)*[c]
Reactor design-basis accident	0 TPBARs (No Action)[d]	Thyroid inhalation dose	300	34.1	88.6	11.0	96.3
		Beta + gamma whole body dose	25	3.5	86.1	3.4	86.2
	3,400 TPBARs	Thyroid inhalation dose	300	34.1	88.6	11.0	96.3
		Beta + gamma whole body dose	25	3.5	86.1	3.4	86.2
Nonreactor design-basis accident	0 TPBARs (No Action)[d]	Thyroid inhalation dose	300	0.018	99.99	0.0042	99.999
		Beta + gamma whole body dose	25	0.13	99.5	0.031	99.9
	3,400 TPBARs	Thyroid inhalation dose	300	0.025	99.92	0.0058	99.998
		Beta + gamma whole body dose	25	0.13	99.5	0.031	99.9

[a] Dose is the total dose from the reactor plus the contribution from the TPBARs.
[b] 10 CFR 100.11.
[c] Margin below the site dose criteria.
[d] TVA 1995c.

Table 5–9 presents the incremental risks due to tritium production for the postulated set of design-basis and handling accidents and the total risks from beyond design-basis accidents to the maximally exposed offsite individual, an average individual in the public within an 80-kilometer (50-mile) radius of the reactor site, and a noninvolved worker 640 meters (0.4 miles) from the release point. Accident consequences for the same receptors are summarized in **Table 5–10**. The assessment of dose and the associated cancer risk to the noninvolved worker are not applicable for beyond design-basis accidents. A site emergency would have been declared early in the beyond design-basis accident sequence; all nonessential site personnel would have evacuated the site in accordance with site emergency procedures before any radiological release to the environment. In accordance with emergency action guidelines, evacuation of the public within 16.1 kilometers (10 miles) of the plant would have been initiated.

Table 5–9 Annual Accident Risks at Watts Bar 1

Accident	*Tritium Production*	*Maximally Exposed Offsite Individual*[a]	*Average Individual in Population to 80 kilometers (50 miles)*[a]	*Noninvolved Worker*[a]
Design-Basis Accidents				
Reactor design-basis accident[b]	1,000 TPBARs	1.4×10^{-10}	1.1×10^{-12}	1.9×10^{-12}
	3,400 TPBARs	4.8×10^{-10}	3.8×10^{-12}	6.4×10^{-12}
Nonreactor design-basis accident[b]	1,000 TPBARs	3.4×10^{-8}	4.0×10^{-10}	4.2×10^{-10}
	3,400 TPBARs	1.1×10^{-7}	1.4×10^{-9}	1.5×10^{-9}
Sum of design-basis accident risks	1,000 TPBARs	3.4×10^{-8}	4.0×10^{-10}	4.2×10^{-10}
	3,400 TPBARs	1.1×10^{-7}	1.4×10^{-9}	1.5×10^{-9}
Handling Accidents				
TPBAR handling accident	1,000 TPBARs	2.4×10^{-8}	2.7×10^{-10}	1.2×10^{-9}
	3,400 TPBARs	8.1×10^{-8}	9.3×10^{-10}	3.9×10^{-9}
Truck cask handling accident	1,000 TPBARs	1.9×10^{-13}	2.1×10^{-15}	9.0×10^{-15}
	3,400 TPBARs	5.8×10^{-13}	6.4×10^{-15}	2.7×10^{-14}
Rail cask handling accident	1,000 TPBARs	9.7×10^{-14}	1.1×10^{-15}	4.6×10^{-15}
	3,400 TPBARs	2.9×10^{-13}	3.2×10^{-15}	1.4×10^{-14}
Sum of handling accident risks	1,000 TPBARs	2.4×10^{-8}	2.7×10^{-10}	1.2×10^{-9}
	3,400 TPBARs	8.1×10^{-8}	9.3×10^{-10}	3.9×10^{-9}
Beyond Design-Basis Accidents (Severe Reactor Accidents)				
Reactor core damage accident with early containment failure	0 TPBARs (No Action)	6.7×10^{-9}	8.8×10^{-11}	Not applicable
	3,400 TPBARs	6.7×10^{-9}	8.8×10^{-11}	Not applicable
Reactor core damage accident with containment bypass	0 TPBARs (No Action)	2.2×10^{-8}	1.2×10^{-9}	Not applicable
	3,400 TPBARs	2.2×10^{-8}	1.2×10^{-9}	Not applicable
Reactor core damage accident with late containment failure	0 TPBARs (No Action)	2.4×10^{-9}	1.1×10^{-10}	Not applicable
	3,400 TPBARs	2.5×10^{-9}	1.2×10^{-10}	Not applicable
Sum of severe reactor accident risks	0 TPBARs (No Action)	3.1×10^{-8}	1.4×10^{-9}	Not applicable
	3,400 TPBARs	3.1×10^{-8}	1.4×10^{-9}	Not applicable

[a] Increased likelihood of cancer fatality per year.
[b] Design-basis accident risks only reflect the incremental increase in accident risk due to the production of tritium in TPBARs.

Table 5–10 Accident Frequencies and Consequences at Watts Bar 1

Accident	Accident Frequency (per year)	Tritium Production	Maximally Exposed Offsite Individual		Average Individual in Population to 80 kilometers (50 miles)		Noninvolved Worker	
			Dose (rem)	Cancer Fatality [a]	Dose (rem)	Cancer Fatality [a]	Dose (rem)	Cancer Fatality [a]
Design-Basis Accidents								
Reactor design-basis accident [b]	0.0002	1,000 TPBARs	0.0014	7.0×10^{-7}	0.000011	5.5×10^{-9}	0.000024	9.6×10^{-9}
		3,400 TPBARs	0.0047	2.4×10^{-6}	0.000038	1.9×10^{-8}	0.000081	3.2×10^{-8}
Nonreactor design-basis accident [b]	0.01	1,000 TPBARs	0.0067	3.4×10^{-6}	0.000079	4.0×10^{-8}	0.00010	4.2×10^{-8}
		3,400 TPBARs	0.022	0.000011	0.00027	1.4×10^{-7}	0.00036	1.5×10^{-7}
Handling Accidents								
TPBAR handling accident	0.0017/ 0.0058[c]	All TPBAR Configurations	0.028	0.000014	0.00031	1.6×10^{-7}	0.0017	6.8×10^{-7}
Truck cask handling accident	5.3×10^{-7}/ 1.6×10^{-6} [c]	All TPBAR configurations	0.00072	3.6×10^{-7}	8.0×10^{-6}	4.3×10^{-9}	0.000043	1.7×10^{-8}
Rail cask handling accident	2.7×10^{-7}/ 8.0×10^{-7} [c]	All TPBAR configurations	0.00072	3.6×10^{-7}	8.0×10^{-6}	4.3×10^{-9}	0.000045	1.8×10^{-8}
Beyond Design-Basis Accidents (Severe Reactor Accidents)								
Reactor core damage with early containment failure	6.8×10^{-7}	0 TPBARs (No Action)	19.7	0.0099	0.25	0.00013	N/A	N/A
		3,400 TPBARs	19.8	0.0099	0.25	0.00013	N/A	N/A
Reactor core damage with containment bypass	6.9×10^{-6}	0 TPBARs (No Action)	6.4	0.0032	0.35	0.00018	N/A	N/A
		3,400 TPBARs	6.4	0.0032	0.35	0.00018	N/A	N/A
Reactor core damage with late containment failure	9.1×10^{-6}	0 TPBARs (No Action)	0.51	0.00026	0.024	0.000012	N/A	N/A
		3,400 TPBARs	0.53	0.00027	0.025	0.000013	N/A	N/A

N/A = Not applicable.
[a] Increased likelihood of cancer fatality.
[b] Design-basis accident consequences only reflect the incremental increase in accident consequences due to the production of tritium in TPBARs.
[c] Frequency for 1,000 TPBARs/frequency for 3,400 TPBARs.

Presented in Tables 5–9 and 5–10 are calculations of the risks and consequences of both the No Action Alternative (0 TPBARs) and maximum tritium production (3,400 TPBARs) for severe reactor accidents. Tritium release is governed by the nature of the core melt accident scenarios analyzed; accident risks and consequences are governed by actions taken in accordance with the EPA Plant Protective Action Guidelines (e.g., evacuation of the public, interdiction of the food and water supply, condemnation of farmland and public property) in response to the postulated core melt accident with containment failure or containment bypass.

The severity of the reactor accident dominates the consequences, is the basis for implementation of protective actions, and is independent of the number of TPBARs. The accident risk is the product of the accident probability (i.e, accident frequency) times the accident consequences. In this EIS, risk is expressed as the increased likelihood of a cancer fatality per year for an individual (e.g., the maximally exposed offsite individual, an average individual in the population within 80 kilometers [50 miles] of the reactor site, or a noninvolved worker). Table 5–9 indicates that the risks associated with tritium production are low. The highest risk to each individual—the maximally exposed offsite individual, one fatality every 9.1 million years (1.1×10^{-7} per year); an average member of the public, one fatality every 710 million years (1.4×10^{-9} per year); the exposed population, one fatality every 3.8 thousand years (0.00026 per year); and a noninvolved worker, one fatality every 670 million years (1.5×10^{-9} per year)—is from the nonreactor design-basis accident.

The nonreactor design-basis accident has the highest consequence of the design-basis and handling accidents because the postulated accident scenario entails an acute release of tritium in oxide form directly to the environment without any mitigation. Review of Table 5–10 indicates that there would be a very small increase of severe reactor accident consequences due to the irradiation of TPBARs at the Watts Bar plant. The accident consequences are dominated by the effects of the radionuclide releases inherent to the No Action Alternative. The secondary impacts of severe reactor accidents are discussed in Section 5.2.13.

HAZARDOUS CHEMICALS IMPACTS

No Action

No impacts on public and occupational health and safety from exposure to hazardous chemicals are anticipated at the Watts Bar site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Tritium production would introduce no additional operations at the plant that would require the use of hazardous chemicals.

5.2.1.10 Environmental Justice

As discussed in Appendix G, Executive Order 12898 directs Federal agencies to address disproportionately high and adverse health or environmental effects of alternatives on minority and low-income populations. The Executive Order does not alter prevailing statutory interpretations under the National Environmental Policy Act (NEPA) or existing case law. Regulations prepared by the Council on Environmental Quality remain the foundation for the preparation of environmental documentation in compliance with NEPA (40 CFR, 1500 through 1508).

No Action

Under the No Action Alternative, there would be no impacts on the general population and thus, no disproportionately high and adverse consequences for minority and low-income populations beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Analyses of incident-free operations and accidents show the risk of latent cancer fatalities among the public residing within 80 kilometers (50 miles) of the reactor site to be much less than 1. Because tritium production would not have high and adverse consequences for the population at large, no minority or low-income populations would be expected to experience disproportionately high and adverse consequences.

5.2.1.11 Waste Management

No Action

Under the No Action Alternative, waste generation at Watts Bar 1 should continue at the levels described in Section 4.2.1.10. Provisions for the management of these wastes would continue unchanged.

Tritium Production

No additional hazardous waste, nonhazardous solid waste, or sanitary liquid waste should be generated at Watts Bar 1 as a result of tritium production. Management of these wastes would continue as described in Section 4.2.1.10. However, it is expected that an additional 0.43 cubic meters per year (15 cubic feet per year) of low-level radioactive waste would be generated as a result of tritium production (WEC 1999). It would consist of the approximately 140 base plates and other irradiated hardware remaining after the TPBARs were separated from their assemblies to be placed in the 17 × 17 array consolidation baskets at the reactor site.

Similar to the quantities of low-level radioactive waste generated as a result of activities independent of this action, the additional low-level radioactive waste generated as a result of tritium production (with the exception of the base plates and associated hardware) would be shipped to a commercial processor where it would be compacted to a lesser volume and shipped to the Barnwell, South Carolina, low-level radioactive waste disposal facility. The base plates and associated hardware would accumulate until a sufficient amount were on hand to ship directly to Barnwell for disposal. The additional low-level radioactive waste of 0.43 cubic meters (15 cubic feet) represents approximately 0.1 percent of the total low-level radioactive waste currently generated at the site.

For completeness, this EIS also analyzes the management of the additional volume of low-level radioactive waste (0.43 cubic meters [15 cubic feet]) generated as a result of tritium production at DOE-owned facilities at the Savannah River Site. Under this scenario, the additional low-level radioactive wastes could be transported to the Low-Level Radioactive Waste Disposal Facility at the Savannah River Site near Aiken, South Carolina. The facility consists of a series of vaults in E-Area that have been operational since September 1994. The operating capacity of each vault is 30,500 cubic meters of low-level radioactive waste (DOE 1998c, DOE 1999b). Therefore, the addition of low-level radioactive waste from the proposed action at Watts Bar for a 40-year period would be approximately 0.06 percent of the capacity of a single vault.

5.2.1.12 Spent Fuel Management

Production of tritium at Watts Bar 1 would not increase the generation of spent nuclear fuel if less than approximately 2,000 TPBARs were irradiated in a fuel cycle. For the irradiation of the maximum number of 3,400 TPBARs, up to 140 spent nuclear fuel assemblies could be generated. This represents up to 60 additional spent nuclear fuel assemblies beyond the normal refueling batch of 80 assemblies. For the purposes of this EIS, it is assumed that the additional spent nuclear fuel would be stored on site for the duration of the proposed action. If needed, a dry cask ISFSI would be constructed at the site. Environmental impacts of the construction and operation of a generic dry cask ISFSI are presented in Section 5.2.6.

5.2.2 Sequoyah Nuclear Plant Units 1 and 2

5.2.2.1 Land Resources

The land resources analysis addresses land use and visual resources for the region of influence. The region of influence for land use includes land within 3.2 kilometers (2 miles) of the site. The region of influence for visual resources includes those lands and waters from which the Sequoyah Nuclear Plant is visible (the viewshed).

LAND USE

No Action

No land use impacts are anticipated at the Sequoyah site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

No additional property would be required and no additional land would be disturbed to prepare for tritium production at the Sequoyah Nuclear Plant site. Land use would remain unchanged from its current industrial use. The 212-hectare (525-acre) site contains ample area for construction of a dry cask ISFSI. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

VISUAL RESOURCES

No Action

No visual impacts are anticipated at the Sequoyah site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

There would be no change in the visual character of the Sequoyah site as a result of tritium production. The major visual elements of the plant already exist, including the cooling towers and the transmission lines. As described in Section 4.2.2.1, views of the Sequoyah Nuclear Plant from passing river traffic on the Tennessee River are partially screened by the wooded area east of the plant (TVA 1974a).

5.2.2.2 Noise

No Action

No noise impacts are anticipated at the Sequoyah site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Noise levels should not change as a result of tritium production at the Sequoyah site. No construction would occur at the Sequoyah site, unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

5.2.2.3 Air Quality

NONRADIOACTIVE GASEOUS EMISSIONS

No Action

No air quality impacts are anticipated at the Sequoyah site beyond the effects of existing and future activities that are independent of the proposed action (see Section 4.2.2.3, Table 4–13).

Tritium Production

Air quality should not change as a result of the production of tritium at the Sequoyah site. No construction would occur at the Sequoyah site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

RADIOACTIVE GASEOUS EMISSIONS

No Action

Under the No Action Alternative, the radioactive gaseous emissions at Sequoyah 1 or Sequoyah 2 should continue at the levels described in Section 4.2.2.3, Table 4–14, assuming that no significant operational deviations would occur.

Tritium Production

A design objective of the TPBARs is to retain as much tritium as possible within the TPBAR. The performance of the tritium "getter" is such that there is virtually no tritium available in a form that could permeate through the TPBAR cladding. However, for the purposes of this EIS it was conservatively assumed that an average of 1 Curie of tritium per TPBAR per year could permeate to the reactor coolant (PNNL 1997b, PNNL 1999). It also was assumed that 10 percent of this tritium could be released to the environment as gaseous emission. Because of this assumption the radioactive gaseous emissions from Sequoyah 1 or Sequoyah 2 would increase. **Table 5–11** shows the annual radioactive gaseous emissions during tritium production at Sequoyah 1 or Sequoyah 2 with 0, 1,000, and 3,400 TPBARs. The method and assumptions used for the calculations are included in Appendix C, Section C.3.4. Radiological exposures of the public and workers from radioactive emissions are presented in Section 5.2.2.9. The impacts on plants and animals are described in Section 5.2.2.6.

Table 5–11 Annual Radioactive Gaseous Emissions at Sequoyah 1 or Sequoyah 2

	No Action (0 TPBARs)	*Tritium Production*	
		1,000 TPBARs	*3,400 TPBARs*
Tritium release (Curies)	25	125	365
Other radioactive release (Curies)	120[a]	120	120
Total release (Curies)	145	245	485

[a] The isotopic distribution of this release is presented in Appendix C, Table C-10.
Source: TVA 1998a.

5.2.2.4 Water Resources

SURFACE WATER

No Action

No surface water impacts are anticipated at the Sequoyah site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Impacts on surface water from nonradiological discharges at the Sequoyah site should not change as a result of tritium production. No construction would occur at the Sequoyah site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

GROUNDWATER

No Action

No groundwater impacts are anticipated at Sequoyah beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Impacts on groundwater at Sequoyah 1 or Sequoyah 2 should not change as a result of tritium production. No construction would occur at the Sequoyah site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

RADIOACTIVE LIQUID EFFLUENT

No Action

Under the No Action Alternative, the liquid radioactive effluent at Sequoyah 1 or Sequoyah 2 should continue at the levels described in Section 4.2.2.4, Table 4–16, assuming that no significant operational deviations would occur.

Tritium Production

Based on the assumption that, on average, 1 Curie of tritium per TPBAR per year could permeate to the reactor coolant and 90 percent of this tritium could be released as liquid effluent, radioactive liquid effluents from Sequoyah 1 or Sequoyah 2 would increase. **Table 5–12** shows the increase in tritium release in liquid effluent during tritium production at Sequoyah 1 or Sequoyah 2 with 0, 1,000, and 3,400 TPBARs. The method and assumptions used for the calculations are included in Appendix C, Section C.3. Radiological exposures of the public and workers from radioactive emissions are presented in Section 5.2.2.9. The impacts on plants and animals are described in Section 5.2.2.6.

In accordance with the Safe Drinking Water Act requirements, promulgated by the EPA in 40 CFR, 100-149, a tritium concentration of 20,000 picocuries per liter has been established as a limit for drinking water. In view of this regulatory limit, an analysis was performed to estimate tritium concentrations in the Tennessee River that could result from tritium production at Sequoyah 1 or Sequoyah 2. The average expected tritium concentrations in the river were calculated using CORMIX (Cornell 1996). **Table 5–13** presents the potential tritium concentrations from the incident-free irradiation of 1,000 and 3,400 TPBARs at two points: (1) the edge of the near-field, and (2) the nearest drinking water intake. "Near-field" in CORMIX is the area surrounding the discharge point of the effluent where initial mixing is taking place. The edge of the near-field typically extends to a few meters away from the point of discharge. Table 5–13 also presents potential tritium concentrations in the unlikely event of 2 TPBAR failures during a given 18-month operating cycle. The results indicate that tritium concentrations would remain well below the 20,000 picocuries per liter limit, and at the drinking water intake the tritium concentration would be below or close to the lower detection limit for tritium which is approximately 300 picocuries per liter. Tritium production is not expected to affect the requirements in the Sequoyah NPDES Permit.

Table 5–12 Annual Radioactive Liquid Effluent at Sequoyah 1 or Sequoyah 2

	No Action (0 TPBARs)	***Tritium Production***	
		1,000 TPBARs	***3,400 TPBARs***
Tritium release (Curies)	714	1,614	3,774
Other radioactive release (Curies)	1.15	1.15	1.15
Total release (Curies)	715.2	1,615.2	3,775.2

Source: TVA 1998e, TVA 1999.

Table 5–13 Tritium Concentration in the Tennessee River from Tritium Production at Sequoyah 1 or Sequoyah 2

	No Action (0 TPBARs) (picocuries per liter)	***Incident-Free Tritium Production***[a]		***2 TPBAR Failures***[b] ***(picocuries per liter)***
		1,000 TPBARs (picocuries per liter)	***3,400 TPBARs (picocuries per liter)***	
Edge of near-field	93	150	286	879
At nearest drinking water intake	63	102	195	600

[a] Concentrations include the effect of one nontritium-producing unit.
[b] See Appendix C, Table C-8 for tritium release.

5.2.2.5 Geology and Soils

No Action

No impacts on geology and soils are anticipated at the Sequoyah site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Impacts on geology and soils at the Sequoyah site should not change as a result of tritium production. No construction would occur at the Sequoyah site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

5.2.2.6 Ecological Resources

No Action

No impacts on land use, air quality, or water quality are anticipated at the Sequoyah site beyond the effects of existing and future activities that are independent of the proposed action. Therefore, no impacts on ecological resources are expected under this alternative.

Tritium Production

Operation of Sequoyah 1 or Sequoyah 2 in a tritium production mode would not involve any physical changes to the terrestrial or aquatic habitat at the site. Thermal and nonradioactive chemical discharges that could affect the ecology at the site would remain the same. No construction would occur at the Sequoyah site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

Tritium production could increase the release of tritium in gaseous emissions and liquid effluents, as presented in Sections 5.2.2.3 and 5.2.2.4. When tritium is inhaled or ingested by an organism, incorporation into bodily fluids is very efficient. However, long-term accumulation in the organism is limited by tritium's rapid elimination by exhalation, excretion in body water, and its short half-life. The biological properties of tritium are discussed in Appendix C.

According to an IAEA publication (IAEA 1992), a dose rate of 100 millirem per year to the maximally exposed human will lead to dose rates to plants and animals of less than 0.1 rad per day. The IAEA concluded that a dose rate of 0.1 rad per day or less for animals and 1 rad per day or less for plants would not affect these populations. Doses to the public and workers from potential releases at Sequoyah 1 have been estimated and are presented in Section 5.2.2.9. Tritium production could increase the annual dose to the maximally exposed individual of the public from 0.053 millirem per year (No Action) to approximately 0.11 millirem per year (3,400 TPBARs). This cumulative exposure rate is below the IAEA's benchmarks. Therefore, the increase in tritium releases due to tritium production would have no effect on plants and animals at the Sequoyah site. TVA has notified the U.S. Fish and Wildlife Service of DOE's proposed action at Sequoyah and has provided the States of Tennessee and South Carolina and the U.S. Fish and Wildlife Service with copies of the CLWR Draft EIS. Copies of the CLWR Final EIS also will be provided to these agencies. The U.S. Fish and Wildlife Service was consulted concerning the identification of threatened or endangered species that should be evaluated in this EIS (DOI 1998b). TVA evaluated those species and concluded that, since small increases in tritium releases in gaseous emissions and liquid effluents are the only operational differences for the Sequoyah plant, no threatened or endangered species should be affected.

In its response to the CLWR Draft EIS, the U.S. Fish and Wildlife Service concluded that adverse effects to listed species potentially occurring at the site from the proposed action are not anticipated (DOI 1998d). TVA and DOE will continue to comply with the requirements of the Endangered Species Act and interact with the U.S. Fish and Wildlife Service as appropriate. TVA is committed to conducting an environmental monitoring program during tritium production operations. Should the monitoring program indicate any adverse impacts to listed species, consultation with the U.S. Fish and Wildlife Service would be initiated immediately to address those impacts.

5.2.2.7 Archaeological and Historic Resources

No Action

No impacts on land use are anticipated at the Sequoyah site beyond the effects of existing and future activities that are independent of the proposed action. As a result, no impacts on historic and archaeological resources are expected.

Tritium Production

Since no additional land would be required for tritium production, there would be no impacts on archaeological and historic resources at the Sequoyah site. It should be noted that the Tennessee State Historic Preservation Office reviewed the CLWR Draft EIS for compliance with Section 106 of the National Historic Preservation Act and determined that tritium production at Sequoyah would have no effect upon properties listed or eligible for listing by the National Register of Historic Places (TN DEC 1998b). No construction would occur at the Sequoyah site unless a dry cask ISFSI were constructed. A description of a generic dry cask ISFSI and its impacts is presented in Section 5.2.6.

5.2.2.8 Socioeconomics

No Action

Under the No Action Alternative, no adverse socioeconomic impacts are expected in the region of influence of the Sequoyah plant beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

As Sequoyah 1 and 2 are operating facilities, only the socioeconomic impacts associated with incremental tritium-related changes to plant operations have been considered. The primary costs to operate a CLWR for tritium production could relate to operations and maintenance, supplemental fuel procurement or fuel enrichment, storage of additional spent fuel, replacement power, capital upgrades or replacements, and fees to the utility. Of these costs, only operations and maintenance would have the potential for material socioeconomic impacts within the region of influence. All the other expenses would relate to nonplant functions that generate corporate income, though not local income (e.g., fees from DOE) or procurements (e.g., potential spent fuel storage casks, fuel elements, TPBARs) in other parts of the country. Small regional costs (e.g., potential maintenance of the spent fuel storage casks) would have no measurable socioeconomic impacts.

Operation of Sequoyah 1 or Sequoyah 2 for tritium production should require less than 10 full-time equivalent workers per unit in addition to normal plant operations staff. The addition of 10 full-time equivalent workers to a normal operations staff would increase local socioeconomic factors such as income, housing requirements, and indirect employment by about 1 percent compared to normal plant operations for power production. Regional income would increase by slightly more than $1 million per year.

The potential increase in spent fuel storage requirements resulting from tritium production would involve some additional costs, but the overall socioeconomic impacts would be small. These requirements would be met via dry cask storage (see Section 5.2.6), using casks procured from outside the region. Annual costs for activities such as additional fuel transfers, spent fuel storage cask maintenance, spent fuel cask pad expansion, and the transfer of spent fuel to shipping casks would be a maximum of $2 million.

Life extension of Sequoyah 1 and 2 as a result of tritium production (see Section 5.2.4) would have substantial regional socioeconomic benefits. An extension of normal plant operations would allow regional earnings to continue at about $100 million per year.

The transportation impacts associated with tritium production would be minimal and would be limited to commuter traffic by the personnel assigned to the site. The impact of 50 additional construction workers and associated construction vehicles, assuming potential construction of the dry cask ISFSI, would be temporary and minor. The traffic impact from 10 to 20 additional tritium production operations workers commuting to and from the plant would not be noticeable. Additional truck traffic during tritium operations would include a total of 16 shipments of TPBARs to and from the plant per year.

5.2.2.9 Public and Occupational Health and Safety

This section describes the impacts of radiological and hazardous chemical releases resulting from normal operation, abnormal conditions, and accidents due to tritium production at Sequoyah 1 or Sequoyah 2.

5.2.2.9.1 Normal Operations

RADIOLOGICAL IMPACTS

During normal operation, there would be incremental radiological releases of tritium to the environment, as well as additional in-plant exposures. The resulting dose and potential health effects on the general public and workers are described below. There would be no new construction of facilities to support tritium production operations at the Sequoyah plant site; therefore, there would be no associated impacts on the public or workers.

The annual increase in gaseous radioactive emissions and liquid radioactive effluents from the production of tritium at Sequoyah 1 or Sequoyah 2 are presented in Sections 5.2.2.3 and 5.2.2.4, respectively. The radiological impacts of both gaseous and liquid radioactive releases are presented in **Table 5–14** for the maximally exposed offsite individual and the general public living within 80 kilometers (50 miles) of Sequoyah 1 or Sequoyah 2 in the year 2025. **Table 5–15** reflects the radiological impacts on the facility workers. A facility worker is defined as any "monitored" reactor plant employee. Doses to these workers would be kept to minimal levels through programs to ensure worker doses are as low as reasonably achievable. The tables also include the impacts of the No Action Alternative.

Background information on the effects of radiation on human health and safety is included in Appendix C. The method and assumptions used in calculating the impacts on public health and safety at Sequoyah 1 or Sequoyah 2 are presented in Appendix C, Section C.3.

Table 5–14 Annual Radiological Impacts to the Public from Incident-Free Tritium Production Operations at Sequoyah 1 or Sequoyah 2

Tritium Production	Release Media	*Maximally Exposed Offsite Individual*		*Population Within 80 kilometers (50 miles) for the Year 2025*	
		Dose (millirem)	*Latent Fatal Cancer Risk*	*Annual Dose (person-rem)*	*Latent Fatal Cancers*
No Action [a] (0 TPBARs)	Air	0.031	1.6×10^{-8}	0.49	0.00025
	Liquid	0.022	1.1×10^{-8}	1.1	0.00055
	Total	0.053	2.7×10^{-8}	1.6	0.00080
Incremental dose for 1,000 TPBARs	Air	0.015	7.5×10^{-9}	0.16	0.000080
	Liquid	0.0016	8.0×10^{-10}	0.41	0.00021

Tritium Production	Release Media	Maximally Exposed Offsite Individual		Population Within 80 kilometers (50 miles) for the Year 2025	
		Dose (millirem)	Latent Fatal Cancer Risk	Annual Dose (person-rem)	Latent Fatal Cancers
Total dose for 1,000 TPBARs	Air	0.046	2.3×10^{-8}	0.65	0.00033
	Liquid	0.024	1.2×10^{-8}	1.5	0.00075
	Total	0.070	3.5×10^{-8}	2.2	0.0011
Incremental dose for 3,400 TPBARs	Air	0.052	2.6×10^{-8}	0.54	0.00027
	Liquid	0.0054	2.7×10^{-9}	1.4	0.00070
Total dose for 3,400 TPBARs	Air	0.083	4.2×10^{-8}	1.0	0.00050
	Liquid	0.027	1.4×10^{-8}	2.5	0.0013
	Total	0.11	5.6×10^{-8}	3.5	0.0018

[a] Doses based on actual measurements during plant operation in 1997 adjusted to reflect population growth to the year 2025.

Table 5–15 Annual Radiological Impacts to Workers from Incident-Free Tritium Production Operations at Sequoyah 1 or Sequoyah 2

Impact	No Action	1,000 TPBARs	Total With 1,000 TPBARs	3,400 TPBARs	Total With 3,400 TPBARs
Average worker dose (millirem)[a]	90	0.24	90.24	0.82	90.82
Latent fatal cancer risk	3.6×10^{-5}	9.6×10^{-8}	3.6×10^{-5}	3.3×10^{-7}	3.6×10^{-5}
Total worker dose (person-rem)	132	0.35	132.35	1.2	133.2
Latent fatal cancers	0.053	0.00014	0.053	0.00048	0.053

[a] Based on 1,470 badged workers per unit for a total of 2,940 badged workers for the site.
Source: NRC 1997b, TVA 1998d.

No Action

Under the No Action Alternative, the health and safety risk of members of the public and facility workers at Sequoyah 1 or Sequoyah 2, assuming that the operating conditions did not change from those expected, would remain at the levels presented in Section 4.2.2.9. As shown in Tables 5–14 and 5–15:

- The annual dose to the maximally exposed offsite individual would remain at 0.053 millirem per year, with an associated 2.7×10^{-8} risk of a latent cancer fatality per year of operation.
- The collective dose to the population within 80 kilometers (50 miles) of Sequoyah 1 or Sequoyah 2 would remain at 1.6 person-rem per year, with an associated 0.00080 latent cancer fatality per year of operation.
- The collective dose to the facility workers would remain at 132 person-rem per year, with an associated 0.053 latent cancer fatality per year of operation.

Tritium Production

In the tritium production mode, the health and safety risk of the public and facility workers would increase due to the estimated releases of tritium in gaseous emissions and liquid effluents. As shown in Tables 5–14 and 5–15 for 3,400 TPBARs in the reactor core:

- The annual dose to the maximally exposed offsite individual would be 0.11 millirem per year, with an associated 5.6×10^{-8} risk of a latent cancer fatality per year of operation. This dose is 0.44 percent of the annual total dose limit of 25 millirem set by regulations in 40 CFR 190.

- The collective dose to the population within 50 miles of Sequoyah 1 or Sequoyah 2 would be 3.5 person-rem per year, with an associated 0.0018 latent cancer fatality per year of operation.

- The collective dose to the facility workers would be 133.2 person-rem per year, with an associated 0.053 latent cancer fatality per year of operation.

In addition to the assumed normal operation release of tritium through permeation, an additional potential release scenario considered in this EIS is the failure of 1 or more TPBARs, such that the inventory of the TPBARs is released to the primary coolant. The occurrence of TPBAR failure is considered to be beyond that associated with normal operating conditions and, as discussed in Section 1.9, such an assumption is extremely conservative. The radiological consequences to the public and workers resulting from the assumption of 2 TPBAR failures in a given core load of 3,400 TPBARs at Sequoyah 1 or Sequoyah 2 are presented in **Tables 5-16** and **5-17**. Releases, doses, and cancer risks associated with 1 TPBAR failure can be determined by dividing the values in Tables 5-16 and 5-17 by two.

Table 5–16 Radiological Impacts to the Public from the Failure of 2 TPBARs at Sequoyah 1 or 2

Release Pathway	*Release Quantity (Curies)*	*Dose to Maximally Exposed Individual (millirem)*	*Latent Fatal Cancer Risk*	*Dose to Population Within 80 kilometers (50 miles) (person-rem)*	*Latent Fatal Cancers*
Air	2,315	0.36	1.8×10^{-7}	3.7	0.0018
Liquid	20,835	0.037	1.9×10^{-8}	9.2	0.0046

Table 5–17 Radiological Impacts to Workers from the Failure of 2 TPBARs at Sequoyah 1 or Sequoyah 2

Impact Type	*Impact Quantity*
Average Worker Dose (millirem)[a]	5.6
Latent Fatal Cancer Risk	2.2×10^{-6}
Total Worker Dose (person-rem)	8.2
Latent Fatal Cancers	0.0033

[a] Based on 1,470 badged workers per unit.
Source: NRC 1997b, TVA 1998d.

HAZARDOUS CHEMICAL IMPACTS

No Action

No impacts on public and occupational health and safety from exposure to hazardous chemicals are anticipated at Sequoyah beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Tritium production would introduce no additional operations at the plant that would require the use of hazardous chemicals.

5.2.2.9.2 Facility Accidents

RADIOLOGICAL IMPACTS

The accident set selected for evaluation of the impacts of the No Action Alternative and tritium production are described in Section 5.1 and discussed in detail in Appendix D, Section D.1. The consequences of the reactor and nonreactor design-basis accidents for the No Action Alternative at the Sequoyah plant (0 TPBARs) and for maximum tritium production (3,400 TPBARs) were estimated using the NRC-based deterministic approach presented in the *Sequoyah Nuclear Plant Final Safety Analysis Report* (TVA 1996b). The receptors were an individual at the reactor site exclusion area boundary and an individual at the reactor site low-population zone. The margin of safety for site dose criteria associated with the same accidents and the same receptors are presented in **Table 5–18.** Data presented for the No Action Alternative were extracted directly from the *Sequoyah Nuclear Plant Final Safety Analysis Report*. As indicated in Table 5–18, the irradiation of TPBARs at the Sequoyah plant would result in a very small increase in design-basis accident consequences and thus, a reduction in the consequence margin. The accident consequences would be dominated by the effects of the nuclide releases inherent to the No Action Alternative.

Table 5–18 Design-Basis Accident Consequence Margin to Site Dose Criteria at Sequoyah 1 or Sequoyah 2

Accident	Tritium Production	Dose Description [a]	Site Dose Criteria (rem) [b]	Individual at Area Exclusion Boundary		Individual at Low Population Zone	
				Dose (rem)	Margin (%) [c]	Dose (rem)	Margin (%) [c]
Reactor design-basis accident	0 TPBARs (No Action)[d]	Thyroid inhalation dose	300	145	51.6	27	91.0
		Beta + gamma whole body dose	25	12.2	51.1	2.9	88.4
	3,400 TPBARs	Thyroid inhalation dose	300	145	51.6	27	91.0
		Beta + gamma whole body dose	25	12.2	51.1	2.9	88.4
Nonreactor design-basis accident	0 TPBARs (No Action) [d]	Thyroid inhalation dose	300	0.000013	100	1.1×10^{-6}	100
		Beta + gamma whole body dose	25	0.0017	99.993	0.00014	99.999
	3,400 TPBARs	Thyroid inhalation dose	300	0.019	99.994	0.0022	99.999
		Beta + gamma whole body dose	25	0.0028	99.989	0.00027	99.998

[a] Dose is the total dose from the reactor plus the contribution from the TPBARs.
[b] 10 CFR 100.11.
[c] Margin below the site dose criteria.
[d] TVA 1996b.

Table 5–19 presents the incremental risks due to tritium production for the postulated set of design-basis and handling accidents and the total risks from beyond design-basis accidents to the maximally exposed offsite individual, an average individual in the public within an 80-kilometer (50-mile) radius of the reactor site, and a noninvolved worker at the site boundary 556 meters (0.35 miles) from the release point. Accident consequences for the same receptors are summarized in **Table 5–20**. The assessment of dose and the associated cancer risk to the noninvolved worker are not applicable for beyond design-basis accidents. A site emergency would have been declared early in the beyond design-basis accident sequence; all nonessential site personnel would have evacuated the site in accordance with site emergency procedures before any radiological release to the environment. In accordance with emergency action guidelines, evacuation of the public within 16.1 kilometers (10 miles) of the plant would have been initiated.

Table 5–19 Annual Accident Risks at Sequoyah 1 or Sequoyah 2

Accident	*Tritium Production*	*Maximally Exposed Offsite Individual* [a]	*Average Individual in Population to 80 kilometers (50 miles)* [a]	*Noninvolved Worker* [a]
Design-Basis Accidents				
Reactor design-basis accident [b]	1,000 TPBARs	1.9×10^{-10}	2.2×10^{-12}	6.4×10^{-13}
	3,400 TPBARs	6.6×10^{-10}	7.6×10^{-12}	2.2×10^{-12}
Nonreactor design-basis accident [b]	1,000 TPBARs	7.9×10^{-9}	6.1×10^{-10}	1.3×10^{-10}
	3,400 TPBARs	2.7×10^{-8}	2.1×10^{-9}	4.5×10^{-10}
Sum of design-basis accident risks	1,000 TPBARs	8.1×10^{-9}	6.1×10^{-10}	1.3×10^{-10}
	3,400 TPBARs	2.8×10^{-8}	2.1×10^{-9}	4.5×10^{-10}
Handling Accidents				
TPBAR handling accident	1,000 TPBARs	3.1×10^{-8}	2.6×10^{-10}	9.5×10^{-10}
	3,400 TPBARs	1.0×10^{-7}	8.7×10^{-10}	3.2×10^{-9}
Truck cask handling accident	1,000 TPBARs	2.5×10^{-13}	2.0×10^{-15}	7.4×10^{-15}
	3,400 TPBARs	7.5×10^{-13}	6.1×10^{-15}	2.2×10^{-14}
Rail cask handling accident	1,000 TPBARs	1.3×10^{-13}	1.0×10^{-15}	3.8×10^{-15}
	3,400 TPBARs	3.8×10^{-13}	3.0×10^{-15}	1.1×10^{-14}
Sum of handling risks	1,000 TPBARs	3.1×10^{-8}	2.6×10^{-10}	9.5×10^{-10}
	3,400 TPBARs	1.0×10^{-7}	8.7×10^{-10}	3.2×10^{-9}
Beyond Design-Basis Accidents (Severe Reactor Accidents)				
Reactor core damage accident with early containment failure	0 TPBARs (No Action)	1.7×10^{-8}	1.6×10^{-10}	Not applicable
	3,400 TPBARs	1.7×10^{-8}	1.6×10^{-10}	Not applicable
Reactor core damage accident with containment bypass	0 TPBARs (No Action)	2.1×10^{-8}	1.4×10^{-9}	Not applicable
	3,400 TPBARs	2.1×10^{-8}	1.5×10^{-9}	Not applicable
Reactor core damage accident with late containment failure	0 TPBARs (No Action)	3.9×10^{-9}	2.4×10^{-10}	Not applicable
	3,400 TPBARs	4.0×10^{-9}	2.5×10^{-10}	Not applicable
Sum of severe reactor accident risks	0 TPBARs (No Action)	4.2×10^{-8}	1.4×10^{-9}	Not applicable
	3,400 TPBARs	4.2×10^{-8}	1.5×10^{-9}	Not applicable

[a] Increased likelihood of cancer fatality per year.
[b] Design-basis accident risks only reflect the incremental increase in accident risk due to the production of tritium in TPBARs.

Table 5–20 Accident Frequencies and Consequences at Sequoyah 1 or Sequoyah 2

Accident	Accident Frequency (per year)	Tritium Production	Maximally Exposed Offsite Individual		Average Individual in Population to 80 kilometers (50 miles)		Noninvolved Worker	
			Dose (rem)	Cancer Fatality [a]	Dose (rem)	Cancer Fatality [a]	Dose (rem)	Cancer Fatality [a]
Design-Basis Accidents								
Reactor design-basis accident [b]	0.0002	1,000 TPBARs	0.0019	9.5×10^{-7}	0.000022	1.1×10^{-8}	8.1×10^{-6}	3.2×10^{-9}
		3,400 TPBARs	0.0065	3.3×10^{-6}	0.000075	3.8×10^{-8}	0.000028	1.1×10^{-8}
Nonreactor design-basis accident [b]	0.01	1,000 TPBARs	0.0016	7.9×10^{-7}	0.00012	6.1×10^{-8}	0.000032	1.3×10^{-8}
		3,400 TPBARs	0.0054	2.7×10^{-6}	0.00042	2.1×10^{-7}	0.00011	4.5×10^{-8}
Handling Accidents								
TPBAR handling accident	0.0017/ 0.0058[c]	All TPBAR Configurations	0.036	0.000018	0.00029	1.5×10^{-7}	0.0014	5.6×10^{-7}
Truck cask handling accident	5.3×10^{-7}/ 1.6×10^{-6} [c]	All TPBAR Configurations	0.00093	4.7×10^{-7}	7.5×10^{-6}	3.8×10^{-9}	0.000036	1.4×10^{-8}
Rail cask handling accident	2.7×10^{-7}/ 6.0×10^{-7} [c]	All TPBAR Configurations	0.00093	4.7×10^{-7}	7.5×10^{-6}	3.8×10^{-9}	0.000036	1.4×10^{-8}
Beyond Design-Basis Accidents (Severe Reactor Accidents)								
Reactor core damage with early containment failure	6.8×10^{-7}	0 TPBARs (No Action)	25.0 [d]	0.025 [d]	0.48	0.00024	N/A	N/A
		3,400 TPBARs	25.1 [d]	0.025 [d]	0.48	0.00024	N/A	N/A
Reactor core damage with containment bypass	4.0×10^{-6}	0 TPBARs (No Action)	10.4	0.0052	0.72	0.00036	N/A	N/A
		3,400 TPBARs	10.4	0.0052	0.73	0.00037	N/A	N/A
Reactor core damage with late containment failure	9.2×10^{-6}	0 TPBARs (No Action)	0.84	0.00042	0.051	0.000026	N/A	N/A
		3,400 TPBARs	0.87	0.00044	0.053	0.000027	N/A	N/A

N/A = Not applicable.

a Increased likelihood of cancer fatality.

b Design-basis accident consequences only reflect the incremental increase in accident consequences due to the production of tritium in TPBARs.

c Frequency for 1,000 TPBARs/frequency for 3,400 TBPARs.

d Dose greater than 20 rem. Cancer fatality risk doubled.

Presented in Tables 5–19 and 5–20 are calculations of both risks and consequences of the No Action Alternative (0 TPBARs) and maximum tritium production (3,400 TPBARs) for severe reactor accidents. The tritium release is governed by the nature of the core melt accident scenarios analyzed; the accident risks and consequences are governed by actions taken in accordance with the EPA Protective Action Guidelines (e.g., evacuation of the public, interdiction of the food and water supply, condemnation of farmland and public property) in response to the postulated core melt accident with containment failure or containment bypass.

The severity of the reactor accident dominates the consequences, is the basis for implementation of protective actions, and is independent of the number of TPBARs. The accident risk is the product of the accident probability (i.e, accident frequency) times the accident consequences. In this EIS, risk is expressed as the increased likelihood of cancer fatality per year for an individual (i.e., the maximally exposed offsite individual, an average individual in the population within 80 kilometers [50 miles] of the reactor site, or a noninvolved worker). Table 5–19 indicates that the risks associated with tritium production are low. The highest risk to each individual—the maximally exposed offsite individual, one fatality every 37 million years (2.7×10^{-8} per year); an average member of the public, one fatality every 480 million years (2.1×10^{-9} per year); the exposed population, one fatality every 1.9 thousand years (0.00052 per year); and a noninvolved worker, one fatality every 2.2 billion years (4.5×10^{-10} per year)—is from the nonreactor design-basis accident.

The nonreactor design-basis accident has the highest consequence of the design-basis and handling accidents because the postulated accident scenario entails an acute release of tritium, in oxide form, directly to the environment without any mitigation. Review of Table 5–20 indicates that there would be a very small increase of severe reactor accident consequences due to the irradiation of TPBARs at the Sequoyah plant. The accident consequences are dominated by the effects of the radionuclide releases inherent to the No Action Alternative. The secondary impacts of severe reactor accidents are presented in Section 5.2.13.

HAZARDOUS CHEMICAL IMPACTS

No Action

No impacts on public and occupational health and safety from exposure to hazardous chemicals are anticipated at the Sequoyah site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Tritium production would introduce no additional operations at the plant that would require the use of hazardous chemicals.

5.2.2.10 Environmental Justice

As discussed in Appendix G, Executive Order 12898 directs Federal agencies to address disproportionately high and adverse health or environmental effects of alternatives on minority and low-income populations. The Executive Order does not alter prevailing statutory interpretations under NEPA or existing case law. Regulations prepared by the Council on Environmental Quality remain the foundation for the preparation of environmental documentation in compliance with NEPA (40 CFR, 1500 through 1508). As discussed previously, the alternatives would have no adverse or beneficial environmental effects on the general population, nor would they have any effects on any particular group within the general population, including minority and low-income populations.

No Action

Under the No Action Alternative, there would be no impacts on the general population. Therefore, no disproportionately high and adverse consequences for minority and low-income populations are expected beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Analyses of incident-free operations and accidents show the risk of latent cancer fatalities among the public residing within 80 kilometers (50 miles) of the reactor site to be much less than 1. Because tritium production would not have high and adverse consequences for the population at large, no minority or low-income populations would be expected to experience disproportionately high and adverse consequences.

5.2.2.11 Waste Management

No Action

Under the No Action Alternative, waste generation at Sequoyah 1 or Sequoyah 2 should continue at the levels described in Section 4.2.2.10. Provisions for the management of these wastes would continue unchanged.

Tritium Production

No additional hazardous waste, nonhazardous solid waste, or sanitary liquid waste should be generated at Sequoyah 1 or Sequoyah 2 as a result of tritium production. Management of these wastes would continue as described in Section 4.2.2.10. However, it is expected that an additional 0.43 cubic meters per year (15 cubic feet per year) of low-level radioactive waste would be generated as a result of tritium production (WEC 1999). It would consist of the approximately 140 base plates and other irradiated hardware remaining after the TPBARs were separated from their assemblies to be placed in the 17 × 17 array consolidation baskets at the reactor site.

Similar to the quantities of low-level radioactive waste generated as a result of activities independent of this action, the additional low-level radioactive waste generated as a result of tritium production (with the exception of the base plates and associated hardware) would be shipped to a commercial processor where it would be compacted to a lesser volume and shipped to the Barnwell, South Carolina, low-level radioactive waste disposal facility. The base plates and associated hardware would accumulate until a sufficient amount were on hand to ship directly to Barnwell for disposal. The additional low-level radioactive waste of 0.43 cubic meters (15 cubic feet) represents less than 0.1 percent of the total low-level radioactive waste generated currently at Sequoyah 1 or Sequoyah 2.

For completeness, this EIS also analyzes the management of the additional volume of low-level radioactive waste (0.43 cubic meters [15 cubic feet]) generated as a result of tritium production at DOE-owned facilities at the Savannah River Site. Under this scenario, the additional low-level radioactive waste could be transported to the Low-Level Radioactive Waste Disposal Facility at the Savannah River Site near Aiken, South Carolina. The facility consists of a series of vaults in E-Area that have been operational since September 1994. The operating capacity of each vault is 30,500 cubic meters of low-level radioactive waste (DOE 1998c, DOE 1999b). Therefore, the addition of low-level radioactive waste from the proposed action at Sequoyah 1 or Sequoyah 2 for a 40-year period would be approximately 0.06 percent of the capacity of a single vault.

5.2.2.12 Spent Fuel Management

Production of tritium at Sequoyah 1 or Sequoyah 2 would not increase the generation of spent nuclear fuel if less than approximately 2,000 TPBARs were irradiated in a fuel cycle. For the irradiation of the maximum number of 3,400 TPBARs, up to 140 spent nuclear fuel assemblies could be generated. This represents up to 60 additional spent nuclear fuel assemblies beyond the normal refueling batch of 80 assemblies. For the purposes of this EIS it is assumed that the additional spent nuclear fuel would be stored on site for the duration of the proposed action. If needed, a dry cask ISFSI would be constructed at the site. Environmental impacts of the construction and operation of a generic dry cask ISFSI are presented in Section 5.2.6.

5.2.3 Bellefonte Nuclear Plant Units 1 and 2

5.2.3.1 Land Resources

The land resources analysis addresses land use and visual resources for the region of influence. The region of influence for land use includes land within 3.2 kilometers (2 miles) of the site. The region of influence for visual resources includes those lands from which the Bellefonte Nuclear Plant is visible (the viewshed). The land use impacts of tritium production are compared with the existing land use patterns. Visual resource impacts are associated with changes in the existing landscape character that could result from tritium production.

LAND USE

No Action

No land use impacts are anticipated at the Bellefonte site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

The land use analysis considers the magnitude and extent of potential impacts on current land use patterns and densities that are attributable to the alternative. The amount of land disturbed during construction and used during operation is identified, as are the potential changes in land use and conflicts with land use policies, plans, and controls.

Construction

The 607-hectare (1,500-acre) site contains ample existing construction laydown areas that are conveniently located near large warehouse storage buildings and yard storage areas. Land disturbance would be limited to that required for new support buildings. Completing construction of Bellefonte 1 alone or both Bellefonte 1 and 2 would require land already disturbed during previous construction at the site. There would be no impacts on undisturbed grassland and forest land. Completing construction should not impact the ability to continue hay production on areas of the site. The total land disturbed is discussed in Section 4.2.3.1. Land use would remain unchanged from its current industrial and agricultural uses.

An electric power distribution system exists to adequately support the power demands of plant equipment, construction shops, and employee facilities. No additional land area would be required for furnishing utilities to the site. Utility distribution systems are in place and occupy sufficient land area to accommodate any required additions or enhancements.

Based on the evaluation of land use impacts for the Bellefonte Conversion Project (for completion of Bellefonte 1 or both Bellefonte 1 and 2) there would be a small increase in the amount of land used for residential development and mobile homes to accommodate construction workers. The overall impact, however, should be very small (TVA 1997f).

Operation

Operation of Bellefonte 1 or both Bellefonte 1 and 2 would require no additional undisturbed land on the site other than that described for construction.

Based on the evaluation of the land use impacts for the Bellefonte Conversion Project (TVA 1997f) and the projected operations employment at Bellefonte 1 or both units, the anticipated population increase in Jackson County from operation of the Bellefonte Nuclear Plant would result in an increased demand for new housing units, as discussed in Section 5.2.3.8. According to the latest population estimates by the U.S. Census Bureau, Jackson County has averaged an increase of about 391 persons per year since the 1990 Census of Population was taken. The population increase resulting from completion and operation of the Bellefonte plant would noticeably exceed normal growth. Therefore, an increased demand for housing would increase the amount of land needed for residential development, but this would not be an important impact in the context of the county land base.

VISUAL RESOURCES

The visual resources analysis addresses the magnitude and extent of potential changes in the visual environment that could result from tritium production. Visual resources impact assessments are conducted using the Bureau of Land Management Visual Resource Management method (DOI 1986a). The existing landscape at a site is assigned a classification ranging from 1 to 4. The existing landscape at the Bellefonte site would be Class 3 or 4. Class 3 includes areas in which there have been moderate changes in the landscape that could attract attention, but do not dominate the view of the casual observer. Class 4 includes areas in which major modifications to the character of the landscape have occurred. These changes may be dominant features of the view and the major focus of viewer attention (DOI 1986b).

Class designations are derived from an inventory of the scenic quality, sensitivity levels, and distance zones of a particular area. The elements of scenic quality are landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modification. Scenic value is determined by the variety and harmonious composition of the elements of scenic quality. Sensitivity levels are determined by user volumes and user attention. Distance zones concern the relative visibility from travel routes or observation points. They include the following categories: foreground–middleground, less than 4.8 to 8 kilometers (3 to 5 miles) away; background, 4.8 to 24 kilometers (3 to 15 miles); and seldom seen, 24 kilometers (15 miles) to infinity and areas blocked or screened from view. The analysis objectives include identification of the degree of contrast between the proposed action and the existing landscape, the location and sensitivity levels of viewpoints accessible to the public, and the visibility of the proposed action from the viewpoints. The distance from a viewpoint to the affected area and the atmospheric conditions also are taken into consideration because distance and haze can diminish the degree of contrast and visibility (DOI 1986a, DOI 1986b, DOE 1996c).

No Action

No visual impacts are anticipated at the Bellefonte site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Construction

Little physical change would be required to the parts of the Bellefonte Nuclear Plant that are visible to the public. The major visual elements of the plant, the two hyperbolic cooling towers and the transmission lines, already exist. As discussed in Section 4.2.3.1, views of Bellefonte from passing river traffic on the Tennessee River are partially screened by the ridge lines close to the shoreline. The plant is overlooked by a few residences on Sand Mountain on the east side of the river. Distant glimpses of the plant site can be had from the coves and hollows along the Sand Mountain rim, from State Roads 35 and 40 as they traverse Sand Mountain, and from Comer Bridge, which crosses Guntersville Reservoir (TVA 1997f). The plant also can be seen from various locations along U.S. Highway 72 to the northwest and from residences on the north shore of Town Creek Embayment. Completion of construction would result in little or no visual change from offsite viewpoints.

Operation

During operation, additional visual impacts would result from the vapor plume associated with the 145-meter (477-foot) cooling towers; one would be operating with Bellefonte 1, and two would be operating with the combination of Bellefonte 1 and 2. The plume would be visible up to 16 kilometers (10 miles) away. The plume would vary with atmospheric conditions, being most visible during cooler months and after the passage of weather fronts. Plumes would be less visible during summer months when hazy conditions persist and morning fog is more common. Since the reactor site represents an existing condition that would be classified as Visual Resource Management Class 4, contrasts created by minor changes at the plant site and the cooling tower plume are considered to be moderate to none; that is, there would be no visual impact when there is no plume (TVA 1974b, TVA 1997f). Vapor plumes would have an aesthetic impact on the towns of Pisgah, Hollywood, and Scottsboro, as well as on traffic along U.S. Highway 72 (TVA 1974b).

5.2.3.2 Noise

Sound results from the compression and expansion of air or some other medium when an impulse is transmitted through it. Sound requires a source of energy and a medium for transmitting the sound wave. The propagation of sound is affected by various factors, including meteorology, topography, and barriers. Noise is undesirable sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities (e.g., hearing, sleep), damage hearing, or diminish the quality of the environment (i.e., cause annoyance).

Sound-level measurements used to evaluate the effects of nonimpulsive sound on humans are compensated for by an A-weighting scale that accounts for the hearing response characteristics (i.e., frequency) of the human ear. Sound levels are expressed in decibels (dB) or, in the case of A-weighted measurements, decibels A-weighted (dBA). The most common measure of environmental noise impact is the day-night average sound level, a 24-hour, A-weighted equivalent sound level with a 10-dBA penalty added to sound levels between 10:00 p.m. and 7:00 a.m to account for increased annoyance due to noise during nighttime hours. The EPA has developed noise-level guidelines for different land use classifications that are based on the day-night average and equivalent sound levels. The U.S. Department of Housing and Urban Development has established noise impact guidelines for residential areas that are based on day-night average sound levels. Some states and localities have established noise control regulations or zoning ordinances that specify acceptable noise levels by land use category. The State of Alabama has not developed a noise regulation that specifies acceptable numerical community noise levels.

For the purpose of this document, noise impacts are assessed using a day-night average sound level of 65 dBA as the level above which noise impacts would be considered “significant impacts” and an increase of 2 dBA as an indicator of “substantial” increases in noise. This approach is based on the TVA noise analysis for the Bellefonte Conversion Project (TVA 1997f). Short-term noises above a level of about 75 dBA, such as steam releases, could have a “startle” effect on humans and wildlife (TVA 1997f).

The noise analysis conducted by TVA for the conversion project considered the nearest fence line receptor as representative of a future residential land use or other use, as well as the nearest existing residential area (across Town Creek), the nearest ecologically sensitive area (a heron rookery near the confluence of Town Creek and the Tennessee River), and a location on the high bluffs on Sand Mountain across the Tennessee River from the site. Measured sound levels near the boundaries of the site range from a day-night average sound level of 50 dBA to 55 dBA. For the purpose of the analysis, a background day-night average sound level of 50 dBA was used. This level is typical of a low-density residential or rural location (TVA 1997f).

No Action

No noise impacts are anticipated at the Bellefonte site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Construction

The location of the Bellefonte facilities relative to the Bellefonte site boundary and sensitive receptors was examined to evaluate the potential for onsite and offsite noise impacts. Noise sources during construction would include materials-handling equipment (e.g., cranes and forklifts), employee vehicles, and truck traffic. Traffic noise associated with construction of these facilities would occur both on site and along offsite local and regional transportation routes used to bring construction materials and workers to the site.

The Bellefonte Conversion Project noise analysis was based on a composite of construction noise. This composite included excavation and structure erection activities, with all activities occurring during daylight hours between 7 a.m. and 5 p.m. Noise impacts from these construction activities would depend on the equipment used, the noise levels from individual equipment items, the number of sources, the duration and frequency of operation, the time of day, and other factors. Most of the activities associated with completion of Bellefonte 1 or both Bellefonte 1 and 2 would be indoors. Activities occurring outdoors would not be expected to produce the high levels of noise that were analyzed for the Bellefonte Conversion Project. The analysis indicated that the daytime equivalent sound levels would not increase at the two more distant sensitive receptors evaluated, the heron rookery and Sand Mountain. At the fence line receptor and the nearest residential area, the daytime equivalent sound levels would increase less than 1 dBA. Regular sounding of the shift change whistle would be heard at the fence line receptor and at the nearest residence.

Table 5–21 presents a range of noise levels for the major construction equipment expected to be used during construction activities for Bellefonte 1 or both Bellefonte 1 and 2. In addition, a variety of other noise-producing equipment would be used, including pumps, generators, compressors, pneumatic wrenches, vibrators, saws, hand compactors, concrete mixers, concrete pumps, pavers, and compactors. These items are typically somewhat quieter than the items shown in the table.

Table 5–21 General Construction Equipment Noise Levels

Activity	*Item*	*Maximum Noise Level (dBA) at 15 meters (50 feet)*
Earthmoving:	Front-end loaders	82–86
	Backhoes	81–84
	Tractors	82–86
	Scrapers, graders	86–91
	Trucks	81–87
	Dozers	81–90
Materials handling:	Concrete trucks	81–87
	Cranes (movable)	80–85
	Cranes (derrick)	82–86
	Fork-lift trucks	82–86
	Delivery trucks	81–87
Impact equipment:	Jack hammers, rock drills	83–99
	Pile drivers	81–96

Source: BBN 1977, TVA 1998a.

Noise from traffic associated with construction of these facilities should result in a less than 1 dBA increase in day-night average sound level from traffic along U.S. Highway 72 near the Bellefonte plant entrance. This noise level should not result in any increased annoyance of the public. Peak-hour construction traffic noise at the beginning and end of the workday would result in about a 2 dBA increase in traffic noise levels (1-hour equivalent sound level) along U.S. Highway 72 from about 65 dBA at 30 meters (100 feet) to about 67 dBA.

Traffic noise levels along the access road, which has been fairly quiet since construction of Bellefonte was deferred, would increase to a day-night average sound level of about 55 dBA during construction. Much of the traffic during the construction period would be at the beginning and end of the work day. Peak-hour traffic noise would increase by about 12 dBA along the access road. Traffic noise during the peak hours should be noticeable at the nearby residences.

Operation

The location of Bellefonte 1 and 2 relative to the site boundary and sensitive receptors was examined to evaluate the potential for onsite and offsite noise impacts. Noise sources during operation would include cooling towers; heating, ventilation, and air conditioning systems; vents; motors; pumps; transformers; switchyard equipment; generators; material-handling equipment; audible paging systems; sirens; employee vehicles; and truck traffic. Traffic noise associated with operation of these facilities would occur both on site and along offsite local and regional transportation routes used to bring materials and workers to the site. Operational noise sources would be primarily in the center of the site near the switchyard, turbine building, and cooling towers. Modeling of routine onsite noise sources associated with the operation of Bellefonte 1 or both Bellefonte 1 and 2 indicates that day-night average sound levels would increase to about 51 dBA at the site boundary receptor and at the nearest residence receptor. Day-night average sound levels at the other two receptors considered, the heron rookery and Sand Mountain, would not change from the 50-dBA background level. The routine noise should have no impact (less than 2 dBA) on the nearby residential areas. Other noise sources such as the infrequent actuation of the modulating atmospheric dump valves would result in higher noise levels at the site boundary and could disturb wildlife on the site. Noise from traffic associated with the operation of Bellefonte 1 or both Bellefonte 1 and 2 should result in an increase of less than 4 dBA in the day-night average sound level along U.S. Highway 72, and could be noticeable at nearby residences. Peak-hour operations traffic noise at shift changes would result in an increase in traffic noise levels along U.S. Highway 72 from about 65 dBA at 30 meters (100 feet) to about 67 dBA.

Traffic noise levels along the access road would increase to a day-night average sound level of about 57 dBA during operation. Peak-hour traffic would result in an increase in traffic noise levels along the access road from about 51 dBA at 30 meters (100 feet) to about 58 dBA. This increase in noise levels could be noticeable at nearby residences.

Regular testing of the emergency warning siren system would result in outdoor noise levels of about 60 dBC (C-weighted) in areas within a radius of about 16 kilometers (10 miles) of the site. At other nuclear plants TVA typically tests siren systems on a given day of the month at noon (TVA 1998a).

Noise exposure for workers is regulated under Occupational Safety and Health Administration regulations (29 CFR 1910.95). Where the 8-hour noise exposure guidelines would be exceeded, appropriate administrative and engineering controls would be implemented to control noise exposure, and a hearing protection program would be implemented.

5.2.3.3 Air Quality

NONRADIOACTIVE GASEOUS EMISSIONS

Air pollution refers to any substance in the air that could harm human or animal populations, vegetation, or structures, or that unreasonably interferes with the comfortable enjoyment of life and property. For the purpose of this document, only outdoor air pollutants are addressed. These may be in the form of solid particles, liquid droplets, gases, or any combination of these forms. Generally, they can be categorized as primary pollutants (those emitted directly from identifiable sources) and secondary pollutants (those produced in the air by interaction between two or more primary pollutants or by reaction with normal atmospheric constituents that may be influenced by sunlight). Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

Ambient air quality in a given location can be described in terms of a comparison of the concentrations of various pollutants in the atmosphere against the corresponding standards. Ambient air quality standards have been established by Federal and state agencies to ensure an adequate margin of safety for the protection of the public health and welfare from the adverse effects of pollutants in the ambient air. Pollutant concentrations higher than the corresponding standards are considered unhealthy. Concentrations below the corresponding standards are considered acceptable.

The pollutants of concern are primarily those for which Federal and state ambient air quality standards have been established, including criteria air pollutants, hazardous air pollutants, and other toxic air compounds. The criteria pollutants are those listed in 40 CFR 50, National Primary and Secondary Ambient Air Quality Standards. The hazardous air pollutants and other toxic compounds are those listed in Title III of the 1990 Clean Air Act, as amended; those regulated by the National Emissions Standards for Hazardous Air Pollutants; and those that have been proposed or adopted for regulation by the state or are listed in state guidelines. Also of concern are air pollutant emissions that may contribute to the depletion of stratospheric ozone or to global warming.

An assessment of the impacts on air quality is based on a comparison of air pollutant concentrations with applicable Federal and state ambient air quality standards and concentration limits. The more stringent of either the EPA or state standards serve as the assessment criteria. The primary air pollutant emissions resulting from completing the construction of Bellefonte 1 and the operation of Bellefonte 1 or both Bellefonte 1 and 2 would consist largely of sulfur dioxide, nitrogen oxide compounds, particulate matter, and carbon monoxide, as shown in **Table 5–22**. The ambient standards for these pollutants are presented in **Table 5–23**. Compliance with the new standards for particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$) was not evaluated because the currently available emission factors are for particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (PM_{10}).

No Action

No air quality impacts are anticipated at the Bellefonte site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Construction

The potential air quality impacts of construction activities required to complete Bellefonte 1 or both Bellefonte 1 and 2 were evaluated. Since most of the activities such as earth-moving, excavation, and erection of major structures have been completed, the air pollution sources associated with unit completion would be similar to those associated with ongoing maintenance of the facilities and sources associated with completion of interior work and a few structures (e.g., piping systems). These include diesel generators, auxiliary boilers, employee vehicles, and trucks moving materials and wastes. Emissions from the currently operating generators and boilers are discussed in Section 4.2.3.3.

Air pollutant concentrations during construction should be similar to those for maintenance of the existing facilities, as discussed in Section 4.2.3.3, except for increased vehicular traffic; additional emissions from materials-handling equipment such as trucks, cranes, and forklifts; welding fumes; and emissions of cleaning solvents. Estimated emissions from these sources are presented in Table 5–22.

Table 5–22 Annual Nonradioactive Gaseous Emissions from Bellefonte 1 or Both Bellefonte 1 and 2 During Construction

	Emissions (kilograms per year)			
			Vehicles	
Pollutant	*Bellefonte 1 Equipment*	*Bellefonte 1 and Bellefonte 2 Equipment*	*Bellefonte 1*	*Bellefonte 1 and Bellefonte 2*
Carbon monoxide	20,800	24,700	57,800	87,300
Nitrogen dioxide	54,400	64,700	16,400	24,800
Particulate matter	4,220	5,000	57,300	86,700
Sulfur dioxide	6,110	7,160	0	0
Formaldehyde	6.34	6.34	0	0
Arsenic	0.0658	0.0658	0	0
Beryllium	0.0392	0.0392	0	0
Cadmium	0.172	0.172	0	0
Chromium	1.05	1.05	0	0
Lead	0.14	0.14	0	0
Manganese	0.219	0.219	0	0
Mercury	0.047	0.047	0	0
Nickel	2.66	2.66	0	0

Source: TVA 1995c, TVA 1998a.

The total amount of these emissions would be small and would result in minimal offsite impacts, as shown in Table 5–23. As described in Appendix B, the short-term version of the ISC3 model, ISCST3, was used to calculate concentrations with averaging times of 1 to 24 hours, as well as calendar quarter concentrations and annual average concentrations. Construction equipment and other associated emissions for each alternative were evaluated as a volume source using the ISC3 model. Although there would be finite increases in air pollutant concentrations from construction activities, they would not exceed the ambient air quality standards.

Concentrations of toxic air pollutants from the combustion of diesel fuel in the auxiliary boilers, diesel generators, and construction equipment were also evaluated. There are no Alabama State standards that specify acceptable ambient concentrations of toxic air pollutants. During the permitting process, Alabama compares 1-hour concentrations of toxic air pollutants to 1/40 of the applicable threshold limit value for a pollutant to assess whether the pollutant is of concern and should be evaluated in more detail. Offsite concentrations of all toxic pollutants evaluated for construction at Bellefonte would be below 1 percent of the applicable threshold limit value.

Table 5–23 Annual Air Pollutant Concentrations from Bellefonte 1 and 2 During Construction

Pollutant	*Averaging Period*	*Most Stringent Standard or Guidelines*[a] *(μg/m³)*	*Construction's Contribution (μg/m³)*	*Total Concentration*[b] *(μg/m³)*	*Percent of Standard or Guideline*
Carbon monoxide	8-hour 1-hour	10,000 40,000	211 846	4,350 6,370	44 16
Lead	Calendar Quarter 1-hour	1.5 3.75	0.00007 0.00275	0.0301 0.00275	2.0 0.22
Nitrogen dioxide	Annual	100	69.1	93.2	93
Ozone	8-hour (3-year average of annual 4th highest)	157	Not applicable	c	c
Particulate matter	PM_{10} Annual 24-hour	 50 150	 5.29 24.2	 29.3 70.2	 59 47
Sulfur dioxide	Annual 24-hour 3-hour	80 365 1,300	7.04 31.1 79.7	20.0 105 290	25 29 22
Formaldehyde	1-hour	9.25	0.126	0.126	1.4
Arsenic	1-hour	0.25	0.00130	0.00130	0.52
Beryllium	1-hour	0.05	0.000773	0.000773	1.5
Cadmium	1-hour	0.05	0.0034	0.0034	6.8
Chromium	1-hour	12.5	0.0207	0.0207	0.17
Manganese	1-hour	5.0	0.00432	0.00432	0.086
Mercury	1-hour	0.625	0.000928	0.000928	0.15
Nickel	1-hour	1.25	0.0526	0.0526	2.1

$\mu g/m^3$ = micrograms per cubic meter.
PM_n = Particulate matter less than or equal to *n* micrometers.
[a] The more stringent of the Federal and state standards are presented for the averaging time. For toxic air pollutants, a value of 1/40 of the applicable threshold limit value is used for comparison.
[b] Sum of the maximum ambient monitored concentration and the construction contribution.
[c] There is insufficient monitoring data to compare to the 8-hour standard for ozone.

Note: The National Ambient Air Quality Standards (40 CFR 50), other than those for particulate matter and those based on annual averages, are not to be exceeded more than once per year. The 1-hour ozone standard applies only to nonattainment areas. The 8-hour ozone standard is attained when the 3-year average of the annual fourth-highest daily maximum 8-hour average concentration is less than or equal to 157 $\mu g/m^3$. The 24-hour particulate matter standard is attained when the expected number of days with a 24-hour average concentration above the standards is ≤ 1. The annual arithmetic mean particulate matter standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. EPA recently revised the ambient air quality standards for particulate matter. The new standards were finalized on July 18, 1997. The current PM_{10} annual standard was retained and two $PM_{2.5}$ (particulate matter less than or equal to 2.5 micrometers) standards were added. These standards were set at 15 $\mu g/m^3$ 3-year annual average arithmetic mean based on community-oriented monitors and 65 μg/cubic meters 3-year average of the 98th percentile of 24-hour concentrations at population-oriented monitors. The current 24-hour PM_{10} standard was revised to be based on the 99th percentile of 24-hour concentrations. The existing PM_{10} standards would continue to apply in the interim period (62 FR 38652).

Source: ADEM 1972, TVA 1998a, TVA 1995b, ADEM 1995.

Operation

Operational impacts would result from emissions from four diesel generators, four diesel fuel-fired fire pumps, a security power diesel generator, two auxiliary boilers fueled with No. 2 fuel oil (0.05 percent sulfur), two cooling towers, two turbogenerator lube oil systems, and two fixed-roof tanks for storing No. 2 fuel oil (TVA 1997d). Emissions from these sources based on recent operating experience at TVA's Sequoyah Nuclear Plant are summarized in **Table 5–24.** In addition to these sources, there would be emissions from employee vehicles and trucks moving materials and wastes.

Table 5–24 Nonradioactive Gaseous Emissions from Bellefonte 1 and 2 During Operations

Pollutant	Emissions (kilograms per year)	
	Stationary Sources[a]	Vehicles
Carbon monoxide	23,714	48,100
Nitrogen dioxide	90,707	13,700
Particulate matter	12,611	47,800
Sulfur dioxide	8,869	0
Volatile organic compound	2,105	6,230
Benzene	16.9	0
Toluene	6.13	0
Xylenes	4.21	0
1,3-Butadiene	0.00696	0
Formaldehyde	62.9	0
Acetaldehyde	0.679	0
Acrolein	0.186	0
Arsenic	0.632	0
Beryllium	0.376	0
Cadmium	1.66	0
Chromium	10.1	0
Lead	1.34	0
Manganese	2.11	0
Mercury	0.451	0
Nickel	25.6	0

[a] Stationary sources include diesel generators, diesel fuel-fired fire pumps, security power diesel generators, auxiliary boilers, the lube oil system, fuel oil storage, and cooling towers.

Source: TVA 1997d, TVA 1998a

Maximum air pollutant concentrations resulting from the stationary sources (diesel generators, diesel fuel-fired fire pumps, security power diesel generators, and auxiliary boilers) are summarized in **Table 5–25**. There would be finite increases in air pollutant concentrations from operational activities, but even in combination with air pollutant concentrations from offsite sources (see Section 4.2.3.3), they would continue to meet the ambient air quality standards for carbon monoxide, nitrogen dioxide, PM_{10}, and sulfur dioxide. Concentrations of toxic air pollutants from the combustion of diesel fuel in the auxiliary boilers and diesel generators also were evaluated. There are no Alabama State standards that specify acceptable ambient concentrations of toxic air pollutants. During the permitting process, Alabama compares the concentrations of toxic air pollutants to 1/40 of the applicable threshold limit value for a pollutant to assess whether the pollutant is of concern and should be evaluated in more detail. The offsite concentrations of all the toxic pollutants evaluated for operations at Bellefonte would be below 15 percent of the applicable 1/40 of the threshold limit value. Emissions and resulting concentrations of air pollutants from the operation of Bellefonte 1 individually would be similar to those from operation of the combined units, since the testing and maintenance of the stationary sources would not vary.

Table 5–25 Annual Air Pollutant Concentrations from Bellefonte 1 and 2 During Operations

Air Pollutant	*Averaging Period*	*Most Stringent Standard or Guidelines[a] ($\mu g/m^3$)*	*Operation's Contribution ($\mu g/m^3$)*	*Total Concentration ($\mu g/m^3$)*	*Percent of Standard or Guideline*
Carbon monoxide	8-hour 1-hour	10,000 40,000	404.0 662.0	4,540 6,180	45 15
Lead	Calendar Quarter 1-hour	1.5 1.25	0.000132 0.00541	0.0301 0.00541	2 0.43
Nitrogen dioxide	Annual	100	1.19	25.3	25
Ozone	8-hour (3-year average of annual 4th highest)	157	Not applicable	b	b
Particulate matter	PM_{10} Annual 24-hour	 50 150	 0.169 18.6	 24.2 64.6	 48 43
Sulfur dioxide	Annual 24-hour 3-hour	80 365 1,300	0.198 15.6 64.6	13.2 89 275	16 24 21
Benzene	1-hour	24	0.618	0.618	2.6
Toluene	1-hour	4,700	0.226	0.226	0.0048
Xylenes	1-hour	10,850	0.15	0.15	0.0014
1,3-Butadiene	1-hour	110	0.00148	0.00148	0.0013
Formaldehyde	1-hour	9.25	0.35	0.35	3.8
Acetaldehyde	1-hour	1,125	0.0479	0.0479	0.0043
Acrolein	1-hour	5.75	0.0094	0.0094	0.16
Arsenic	1-hour	0.25	0.00256	0.00256	1.0
Beryllium	1-hour	0.05	0.00152	0.00152	3.0
Cadmium	1-hour	0.05	0.00668	0.00668	13
Chromium	1-hour	12.5	0.0407	0.0407	0.33
Manganese	1-hour	5.0	0.00851	0.00851	0.17
Mercury	1-hour	0.625	0.00183	0.00183	0.29
Nickel	1-hour	2.5	0.104	0.104	4.2

$\mu g/m^3$ = micrograms per cubic meter.
PM_n = Particulate matter less than or equal to *n* micrometers.
[a] The more stringent of the Federal and state standards is presented for the averaging time. For toxic air pollutants, a value of 1/40 of the applicable threshold limit value is used for comparison.
[b] There is insufficient monitoring data to compare to the 8-hour standard for ozone.
Note: The National Ambient Air Quality Standards (40 CFR 50), other than those for particulate matter and those based on annual averages, are not to be exceeded more than once per year. The 1-hour ozone standard applies only to nonattainment areas. The 8-hour ozone standard is attained when the 3-year average of the annual fourth-highest daily maximum 8-hour average concentration is less than or equal to 157 $\mu g/m^3$. The 24-hour particulate matter standard is attained when the expected number of days with a 24-hour average concentration above the standards is ≤ 1. The annual arithmetic mean particulate matter standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. EPA recently revised the ambient air quality standards for particulate matter. The new standards were finalized on July 18, 1997. The current PM_{10} annual standard was retained and two $PM_{2.5}$ (particulate matter less than or equal to 2.5 micrometers) standards were added. These standards were set at 15 $\mu g/m^3$ 3-year annual average arithmetic mean based on community-oriented monitors and 65 $\mu g/m^3$ 3-year average of the 98th percentile of 24-hour concentrations at population-oriented monitors. The current 24-hour PM_{10} standard was revised to be based on the 99th percentile of 24-hour concentrations. The existing PM_{10} standards would continue to apply in the interim period (62 FR 38652).
Source: TVA 1997d, TVA 1998a.

The potential air pollutant emissions from the auxiliary boilers would exceed the emission level for applicability of the Prevention of Significant Deterioration permitting requirements, although the actual emissions from these sources would be well under these levels. The auxiliary boilers are currently permitted by the Alabama Department of Environmental Management. This department has stated that the boilers are not subject to the Prevention of Significant Deterioration regulations, so it has not issued a Prevention of Significant Deterioration Permit. The diesel generators are operating under a "synthetic minor" permit by the Alabama Department of Environmental Management, owing to their continued operation at less than 50 percent of the 91 metric tons per year (100 tons per year) emission threshold. Under the new operating permit program, permits could be required for other sources such as chlorine, ammonia, and hydrazine storage tanks; lubricating oil system vapor extraction vents; paint and welding shops; and oil storage tanks. Emissions from employee vehicles and trucks carrying materials and wastes would result in some emissions, as shown in Table 5–24.

The combustion of fossil fuels associated with this alternative would result in the emission of carbon dioxide, one of the atmospheric gases believed to influence global climate. Annual carbon dioxide emissions from this alternative would represent less than 0.0006 percent of the 1995 annual U.S. emissions of carbon dioxide from fossil fuel combustion and industrial processes (EPA 1997b). Operation of Bellefonte in lieu of fossil fuel-fired generation would significantly reduce future TVA carbon dioxide emissions.

The possible effects of the natural-draft cooling tower operation would include inadvertent localized atmospheric modifications such as the creation of plumes; cloud formation; changes in local rain, drizzle, fog, icing, and snowfall patterns; and the fallout of salts from cooling tower drift. Cooling tower drift is the dispersion and deposition of wet or dry aerosols emitted from cooling towers. Plans for normal operation of the Bellefonte cooling towers were based on the discharge of heated air carrying 62,800 liters per minute (16,600 gallons per minute) water as vapor and 170 liters per minute (45 gallons per minute) of water as drift from each of the towers (AEC 1974). Most of the drift that fell to the ground would do so within 300 meters (1,000 feet) of the towers. The remainder of the drift and residue would disperse and eventually be removed from the air and deposited on the ground by precipitation. Studies of natural-draft cooling towers in England indicate maximum rates of salt deposition on the order of 0.001 grams per square meter per hour (grams/ m^2-hr). Solids deposition near the Bellefonte cooling towers is estimated to be less than 0.002 grams per square meter per hour (grams/m^2-hr). The major anions in the drift at Bellefonte would be sulphate and carbonate (AEC 1974).

Modeling of the occurrence of visible plumes was performed for the Bellefonte Environmental Statement (AEC 1974). Incidents of the plumes descending to the ground or causing localized surface fogging should be rare. However, the plumes would frequently cause surface fog on Sand Mountain Plateau, about 2.4 to 4.0 kilometers (1.5 to 2.5 miles) southeast from the site at an elevation 122 meters (400 feet) higher than the tops of the cooling towers. Fogging along roads in this area is predicted to occur about 80 hours per year. The plume modeling is expected to overpredict the occurrence of fog; however, the model does not account for the tendency of the plume to follow the terrain. For this reason, ground-level fog from operation of the cooling towers would likely occur only one to two days per year; icing in the Sand Mountain Plateau area would occur less frequently (AEC 1974).

Ozone is produced from corona discharge (ionization of the air) in the operation of transmission lines and substations, particularly at the higher voltages. TVA gives careful attention to the design and construction of its transmission facilities to minimize corona discharges (TVA 1974b). All but 20 miles of the transmission lines serving the Bellefonte Nuclear Plant site are currently energized, and no change in corona discharge from them is anticipated.

RADIOACTIVE GASEOUS EMISSIONS

No Action

Under the No Action Alternative, construction of Bellefonte 1 and 2 would not be completed. As described in Section 4.2.3.3, there would be no radioactive gaseous emissions at the Bellefonte site.

Tritium Production

Operation of Bellefonte 1 and 2 as nuclear reactor facilities would result in radioactive gaseous emissions. These would include operational emissions typical of nuclear reactor facilities, as well as a potential increase in tritium emissions due to tritium production. A design objective of the TPBARs is to retain as much tritium as possible within the TPBAR. The performance of the tritium "getter" is such that there is virtually no tritium available in a form that could permeate through the TPBAR cladding. However, for the purposes of this EIS it was conservatively assumed that an average of 1 Curie of tritium per TPBAR per year could permeate to the reactor coolant and 10 percent could be released to the environment as gaseous emission. **Table 5–26** shows the anticipated radioactive gaseous emissions at Bellefonte 1 from operations with 0; 1,000; and 3,400 TPBARs. The values presented for 0 TPBARs are based on the operational experience of Watts Bar 1. The calculation method and assumptions are described in Appendix C. Radiological exposures of the public and workers are presented in Section 5.2.3.9.

Table 5–26 Annual Radioactive Gaseous Emissions from Tritium Production at Bellefonte 1

		Tritium Production	
	0 TPBARs	***1,000 TPBARs***	***3,400 TPBARs***
Tritium release (Curies)	5.6	105.6	345.6
Other radioactive release (Curies)	283	283	283
Total release (Curies)	288.6	388.6	628.6

Note: For Bellefonte 1 and 2 operation, the emission values would be twice the values given.
Source: Based on Watts Bar 1 operation (see Table 5-1).

5.2.3.4 Water Resources

The availability and quality of water resources (surface water and groundwater) and the facility-related effects on those resources that could affect other users, are important factors in evaluating the acceptability of these facilities. The presence of floodplains is another important consideration. Legislation passed to protect water resources includes the Clean Water Act, especially Section 402, National Pollutant Discharge Elimination System, and 307(b), Pretreatment Standards, and the Safe Drinking Water Act. DOE regulation 10 CFR 1022, Compliance with Floodplains/Wetlands Environmental Review Requirements, implements Executive Orders 11988 and 11990 and requires evaluation of the potential effects of an action on floodplains and wetlands.

The issues related to water resources include: (1) whether there is sufficient water available for both the proposed use and local domestic consumption, (2) whether water quality would be degraded or further degraded, (3) whether the proposed use challenges legislative or regulatory compliance, and (4) whether the proposed action is threatened by flooding.

The State of Alabama implements the requirements of the Clean Water Act and Safe Drinking Water Act and NPDES regulations through its Department of Environmental Management's Water Quality Program.

Bellefonte operations are covered under the Alabama Department of Environmental Management's NPDES Permit, as described in Section 4.2.3.4.

SURFACE WATER

No Action

No surface water impacts are anticipated at the Bellefonte site beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Analyses of impacts to surface water are presented separately for construction and operations activities.

Construction

Water uses during construction would include water for employee use, demineralized water, and raw water for cleaning, systems testing, and cooling. A peak use of 3,330,000 liters per day (872,000 gallons per day) of water would be required during startup when plant flushing and cleanup are performed (TVA 1998e). Approximately 379,000 liters per day (100,000 gallons per day) of this peak usage would be potable water. Peak usage could occur over a period of several weeks. A peak use of 280,000 liters per day (74,000 gallons per day) would be required for completion of Unit 2. Potable water would continue to be obtained from the Hollywood water supply system (see Table 5–27). The quantities of water (raw and potable) obtained from the Guntersville Reservoir would have little effect on the availability of water for other uses.

Since construction completion would involve little or no new land disturbance or excavation, there would be little or no impact to surface water quality as a result of soil erosion of disturbed land or siltation of surface drainage channels. Stormwater runoff would continue to be collected and treated, if necessary, before discharge. An NPDES Permit was issued for the Bellefonte Nuclear Plant that covers existing site outfalls and stormwater monitoring during construction of the nuclear facility.

Sanitary wastewater would be treated at the Hollywood Waste Water Treatment Facility. This facility is a publicly owned treatment works designed to ensure compliance with the effluent limitations of the state. The city of Hollywood has agreed to add additional treatment facilities as needed to handle the sanitary wastewater from the Bellefonte Nuclear Plant. A small quantity of sanitary wastewater from the simulator building, training facility, and environmental data station is treated on site by sand filters and a septic system.

Operation

All water for operation of Bellefonte 1 or both Bellefonte 1 and 2 would be drawn from the Guntersville Reservoir, except for potable water, which is obtained from the Hollywood water supply system. Potable water requirements would average 95,000 liters per day (25,000 gallons per day) with two units operating (TVA 1998a). Average river flow rates at the Bellefonte Nuclear Plant are 65.9 million liters per minute (17.4 million gallons per minute); the 7-day, 10-year minimum flow, 21.9 million liters per minute (5.78 million gallons per minute). Operation of Bellefonte 1 and 2 would require 376 million liters per day (99.4 million gallons per day) for normal full operation. This represents about 0.4 percent of the average river flow and about 1.2 percent of the 7-day, 10-year minimum. In addition, about 24 million liters per year (6 million gallons per year) of water would be used for firefighter training and the testing and maintenance of fire protection systems. Other major water uses served by the Guntersville Reservoir include the 30 million liters per day (7.8 million gallons per day) of potable water demand of several municipalities in Alabama and Tennessee; the 4.9 billion liters per day (1.1 billion gallons per day) for the Widows Creek Fossil Plant; and various smaller, industrial uses. The water supply from Guntersville Reservoir appears to be adequate to meet the foreseeable requirements for the area (TVA 1997d, TVA 1997f). Water required from the Guntersville Reservoir for Bellefonte operation would be a small fraction of the river flow, and most of it would be returned to the reservoir after use.

Discharges from the Bellefonte plant include storm and process water outfalls, covered by the existing NPDES Permit, which would be treated and monitored before release. Water quality-based limitations include the following:

- Use classification of the upper stretch of the Tennessee River Basin as a public water supply and for swimming, fishing, and wildlife protection

- Select water quality criteria (e.g., temperature, dissolved oxygen, and toxics) for public water supply-designated segments

- Secondary treatment, or the equivalent, of all industrial, sanitary, and combined discharges for biologically degradable waste [Parameters of interest are biochemical/biological oxygen demand, total suspended solids, and acidity (pH) (TVA 1997f).]

Process water discharges would come mostly from cooling tower blowdown (about 247 million liters per day [65.2 million gallons per day]) and sump collection ponds (2.46 million liters per day [0.65 million gallons per day]) with both units operating. These discharges would be to the main river channel (Guntersville Reservoir). In addition to these discharges, approximately 2,720,000 liters per day (718,000 gallons per day) of water would be used for intake strainer and screen backwash (TVA 1997e).

Sanitary wastewater would be treated at the Hollywood Waste Water Treatment Facility, a publicly owned treatment works designed to ensure compliance with the effluent limitations of the State of Alabama. The city of Hollywood has agreed to add additional treatment facilities as needed to handle the wastewater from the Bellefonte plant. Discharges to the treatment facility would not include industrial wastes. The outfall from the Hollywood Waste Water Treatment Facility is covered under the NPDES Permit held by the city of Hollywood.

Discharges from the plant would be monitored to comply with the Bellefonte NPDES Permit limitations. Limitations of the existing NPDES Permit issued by the Alabama Department of Environmental Management are summarized in Section 4.2.3.4. **Table 5–27** presents changes to surface water resources attributable to the alternatives involving the Bellefonte plant.

Chemical discharges to the Guntersville Reservoir from various systems at the Bellefonte plant are summarized in **Tables 5–28** and **5–29**. The blowdown diffuser is designed to mix the blowdown with reservoir water. The average expected chemical concentrations in the reservoir after mixing have been calculated using CORMIX (Cornell 1996). Sources of chemical discharges would include cooling tower blowdown, cooling tower makeup and essential raw water systems, the water filtration plant, steam system makeup water demineralizers, alternative treatment of wastes from makeup and condensate demineralizers, component-cooling systems, the reactor coolant system, auxiliary steam generator blowdown, and yard drainage systems and various sumps (TVA 1974b). Even under adverse conditions, chemical discharges would be small. The change in average concentrations in the reservoir after mixing would represent a small increase over the observed background concentrations. Actual discharges and concentrations in the reservoir should meet the limitations of the NPDES Permit and Alabama Department of Environmental Management drinking water standards. Federal secondary drinking water standards and health advisories also would be met, except for those pertaining to constituents such as aluminum, iron, and molybdenum where the existing concentrations exceed those levels.

A portion of the circulated cooling water would be discharged to prevent the buildup of dissolved salts and minerals in the cooling system (blowdown), resulting in the discharge of heated water to the Guntersville Reservoir. The NPDES Permit for Bellefonte (ADEM 1992) limits in-stream temperatures to less than or equal to 30°C (86°F). Ambient upstream temperatures typically exceed this limit an average of 8.5 days per year in July and August, primarily as a result of natural heating of the lake. Monitoring data for 1975 to 1991 indicate that the ambient upstream temperature ranged from 1.7°C (35°F) to 32.2°C (90°F) (TVA 1997f).

Table 5–27 Potential Changes to Water Resources from Bellefonte 1 or Bellefonte 1 and 2

Affected Resource Indicator	*No Action*	*Tritium Production Bellefonte 1*	*Tritium Production Bellefonte 1 and Bellefonte 2*
Construction			
Water availability and use:			
Raw water source	Guntersville Reservoir	Guntersville Reservoir	Guntersville Reservoir
Site water use requirement (million liters per year)	None	1,260[a]	1,390[a]
Percent of river flow	None	0.0036	0.004
Water quality:			
Discharge to surface water (million liters per year)	None[b]	3,100[c]	3,430[c]
Discharge of sanitary waste to local treatment plant (million liters per year)	Not applicable	155[c]	155[c]
Operation			
Water availability and use:			
Water source	Guntersville Reservoir	Guntersville Reservoir	Guntersville Reservoir
Site raw water use requirement (million liters per year)	Not applicable[d]	68,700[e]	137,000
Percent of river flow	Not applicable	0.2	0.39
Potable water use requirement (million liters per year)	2.76	27.6	34.5
Water quality:			
Discharge to surface water (million liters per year)	None[b]	46,000[e]	91,100
Discharge of sanitary waste to local treatment plant (million liters per year)	2.76	27.6	34.5
Floodplain:			
Actions in 500-year floodplains	None	Intake	Intake

[a] Potable and raw water usage.
[b] Except stormwater runoff and a small quantity discharged from the simulator training facility sand filters.
[c] Discharges from construction activities and from runoff are discharged to the diffuser or to other discharge points.
[d] Current raw water use from Guntersville Reservoir is limited to fire protection and cooling water needs.
[e] Estimated assuming one cooling tower operation.
Source: TVA 1997f, TVA 1997d.

Table 5–28 Summary of "Added" Inorganic Chemical Discharges to Guntersville Reservoir from Operation of Bellefonte 1 and Bellefonte 1 and 2

Chemical	*Finished Drinking Water Standard (milligrams per liter)*	*Background Water Quality–Average Concentration (milligrams per liter)*	*Average Daily Discharge of Chemical for One Unit (kilograms)*	*Average Daily Contribution to Cooling Tower Blowdown[a] (milligrams per liter)*		*Average Blowdown Concentration (milligrams per liter)*		*Concentration in Reservoir after Mixing[b] (milligrams per liter)*	
				Unit 1	*Units 1 and 2*	*Unit 1*	*Units 1 and 2*	*Unit 1*	*Units 1 and 2*
Ammonia	30	0.03	0.0162	0.000087	0.000103	0.0601	0.0601	0.0336	0.0336
Chlorides	250	7.6	24.5	0.132	0.155	15.3	15.4	8.51	8.52
Copper	1.3	0.011	7.7	0.0416	0.0489	0.0636	0.0709	0.0148	0.0152
Nickel	0.1	0.0017	0.858	0.00463	0.00544	0.00803	0.00884	0.00218	0.00223
Sodium	20	6.83	419	2.26	2.66	15.9	16.3	7.77	7.8
Total dissolved solids	500	100	146	0.788	0.927	201	201	112	112
Sulfates	250	15.4	1210	6.55	7.72	37.4	38.5	17.6	17.7
Zinc	3	0.11	111	0.601	0.707	0.821	0.927	0.159	0.165

[a] Based on annual contributions in blowdown stream for a one-unit plant with a 67,650 liter per year blowdown rate and a two-unit plant with a 115,000 liter per year blowdown rate.
[b] Average concentration at the edge of the near-field mixing zone (6 meters downstream of the diffuser).
Source: Alabama 1998, ADEM 1998b, EPA 1996a, TVA 1997d, TVA 1997f.

Table 5–29 Summary of Observed Trace Metal Concentrations and Expected Trace Metal Concentrations in the Discharge Stream and at the Edge of the Mixing Zone from Operation of Bellefonte 1 and Bellefonte 1 and 2

Parameter (Dissolved)	*Finished Drinking Water Standard (milligrams per liter)*	*Background Water Quality–Average Concentration (milligrams per liter)*	*Average Blowdown Concentration (milligrams per liter)*		*Average Concentration in Reservoir After Mixing[a] (milligrams per liter)*	
			Unit 1	*Units 1 and 2*	*Unit 1*	*Units 1 and 2*
Aluminum	0.2	0.43	0.86	0.86	0.481	0.481
Arsenic	0.05	0.0002	0.0004	0.0004	0.000224	0.000224
Barium	2	0.05	0.1	0.1	0.0559	0.056
Beryllium	0.004	0.001	0.002	0.002	0.00112	0.00112
Boron	0.9	0.15	0.3	0.3	0.168	0.168
Cadmium	0.005	0.0005	0.001	0.001	0.000559	0.00056
Chromium	0.1	0.003	0.006	0.006	0.00336	0.00336
Iron	0.3	0.53	1.06	1.06	0.593	0.593
Lead	0.015	0.006	0.012	0.012	0.00671	0.00672
Mercury	0.002	0.0009	0.0018	0.0018	0.00101	0.00101
Molybdenum	0.01	0.02	0.04	0.04	0.0224	0.0224
Silver	0.2	0.01	0.02	0.02	0.00112	0.00112

[a] Average concentration at the edge of the near-field mixing zone (6 meters downstream of the diffuser).
Source: Alabama 1998, ADEM 1998b, EPA 1996a, TVA 1997d, TVA 1997f.

The combined discharges to the Guntersville Reservoir would be through the submerged diffuser to provide dilution with the stream flow. The temperature of the discharge would vary with the ambient wet-bulb temperature. Alabama water quality standards limit the maximum temperature rise (difference between upstream and downstream temperature) to no more than 2.8°C (5°F). The maximum temperature rise would occur when the river was cold and the discharge warm (TVA 1997f).

Results of temperature analyses for various discharges using CORMIX system indicate that the maximum water temperature 3 meters (10 feet) downstream from the diffuser would be 32.6°C (90.7°F) for a 2,720-megawatts-electric facility with multiple units (somewhat larger than the two-unit, 2,440-megawatts-electric nuclear option). At 800 meters (2,620 feet) downstream the predicted maximum temperature was 32.3°C (90.1°F). The maximum temperature rise would occur in January and February; it has been computed at 1.8°C (3.2°F) within 3 meters (10 feet) downstream, cooling (with dilution) to 0.4°C (0.7°F) at 16 kilometers (10 miles) downstream (TVA 1997f, TVA 1998a). The one-unit option would result in lower temperatures downstream due to the lower discharge rate.

An earlier analysis for two-unit operation indicated that the maximum discharge temperature at the diffusers would vary from 28.5°C (83.3°F) in January to 34.7°C (94.5°F) in July (TVA 1982). Given a minimum mixing ratio of 9 to 1, the maximum in-stream temperature at the edge of the mixing zone would vary from 16.8°C (62.2°F) in January to 32°C (90°F) in July for the two-unit nuclear option. In-stream temperatures for the one-unit option would be lower due to the lower discharge flow rate. The maximum predicted discharge temperature rise (downstream temperature minus upstream temperature) would be 1.6°C (2.9°F) in February (TVA 1982). Holdup of the blowdown could be necessary on occasion when the ambient temperature in the summer nears or exceeds the maximum temperature standards. A temperature variance to the NPDES Permit has been requested from the Alabama Department of Environmental Management. Although there would be a finite increase in reservoir water temperature due to the discharge from Bellefonte operation, both the increase in temperature and the maximum temperature would be limited such that impacts on aquatic species would meet the limitations of the NPDES Permit.

The Widows Creek Fossil Plant is about 24 kilometers (15 miles) upstream of the Bellefonte site. It discharges approximately 68 cubic meters per second (2,400 cubic feet per second) of water heated to 10°C (18°F) above ambient water temperature. Assuming that full mixing occurred before the water reached the Bellefonte site, the temperature increase would be 0.8°C (1.5°F) during the summer and 0.6°C (1.0°F) during the winter, excluding surface heat loss. Temperature measurements at Guntersville Dam and Nickajack Dam indicate that the water at the downstream dam is about 0.7°C (1.3°F) warmer on the average. One portion of this temperature increase could be due to the Widows Creek plant, and another portion to solar heating. The Bellefonte plant by comparison would increase the average water temperature flowing past the plant by about 0.05°C (0.1°F). Any combined thermal effect assignable to Bellefonte likely would be small (AEC 1974).

Since stormwater runoff would continue to be collected and treated (if necessary) before discharge, little or no impact on surface water would result from soil erosion or the siltation of surface drainage channels.

GROUNDWATER

Construction

Construction activities related to the completion of Bellefonte 1 or both Bellefonte 1 and 2 should have no effect on groundwater availability. There are no planned withdrawals of groundwater. The potential for groundwater contamination from fuels, oils, solvents, or other chemicals used in the operation and maintenance of equipment and other activities during construction would be minimized by careful handling and proper disposal of potential contaminants. TVA's Spill Prevention, Control, and Countermeasures Plan provides a method for mitigating releases of contamination into the groundwater at the site. Should a release occur, remediation methods would be employed to prevent impacts on water supplies (TVA 1997f).

Operations

Groundwater availability would not be affected by operation of Bellefonte 1 and 2. There are no planned withdrawals of groundwater. Any impacts on groundwater quality during operations most likely would be associated with the storage and handling of fuel oil and the storage, handling, and disposal of the wastes generated. The disposal of wastes is discussed in Section 5.2.3.11. No impacts on groundwater are expected. TVA's Spill Prevention, Control, and Countermeasures Plan provides a method for mitigating groundwater releases at the site. Should a release occur, remediation methods would be employed to prevent impacts on water supplies (TVA 1997f).

FLOODING

The Bellefonte facilities have been sited to provide a reasonable level of protection from flooding. The requirements of Executive Order 11988, "Floodplain Management," would be fulfilled. To the extent practicable, required actions would be conducted outside the limits of the 100-year floodplain unless there are no practicable alternatives. If possible, "critical action" facilities (i.e., those facilities whose inoperability would compel the curtailment or shutdown of power generation) would be located outside the 500-year floodplain or protected to the 500-year flood elevation. All safety-related structures, systems, and components have been designed to remain functional in the worst potential flood from any cause (TVA 1997f).

The maximum plant-site flood level from any cause would be elevation 190.4 meters (624.8 feet). Coincident wind waves would raise the reservoir to a maximum elevation of 191.3 meters (627.7 feet). The safety-related facilities, systems, and equipment in the reactor building have been protected against the maximum flood level and the maximum wind- or wave-induced levels. The intake pumping station has been designed for the static and dynamic forces resulting from such an event, and is protected from runup by a wall built around the top deck (TVA 1991).

The situation conducive to the maximum plant-site flood level has been determined to be a sequence of March storms producing maximum precipitation on the watershed above Chattanooga. The flood crest would be augmented by the failure of earth embankments at the Fort Loudoun-Tellico, Watts Bar, Chickamauga, and Nickajack Dams upstream (TVA 1991). While some support facilities and utilities (e.g., the railroad, water, and sewer pipelines) would be below the 500-year flood level, they too have been constructed to protect them from flood damage.

Radioactive Liquid Effluent

No Action

Under the No Action Alternative, construction of Bellefonte 1 and 2 would not be completed. As discussed in Section 4.2.3.4, there would be no radioactive liquid effluent at the Bellefonte site.

Tritium Production

Surface Water

Operation of Bellefonte 1 and 2 as nuclear reactor facilities should produce the liquid radioactive effluents typical of such operation, as well as those attributable exclusively to tritium production. An increase in the tritium release as a result of tritium production is based on the assumption that an average of 1 Curie of tritium per TPBAR per year could permeate through the TPBAR cladding to the reactor coolant, and that 90 percent of that amount could be released to the environment as liquid effluent. **Table 5–30** shows the expected radioactive liquid effluents from operation of Bellefonte 1 with 0, 1,000, and 3,400 TPBARs. The values presented for 0 TPBARs are based on the operational experience at Watts Bar 1. The calculation method and assumptions are described in Appendix C, Section C.3. Radiological exposures of the public and workers are presented in Section 5.2.3.9.

In accordance with the Safe Drinking Water Act requirements promulgated by the EPA in 40 CFR, 100-149, a tritium concentration of 20,000 picocuries per liter has been established as a limit for drinking water. In view of this regulatory limit, an analysis was performed to estimate tritium concentrations in the Tennessee River that could result from tritium production at Bellefonte 1 or Bellefonte 2. The average expected tritium concentrations in the river were calculated using CORMIX (Cornell 1996). **Table 5–31** presents the potential tritium concentrations from the incident-free irradiation of 1,000 and 3,400 TPBARs at two points: (1) the edge of the near-field, and (2) at the nearest drinking water intake. "Near-field" in CORMIX is the area surrounding the discharge point of the effluent, where initial mixing is taking place. The edge of the near-field typically extends to a few meters away from the point of discharge. Table 5–31 also presents potential tritium, concentrations in the unlikely event of 2 TPBAR failures during a given 18-month operating cycle. The results indicate that tritium concentrations would remain well below the 20,000 picocurie per liter limit, and at the drinking water intake, the tritium concentration would be below or close to the lower detection limit for tritium, which is approximately 300 picocuries per liter.

Table 5–30 Annual Radioactive Liquid Effluents from Tritium Production at Bellefonte 1

		Tritium Production [a]	
	0 TPBARs	*1,000 TPBARs*	*3,400 TPBARs*
Tritium release (Curies)	639	1,539	3,699
Other radioactive release (Curies)	1.3	1.3	1.3
Total release (Curies)	640.3	1,540.3	3,700.3

[a] For Bellefonte 1 and Bellefonte 2 operation the effluent values would be twice the values given.
Source: Based on Watts Bar 1 operation (see Table 5-2).

Table 5–31 Tritium Concentration in the Tennessee River from Tritium Production at Bellefonte 1 or Bellefonte 2

		Incident-Free Tritium Production		
	0 TPBARs (picocuries per liter)	*1,000 TPBARs (picocuries per liter)*	*3,400 TPBARs (picocuries per liter)*	*2 TPBAR Failures*[a] *(picocuries per liter)*
Edge of near-field	560	1,348	3,240	12,219
At nearest drinking water intake	36	88	211	796

[a] See Appendix C, Table C-8, for tritium release.

5.2.3.5 Geology and Soils

No Action

No impacts on geology and soils are anticipated at Bellefonte beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Construction

The limited construction activities required to complete Bellefonte 1 and 2 should have no effect on geology and soils.

Soil Amplification and Ground Deformation—Liquefaction of soils at Bellefonte due to earthquake ground motion is believed to be very unlikely. The effects of the amplification of ground motions through soil columns should be considered in the seismic design of structures not founded on rock.

Seismic Hazard Assessments—Bellefonte is in a Seismic Hazard Zone 2, or a zone of low seismic hazard. The use of existing building codes should adequately address the earthquake hazard to ordinary buildings at Bellefonte. Additional considerations might be needed for special structures that house hazardous processes or sensitive equipment. Underground or aboveground piping that transports hazardous substances could also require nonroutine design to address seismic hazards at the site.

Bedrock—No problems should be created within the consolidated bedrock (the Chickamauga Formation) beneath the main plant area footprint by activities such as excavation or dewatering. All of the unweathered rock at the site is capable of supporting intended loads.

Overburden—Soils beneath the footprint areas are variable in depth (0 to 7 meters [0 to 23 feet]) and are expected to consist primarily of stiff silty clays and clayey silts. Structural design would be based upon in-situ soil investigations at the proposed foundation location and appropriate safety factors for the proposed foundations of new facilities on soil.

Operation

No impacts on geologic stability are expected to occur. All structures would be designed and constructed according to sound engineering practices; no materials would be injected underground; and groundwater would not be required for tritium production. The normal operation of Bellefonte 1 and 2 would have no effect on soils and prime farmland at the site.

5.2.3.6 Ecological Resources

No Action

No impacts on land use, air quality, or water quality are anticipated at the Bellefonte site beyond the effects of existing and future activities that are independent of the proposed action. Therefore, no impacts on ecological resources are expected under this alternative.

Tritium Production

The evaluation of impacts on ecological resources was based on a review of previous studies for the Bellefonte plant and analysis of any changes associated with tritium production that might be relevant to previously disclosed impacts. Where relevant, these impacts were identified.

Construction

Evaluation of the ecological impacts of construction activities at the Bellefonte site encompassed terrestrial resources, aquatic resources, wetlands, and threatened and endangered species. Specific sources of construction impacts include increases in air emissions, runoff and sedimentation, human activity, and noise.

Terrestrial Resources

Construction activities required to complete Bellefonte 1 or both Bellefonte 1 and 2 would include the installation of additional equipment, the construction of new support buildings, and minor activities associated with making the intake water structure operational (TVA 1998a) (see the description in Section 3.2.5.3). Most major facilities at Bellefonte have already been completed (TVA 1993). The area of the site that was cleared during initial construction should be adequate for the construction of the new support buildings and for the remaining construction-related activities. Therefore, no additional land would be cleared, and there would be no impacts from disturbance or destruction of vegetation or wildlife habitat in currently undisturbed areas of the site. The transient emissions of gaseous and particulate air pollutants from construction operations would have little or no adverse effect on terrestrial ecological resources (TVA 1974b). During construction, no radioactive materials would be handled. Thus, there should be no radiological impacts on terrestrial resources. Although there would be increased activity at the site and increases in sound levels from construction activities and from traffic along the access road, these changes should have little effect on wildlife on the site (TVA 1974b).

Aquatic Resources

Impacts to aquatic resources from increased surface runoff and sediment loading should be temporary and limited. Land disturbance would be limited to that required for the new support buildings, and there would be no physical disturbance of the Guntersville Reservoir shoreline or adjacent riparian habitat in the vicinity of the Bellefonte site. Standard erosion control and sedimentation mitigation techniques would be used as appropriate in any construction areas. Runoff from construction activities would be collected and processed before release to surface waters. Monitoring investigations from 1974 to 1979 during the major construction activities at Bellefonte indicated that these activities did not adversely impact the Guntersville Reservoir or Town Creek Embayment (TVA 1980).

Wetlands

Construction activities required to complete Bellefonte 1 or both Bellefonte 1 and 2 should disturb no additional wetlands beyond those disturbed during initial construction of the Bellefonte plant. Activities required to make the intake structure operational would involve desilting of the existing pumps. This would not disturb any wetlands. As discussed previously for aquatic resources, impacts to wetlands from increased surface runoff and sedimentation would be both temporary and limited.

Threatened and Endangered Species

Construction activities at the Bellefonte site would not adversely affect any Federally or state-listed threatened or endangered terrestrial species. There should be no impacts on threatened or endangered aquatic animals or plants from construction activities, because no such species have been reported around the Guntersville Reservoir in the vicinity of Bellefonte in recent years.

The gray bat and Indiana bat, both Federally listed as endangered, are known to forage along the Guntersville Reservoir shoreline. Indiana bats also roost in heavily wooded areas on the hillsides and bluff areas along the Tennessee River. The bald eagle, Federally listed as threatened, has been seen along the wooded shoreline on the eastern side of the Bellefonte site and along the intake canal during the winter. Activities associated with completion of Bellefonte 1 and 2 would not reduce foraging areas and roosting sites for the gray bat, Indiana bat, or the bald eagle. Noise and human disturbance associated with construction should have only minor, short-term effects on these species (TVA 1993, TVA 1997f).

TVA has notified the U.S. Fish and Wildlife Service of DOE's proposed action and will provide the States of Tennessee, Alabama, and South Carolina and the U.S. Fish and Wildlife Service with copies of the CLWR Draft and Final EISs. TVA and DOE will continue to comply with the requirements of the Endangered Species Act and interact with the U.S. Fish and Wildlife Service, as appropriate.

Operation

Evaluation of the ecological impacts of the operation of Bellefonte 1 or both Bellefonte 1 and 2 encompassed terrestrial resources, aquatic resources, wetlands, and threatened and endangered species. Specific sources of operational impacts would include increases in emissions of air pollutants, effluent releases to surface waters, human activity, and noise levels.

<u>Terrestrial Resources</u>

Wildlife on the Bellefonte site would be exposed to increased noise levels from operational sources and from traffic during peak traffic hours. Short-term noises above a level of about 75 dBA could startle wildlife (TVA 1997f). Noises from site activities above this level likely would not be experienced by wildlife in the undeveloped areas of the site. The increased operational noise levels should cause little or no disturbance of wildlife on the site; therefore, no changes in local wildlife populations should occur. Testing of the emergency sirens could elicit a “startle” response in nearby wildlife, but these infrequent tests should cause no changes in wildlife populations in these areas.

Emissions of gaseous and particulate air pollutants from combustion sources would result in small increases in air pollutant concentrations (see Section 5.2.3.3). However, the resulting concentrations of hazardous and toxic pollutants in the vicinity of the site should continue to meet the ambient standards and guidelines and have no adverse effect on terrestrial resources.

Surface deposition or root uptake of concentrated salts could cause stress on vegetation. Effects on vegetation would vary with the plant species and the salts being deposited. Most of the drift that fell to the ground would do so within 300 meters (1,000 feet) of the towers (AEC 1974). The remainder would disperse and eventually be removed from the air and deposited on the ground by precipitation. The estimated salt deposition rate for the cooling towers is 10^{-3} grams per square meters per hour (grams per m^2-hr). The analysis of cooling tower drift for Bellefonte 1 and 2 indicates that gross impacts on terrestrial biota as a result of salt deposition from the cooling towers would be unlikely, but sensitive species could be adversely affected (AEC 1974).

Changes in incoming radiation (due to shadows from the cooling tower plume) and moisture could affect biota in the vicinity of the cooling towers. However, these changes likely would be indistinguishable from natural variations. Impacts should not be adverse—they might not even be measurable—but over the lifetime of the station, subtle effects could appear (AEC 1974). There should be no operations-related changes in bird mortalities from collision with the cooling towers.

Operation of Bellefonte 1 or both Bellefonte 1 and 2 for tritium production would release radioactive gaseous emissions and radioactive liquid effluents to the Guntersville Reservoir, as discussed in Sections 5.2.3.3 and 5.2.3.4. When tritium is inhaled or ingested by an organism, incorporation into bodily fluids is very efficient. However, long-term accumulation in the organism is limited by tritium’s rapid elimination by exhalation, excretion in body water, and its short half-life. The biological properties of tritium are discussed in Appendix C.

Doses to the public and workers have been estimated and are presented in Section 5.2.3.9. Various studies on exposure of vegetation, wildlife, and aquatic species indicate that radiological effects on the human species are a reasonable indicator of the effects on other organisms. In the Bellefonte Final Environmental Statement (TVA 1974b), maximum radiological doses to terrestrial vertebrates (excluding doses from tritium production) from liquid effluent releases under normal operating conditions were estimated at 160 millirad per year. Particularly instructive in this connection is the IAEA's 100-millirad per day benchmark of a chronic dose rate that appears unlikely to cause observable changes in terrestrial animal populations (IAEA 1992). It has been concluded that, since the exposure estimates are small relative to that benchmark and the incremental doses due to tritium production (see the analysis for the public and workers in Section 5.2.3.9) also would be small, the impact of radiological releases on terrestrial species would be minor.

<u>Aquatic Resources</u>

Possible major environmental impacts on the aquatic ecosystem of the Guntersville Reservoir due to the operation of Bellefonte 1 or both Bellefonte 1 and 2 include fish losses at the cooling water intake screens; almost total loss of entrained, unscreened organisms; and thermal and chemical discharges.

Fish Impingement—Since the water velocity in the intake channel would be low, fish would enter the channel in the normal course of their activities. The recessed embayment location of the intake would be conducive to fish congregation. If congregated fish swam until they were fatigued, they could eventually be impinged on the traveling screens. Since the overbank area has a high density of young-of-the-year fish, impingement should be high for this age group (AEC 1974).

Entrainment—Because of closed-cycle cooling, it can be assumed that all free-floating organisms that pass through the vertical traveling intake screens would be destroyed. These would include phyto- and zooplankton, fish eggs and larvae (ichthyoplankton), and small fish. An evaluation of plankton population densities and stream flow data indicates that there would be no discernible effect on the plankton populations in the Guntersville Reservoir. This is due largely to the small volume of water (less than 1 percent of the Tennessee River flow) that would be used by Bellefonte 1 or both units relative to the volume in the river (TVA 1991). Similarly, no adverse effect on fish populations in the reservoir would be expected from fish egg and larvae mortalities, since the withdrawal requirements for the closed-cycle cooling system would be small relative to the volume of the river (TVA 1974b).

Entrainment effects on aquatic macrophytes would mean the probable destruction of submerged floating plants and plant fragments. However, these losses would not constitute a significant reduction in the aquatic macroflora (TVA 1991).

Thermal Effects—Fish are normally attracted to the outfalls of power plants, especially when the ambient river temperatures are lower than the preferred temperature of a given species. In some cases, fish captured in the discharge region for a power plant are in poorer condition than those from unheated regions. Although the condition of some fish could be adversely affected, there should be no major effect on the abundance of fish species in the Guntersville Reservoir (AEC 1974).

The impact from thermal effects on the population of plankton in the Guntersville Reservoir should be small, given the limited diffuser mixing zone, which would limit the time of plankton entrainment in the plume, and the 10-fold dilution that would occur in the mixing zone. Some localized changes of backwater plankton assemblages (e.g., upstream and downstream of Jones Creek [Tennessee River Mile 388]) could result from plume dispersion along the left shore, beginning within 1.6 kilometers (1 mile) of the diffuser. Because of the small amounts of heat involved, these changes should be small (TVA 1991).

A major benthic community has been identified along the near shore (right side) overbank area extending downstream of the Bellefonte Nuclear Plant site (see Section 4.2.3.6). The impact of the thermal plume to the macrobenthos should be small. The benthos in the main channel is very limited in diversity, being composed primarily of the Asiatic clam, *Corbicula fluminea*. No thermal impacts would be expected on mainstream benthic populations. The impact of the thermal plume on emersed, floating-leaved, and submerged aquatic macrophyte species should be limited due to the small temperature change predicted. Some localized enhancement of macrophyte growth could occur along portions of the mainstream left bank and the adjacent shallow overbank area.

During startup and shutdown operations, blowdown discharges would continue. Therefore, changes in the mixed temperature at the edge of the diffuser mixing zone would not be rapid and would be expected to occur primarily from routine changes in plant operation. These changes would be smaller than the maximum changes of -0.4°C (-0.7°F) and 2.0°C (3.6°F). Therefore, impacts on the rate of temperature change (e.g. fish kills due to cold shock) should be small (AEC 1974, TVA 1991).

Chemical Effects—Analyses of chemical releases to surface waters from operations indicate that releases should comply with NPDES Permit limitations; therefore, the potential impacts of these releases should be minor (TVA 1993). The potential impacts on aquatic organisms from the use of biocides such as chlorine in the treatment of cooling tower makeup water and raw cooling water systems and the use of tolytriazole and potassium hydroxide for pH and corrosion control in the cooling system also should be minor, as the release of these compounds to surface waters is controlled by provisions of the NPDES Permit. Runoff would be treated before release to receiving surface water bodies in accordance with applicable NPDES Permit requirements (TVA 1993).

Radiological Effects—When tritium is ingested by an aquatic organism, incorporation into bodily fluids is very efficient. However, long-term accumulation in the organism is limited by tritium's elimination in body water and its short half-life. The biological properties of tritium are discussed in Appendix C.

TVA has estimated maximum annual doses to aquatic organisms from liquid effluent releases from Bellefonte as originally designed (i.e., without tritium production) at 8.5 millirads for plants, 3.5 millirads for suspended invertebrates, 120 millirads for benthic invertebrates, and 0.4 millirads for fish (TVA 1974b). Instructive in this connection is the benchmark dose of 1 rad per day (1,000 millirads per day) established by the National Council on Radiation Protection and Measurements and IAEA as a level that appears unlikely to cause observable changes in aquatic populations (NCRP 1991, IAEA 1992). It has been concluded that, since the exposure estimates would be small relative to that benchmark and the incremental doses due to tritium production (see the analysis for the public and workers in Section 5.2.3.9) also would be small, the impact of radiological releases on aquatic species would be small, as defined by 10 CFR 51 (see Glossary term "qualitative environmental impacts").

Wetlands

Wetlands likely would not be impacted from runoff or sedimentation during tritium production.

Threatened and Endangered Species

Operational impacts on threatened or endangered species could occur through the release of thermal, chemical, or radioactive discharges to the atmosphere or river. These releases could affect listed species in the vicinity of the site and in the reservoir downstream of the site, either directly or indirectly, through the food chain. Listed species occurring on or in the immediate vicinity of the Bellefonte site also could be affected by the increased human presence or noise during plant operations.

Impacts on threatened or endangered plants from operational activities would not occur, as no Federally or state-listed plant species occur on or in the immediate vicinity of the Bellefonte site. The periodic presence of plant workers at the intake canal and the increased noise levels could cause foraging eagles to move from this area; however, this disruption would be temporary and unlikely to affect the eagles negatively. There should be no other operational impacts on wooded areas used by eagles, gray bats, or Indiana bats.

Potential thermal and chemical effects on aquatic biota are described above. No aquatic listed species occur in the immediate vicinity of the Bellefonte site, and no thermal or chemical impacts to the endangered pink musket and orange-footed pearly mussels that reside in the Guntersville Dam tailwater would be expected. Thermal and chemical effects on the potential prey of bald eagles and gray bats should be small and localized. Thus, thermal or chemical effects on listed threatened or endangered species would be unlikely.

As discussed previously for terrestrial and aquatic species, the impact of radiological releases should not adversely affect the listed threatened and endangered species.

TVA has notified the U.S. Fish and Wildlife Service of DOE's proposed action at Bellefonte and has provided the States of Alabama and South Carolina and the U.S. Fish and Wildlife Service with copies of the CLWR Draft EIS. Copies of the CLWR Final EIS also will be provided to these agencies. The U.S. Fish and Wildlife Service was consulted initially concerning the identification of threatened or endangered species that should be evaluated in the EIS (DOI 1998c). In its response to the CLWR Draft EIS, the U.S. Fish and Wildlife Service concluded that adverse effects to listed species potentially occurring at the site from the proposed action are not anticipated (DOI 1998d). TVA and DOE will continue to comply with the requirements of the Endangered Species Act and will interact with the U.S. Fish and Wildlife Service, as appropriate. TVA is committed to conducting an environmental monitoring program during tritium production operations. Should the monitoring program indicate any adverse impacts to listed species, consultation with the U.S. Fish and Wildlife Service would be initiated immediately to address those impacts.

Environmental Monitoring

Before and during the construction of Bellefonte 1 and 2, TVA conducted an extensive environmental monitoring program. It has continued environmental monitoring for various parameters during the period of construction deferment, especially as required to comply with various permits (e.g., the NPDES Permit). TVA also has committed to an extensive environmental monitoring program to be conducted during operations, the aim being to confirm that operation of the plant does not have a significant adverse impact on the environment, including threatened and endangered species (TVA 1993).

5.2.3.7 Archaeological and Historic Resources

No Action

No impacts on land use are anticipated at the Bellefonte site beyond the effects of existing and future activities that are independent of the proposed action. As a result, no impacts on archaeological or historic resources are expected.

Tritium Production

Analyses of impacts on archaeological and historic resources are presented separately for construction and operations activities.

Construction

There are no known archaeological sites within the previously disturbed areas of the Bellefonte site. Historic resources would be unaffected, as all structures associated with the original Bellefonte town site have been removed since 1974, when it was determined that the site was eligible for placement on the National Register of Historic Places. The town site was not on TVA property, and the buildings were removed by non-TVA land owners. Before construction of the existing facilities at Bellefonte, the Alabama State Historic Preservation Office approved the design and indicated that no mitigation would be required (TVA 1997f).

Operation

No impacts to historic or archaeological resources would occur from tritium production activities at the Bellefonte site.

5.2.3.8 Socioeconomics

The socioeconomic impacts resulting from the completion and operation of the Bellefonte units are presented for Unit 1 and then for both units combined. Completion and operation of Bellefonte 2 without Bellefonte 1 is not considered a Reasonable Alternative (see Section 3.2.3).

5.2.3.8.1 Bellefonte 1

No Action

The No Action Alternative requires the continuation of the deferred status of Bellefonte 1. Therefore, no socioeconomic impacts are expected. Approximately 80 employees maintain the partially completed plant in its layup condition.

Tritium Production

Estimates of the staffing requirements needed to complete and operate Bellefonte 1 as a nuclear power plant for the production of tritium are presented as **Table 5–32**. About 12,800 person-years will be needed through the five-year construction phase and 800 per year for plant operations. [The estimate of 12,800 person-years takes into account the tendency to variation in employment throughout the construction period, especially in years one and five, and does not reflect the total construction employment figure given in the table.] A comparison of peak staffing levels by year for the No Action Alternative and for the completion of Bellefonte 1 is provided as **Figure 5–1**.

Table 5–32 Staffing for Completion and Operation of Bellefonte 1

Construction Year	*Staffing (Peak)*
1	1,500
2	2,700
3	4,100
4	4,500
5	2,600
6	800+ (operations begin)
7	800
8	800
9	800
10 to 40+	800

Sources: TVA 1998a, TVA 1997e.

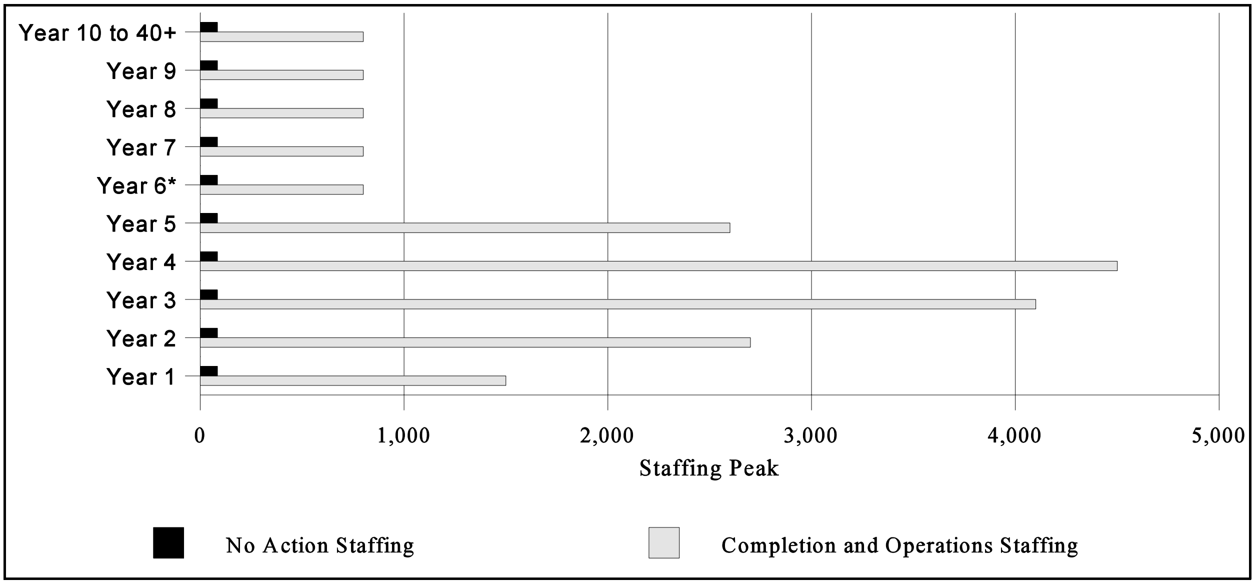

Figure 5–1 Staffing for Completion and Operation of Bellefonte 1, Compared to No Action from First Year of Construction

* Operations begin.
Source: TVA 1998a, TVA 1997e.

Income estimates for construction and operations staff are based on local earnings of about $65,000 per person-year, an estimate that is 30 percent higher than the estimated labor cost to complete and operate the facility as a nonnuclear plant. Such high compensation reflects the requirements levels for many categories of nuclear construction and operations and would provide increased revenues to the local economy.

Another potentially important socioeconomic benefit is the direct and indirect income associated with the procurement of equipment and supplies for completion of the plant. Millions of dollars would be added to the local economy during the construction and operations periods.

The largest impacts would be experienced in the Scottsboro-Hollywood area of Jackson County. A larger region of influence encompassing the commuting area would have a lesser effect. The reasons for the concentration of socioeconomic impacts within Jackson County and Scottsboro-Hollywood are several. First, Scottsboro-Hollywood—population approximately 15,000 (DOC 1998c),—is the only densely populated area within Jackson County. Second, due to the sparseness of the plant environs, local spending and indirect income generation from that spending are concentrated in the Scottsboro-Hollywood area. Third, procurement of goods and services by the plant and TVA outside Jackson County would be modest. Major impacts such as those relating to schools and taxes would be felt within the county, but not within the region of influence outside the county.

Population and Housing

The completion of Bellefonte 1 would result in a temporary increase in population and income in the region of influence as a direct and indirect result of increased employment at the site. An estimated 33 percent of the construction workers and 50 percent of the operations workers would be expected to move into the area. This is consistent with the values in the *Final Environmental Impact Statement for the Bellefonte Conversion Project* (TVA 1997f).

About 75 percent of the construction workers and 90 percent of the operations workers would be expected to live in Jackson County. About 70 percent could be expected to live in the Scottsboro-Hollywood area, assuming housing were available. About 20 percent likely would be located along Routes 79 and 72 in the valley between Guntersville and Bridgeport, with the remainder scattered throughout the county.

The influx of construction and plant operations personnel, plus families, would increase the population of Jackson County by about 3,200, or more than 6 percent. This influx within a period of four years would be about 70 percent greater than local growth in the seven years from 1990 through 1997. Within the Scottsboro-Hollywood area, the estimated peak population influx of about 2,200 workers and family members would represent a 14 percent overall population increase. Adding indirect employees and their families, the population influx into the Scottsboro-Hollywood area could exceed 25 percent at the peak. Peak population growth in Jackson County, including indirect employees and their families, would probably be no more than about 10 percent. Population impacts outside Jackson County would be negligible.

Most construction workers prefer not to buy permanent housing. Their housing needs would include rental homes and apartments, mobile homes, and camper-trailers. Operations workers generally purchase permanent single-family housing. Up to 70 percent of all incoming construction workers and 90 percent of all operations workers would be expected to bring their families. That number could be appreciably lower than 70 percent, depending on the availability of rentals and trailer parks for camper-trailers. Currently, trailer parks near the Bellefonte site are close to capacity. A trailer park with an estimated capacity of 250 campers/trailers is planned for operation near the site in the fall of 1998. Additional trailer parks could be built in three to four months if construction activity at the plant increased rapidly. DOE is estimating maximum housing and, more importantly, school system impacts, based on the expectation that up to 70 percent of construction workers moving into the area would bring their families.

Demand for housing by construction and operations workers in the vicinity of Bellefonte would increase during the completion and operation of the plant. Data indicate that vacant permanent housing for sale and rent in the vicinity of the Bellefonte plant is insufficient to meet this demand. It is anticipated, however, that the completion and operation of Bellefonte will stimulate the construction of additional permanent housing, the opening of new trailer parks, and the expansion of existing parks to meet this demand, thereby producing a positive effect on the regional economy. It is expected that these new units also would meet permanent housing requirements for plant operations workers and their families.

Employment and Income

Peak employment during construction has been estimated at 4,500. Average employment for construction workers during the four years of the construction phase would be about 2,400 per year. Operations workers would average 800 per year over the operational life of the plant. Indirect employment (e.g., food, retail, banking) could reach an average at least equal to the number of operations workers. During the construction phase, indirect employment would be considerably higher. The effect of this change in employment at the county level would be high. Unemployment in 1997 averaged 8.2 percent. This could decline by very roughly half over the first few years of construction, and then unemployment likely would stabilize at least two points below the average. The unemployment rate would not drop by as much as the employment requirements would suggest. As the construction project escalated and the labor market tightened, the labor pool would expand from the influx of immigrating workers.

Total person-years of employment during construction, including operations staff, have been estimated at about 12,800 over the five-year construction phase. This level of employment should generate about $835 million in direct labor earnings to the region of influence (i.e., wages and benefits). A large fraction of the locally generated income would be spent locally, and indirect economic impacts would be expected. By means of an income multiplier of 1.7, total earnings during the period would exceed approximately $1.4 billion. This multiplier compares to the roughly 1.8 to 2.5 multipliers TVA used to estimate the impact of conversion of Bellefonte 1 to a nonnuclear plant (TVA 1997f).

Regional earnings during the period of plant operation have been estimated at a minimum of $100 million per year. This estimate was developed using a multiplier of 1.8. The higher multiplier reflects the longer-term, more level injection of income into the region during operations than during construction. It is consistent with the multipliers used by TVA for the largest conversion scenario at Bellefonte.

Public Finance and Schools

Construction and operation of Bellefonte 1 as a nuclear unit would generate about $5.5 million per year in tax-equivalent payments (payments in-lieu-of-taxes) for Alabama. Tax revenues to the region of influence and Jackson County and, in part, to the Scottsboro-Hollywood area are derived from real estate taxes, motor vehicle taxes, and motor vehicle and mobile home sales taxes. Income and sales taxes are collected at the state level. Jackson County collected approximately $9.4 million (roughly $200 per capita) in taxes in 1997.

Completion of the plant would affect the school systems of Jackson County and Scottsboro City. The county school system has approximately 6,500 students; the city system, approximately 3,000. Roughly two-thirds of the students (about 6,300) are in the Scottsboro-Hollywood area and the Guntersville-to-Bridgeport corridor, the major impact areas within the county and the region of influence. School facilities within the Scottsboro-Hollywood area and the Guntersville-Bridgeport corridor have the capacity to accommodate about 7,850 students. The peak influx of schoolchildren associated with in-migrating construction and operations workers in the fourth year of construction would be an estimated 970 for the whole of Jackson County, consisting of about 640 in the Scottsboro-Hollywood area, 220 in the Guntersville-Bridgeport corridor, and the remainder in other parts of the county. DOE believes these estimates to be conservative. As discussed in the section on housing, more construction workers than expected could choose to live without their families in camper-trailers rather than with their families in apartments, mobile homes, or single-family homes. As a result, the increase in the number of schoolchildren associated with construction and operations workers would be lower than expected. The number of schoolchildren from the families of in-migrating operations workers would decline to about 325 from the sixth year onward. The impacts of schoolchildren from in-migrating families not directly associated with Bellefonte would be additional.

The Scottsboro school transportation system (excluding Hollywood) operates 26 buses on a dual-route system and 8 on a single-route system (for a maximum of 3,600 students). The actual number of students transported is less than 3,000, leaving a surplus of more than 600. The conversion of some of the 8 single-route buses to a dual-route system could accommodate the peak influx of about 600 students in the Scottsboro system (excluding about 40 students in Hollywood) from families of in-migrating construction and operation workers.

The Jackson County school transportation system would experience an impact similar to the Scottsboro school transportation system. By increasing the number of dual-route operations, the additional number of schoolchildren associated with construction and operation workers could be accommodated.

The combined Jackson County and Scottsboro Boards of Education receive about 40 percent of TVA's payment in-lieu-of-taxes. Completion of Bellefonte 1 would increase TVA's payment to about $5.5 million. Assuming that the 40 percent share were maintained, this would translate into a payment to the Jackson County and Scottsboro boards of about $2.2 million. Over the long term, a payment of $2.2 million would exceed the increase in school costs attributable to students whose families directly support the operation of Bellefonte 1.

In the short term, however, construction of Bellefonte 1 would impose costs averaging almost twice Jackson County's likely long-term receipts from the TVA payment. The TVA payment would not reach the $5.5 million level until plant operations began. Educational costs in the Scottsboro school system could increase by an estimated average of $3 million per year (1997$) for the three busiest years of the construction phase. This estimate includes the cost of hiring 37 additional teachers for the estimated 530 new students averaged over the three peak years of construction to maintain the current student-teacher ratio of about 14:1. The peak year of construction could require an additional 5 teachers over the three-year average of 37 to maintain the current student-teacher ratio. Average educational costs could rise to an estimated $5,432 per student (1997$), based on actual costs of $5,120 per student for the 1995-96 school year plus inflation.

For the Jackson County school system (excluding Scottsboro but including Hollywood), educational costs could increase by an average of less than $1.8 million per year (1997$) for the three busiest years of the construction phase. This estimate includes the cost of hiring 23 additional teachers for the estimated 305 new students averaged over the three peak years to maintain the current student-teacher ratio of about 14:1. The peak year of construction could require an additional 4 teachers over the three-year average of 23 to maintain the current student-teacher ratio. Average educational costs could rise to an estimated at $5,716 per student (1997$), based on actual costs for the 1997-98 school year.

Assuming inflation-related increases of 3 percent per year in costs per student from the amounts reported above, average annual costs for the three-year period beginning with the 2001-2002 school year could rise to an estimated $3.4 million per year for Scottsboro and $1.9 million for the rest of Jackson County. These amounts are in the range of 18 percent and 4 percent of the current school system budgets for Scottsboro and Jackson County, respectively. The costs per student from in-migrating families not directly associated with Bellefonte would be additional.

Costs for the first two years would be well below the three-year construction period average and would allow a gradual phase-in of revenues and expenses to meet the costs associated with the increased student population. **Figures 5-2** and **5-3** reflect the projected budget requirements for the first four years of construction versus the No Action Alternative for the Scottsboro and Jackson County school boards. To meet its expenses, the Scottsboro Board of Education could request additional funding from the State of Alabama.

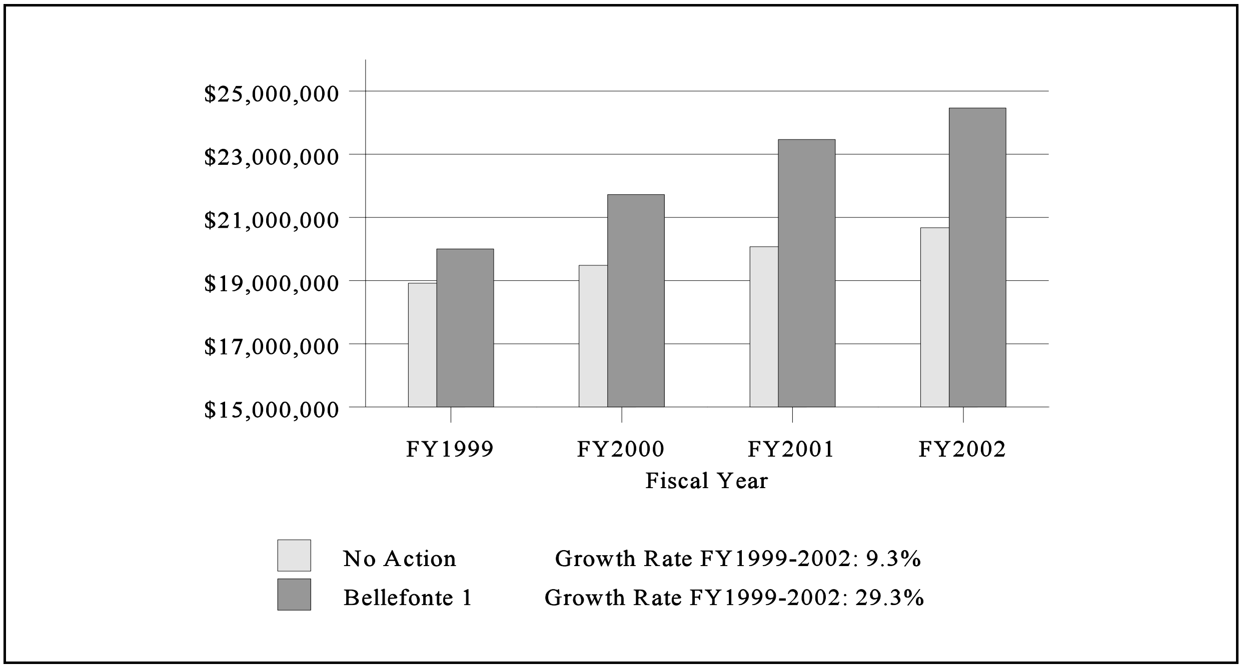

Figure 5-2 Scottsboro School Board Projected Budget, Completion of Bellefonte 1 Versus the No Action Alternative (FY 1999-2002)

Source: Scottsboro 1998.

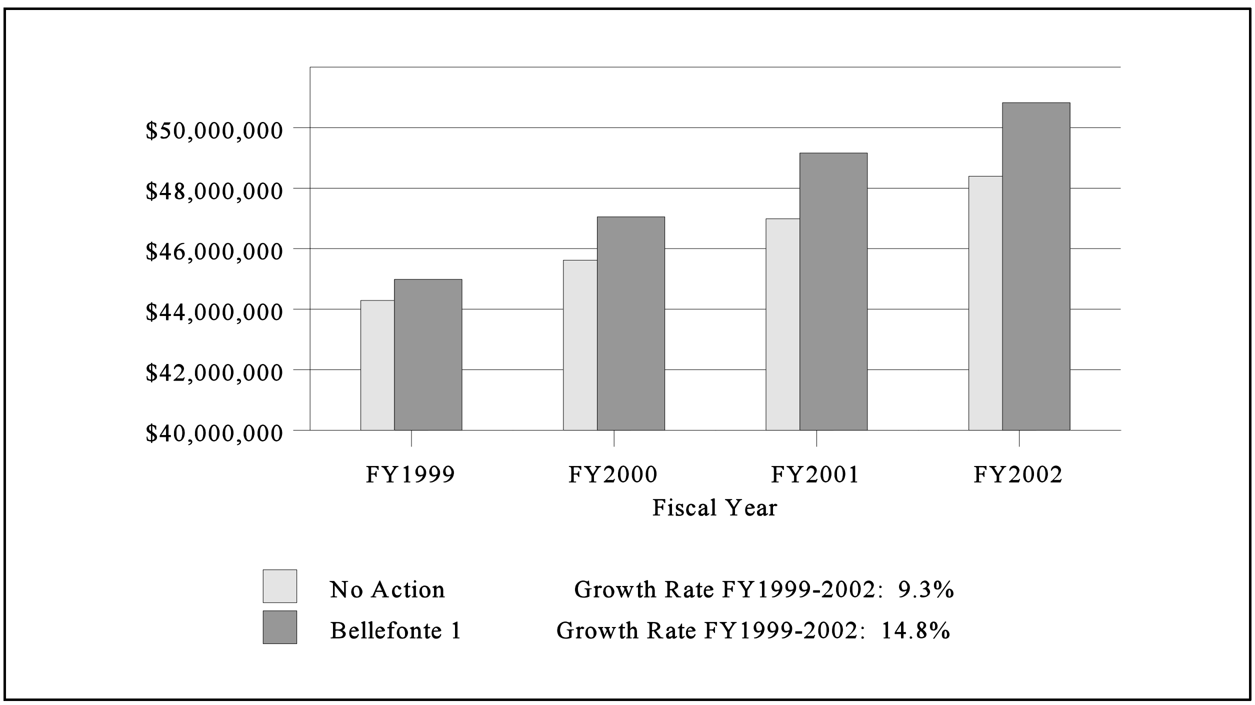

Figure 5-3 Jackson County School Board Projected Budget, Completion of Bellefonte 1 Versus the No Action Alternative (FY 1999-2002)

Source: Scottsboro 1998.

Additional tax revenues also would be generated by the increased economic activity involving the plant and plant workers. Such revenues (e.g., property taxes, income taxes, real estate transfer fees, sales taxes, motor vehicle taxes) are collected by or on behalf of the state government and then distributed to the jurisdictions.

The effect of an influx of families on other areas of public finance (e.g., fire, police, ambulance, hospitals) should be minimal. Additional and new equipment would be required for the police and fire departments, but these items could probably be accommodated within the overall expanding budgets arising from additional tax revenues and payments in-lieu-of-taxes.

Local Transportation

Traffic generated by construction activities associated with the completion of Bellefonte 1 could strain the capacity of the local road network. Traffic impacts during construction would be temporary and similar to the impacts described for the Bellefonte conversion project (TVA 1997f). During peak construction periods, U.S. Highway 72 could experience a 46 percent increase in traffic volume during morning and evening rush hours to the north, and a 48 percent increase in traffic volume to the south. Access roads to the Bellefonte site could experience more than an 80 percent increase in traffic volumes during these hours.

Increased traffic volumes during plant operations, attributable both to the commuting of 800 additional plant employees and to truck transport requirements, would decrease the available capacity of site access roads during morning and evening rush hours. The impacts would be lower than those experienced during peak construction. During plant operations, U.S. Highway 72 could experience a 13 percent increase in traffic volume during morning and evening rush hours to the north, and a 14 percent increase in traffic volume to the south. Access roads to the Bellefonte site could experience a 43 to 59 percent increase in traffic volumes during these hours. Additional truck traffic during plant operations would include a total of 16 shipments of TPBARs to and from the plant per year.

Possible measures that could be used to mitigate traffic volume impacts are physical improvements to the local roads or road network to increase capacity, including construction of additional vehicle lanes throughout road segments, construction of passing lanes in certain locations, or realignment to eliminate some of the no-passing zones. Employee programs that provide flexible hours also could reduce road travel during peak hours, and restrictions for trucks traveling during the peak hours could be made. Also, establishing employee programs and incentives for ride-sharing could be encouraged, and bus and/or vanpool programs could be initiated.

5.2.3.8.2 Bellefonte 1 and 2

No Action

The No Action Alternative requires continuation of the deferred status of Bellefonte 1 and 2. Therefore, no socioeconomic impacts are expected. Approximately 80 employees maintain the partially completed plant in its lay-up condition.

Tritium Production

Estimates of the staffing requirements needed to complete and operate Bellefonte 1 and 2 as a nuclear power plant are presented as **Table 5–33**. About 15,600 person-years will be needed through the six-year construction phase and 1,000 persons per year will be needed for plant operations. In terms of construction workers, completion of Bellefonte 1 and 2 is estimated to require about 10 percent more labor hours than completion of Bellefonte 1 alone, because all the common facilities were completed as part of Bellefonte 1. Peak employment would be about the same in either case; the additional Bellefonte 2–related employment would occur mainly in the fifth and sixth years of the construction program. A comparison of the peak staffing levels by year for the No Action Alternative and for the completion of Bellefonte 1 and 2 is provided in **Figure 5–4**.

Table 5–33 Staffing For Completion And Operation of Bellefonte 1 and 2

Construction Year	*Staffing (Peak)*
1	1,400
2	3,000
3	4,000
4	4,500
5	3,900 (Bellefonte 1 operates)
6	2,000 (Bellefonte 2 operates)
7	1,000
8	1,000
9	1,000
10 to 40+	1,000

Source: TVA 1998a.

Figure 5–4 Staffing for Completion and Operation of Bellefonte 1 and 2, Compared to No Action from First Year of Construction

*Operations at Bellefonte 1 begin.
**Operations at Bellefonte 2 begin.
Sources: TVA 1998a, TVA 1997e.

Income estimates for construction and operations staff are based on local earnings of about $65,000 per person-year, an estimate that is 30 percent higher than the estimated labor cost to complete and operate the facility as a nonnuclear plant. Such high compensation reflects the requirements levels for many categories of nuclear construction and operations and would provide increased revenues to the local economy.

Another potentially important socioeconomic benefit is the direct and indirect income associated with the procurement of equipment and supplies for completion of the plant. Millions of dollars would continue to be added to the local economy during the construction and operations period.

The largest impacts would be experienced in the Scottsboro-Hollywood area of Jackson County. A larger region of influence encompassing the commuting area would have a lesser effect. The reasons for the concentration of socioeconomic impacts within Jackson County and Scottsboro-Hollywood are several. First, Scottsboro-Hollywood—population approximately 15,000 (DOC 1998c)—is the only densely populated area within Jackson County. Second, due to the sparseness of the plant environs, local spending and indirect income generation from that spending are concentrated in the Scottsboro-Hollywood area. Third, procurement of goods and services by the plant and TVA outside Jackson County would be modest. Major impacts such as those relating to schools and taxes would be felt within the county, but not within the region of influence outside the county.

Population and Housing

The completion of Bellefonte 1 and 2 would result in a temporary increase in population and income in the region of influence as a direct and indirect result of increased employment at the site. An estimated 33 percent of the construction workers and 50 percent of the operations workers would be expected to move into the area. This is consistent with the values in the *Final Environmental Impact Statement for the Bellefonte Conversion Project* (TVA 1997f).

About 75 percent of the construction workers and 90 percent of the operations workers who moved would be expected to live in Jackson County. About 70 percent could be expected to live in the Scottsboro-Hollywood area, assuming housing were available. About 20 percent likely would be located along Route 79 and Route 72 in the valley between Guntersville and Bridgeport, with the remainder scattered throughout the county.

The influx of construction and plant operations personnel, plus families, would increase the population of Jackson County by about 3,500, or more than 7 percent. This influx within a period of four years would be about 80 percent greater than local growth in the seven years from 1990 through 1997. Within the Scottsboro-Hollywood area, the estimated peak population influx of about 2,300 workers and family members would represent a 15 percent overall population increase. Adding indirect employees and their families, the population influx into the Scottsboro-Hollywood area could exceed 25 percent at the peak. Peak population growth in Jackson County, including indirect employees and their families, would probably be no more than about 12 percent. Population impacts outside Jackson County would be small.

Most construction workers prefer not to buy permanent housing. Their housing needs would include rental homes and apartments, mobile homes, and camper-trailers. Operations workers generally purchase permanent single-family housing. Up to 70 percent of all incoming construction workers and 90 percent of all operations workers would be expected to bring their families. That number could be appreciably lower than 70 percent, depending on the availability of rentals and trailer parks for camper-trailers. Currently, trailer parks near the Bellefonte site are close to capacity. A trailer park with an estimated capacity of 250 campers/trailers is planned for operation near the site in the fall of 1998. Additional trailer parks could be built in three to four months if construction activity at the plant increased rapidly. DOE is estimating maximum housing and, more importantly, school system impacts, based on the expectation that up to 70 percent of construction workers moving into the area would bring their families.

Demand for housing by construction and operations workers in the vicinity of Bellefonte would increase during the completion and operation of the plant. Data indicate that vacant permanent housing for sale and rent in the vicinity of the Bellefonte plant is insufficient to meet this demand. It is anticipated, however, that the completion and operation of Bellefonte would stimulate the construction of additional permanent housing, the opening of new trailer parks, and the expansion of existing parks to meet this demand, thereby producing a positive effect on the regional economy. It is expected that these new units also would meet permanent housing requirements for plant operations workers and their families.

Employment and Income

Peak employment during construction has been estimated at 4,500. Average employment during the middle four years of the construction phase would be about 3,650 per year. Operations workers would average 1,000 per year over the operational life of the plant. Indirect employment (e.g., food, retail, banking) could reach an average at least equal to the number of operations workers. During the construction phase, indirect employment would be considerably higher. The effect of this change in employment in Jackson County would be high. Unemployment in 1997 averaged 8.2 percent. This would be expected to decline to perhaps 3 percent over the first few years of construction, and then likely would stabilize at least two points below the average. The unemployment rate would not drop by as much as the employment requirements would suggest. As the construction project escalated and the labor market tightened, the labor pool would expand from the influx of immigrating workers.

Total person-years of employment during construction, including operations staff, have been estimated at about 15,600 over the six-year construction phase. This level of employment should generate about $1 billion in direct labor earnings to the region of influence (i.e., wages and benefits). A large fraction of the locally generated income would be spent locally, and indirect economic impacts would be expected. By means of an income multiplier of 1.7, total earnings during the period have been estimated at more than $1.7 billion. This multiplier compares to the roughly 1.8 to 2.5 multipliers TVA used to estimated the impact of conversion of the Bellefonte Nuclear Plant to a nonnuclear plant (TVA 1997e).

Regional earnings during the period of plant operation have been estimated at a minimum of $115 million per year. This estimate was developed using a multiplier of 1.8. The higher multiplier reflects the longer-term, more level injection of income into the region during operations than during construction. It is consistent with the multipliers used by TVA for the largest conversion scenario at Bellefonte.

Public Finance and Schools

Construction and operation of Bellefonte 1 and 2 as a nuclear plant would generate more than $8 million per year in tax-equivalent payments (payments in-lieu-of-taxes) for Alabama. Tax revenues to the region of influence and Jackson County and, in part, to the Scottsboro-Hollywood area are derived from real estate taxes, motor vehicle taxes, and motor vehicle and mobile home sales taxes. Income and sales taxes are collected at the state level. Jackson County collected approximately $9.4 million (roughly $200 per capita) in taxes in 1997.

Completion of the plant would affect the school systems of Jackson County and Scottsboro City. The Jackson County school system has approximately 6,500 students; the city system, approximately 3,000. Roughly two-thirds of the students (about 6,300) are in the Scottsboro-Hollywood area and the Guntersville-to-Bridgeport corridor, the major impact areas within the county and the region of influence. School facilities within the Scottsboro-Hollywood area and Guntersville-Bridgeport corridor have the capacity to accommodate about 7,850 students. The peak influx of schoolchildren associated with in-migrating construction and operations workers in the fourth year of construction would be an estimated 1,055 for the whole of Jackson County, consisting of about 700 in the Scottsboro-Hollywood area, 235 in the Guntersville-Bridgeport corridor, and the remainder in other parts of the county. DOE believes these estimates to be conservative. As discussed in the section on housing, more construction workers than expected could choose to live without their families in camper-trailers rather than with their families in apartments, mobile homes, or single-family homes. As a result, the increase in the number of schoolchildren associated with construction and operations workers would be lower than expected. The number of schoolchildren from the families of in-migrating operations workers would decline to about 400 from the seventh year onward. The impacts of schoolchildren from in-migrating families not directly associated with Bellefonte would be additional.

The Scottsboro school transportation system (excluding Hollywood) operates 26 buses on a dual-route system and 8 on a single-route system (for a maximum of 3,600 students). The actual number of students transported is less than 3,000, leaving a surplus of more than 600. The conversion of some of the 8 single-route buses to a dual-route system could accommodate the peak influx of about 655 students in the Scottsboro system (excluding about 45 students in Hollywood) from families of in-migrating construction and operation workers.

The Jackson County school transportation system would experience an impact similar to the Scottsboro school transportation system. By increasing the number of dual-route operations, the additional number of schoolchildren associated with construction and operation workers could be accommodated.

The combined Jackson County and Scottsboro Boards of Education receive about 40 percent of TVA's payment in-lieu-of-taxes. Completion of Bellefonte 1 and 2 would increase TVA's payment to about $8 million. Assuming that the 40 percent share were maintained, this would translate into a payment to the Jackson County and Scottsboro boards of about $3.2 million. Over the long term, a payment of $3.2 million would exceed the increase in school costs attributable to students whose families directly support the operation of Bellefonte 1 and 2.

In the short term, however, construction of Bellefonte 1 and 2 would impose costs averaging almost twice Jackson County's likely long-term receipts from the TVA payment. The TVA payment would not reach the $8 million level until plant operations began. Educational costs in the Scottsboro school system could increase by an estimated average of $3.5 million per year (1997$) for the three busiest years of the construction phase. This estimate includes the cost of hiring 43 additional teachers for the estimated 615 new students averaged over the three peak years of construction to maintain the current student-teacher ratio of about 14:1. The peak year of construction could require an additional 3 teachers over the three-year average of 43 to maintain the current student-teacher ratio. Average educational costs could rise to an estimated $5,432 per student (1997$), based on actual costs of $5,120 per student for the 1995-96 school year plus inflation.

For the Jackson County school system (excluding Scottsboro but including Hollywood), educational costs could increase by an average of less than $2.1 million per year (1997$) for the three busiest years of the construction phase. This estimate includes the cost of hiring 23 additional teachers for the estimated 355 new students averaged over the three peak years to maintain the current student-teacher ratio of about 14:1. The peak year of construction could require an additional 6 teachers over the three-year average of 23 to maintain the current student-teacher ratio. Average educational costs could rise to an estimated $5,716 per student (1997$), based on actual costs for the 1997-98 school year.

Assuming inflation-related increases of 3 percent per year in costs per student from the amounts reported above, average annual costs for the three-year period beginning with the 2001-2002 school year could rise to an estimated $3.9 million per year for Scottsboro and $2.3 million for the rest of Jackson County. These amounts are in the range of 20 percent and 4 percent of the current school system budgets for Scottsboro and Jackson County, respectively. The costs per student from in-migrating families not directly associated with Bellefonte would be additional.

Costs for the first two years would be well below the three-year construction period average and would allow a gradual phase-in of revenues and expenses to meet the costs associated with the increased student population. **Figures 5–5** and **5–6** reflect the projected budget requirements for the first four years of construction versus the No Action Alternative for the Scottsboro and Jackson County School Boards. These growth rates are similar to those for the case in which only Bellefonte Unit 1 is completed, as the differential impacts of

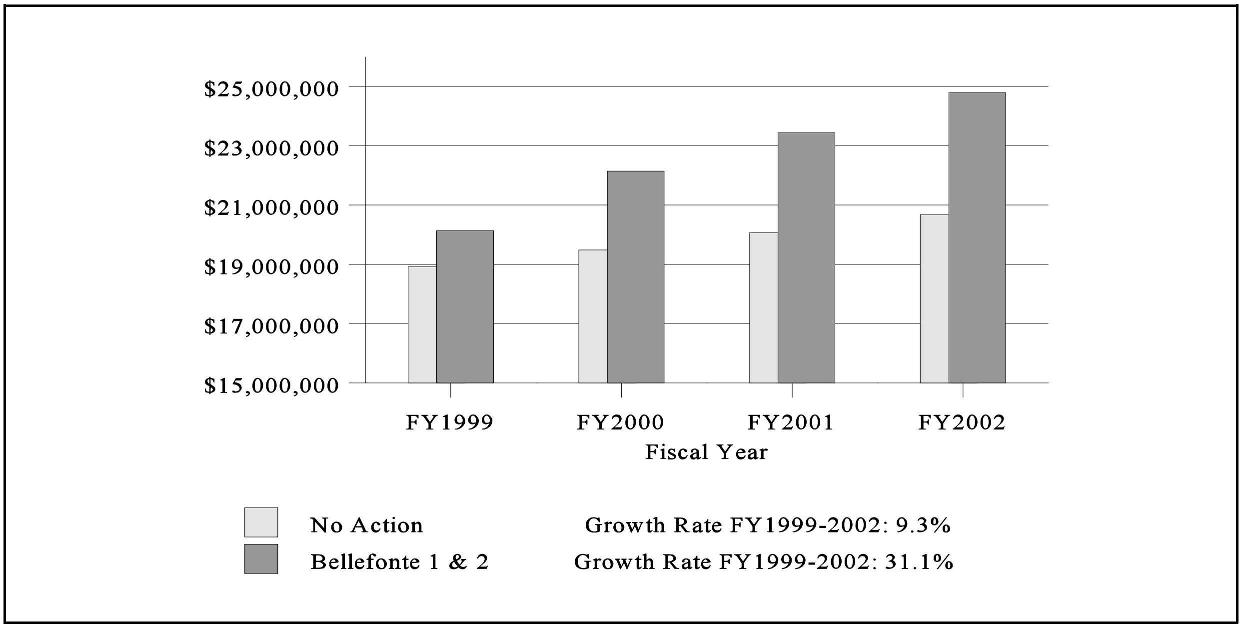

Figure 5-5 Scottsboro School Board Projected Budget, Completion of Bellefonte 1 and 2 Versus the No Action Alternative (FY 1999-2002)

completing Unit 2 become greater in the fifth year of construction. To meet its expenses, the Scottsboro Board of Education could request additional funding from the State of Alabama.

Source: Scottsboro 1998.

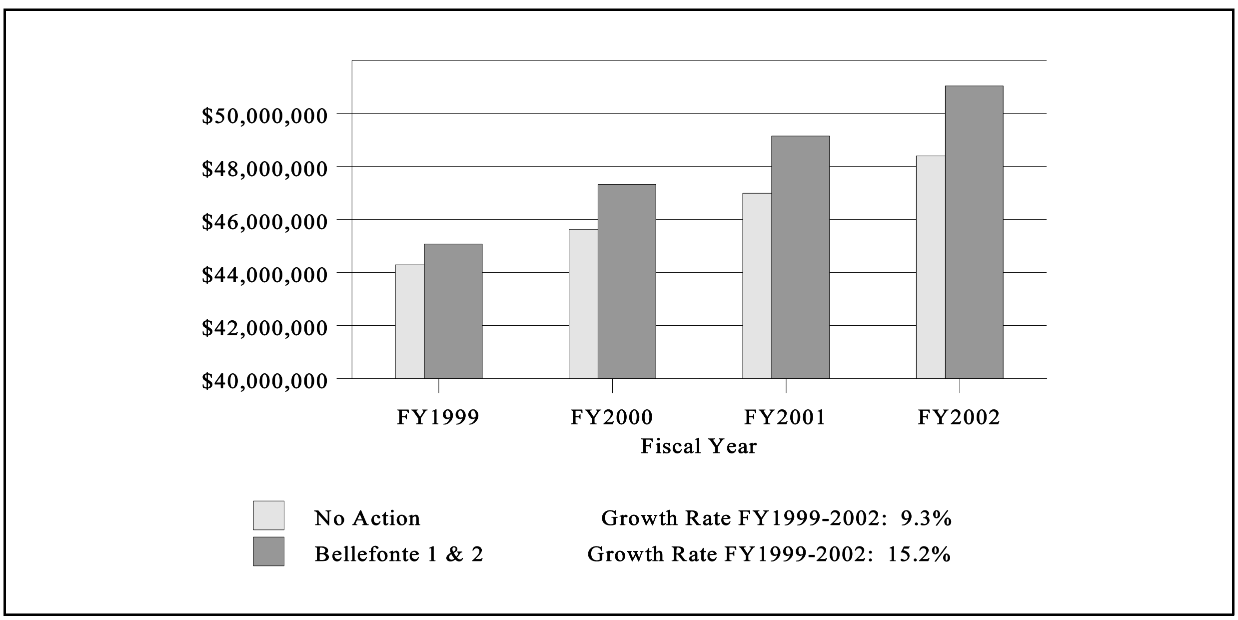

Figure 5-6 Jackson County School Board Projected Budget, Completion of Bellefonte 1 and 2 Versus the No Action Alternative (FY 1999-2002)

Source: Scottsboro 1998.

Additional tax revenues also would be generated by the increased economic activity involving the plant and plant workers. Such revenues (e.g., property taxes, income taxes, real estate transfer fees, sales taxes, motor vehicle taxes) are collected by or on behalf of the state government and then distributed to the jurisdictions. The effect of an influx of families on other areas of public finance (e.g., fire, police, ambulance, hospitals) should be minimal. Additional and new equipment would be required for the police and fire departments, but these items could probably be accommodated within the overall expanding budgets arising from additional tax revenues and payments in-lieu-of-taxes.

Local Transportation

Traffic generated by construction activities associated with the completion of Bellefonte 1 and 2 could strain the capacity of the local road network. Traffic impacts during construction would be temporary and similar to the impacts described for the Bellefonte conversion project (TVA 1997f). During peak construction periods, U.S. Highway 72 could experience a 46 percent increase in traffic volume during morning and evening rush hours to the north, and a 48 percent increase in traffic volume to the south. Access roads to the Bellefonte site could experience more than an 80 percent increase in traffic volumes during these hours.

Increased traffic volumes during plant operations, attributable both to the commuting of 1,000 additional plant employees and to truck transport requirements, would decrease the available capacity of site access roads during morning and evening rush hours. The impacts would be lower than those experienced during peak construction. During plant operations, U.S. Highway 72 could experience a 16 percent increase in traffic volume during morning and evening rush hours to the north and a 17 percent increase in traffic volume to the south. Access roads to the Bellefonte site could experience a 48 to 64 percent increase in traffic volumes during these hours. Additional truck traffic during plant operations would include a total of 16 shipments of TPBARs to and from the plant per year.

Possible measures that could be used to mitigate traffic volume impacts are physical improvements to the local roads or road network to increase capacity, including construction of additional vehicle lanes throughout road segments, construction of passing lanes in certain locations, or realignment to eliminate some of the no-passing zones. employee programs that provide flexible hours also could reduce road travel during peak hours, and restrictions for trucks traveling during the peak hours could be made. Also, establishing employee programs and incentives for ride-sharing could be encouraged, and bus and/or vanpool programs could be initiated.

5.2.3.9 Public and Occupational Health and Safety

This section describes the impacts of radiological and hazardous chemical releases resulting from the construction activities required to complete the units, as well as the normal operation, abnormal conditions, or accidents due to tritium production at Bellefonte 1 or both Bellefonte 1 and 2.

5.2.3.9.1 Normal Operation

RADIOLOGICAL IMPACTS

The annual gaseous radioactive emissions and liquid radioactive effluents from the production of tritium at Bellefonte 1 are presented in Sections 5.2.3.3 and 5.2.3.4, respectively. Presented in **Table 5–34** are the radiological impacts of both gaseous and liquid radioactive releases on the maximally exposed offsite individual and on the general public living within 80 kilometers (50 miles) of Bellefonte 1 in the year 2025. **Table 5–35** provides the radiological impacts on the facility workers. A facility worker is defined as any “monitored” reactor plant employee. Doses to these workers would be kept to minimal levels through programs to keep worker doses as low as reasonably achievable. The tables include the impacts of the No

Action Alternative and, for comparison purposes, the estimated radiological impacts of operation of Bellefonte 1 and 2 without tritium production (0 TPBARs). These values are based on the Bellefonte Final

Table 5–34 Annual Radiological Impacts from Incident-Free Tritium Production Operations at Bellefonte 1

Tritium Production	*Release Media*	*Maximally Exposed Offsite Individual*		*Population Within 80 kilometers (50 miles) for the Year 2025*	
		Dose (millirem)	*Latent Fatal Cancer Risk*	*Dose (person-rem)*	*Latent Fatal Cancers*
No Action (not operating)	Air	0	0	0	0
	Liquid	0	0	0	0
	Total	0	0	0	0
0 TPBARs [a] (operation without tritium production)	Air	0.25	1.3×10^{-7}	0.27	0.00014
	Liquid	0.012	6.0×10^{-9}	1.1	0.00055
	Total	0.26	1.4×10^{-7}	1.4	0.00069
Incremental dose for 1,000 TPBARs	Air	0.0020	1.0×10^{-9}	0.13	0.000065
	Liquid	0.0012	6.0×10^{-10}	0.14	0.000070
Total dose for 1,000 TPBARs [b]	Air	0.25	1.3×10^{-7}	0.40	0.00020
	Liquid	0.013	6.5×10^{-9}	1.2	0.00060
	Total	0.26	1.3×10^{-7}	1.6	0.00080
Incremental dose for 3,400 TPBARs	Air	0.0065	3.3×10^{-9}	0.44	0.00022
	Liquid	0.0042	2.1×10^{-9}	0.47	0.00024
Total dose for 3,400 TPBARs [b]	Air	0.26	1.3×10^{-7}	0.71	0.00036
	Liquid	0.016	8.0×10^{-9}	1.6	0.00080
	Total	0.28	1.4×10^{-7}	2.3	0.0012

[a] AEC 1974.
[b] The total values are a summation of incremental impacts attributable to tritium production and estimated Bellefonte 1 operational impacts.
Note: The impacts from Bellefonte 1 and 2 operation would be twice those for Bellefonte 1.

Environmental Statement (AEC 1974). Based on actual experience at Watts Bar 1 and Sequoyah 1 and 2 (see Tables 5–4 and 5–14), the actual values are expected to be lower.

Background information on the effects of radiation to human health and safety is included in Appendix C. The calculation method and assumptions are presented in Appendix C, Section C.3.

Table 5–35 Annual Radiological Impacts to Workers from Incident-Free Tritium Production Operations at Bellefonte 1

Impact	*No Action*[a]	*0 TPBARs*[b]	*1,000 TPBARs*	*Total With 1,000 TPBARs*[c]	*3,400 TPBARs*	*Total With 3,400 TPBARs*[c]
Average worker dose (millirem)[d]	0	104	0.33	104.33	1.1	105.1
Latent fatal cancer risk	0	4.2×10^{-5}	1.6×10^{-7}	4.2×10^{-5}	4.5×10^{-7}	4.2×10^{-5}
Total worker dose (person-rem)	0	112	0.35	112.35	1.2	113.2
Latent fatal cancers	0	0.045	0.00014	0.045	0.00048	0.045

[a] These no action values represent the absence of impacts associated with the nonoperational status of Bellefonte.
[b] The 0 TPBARs entry is included for consistency with the Watts Bar and Sequoyah analyses.
[c] These values are a summation of incremental impacts and estimated single Bellefonte unit operational (baseline) impacts. "Baseline" impacts are defined as those impacts that result from normal plant (design specification) operation (i.e., operations without tritium production activities).
[d] Based on 1,073 badged workers.
Note: The impacts from Bellefonte 1 and 2 are twice those for Bellefonte 1.
Sources: TVA 1998d, TVA 1998e.

No Action

Under the No Action Alternative, the health and safety risk of members of the public and facility workers at Bellefonte 1 would remain at the level associated with the natural background radiation.

Tritium Production

Construction

During construction, no radioactive materials would be handled. Therefore, there would be no radiological impacts on the workers and the general population.

Operation

During tritium production, the health and safety risk of the public and facility workers would increase as a function of Bellefonte's normal operation as a nuclear reactor facility and the estimated releases of tritium in gaseous emissions and liquid effluents. As shown in Tables 5–34 and 5–35, for 3,400 TPBARs in the reactor core:

- The annual dose to the maximally exposed offsite individual would be 0.28 millirem per year, with an associated 1.4×10^{-7} latent cancer fatality per year of operation. This dose is 1.1 percent of the annual total dose limit of 25 millirem set by regulations in 40 CFR 190.

- The collective dose to the population within 50 miles of Bellefonte 1 would be 2.3 person-rem per year, with an associated 0.0012 latent cancer fatality per year of operation.

- The collective dose to the facility workers would be 113.2 person-rem per year, with an associated 0.045 latent cancer fatality per year of operation.

In addition to the assumed normal operation release of tritium through permeation, an additional potential release scenario considered in this EIS is the failure of 1 or more TPBARs such that the inventory of the TPBARs is released to the primary coolant. The occurrence of TPBAR failure is considered to be beyond that associated with normal operating conditions and, as discussed in Section 1.9, such an assumption is extremely conservative. The radiological consequences to the public and workers resulting from the assumption of 2 TPBAR failures in a given core load of 3,400 TPBARs at Bellefonte 1 are presented in **Tables 5–36** and **5–37**. Releases, doses, and cancer risk associated with 1 TPBAR failure can be determined by dividing the values in Tables 5–36 and 5–37 by two.

Table 5–36 Radiological Impacts to the Public from the Failure of 2 TPBARs at Bellefonte 1

Release Pathway	*Release Quantity (Curies)*	*Dose to Maximally Exposed Individual (millirem)*	*Latent Fatal Cancer Risk*	*Dose to Population Within 80 kilometers (50 miles) (person-rem)*	*Latent Fatal Cancers*
Air	2,315	0.045	2.3×10^{-8}	3.0	0.0015
Liquid	20,835	0.028	1.4×10^{-8}	3.2	0.0016

Table 5–37 Radiological Impacts to Workers from the Failure of 2 TPBARs at Bellefonte 1

Impact Type	*Impact Quantity*
Average Worker Dose (millirem)[a]	7.7
Latent Fatal Cancer Risk	3.1×10^{-6}
Total Worker Dose (person-rem)	8.2
Latent Fatal Cancers	0.0033

[a] Based on 1,073 badged workers.
Note: The impacts from Bellefonte 1 and Bellefonte 2 are twice that for Bellefonte 1.
Source: TVA 1998d, TVA 1998e.

HAZARDOUS CHEMICAL IMPACTS

No Action

Under the No Action Alternative, no additional impacts on public and occupational health and safety from exposure to hazardous chemicals are anticipated at Bellefonte 1 and 2 beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Analyses of impacts on public and occupational health and safety from exposure to hazardous chemicals are presented separately for construction and operations activities.

Construction

Construction activities at the Bellefonte plant could release a number of hazardous chemicals to the atmosphere, as discussed in Section 5.2.3.3 and presented in Table 5–22. The estimated annual and daily airborne concentrations of these chemicals at the location of the maximally exposed offsite individual during construction of both Bellefonte 1 and 2 are presented in **Table 5–38.** Airborne concentrations were estimated using the method described in Section 5.2.3.3 and Appendix C, Section C.4. Table 5–38 also presents the

EPA Inhalation Cancer Unit Risk Factor values for the carcinogenic chemicals (e.g., formaldehyde, arsenic, beryllium, cadmium, chromium, and nickel) and the Reference Concentration values for the noncarcinogenic chemicals (e.g., beryllium, manganese, and mercury). Application of the estimated airborne concentrations to the chemical-specific inhalation cancer unit risk factor and Reference Concentration values, as described in Section C.4, enables estimation of the potential adverse health effects for the maximally exposed offsite individual. For the noncarcinogens, these estimates are chemical-specific Hazard Quotient values; for the carcinogens, they are probabilities of excess latent cancer incidence. Both types of estimates are also presented in Table 5–38.

Table 5–38 Cancer and Noncancer Adverse Health Impacts from Exposure to Hazardous Chemicals at Bellefonte 1 and 2 During Construction

Chemical	*Estimated Annual Airborne Concentration[a] (µg/m3)*	*Estimated Daily Airborne Concentration [a](µg/m³)*	*Reference Concentration[b] (µg/m³)*	*Cancer Inhalation Unit Risk Factor[c] (cancers/(µg/m³)*	*Hazard Quotient[d]*	*MEI Cancer Incidence Probability[e]*
Formaldehyde	8.5×10^{-5}	0.031	Not applicable	0.000013	Not applicable	1×10^{-9}
Arsenic	9×10^{-7}	0.0003	Not applicable	0.0043	Not applicable	4×10^{-9}
Beryllium	5×10^{-7}	0.0002	0.02	0.0024	0.01	1×10^{-9}
Cadmium	2.3×10^{-6}	0.00083	Not applicable	0.0018	Not applicable	4×10^{-9}
Chromium	1.4×10^{-5}	0.005	Not applicable	0.012	Not applicable	2×10^{-7}
Manganese	2.9×10^{-6}	0.001	0.05	Not applicable	0.02	Not applicable
Mercury	6×10^{-7}	0.0002	0.3	Not applicable	0.0007	Not applicable
Nickel	3.6×10^{-5}	0.013	Not applicable	0.00048	Not applicable	2×10^{-8}

MEI = maximally exposed individual
µg/m³ = micrograms per cubic meter
[a] Estimates of annual and daily airborne concentrations developed by using the ISC3 air dispersion model. See Appendix C, Section C.4, for additional information.
[b] Reference Concentration values are estimates, with uncertainties spanning perhaps an order of magnitude, of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime. Values are developed by the EPA (EPA 1997a , EPA 1998).
[c] Cancer Inhalation Unit Risk Factors are estimates of the cancer potency of carcinogens by the inhalation pathway. Values are developed by the EPA (EPA 1997a, EPA 1998).
[d] Hazard Quotient estimates are developed by dividing the estimated daily airborne concentration by the Reference Concentration. Hazard Quotient estimates are chemical-specific measures of potential noncancer health effects. The Hazard Index is the sum of the Hazard Quotient values. Hazard Index values of less than one suggest low concern for noncancer effects as a result of the exposure, whereas Hazard Index values of greater than one suggest a potential for noncancer effects.
[e] The offsite population maximally exposed individual cancer incidence probability is estimated by multiplying the estimated annual airborne concentration by the Cancer Inhalation Unit Risk Factor. See Appendix C, Section C.4 for additional information.

For the noncarcinogenic chemicals, the chemical-specific Hazard Quotient values are summed to generate a Hazard Index value. Hazard Index values lower than 1 suggest that the offsite receptor likely would not experience adverse noncancer health effects as a result of the exposure. The Hazard Index value for the noncarcinogenic chemicals presented in Table 5–38 is 0.03.

The highest probability estimate for excess latent cancer incidence presented in Table 5–38 (2×10^{-7} for chromium) is lower than the 1 in 1 million established by the EPA as the lower bound of concern. This value suggests that exposure to chromium released from construction activity would result in 2 in 10 million additional chances of cancer incidence for the maximally exposed offsite individual. This estimate is actually higher than would be expected, because all of the released chromium was conservatively assumed to be in the form of chromium VI, which is carcinogenic. Actual releases of chromium also would include some amount of chromium III, which is not carcinogenic.

Operation

During normal operation, the Bellefonte Nuclear Plant could release a number of toxic chemicals to the atmosphere. These chemicals, discussed in Section 5.2.3.3 (Table 5–24), include carcinogenic (e.g., benzene, acetaldehyde, formaldehyde, arsenic, cadmium, chromium VI, and nickel) and noncarcinogenic (e.g., toluene, acetaldehyde, acrolein, manganese, and mercury) substances. The annual and daily airborne concentrations of these chemicals were estimated at the location of the maximally exposed offsite individual using the method described in Section 5.2.3.3 and Appendix C, Section C.4. The concentrations from the operation of both Bellefonte 1 and 2 are presented in **Table 5–39**. The table presents the EPA's Inhalation Cancer Unit Risk Factor values for the carcinogens and the Reference Concentration values for the noncarcinogens. Also presented are the chemical-specific Hazard Quotient estimates for noncarcinogens and the probability estimates for excess latent cancer incidence for carcinogens.

Table 5–39 Cancer and Noncancer Adverse Health Impacts from Exposure to Hazardous Chemicals at Bellefonte 1 and 2 During Normal Operation

Chemical	*Estimated Annual Airborne Concentration[a] ($\mu g/m^3$)*	*Estimated Daily Airborne Concentration[a] ($\mu g/m^3$)*	*Reference Concentration[b] ($\mu g/m^3$)*	*Cancer Inhalation Unit Risk Factor[c] (cancers/($\mu g/m^3$))*	*Hazard Quotient[d]*	*MEI Cancer Incidence Probability[e]*
Benzene	0.0002	0.15	Not applicable	8.3×10^{-6}	Not applicable	2×10^{-9}
Toluene	0.00008	0.06	400	Not applicable	0.0002	Not applicable
Formaldehyde	0.0015	0.085	Not applicable	0.000013	Not applicable	2×10^{-8}
Acetaldehyde	9×10^{-6}	0.012	9	2.2×10^{-6}	0.0013	2×10^{-11}
Acrolein	2.5×10^{-6}	0.002	0.02	Not applicable	0.1	Not applicable
Arsenic	0.000015	0.00062	Not applicable	0.0043	Not applicable	6×10^{-8}
Cadmium	0.000039	0.0016	Not applicable	0.0018	Not applicable	7×10^{-8}
Chromium VI	0.00024	0.0098	Not applicable	0.012	Not applicable	3×10^{-6}
Manganese	0.00005	0.002	0.05	Not applicable	0.04	Not applicable
Mercury	0.000011	0.00044	0.3	Not applicable	0.001	Not applicable
Nickel	0.0006	0.025	Not applicable	0.00048	Not applicable	3×10^{-7}

MEI = maximally exposed individual
$\mu g/m^3$ = micrograms per cubic meter
[a] Estimates of annual and daily airborne concentrations were developed by using the ISC3 air dispersion model. See Appendix C, Section C.4, for additional information. Note that 24-hour maximum daily concentrations were used to calculate Hazard Quotient values in order to be conservative.
[b] Reference Concentration values are estimates, with uncertainties spanning perhaps an order of magnitude, of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime. Values are developed by the EPA (EPA 1997a).
[c] Cancer Inhalation Unit Risk Factors are estimates of the cancer potency of carcinogens by the inhalation pathway. Values are developed by the EPA (EPA 1997a).
[d] Hazard Quotient estimates are developed by dividing the estimated daily airborne concentration by the Reference Concentration. Hazard Quotient estimates are chemical-specific measures of potential noncancer health effects. The Hazard Index is the sum of the Hazard Quotient values. Hazard Index values of less than one suggest low concern for noncancer effects as a result of the exposure, whereas, Hazard Index values of greater than one suggest a potential for noncancer effects.
[e] The offsite population maximally exposed individual cancer incidence probability is estimated by multiplying the estimated annual airborne concentration by the Cancer Inhalation Unit Risk Factor. See Appendix C, Section C.4, for additional information.

The sum of all of the Hazard Quotient estimates is called the Hazard Index. Hazard Index values lower than 1 suggest that the offsite receptor likely would not experience adverse noncancer health effects as a result of the exposure. The Hazard Index value for the noncarcinogenic chemicals presented in Table 5–39 is 0.1, which is considerably lower than 1.

The only probability of excess latent cancer incidence greater than 1 in 1 million (the lower EPA bound for concern) is the probability attributed to chromium VI: 3 in 1 million (3×10^{-6}). However, all the chromium was conservatively assumed to be in the form of chromium VI, which is carcinogenic. Actual releases of chromium also would include some amount of chromium III, which is not carcinogenic.

The health risk estimates presented in Table 5–39 assume that the airborne pathway would be the exposure route of most importance because aqueous waste streams would be treated before release to potable water sources. The hazardous trace chemicals in Table 5-39 would be generated by operating the support and backup systems identified in the footnote to Table 5-24. These are primarily internal combustion systems with engineering controls that emit combustion byproducts considered to be point sources and, therefore, are emitted through exhaust stacks above the level where they would affect workers in the immediate vicinity of the emission source. The backup systems are run on periodic schedules for testing. Because of their infrequent operation, engineering controls, and external emissions, the hazardous trace chemicals generated by these systems pose no hazard to plant workers during operations.

Other potential occupational health risks for facility workers were not estimated because their exposures to additional hazardous chemicals would be adequately controlled by procedural, engineering, and personal protective methods. Historically, facility worker exposures have been well under the permissible exposure levels of the Occupational Safety and Health Administration and the threshold limits values of the American Conference of Governmental Industrial Hygienists.

ENERGIZING TRANSMISSION LINES FROM BELLEFONTE 1 AND 2

No Action

Under the No Action Alterative, construction of Bellefonte 1 and 2 would not be completed. Unenergized transmission lines from the plant switchyard would remain unenergized; therefore, no impacts would be expected.

Tritium Production

Operation of the Bellefonte Nuclear Plant would result in energizing approximately 20 miles of 500-kilovolt line leading from the Bellefonte switchyard to the 500-kilovolt line connecting the Widows Creek and Huntsville substations. All other transmission lines in the vicinity of Bellefonte are currently in use. The Bellefonte Final Environmental Statement (AEC 1974) addressed the environmental impacts of transmission lines. Issues associated with their activation include ozone from corona effects, compatibility with communications equipment, and electromagnetic field effects.

Ozone can be produced from corona discharges (ionization of the air) in the operation of transmission lines and substations, particularly at the higher voltages. It can be harmful if breathed in sufficient concentrations over prolonged periods. However, it is not considered to be injurious to vegetation, animals, and humans unless concentrations exceed 0.05 parts per million. According to the Bellefonte Final Environmental Statement, any levels of ozone that could reasonably be expected to be generated by Bellefonte's transmission lines would be environmentally inconsequential.

High-voltage power lines operating close to telephone and signaling equipment can produce undesirable effects on the communication circuit through inductive coupling. However, it is TVA's normal practice to send transmission line vicinity maps to railroad and telephone companies having tracks or communication lines in the general area of proposed power lines for the purpose of making inductive coordination studies. If corrective action is indicated, the problem is jointly studied and any required changes are mutually resolved (AEC 1974).

During the past two decades, the potential role of electromagnetic fields in causing or promoting cancer or other adverse health effects has been the subject of scientific investigation and public concern. If Bellefonte 1 or both Bellefonte 1 and 2 were selected for production of tritium, electric power lines to the plant would be activated. Like all such lines, the power lines to Bellefonte would act as a source of weak, extremely low frequency electrical and magnetic fields. While research in electromagnetic field health effects is continuing, there is no conclusive scientific evidence of a "significant" link between cancer and power line fields. In 1995, the American Physical Society (APS 1995) concluded that: "While it is impossible to prove that no deleterious health effects occur from exposure to any environmental factor, it is necessary to demonstrate a consistent, significant, and causal relationship before one can conclude that such effects do occur. From this standpoint, the conjectures relating cancer to power line fields have not been scientifically substantiated." In response to a Congressional request to review the literature concerning potential electromagnetic field health effects, the National Academy of Sciences (NAS 1996) observed: "Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard." While TVA recognizes that continuing research may establish a credible link between adverse health effects and exposure to power line fields, it has concluded that no mitigation of potential electromagnetic field health effects would be implemented at the Bellefonte site until such a link is conclusively established through scientific investigation.

5.2.3.9.2 Facility Accidents

RADIOLOGICAL IMPACTS

The accident set selected for evaluation of impacts of the No Action Alternative and tritium production are described in Section 5.1 and discussed in detail in Appendix D, Section D.1. The consequences of the reactor and nonreactor design-basis accidents at Bellefonte 1 for the no-tritium-production case (0 TPBARs) and for the maximum tritium production case (3,400 TPBARs) were estimated using the NRC-based deterministic approach presented in the *Bellefonte Nuclear Plant Final Safety Analysis Report* (TVA 1991), the receptors being an individual at the reactor site exclusion area boundary and an individual located at the reactor site low-population zone. The margin of safety for site dose criteria associated with the same accidents and the same receptors are presented in **Table 5–40.** Data presented for the no-tritium-production case were extracted directly from the *Bellefonte Nuclear Plant Final Safety Analysis Report*. As indicated in **Table 5–41,** the irradiation of TPBARs at Bellefonte 1 would result in a very small increase in design-basis accident consequences and a reduction in the consequence margin. The accident consequences would be dominated by the effects of the same nuclide releases inherent to operation without tritium production. If constructed, Bellefonte 2 accident consequences would be the same as those for Bellefonte 1.

Table 5–40 Design-Basis Accident Consequence Margin to Site Dose Criteria at Bellefonte 1

Accident	Tritium Production	Dose Description [a]	Site Dose Criteria (rem) [b]	Individual at Area Exclusion Boundary		Individual at Low Population Zone	
				Dose (rem)	Margin (%) [c]	Dose (rem)	Margin (%) [c]
Reactor design-basis accident	0 TPBARs [d]	Thyroid inhalation dose	300	5.8	98.1	2.7	99.1
		Beta + gamma whole body dose	25	0.031	99.9	0.18	99.3
	3,400 TPBARs	Thyroid inhalation dose	300	5.9	98.0	2.7	99.1
		Beta + gamma whole body dose	25	0.032	99.9	0.18	99.3
Nonreactor design-basis accident	0 TPBARs [d]	Thyroid inhalation dose	300	0.0067	99.998	0.0019	99.999
		Beta + gamma whole body dose	25	0.71	97.2	0.14	99.4
	3,400 TPBARs	Thyroid inhalation dose	300	0.029	99.99	0.0064	99.998
		Beta + gamma whole body dose	25	0.71	97.2	0.14	99.4

[a] Dose is the total dose from the reactor plus the contribution from the TPBARs.
[b] 10 CFR 100.11.
[c] Margin below the site dose criteria.
[d] TVA 1991.

Table 5–41 presents the total risks of the postulated set of design-basis, handling, and beyond design-basis accidents to the maximally exposed offsite individual, an average individual in the public within an 80-kilometer (50-mile) radius of the reactor site, and a noninvolved worker 640 meters (0.4 mile) from the release point. Accident consequences to the same receptors are summarized in **Table 5–42**. The assessments of dose and the associated cancer risk to the noninvolved worker are not applicable for beyond design-basis accidents. A site emergency would have been declared early in the accident sequence; all nonessential site personnel would have evacuated the site in accordance with site emergency procedures before any radiological release to the environment; and in accordance with emergency action guidelines, evacuation of the public within 16.1 kilometers (10 miles) of the plant would have been initiated.

Presented in Tables 5–41 and 5–42 are the risks and consequences without tritium production (0 TPBARs) and with maximum tritium production (3,400 TPBARs) for severe reactor accidents. The tritium release is governed by the nature of the core melt accident scenarios analyzed, and the accident risks and consequences are governed by actions taken in accordance with the EPA Protective Action Guidelines (e.g., evacuation of the public, interdiction of the food and water supply, condemnation of farmland and public property) in response to the postulated core melt accident with containment failure or containment bypass.

The severity of the reactor accident dominates the consequences, is the basis for implementation of protective actions, and is independent of the number of TPBARs. Accident risk is the product of the accident probability (i.e, accident frequency) times the accident consequences. In this EIS, risk is expressed as the increased likelihood of cancer fatality per year for an individual (i.e., the maximally exposed offsite individual, an average individual in the population within 80 kilometers [50 miles] of the reactor site, or a noninvolved worker). Table 5–41 indicates that the risks associated with tritium production are low. The highest risk to each individual—the maximally exposed offsite individual, one fatality every 2.8 million years (3.6×10^{-7} per year); an average member of the public, one fatality every 1.3 billion years (8.0×10^{-10} per year); the exposed population, one fatality every 4.6 thousand years (0.00022 per year); and a noninvolved worker, one fatality every 230 billion years (4.3×10^{-12} per year)—is from the nonreactor design-basis accident.

Table 5–41 Annual Accident Risks at Bellefonte 1

Accident	*Tritium Production Core*	*Maximally Exposed Offsite Individual* [a]	*Average Individual in Population to 80 kilometers (50 miles)* [a]	*Noninvolved Worker* [a]
Design-Basis Accidents				
Reactor design-basis accident	0 TPBARs [b]	3.3×10^{-9} [c]	1.4×10^{-12} [c]	[d]
	1,000 TPBARs	3.3×10^{-9}	1.5×10^{-12}	2.4×10^{-15} [e]
	3,400 TPBARs	3.3×10^{-9}	1.9×10^{-12}	8.0×10^{-15} [e]
Nonreactor design-basis accident	0 TPBARs [b]	3.5×10^{-7} [c]	3.8×10^{-11} [c]	[d]
	1,000 TPBARs	3.5×10^{-7}	2.6×10^{-10}	1.2×10^{-12} [e]
	3,400 TPBARs	3.6×10^{-7}	8.0×10^{-10}	4.3×10^{-12} [e]
Sum of design-basis accident risks	0 TPBARs [b]	3.5×10^{-7}	3.8×10^{-11}	[d]
	1,000 TPBARs	3.5×10^{-7}	2.6×10^{-10}	1.2×10^{-12}
	3,400 TPBARs	3.6×10^{-7}	8.0×10^{-10}	4.3×10^{-12}
Handling Accidents				
TPBAR handling accident	1,000 TPBARs	3.9×10^{-9}	2.2×10^{-10}	4.8×10^{-11}
	3,400 TPBARs	1.3×10^{-8}	7.5×10^{-10}	1.6×10^{-10}
Truck cask handling accident	1,000 TPBARs	3.2×10^{-14}	1.7×10^{-15}	3.8×10^{-16}
	3,400 TPBARs	9.6×10^{-14}	5.1×10^{-15}	1.2×10^{-15}
Rail cask handling accident	1,000 TPBARs	1.6×10^{-14}	8.6×10^{-16}	1.9×10^{-16}
	3,400 TPBARs	4.8×10^{-14}	2.6×10^{-15}	5.8×10^{-16}
Sum of handling accident risks	1,000 TPBARs	3.9×10^{-9}	2.2×10^{-10}	4.8×10^{-11}
	3,400 TPBARs	1.3×10^{-8}	7.5×10^{-10}	1.6×10^{-10}
Beyond Design-Basis Accidents (Severe Reactor Accidents)				
Reactor core damage accident with early containment failure	0 TPBARs [c]	1.1×10^{-9}	1.1×10^{-11}	Not applicable
	3,400 TPBARs	1.1×10^{-9}	1.1×10^{-11}	Not applicable
Reactor core damage accident with containment bypass	0 TPBARs [c]	3.1×10^{-8}	9.1×10^{-11}	Not applicable
	3,400 TPBARs	3.1×10^{-8}	9.1×10^{-11}	Not applicable
Reactor core damage accident with late containment failure	0 TPBARs [b]	9.7×10^{-10}	4.1×10^{-11}	Not applicable
	3,400 TPBARs	9.7×10^{-10}	4.3×10^{-11}	Not applicable
Sum of severe reactor accident risks	0 TPBARs [b]	3.3×10^{-8}	1.4×10^{-10}	Not applicable
	3,400 TPBARs	3.3×10^{-8}	1.5×10^{-10}	Not applicable

[a] Increased likelihood of cancer fatality per year.
[b] The No Action Alternative at Bellefonte 1 implies the reactor is not brought into commercial service. The No Action radiological dose is 0.
[c] Derived from AEC 1974.
[d] The dose to the noninvolved worker was not estimated in AEC 1974.
[e] Design-basis accident risks only reflect the incremental increase in accident risk due to the production of tritium in TPBARs.

Table 5–42 Accident Frequencies and Consequences at Bellefonte 1

Accident	Accident Frequency (per year)	Tritium Production	Maximally Exposed Offsite Individual		Average Individual Population to 80 kilometers (50 miles)		Noninvolved Worker	
			Dose (rem)	Cancer Fatality [a]	Dose (rem)	Cancer Fatality [a]	Dose (rem)	Cancer Fatality [a]
Design-Basis Accidents								
Reactor design-basis accident	0.0002	0 TPBARs [b]	0.033 [c]	0.000017	0.000013 [d]	6.7×10^{-9}	e	e
		1,000 TPBARs	0.033	0.000017	0.000015	7.6×10^{-9}	2.9×10^{-8} [f]	1.2×10^{-11}
		3,400 TPBARs	0.033	0.000017	0.000019	9.5×10^{-9}	1.0×10^{-7} [f]	4.0×10^{-11}
Nonreactor design-basis accident	0.01	0 TPBARs [b]	0.070 [c]	0.000035	7.9×10^{-6} [d]	3.9×10^{-9}	e	e
		1,000 TPBARs	0.070	0.000035	0.000051	2.6×10^{-8}	3.1×10^{-7} [f]	1.2×10^{-10}
		3,400 TPBARs	0.071	0.000036	0.00016	8.0×10^{-8}	1.1×10^{-6} [f]	4.3×10^{-10}
Handling Accidents								
TPBAR handling accident	0.0017/ 0.0058 [g]	All TPBAR configurations	0.0045	2.3×10^{-6}	0.00025	1.3×10^{-7}	0.00007	2.8×10^{-8}
Truck cask handling accident	5.3×10^{-7}/ 1.6×10^{-6} [g]	All TPBAR configurations	0.00012	6.0×10^{-8}	6.4×10^{-6}	3.2×10^{-9}	1.8×10^{-6}	7.2×10^{-10}
Rail cask handling accident	2.7×10^{-7}/ 6.0×10^{-7} [g]	All TPBAR configurations	0.00012	6.0×10^{-8}	6.4×10^{-6}	3.2×10^{-9}	1.8×10^{-6}	7.2×10^{-10}
Beyond Design-Basis Accidents (Severe Reactor Accidents)								
Reactor core damage with early containment failure	9.0×10^{-7}	0 TPBARs [b]	2.3	0.0012	0.023	0.000012	Not applicable	Not applicable
		3,400 TPBARs	2.4	0.0012	0.024	0.000012	Not applicable	Not applicable
Reactor core damage with containment bypass	9.1×10^{-7}	0 TPBARs [b]	34 [h]	0.034 [h]	0.20	0.00010	Not applicable	Not applicable
		3,400 TPBARs	34 [h]	0.034 [h]	0.20	0.00010	Not applicable	Not applicable
Reactor core damage with late containment failure	5.1×10^{-6}	0 TPBARs [b]	0.37	0.00019	0.016	8.0×10^{-6}	Not applicable	Not applicable
		3,400 TPBARs	0.38	0.00019	0.017	8.5×10^{-6}	Not applicable	Not applicable

[a] Increased likelihood of cancer fatality.
[b] The No Action Alternative at Bellefonte 1 implies the reactor is not brought into commercial service. The No Action radiological dose is 0.
[c] AEC 1974.
[d] Derived from AEC 1974; estimate adjusted for differences in population data.
[e] The dose to the noninvolved worker was not estimated in AEC 1974.
[f] Consequences only reflect the incremental increase in accident consequences due to the production of tritium in TPBARs.
[g] Frequency for 1,000 TPBARs/frequency for 3,400 TPBARs.
[h] Dose greater than 20 rem. Cancer fatality risk is doubled.

The nonreactor design-basis accident has the highest consequence of the design-basis and handling accidents because the postulated accident scenario entails an acute release of tritium in oxide form directly to the environment without any mitigation.

Review of Table 5–42 indicates that there is a very small increase in design-basis and beyond design-basis reactor accident consequences due to the irradiation of TPBARs at Bellefonte 1. The consequences are dominated by the effects of radionuclide releases inherent to the operation without tritium production. As described in Appendix D, Section D.1.1.10, surrogate data were used for the accident sequences and plant responses in the Bellefonte 1 beyond design- basis accident analysis. Sensitivity analyses indicated that the analysis results are driven by the assumed release fractions and release timing sequences (see Appendix D, Table D–13). As indicated by the results provided in Table 5–42, the accidents involving reactor core damage with containment bypass that have the shortest warning time resulted in the highest dose to a maximally exposed offsite individual. This is because after such accidents the offsite individual would not have sufficient time to evacuate and would be exposed to the radionuclide releases at the site boundary. For the other core damage accidents, the individual would have sufficient time to evacuate before radionuclide releases would occur. It should be noted that Bellefonte 1 beyond design-basis accident analysis estimates do not have the same level of applicability as those for the Watts Bar and Sequoyah plants. TVA will perform a plant-specific severe accident analysis for Bellefonte prior to its operation.

The secondary impacts of severe reactor accidents are discussed in Section 5.2.13.

HAZARDOUS CHEMICAL IMPACTS

No Action

No additional impacts to public and occupational health and safety from exposure to hazardous chemicals are anticipated at Bellefonte 1 beyond the effects of existing and future activities that are independent of the proposed action, i.e., tritium production.

Tritium Production

The impacts of using, handling, and storing hazardous chemicals at Bellefonte 1 were assessed. The chemical inventory for Bellefonte 1 was reviewed to identify potential accident scenarios. Details of the review and accident analysis are presented in Appendix D, Section D.2.

Two hazardous chemical accident scenarios were postulated for this EIS: (1) an accidental, uncontrolled release of ammonium hydroxide from a 15,142-liter (4,000-gallon) tank in the basement of the turbine building; and (2) an accidental, uncontrolled release of hydrazine from a 1,987-liter (525-gallon) tank in the same area. For both scenarios, it was postulated that the total tank inventory is released to form a pool on the floor; the size of the pool is limited by a dike around the chemical storage tanks; and vapor is generated from pool evaporation and fills the immediate area, leaks from the building, and is dispersed downwind.

The potential health impacts of accidental releases of hazardous chemicals were assessed by comparing estimated airborne concentrations of the chemicals to Emergency Response Planning Guidelines developed by the American Industrial Hygiene Association. The Emergency Response Planning Guideline values are not regulatory exposure guidelines and do not incorporate the safety factors normally included in healthy worker exposure guidelines. Emergency Response Planning Guideline–1 values are concentrations below which nearly all individuals could be exposed for up to one hour and could experience only mild, transient, and reversible adverse health impacts. Emergency Response Planning Guideline–2 values are indicative of irreversible or serious health effects or impairment of an individual’s ability to take protective action. Emergency Response Planning Guideline-3 values are indicative of potentially life-threatening health effects.

On release of ammonium hydroxide from the storage tank, ammonia would volatilize and disperse. The Emergency Response Planning Guideline values for ammonia were used to evaluate the potential health impacts of an ammonium hydroxide release. The Emergency Response Planning Guidelines for ammonia and hydrazine are presented in **Table 5–43**.

Table 5–43 Emergency Response Planning Guideline Values for Hydrazine and Ammonia

Chemicals	*Emergency Response Planning Guideline-1 (parts per million)*	*Emergency Response Planning Guideline-2 (parts per million)*	*Emergency Response Planning Guideline-3 (parts per million)*
Hydrazine [a]	0.03	8	80
Ammonia [b]	25	200	1000

[a] Gephart, et al. 1994.
[b] Craig, et al. 1995.
Note: Hydrazine Emergency Response Planning Guidelines were removed by the American Industrial Hygiene Association for further study in 1996 and have not been reinserted as of July 1998.

The potential health impacts of the accidental release of ammonium hydroxide and hydrazine were assessed for two types of receptors: (1) noninvolved workers, or workers assumed to be located 640 meters (2,100 feet) from the point of release; and (2) a maximally exposed offsite individual or member of the public located offsite at the site boundary 914 meters (3,000 feet) from the point of release.

Facility workers (i.e., those individuals in the building at the time of the accident) were assumed to be killed by the release. The analysis took no credit for mitigative actions (e.g., area atmosphere monitoring, area evacuation alarms, emergency operating procedures) or accident precursors (e.g., leak before break) to reduce the accident consequences to the facility worker.

The computer code selected for estimation of airborne concentrations is the Computer-Aided Management of Emergency Operations/Areal Locations of Hazardous Atmospheres, developed by the National Safety Council, EPA, and the National Oceanic and Atmospheric Administration (NSC 1990).

The model results are presented for atmospheric Stability Classes D and F, with wind speeds of 5.3 meters per second (17.4 feet per second) and 1.5 meters per second (4.9 feet per second), respectively. Atmospheric Stability Class D is considered to be representative of “average” weather conditions; Stability Class F is considered to be representative of “worst-case” weather conditions. These weather conditions were selected because they are recommended by the EPA in its *Technical Guidance for Hazards Analysis* (EPA 1987).

The potential health impacts of the accidental releases were assessed by comparing the modeled ambient concentrations of ammonia and hydrazine at each of the receptor locations to the Emergency Response Planning Guidelines. **Table 5–44** presents a summary of the impacts data.

Table 5–44 Summary of Impacts Data for Release Scenarios at Bellefonte 1

Impacts		***Hydrazine (Stability Class D)***	***Hydrazine (Stability Class F)***	***Ammonia (Stability Class D)***	***Ammonia (Stability Class F)***
Maximum distance (meters) to concentrations of	ERPG-1 ERPG-2 ERPG-3	greater than 2,000 179 44	greater than 2,000 500 200	464 150 65	2,250 825 425
Noninvolved worker (640 meters)	Parts per million Level of concern Potential health effects	0.8 ERPG-1 Mild, transient	6 ERPG-1 Mild, transient	16 ERPG-1 Mild, transient	318 ERPG-2 Serious

Impacts		***Hydrazine (Stability Class D)***	***Hydrazine (Stability Class F)***	***Ammonia (Stability Class D)***	***Ammonia (Stability Class F)***
Maximally exposed offsite individual (914 meters)	Parts per million Level of concern Potential health effects	0.4 ERPG-1 Mild, transient	3.2 ERPG-1 Mild, transient	7.7 ERPG-1 None (less than ERPG-1)	169 ERPG-1 Mild, transient

ERPG = Emergency Response Planning Guideline.

Impacts to Noninvolved Workers

The concentrations of ammonia at 640 meters (3,000 feet) would range from 14 to 318 parts per million, depending on the assumed meteorological conditions. The maximum estimated airborne concentration at that point under Stability Class F conditions would exceed the Emergency Response Planning Guideline–2 value of 200 parts per million for ammonia, which suggests that noninvolved workers could experience irreversible or serious, but not life-threatening, adverse health effects if the exposures were not mitigated.

For the hydrazine release scenarios, the concentrations at 640 meters (3,000 feet) range from 0.8 to 6.0 parts per million, depending on the assumed meteorological conditions. As a result, the maximum estimated airborne concentration at that point would exceed the Emergency Response Planning Guideline–1 value of 0.03 parts per million for hydrazine, which suggests the potential for only mild, transient, and reversible adverse health impacts on noninvolved workers.

Impacts to Maximally Exposed Offsite Individual

For the ammonium hydroxide release scenarios, the maximally exposed offsite individual could be exposed to an ammonia concentration of 7.7 parts per million under Stability Class D conditions (see Table 5–44), which is below the Emergency Response Planning Guideline–1 value for ammonia of 25 parts per million. Exposures to concentrations below the Emergency Response Planning Guideline–1 value should not produce any adverse health effects for the maximally exposed offsite individual. Under Stability Class F conditions, the maximally exposed offsite individual could be exposed to an ammonia concentration of about 169 parts per million (see Table 5–44), which is below the Emergency Response Planning Guideline–2 value for ammonia of 200 parts per million. Exposure of the maximally exposed offsite individual to concentrations higher than the Emergency Response Planning Guideline–1 value, but lower than the Emergency Response Planning Guideline–2 value, could produce only mild, transient, and reversible adverse health effects.

For the hydrazine release scenarios, the maximally exposed offsite individual exposure concentrations would range from 0.4 to 3.2 parts per million (see Table 5–44; both stability classes). These concentrations exceed the Emergency Response Planning Guideline–1 value for hydrazine of 0.03 parts per million, but are less than the Emergency Response Planning Guideline–2 value of 8 parts per million. This suggests that the maximally exposed offsite individual could experience only mild, transient, and reversible adverse health effects as a result of the exposure.

The results of this analysis should be considered only as screening-level estimations. TVA would conduct analyses compliant with the requirements of 40 CFR 68 before operation of Bellefonte 1.

5.2.3.10 Environmental Justice

As discussed in Appendix G, Executive Order 12898 directs Federal agencies to address disproportionately high and adverse health or environmental effects of alternatives on minority and low-income populations. The Executive Order does not alter prevailing statutory interpretations under NEPA or existing case law.

Regulations prepared by the Council on Environmental Quality remain the foundation for the preparation of environmental documentation in compliance with NEPA (40 CFR Parts 1500 through 1508).

No Action

There would be no impacts on the general population. Therefore, there would be no disproportionately high and adverse consequences for minority and low-income populations beyond the effects of existing and future activities that are independent of the proposed action.

Tritium Production

Analyses of incident-free operations and accidents have shown estimates of the risk of latent cancer fatalities to the public residing within 80 kilometers (50 miles) of the reactor site to be much lower than 1. Because tritium production would not have significant adverse consequences for the population at large, no minority or low-income populations should experience disproportionately high adverse consequences.

5.2.3.11 Waste Management

No Action

No additional wastes should be generated at the Bellefonte site beyond the wastes generated as a result of activities independent of the proposed action. These wastes and the provisions for their management are described in Section 4.2.3.10. Solid nonhazardous waste is disposed of off site by contract at a permitted facility. The small quantity of hazardous waste is temporarily stored on site until it is shipped to the TVA Hazardous Waste Storage Facility in Muscle Shoals, Alabama, which makes arrangements for disposal at an offsite permitted disposal facility.

Tritium Production

Should Bellefonte 1 or both Bellefonte 1 and 2 be completed for the purpose of producing tritium, some waste would be generated during the construction. During operation, the waste that would be generated would be typical to that of an operating reactor plant like Watts Bar 1, Sequoyah 1, or Sequoyah 2, except for the additional waste due to tritium production.

Construction

No radioactive waste should be generated during construction activities. Hazardous waste generated during construction likely would be due to maintenance activities. This waste could include materials such as waste oils that contain solvent residuals or that are high in selected trace metal content, waste paint and paint thinners, solvents, and degreasers. The estimated amounts of solid and liquid wastes that would be generated over the entire construction period for one or both units are presented in **Table 5–45.**

Table 5–45 Total Amounts of Wastes Generated During Construction to Complete Bellefonte 1 or Both Bellefonte 1 and 2

Waste Category	*Quantity*	
	Bellefonte 1	*Bellefonte 1 and Bellefonte 2*
Hazardous		
Solids (metric tons)	6.3	9.7
Liquids (metric tons)	56.7	87.3
Nonhazardous solids		
Concrete (cubic meters)	392	603
Steel (metric tons)	208	296

Waste Category	Quantity	
	Bellefonte 1	Bellefonte 1 and Bellefonte 2
Other (cubic meters)	21,000	70,000
Nonhazardous liquids		
Sanitary (cubic meters)	309,000	475,000
Flushing (cubic meters)	6,000	49,100
Other (cubic meters)	65	100

Source: TVA 1995b.

It is expected that the monthly solid hazardous wastes generated would be more than 100 kilograms (220 pounds), but less than 1,000 kilograms (2,205 pounds). Hazardous wastes would be stored on site temporarily, pending shipment to the TVA Hazardous Waste Disposal Facility at Muscle Shoals. Nonhazardous solid waste from construction activities would be routinely placed in dumpsters on site and subsequently disposed of off site by contractors.

Operation

Waste would be generated at Bellefonte 1 or both Bellefonte 1 and 2 as a consequence of normal operation as a nuclear power plant. Judging from the operating experience at the Sequoyah and Watts Bar plants, the waste generated under the proposed action would fall into four broad categories: hazardous waste, nonhazardous solid waste, low-level radioactive waste, and sanitary liquid waste. **Table 5–46** summarizes the expected annual amounts of waste that would be generated at Bellefonte 1 or both Bellefonte 1 and 2. The low-level radioactive waste would include an additional 0.43 cubic meters per year (15 cubic feet per year) (WEC 1999) generated as a result of tritium production. It would consist of the approximately 140 base plates and other irradiated hardware remaining after the TPBARs were separated from their assemblies and placed in the 17 × 17 array consolidation baskets at the reactor site.

Table 5–46 Annual Waste Generation at Bellefonte 1

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)	less than 1

Note: For Bellefonte 1 and 2 operations the waste values would be twice the values given for Bellefonte 1.
Source: Based on Watts Bar 1 Operation.

Hazardous Waste

Hazardous waste typical of nuclear plant operation would include paints, solvents, acids, oils, radiographic film and development chemicals, and degreasers. Neutralization would be the only waste treatment performed on site. Hazardous waste normally would be stored in polyethylene containment systems during accumulation. An approved storage building would be used to store hazardous waste for either 90 or 180 days, depending on the plant's hazardous waste generation status (i.e., Small Quantity or Large Quantity Generator) at the time. The waste would be transported to an offsite hazardous waste storage or disposal facility before it exceeded the 90- or 180-day storage limit.

Low-Level Radioactive Waste

One category of low-level radioactive waste would be the solidified and dewatered product of gaseous and liquid waste treatment systems, along with filters and resins. Another would be contaminated protective clothing, paper, rags, glassware, compactible and noncompactible trash, and nonirradiated reactor components. A third category would be the irradiated hardware of the TPBAR assemblies that would have been separated from the TPBARs before the TPBARs were placed in consolidation containers for eventual shipment. Low-level radioactive waste would be shipped to the Barnwell, South Carolina, waste disposal facility.

For purposes of completeness, this EIS also addresses the management of the irradiated TPBAR hardware portion of the low-level radioactive waste at DOE-owned facilities—specifically, the Low-Level Radioactive Waste Disposal Facility at the Savannah River Site, near Aiken, South Carolina. That facility consists of a series of vaults in E–Area that have been operational since September 1994. The operating capacity of each vault is 30,500 cubic meters (1,077,100 cubic feet) of low-level radioactive waste (DOE 1998c, DOE 1999b). Therefore, the addition of low-level radioactive waste from the proposed action at Bellefonte 1 or both Bellefonte 1 and 2 for a 40-year period would be approximately 0.06 percent of the capacity of a single vault. The total production of low-level radioactive waste, approximately 41 cubic meters (1,448 cubic feet), represents 0.1 percent of the capacity of a single vault.

Mixed Waste

Typical sources of mixed low-level radioactive waste would be: beta-counting fluids (e.g., zylene, toluene) used in liquid scintillation detectors; polychlorinated biphenyls susceptible to contact with radioactive contamination through an accidental spill or explosion in a transformer; isopropyl alcohol used for cleaning radioactive surfaces; chelating agents; and various acids. The amount of mixed low-level radioactive waste generated should be less than 1 cubic meter (35 cubic feet), judging from experience with Watts Bar 1 operation.

Bellefonte 1 or Bellefonte 2 would have an active waste minimization program similar to the existing programs described for Watts Bar and Sequoyah in Sections 4.2.1.10 and 4.2.2.10, respectively.

5.2.3.12 Spent Fuel Management

Production of tritium at Bellefonte 1 or Bellefonte 2 with less than 2,000 TPBARs in the reactor core would generate approximately 72 spent nuclear fuel assemblies per fuel cycle. This is the expected normal refueling batch without tritium production. The spent fuel assemblies would be stored in the plant's spent nuclear fuel pools, which have been completed. For the irradiation of the maximum number of 3,400 TPBARs, up to a maximum of 141 spent nuclear fuel assemblies could be generated. This represents up to 69 additional spent nuclear fuel assemblies over the normal refueling batch. For the purposes of this EIS it is assumed that this additional spent nuclear fuel would be stored on site for the duration of the proposed action. If needed, a dry cask ISFSI would be constructed at the site. Environmental impacts of the construction and operation of this generic dry cask ISFSI are presented in Section 5.2.6.

5.2.4 Licensing Renewal

Watts Bar 1 and Sequoyah 1 and 2 are currently operating plants. Their operating licenses would expire before the end of the tritium production program, which is assumed to last until the year 2043. Therefore, these units would need to undergo licensing renewal before the end of the program. The environmental impacts associated with the licensing renewal activities for these units are discussed in this section.

5.2.4.1 Background

The decision whether to seek license renewal rests with the licensees. Each licensee must determine whether they are likely to satisfy NRC requirements and evaluate the costs of the venture. As early as 20 years before the expiration of its current license, an applicant may apply to extend its license for up to 20 years. It is estimated that it would take a licensee between three and five years to prepare an application and that the NRC staff would require between three and five years to complete the review and the hearing process. The license renewal application would be subject to public hearings, using a formal adjudicatory process.

License renewal requirements for power reactors are based on two key principles: (1) the regulatory process, continued into the extended period of operation, is adequate to ensure that the licensing basis of all currently operating plants provides an acceptable level of safety; and (2) each plant's licensing basis is required to be maintained during the renewal term. In other words, the foundation of license renewal rests on the determination that currently operating plants continue to maintain adequate levels of safety and, over the plant's life, this level has been enhanced through maintenance of the licensing bases, with appropriate adjustments to address new information from industry operating experience. Additionally, NRC activities provide ongoing assurance that the licensing bases would continue to provide an acceptable level of safety.

The environmental and technical requirements for the renewal of power reactor operating licenses are contained in NRC regulations 10 CFR, 51 and 54, respectively. The environmental protection regulations in 10 CFR 51 were revised on December 18, 1996, to facilitate the environmental review for license renewal. Part 54 was revised in May 1995 to simplify and clarify the license renewal scope and process.

The license renewal environmental review requirements in 10 CFR 51 are based on a conclusion of a detailed generic environmental impact study (NRC 1996a) that certain environmental issues can be resolved generically rather than separately in each plant-specific licensing application. This approach reduces the number of issues that need to be evaluated in detail for each plant site and improves the efficiency of the licensing process for both the licensee and the NRC.

The changes to the licensing requirements in 10 CFR 54 stress managing the effects of aging rather than managing aging mechanisms, and more explicitly address the role of existing licensee programs and the maintenance rule provisions as means to demonstrate the adequacy of programs to manage the effects of aging for the renewal term. Under this regulatory requirement, licensees are required to identify all systems, structures, and components within the scope of the renewal application. The systems, structures, and components within the scope are: (1) all safety-related systems, structures, and components; (2) all systems, structures, and components whose failure could affect safety-related functions; and (3) systems, structures, and components relied on to demonstrate compliance with the NRC's regulations for fire protection, environmental qualification, pressurized thermal shock, anticipated transients without scram, and station blackout. A screening review is required of all systems, structures, and components within the scope of the rule to identify “passive” and “long-lived” structures and components for which the applicant must demonstrate that the effects of aging would be managed in such a way that the intended function or functions of those structures and components would be maintained for the period of extended operation. Active equipment is considered to be adequately monitored under the current regulatory process where the detrimental aging effects that may occur are more readily detectable and would be identified and corrected by routine surveillances and performance indicators. For some structures and components within the scope of the evaluation, no additional action may be required where the applicant can demonstrate that the existing programs provide adequate aging management throughout the period of extended operation. However, if additional aging management activities are warranted for a structure or component within the scope of the rule, applicants would have the flexibility to determine appropriate actions. These activities could include, for example, new monitoring programs, new inspections, or revised design criteria. Another requirement for license renewal is the identification and updating of time-limited aging analyses, which are those design analyses for systems, structures, and components based on the current operating license term.

In 1996, the NRC developed a draft regulatory guide for the format and content of a license renewal application that proposes to endorse an implementation guideline prepared by the Nuclear Energy Institute as an acceptable method of implementing the license renewal rule. The NRC plans to maintain the regulatory guide in draft form and use it along with the working draft of the standard review plan for license renewal to review plant-specific and owners group reports. An update of the working draft standard review plan was made publicly available in September 1997. NRC staff will use the experience gained from the review of plant-specific and owners group reports to incorporate improvements into the working draft standard review plan and clarify regulatory guidance before soliciting formal public comment and approval of those documents. The NRC has developed a draft inspection guidance for license renewal. Consistent with the development of the standard review plan and regulatory guide, the inspection guidance will be prepared in final form after the NRC staff completes the review of several license renewal applications.

5.2.4.2 Environmental Effect of Renewing the Operating License of a Nuclear Power Plant

The NRC staff has assessed the environmental impacts associated with granting a renewed operating license for a nuclear power plant to a licensee who holds either an operating license or construction permit as of June 30, 1995, and has documented the results in a report titled, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* (NRC 1996a). The NRC amended the environmental protection regulations in 10 CFR 51 to streamline the process of environmental review for license renewal by drawing on the experience of the operating nuclear power reactors and to generically assess many of the environmental impacts. The amendment eliminated consideration of the need for generating capacity and utility economics from the environmental reviews.

The NRC decided to undertake a generic assessment of the environmental impacts associated with the renewal of a nuclear power plant operating license because:

- License renewal would involve nuclear power plants where the environmental impacts of operation are well understood as a result of data evaluated from operating experience to date.

- Activities associated with license renewal are expected to be within this range of operating experience, thus environmental impacts can be reasonably predicted.

- Changes in the environment around nuclear power plants are gradual and predictable with respect to characteristics important to environmental impact analyses.

In general, there are 92 discrete NEPA issues associated with license renewal that require responses in an environmental assessment. Of the 92 issues, 68 were found to have impacts of small significance on all plants and no mitigation would be needed beyond that already employed at the plants. Those issues are adequately addressed in the NRC's generic EIS, and no further assessment of these issues would be required in a plant-specific review. Twenty-four issues were determined to require further analysis and possible new information. The qualitative impacts on these issues were determined to be "small," "moderate," or "large," depending on the specific plant. **Table 5–47** summarizes the issues and the NRC's findings in the generic EIS. These issues need to be addressed by the licensees as part of the plant life extension license renewal application.

Table 5–47 Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants

Issue	*Findings*
Surface Water Quality, Hydrology, and Use (for all plants)	
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	SMALL OR MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on in-stream and riparian communities near these plants could be of moderate significance in some situations. See § 51.53(c)(3)(ii)(A).
Aquatic Ecology	
Entrainment of fish and shellfish in early life stages	SMALL, MODERATE, OR LARGE. The impacts of entrainment are small at many plants, but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See § 51.53(c)(3)(ii)(B).
Impingement of fish and shellfish	SMALL, MODERATE, OR LARGE. The impacts of impingement are small at many plants, but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See § 51.53(c)(3)(ii)(B).
Heat shock	SMALL, MODERATE, OR LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants with once-through and cooling-pond systems. See § 51.53(c)(3)(ii)(B).
Groundwater Use and Quality	
Groundwater use conflicts (potable and service water, and dewatering; plants that use more than 100 gallons per minute)	SMALL, MODERATE, OR LARGE. Plants that use more than 100 gallons per minute may cause groundwater use conflicts with nearby groundwater users. See § 51.53(c)(3)(ii)(C).
Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river)	SMALL, MODERATE, OR LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other groundwater or upstream surface water users come on line before the time of license renewal. See § 51.53(c)(3)(ii)(A).
Groundwater use conflicts (Ranney wells)	SMALL, MODERATE, OR LARGE. Ranney wells can result in potential groundwater depression beyond the site boundary. Impacts of large groundwater withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal. See § 51.53(c)(3)(ii)(C).
Groundwater quality degradation (cooling ponds at inland sites)	SMALL, MODERATE, OR LARGE. Sites with closed-cycle cooling ponds may degrade groundwater quality. For plants located inland, the quality of the groundwater in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See § 51.53(c)(3)(ii)(D).
Terrestrial Resources	
Refurbishment impacts	SMALL, MODERATE, OR LARGE. Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application. See § 51.53(c)(3)(ii)(E).
Threatened or Endangered Species (for all plants)	
Threatened or endangered species	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See § 51.53(c)(3)(ii)(E).
Air Quality	
Air quality during refurbishment (non-attainment and maintenance areas)	SMALL, MODERATE, OR LARGE. Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage. See § 51.53(c)(3)(ii)(F).

Issue	*Findings*
Human Health	
Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	SMALL, MODERATE, OR LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See § 51.53(c)(3)(ii)(G).
Electromagnetic fields, acute effects (electric shock)	SMALL, MODERATE, OR LARGE. Electrical shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been found to be a problem at most operating plants and generally are not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential at the site. See § 51.53(c)(3)(ii)(H).
Electromagnetic fields, chronic effects	UNCERTAIN. Biological and physical studies of 60-Hertz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, research is continuing in this area and a scientific consensus view has not been reached. If in the future the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the Commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.
Socioeconomic	
Housing impacts	SMALL, MODERATE, OR LARGE. Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development. See § 51.53(c)(3)(ii)(I).
Public services: public utilities	SMALL OR MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability. See § 51.53(c)(3)(ii)(I).
Public services, education (refurbishment)	SMALL, MODERATE, OR LARGE. Most sites would experience impacts of small significance, but larger impacts are possible depending on site- and project-specific factors. See § 51.53(c)(3)(ii)(I).
Offsite land use (refurbishment)	SMALL OR MODERATE. Impacts may be of moderate significance at plants in low population areas. See § 51.53(c)(3)(ii)(I).
Offsite land use (license renewal term)	SMALL, MODERATE, OR LARGE. Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal. See § 51.53(c)(3)(ii)(I).
Public services, transportation	SMALL, MODERATE, OR LARGE. Transportation impacts are generally expected to be of small significance. However, the increase in traffic associated with the additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See § 51.53(c)(3)(ii)(J).
Historic and archaeological resources	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection. See § 51.53(c)(3)(ii)(K).
Postulated Accidents	
Severe accidents	SMALL. The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. See § 51.53(c)(3)(ii)(L).
Uranium Fuel Cycle and Waste Management	
Transportation	Table S-4 of CFR 51.52 (c) contains an assessment of impact parameters to be used in evaluating transportation effects in each case. See CFR 51.53(c)(3)(ii)(M).
Environmental Justice	
Environmental Justice	This issue was not addressed in the generic EIS. The need for and content of an environmental justice evaluation will be addressed in a plant-specific review.

Note: Consistent with 10 CFR 51, Subpart A, Appendix B, the following definitions of environmental impacts were used.

Small	Environmental effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC's regulations are considered small as the term is used in this table.
Moderate	Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
Large	Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Source: 10 CFR 51.

5.2.5 Decontamination and Decommissioning

Construction of Bellefonte 1 or Bellefonte 2 has not been completed. Neither of the units are operational. For the purposes of this EIS the future operation of these units depends on whether or not they would be used for tritium production. Consequently, the environmental impacts associated with the production of tritium at Bellefonte would include impacts resulting from construction activities, operation of the units to produce tritium, and decontamination and decommissioning of these reactors at the end of their useful life. The following provides a summary of the impacts that can be expected from the decontamination and decommissioning of the Bellefonte units.

5.2.5.1 Background

Since no CLWRs of a size (i.e., about 1,000 megawatts-electric) comparable to the Bellefonte units have been decommissioned, data for decontamination and decommissioning are limited. In 1988, the NRC issued a *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NRC 1988). That EIS provided generic assessments and projections of the environmental consequences of decontamination and decommissioning for various nuclear facilities. Projections associated with impacts from commercial pressurized water reactors were used to characterize the environmental impacts.

Another aspect of decontamination and decommissioning of commercial reactors that would continue to influence the nature and extent of environmental impacts is the continuing evolution in the NRC and EPA regulations that govern decontamination and decommissioning activities. An example of this evolution is the *Final Rule on Radiological Criteria for License Termination*, which was issued by the NRC in July 1997. The final rule provides specific radiological criteria for the decommissioning of NRC-licensed facilities. The criteria clarify, for example, that a site would be considered acceptable for unrestricted use if decontaminated to a level of 25 millirem per year. Comparable regulatory guidance on other aspects of decontamination and decommissioning are in various stages of creation/issuance.

5.2.5.2 Decontamination and Decommissioning Options

The decontamination and decommissioning of a CLWR can be accomplished via one of the following three options:

- *Entomb*—Complete isolation of radioactivity from the environment by means of massive concrete and metal barriers until radioactivity has decayed to levels that permit unrestricted release from the facility. This decay may take up to several hundreds of thousands of years.

- *Safstor*—Process of placing and maintaining a nuclear facility in a condition that allows the nuclear facility to be safely stored (to allow radioactive decay) and subsequently decontaminated (i.e., deferred decontamination) to levels that permit the property to be released for unrestricted use.

- *Decon*—Process of immediately removing and disposing of all radioactivity in excess of levels that would permit the release of the facility for unrestricted use.

It would be assumed that the decontamination and decommissioning of the CLWR used for tritium production would select the Decon option. The advantages inherent in Decon are prompt termination of the NRC license shortly after cessation of operation; the elimination of radioactivity at a radioactive site; the return of the site for unrestricted use; the availability of reactor operating staff to support site characterization and subsequent decontamination and decommissioning activities; and the elimination of a need for long-term surveillance and maintenance.

5.2.5.3 Decommissioning Activities

The decontamination and decommissioning of a pressurized water reactor would typically be completed in a period of 8 to 12 years after facility shutdown. It is anticipated that the initial 2 to 3 years would focus on planning and scheduling of the decontamination and decommissioning program and the required coordination activities with local, state and regulatory agencies. The decontamination and decommissioning program would be implemented in a series of steps, but the process can be summarized as follows:

Removal/dismantlement of the major components of the primary system—This would involve the removal of the reactor vessel, vessel internals, steam generators, pressurizer, and other major components. The removal phase may be completed in one of two ways: (1) removal of the intact component (e.g., with all reactor vessel internals intact) for shipment to the final disposal site; or (2) segmentation of the major component and/or its internals with the segments shipped to the final disposal site.

Decontamination of primary system piping—The primary system and the other large-bore contaminated piping systems would be decontaminated in place and subsequently removed and disposed of in accordance with appropriate regulations.

Decontamination of primary containment and facility structures—The primary containment surfaces and structures would be decontaminated in place using scabbling, scarifying, and similar technologies. The waste materials would be packaged and disposed of in accordance with appropriate regulations.

Spent fuel and Greater-Than-Class-C waste shipments—It is assumed that a final high level waste repository would be operational to receive spent fuel and Greater-Than-Class-C waste in a timely manner that does not prolong or delay decontamination and decommissioning activities.

Disposal of low-level radioactive waste—Low-level radioactive waste would be processed in accordance with established procedures.

5.2.5.4 Decontamination and Decommissioning Impacts

The impacts to be anticipated as a result of decontamination and decommissioning activities would vary according to operating history, facility maintenance, and related factors. The NRC's *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586 (NRC 1988), provides estimates of impacts that are be used in the discussion below. [The NUREG estimates recently have been characterized as bounding by a commercial reactor (i.e., 619 Megawatts-electric pressurized water reactor) that submitted its Post Shutdown Decommissioning Activity Report in August 1997.]

Radiation Exposure

NUREG–0586 evaluates the radiation dose to plant workers and the public resulting from decontamination and decommissioning activities for a generic pressurized water reactor (1,175 Megawatts-electric) over a four-year period as follows:

Occupational exposure due to decontamination		1,114.5 person-rem
Occupational exposure due to decontamination truck shipments		100.2 person-rem
Total for workers	=	*1,215 person-rem*
Public exposure due to decontamination		Negligible
Public exposure due to decontamination truck shipments		20.6 person-rem
Total for public	=	*21 person-rem*

These doses are considerably lower than the typical worker doses accumulated during reactor operation, maintenance, and refueling operations.

In addition to the doses calculated above, the NUREG summarized the results of exposure calculations to a maximally exposed individual from accidental airborne release during decommissioning. These analyses indicated that the radiation doses were "quite low."

Waste Disposal

Decontamination and decommissioning of a pressurized water reactor would result in the creation of low-level radioactive waste that would require transportation to and burial within a licensed site for disposal. NUREG–0586 estimates that approximately 18,340 cubic meters (647,677 cubic feet) of low-level radioactive waste would be generated.

In addition, the disposal of highly activated components (e.g., reactor, reactor internals) could require disposal in a deep geologic repository. NUREG–0586 estimates that approximately 11 cubic meters of highly activated waste would require disposal in this manner.

Socioeconomics

Completion of Bellefonte 1 and 2 would generate impacts associated with the eventual decontamination and decommissioning of the plant. Currently, decontamination and decommissioning of a two-unit nuclear station to green-field status using the immediate dismantlement approach (commonly called Decon) is estimated to cost between $600 and $700 million. Offsite disposal of low-level radioactive waste would be responsible for at least half the cost. Low-level radioactive waste disposal costs have escalated at double-digit rates for many years and cannot be forecast with confidence. Currently, onsite costs for labor and materials can be rounded to $200–250 million, excluding the potential for onsite long-term spent fuel storage. It is also impossible to predict what these costs would be 40 years in the future. It is reasonable to expect that decontamination and decommissioning 40 years in the future would not require the kind of dry cask ISFSI that is necessary for existing reactors with limited onsite spent fuel storage pools.

Assuming that decontamination and decommissioning 40 years in the future would take six years and that onsite spending at that time would have a net present value of $200–250 million, the effect of decontamination and decommissioning would be to continue local spending at the level of $30 to 40 million per year. Operations spending would be at roughly $90 million per year, including local procurements. Costs at the upper end of any range would be incurred during the last few years of operation as planning for retirement took place. The net socioeconomic effect of decontamination and decommissioning is to extend the local receipt of income by perhaps six years at roughly 30 percent of the operational level. This is beneficial, since it smooths the transition from operational to post-operational status.

Other Environmental Impacts

NUREG–0586 (NRC 1988) characterizes as "minor" other environmental impacts that result from decommissioning activities when compared to the impacts that result from normal operation of the reactor. These impacts include:

- Water use during decontamination and decommissioning activities is estimated to be 18,000 cubic meters (635,670 cubic feet), which is far less than water use and evaporation during operation—i.e., approximately 27 million cubic meters per year (953 million cubic feet per year).

- Numbers of workers on site typically would not exceed the number of workers during initial construction or operation.

- Disturbance of ground cover would be limited to the restoration of contaminated sites.

5.2.6 Spent Fuel Storage

The environmental impacts from the storage of additional spent fuel due to the production of tritium presented in this section assumes that 3,400 TPBARs would be irradiated in a reactor core over an 18-month reactor operating cycle. Westinghouse has estimated (WEC 1999) that no additional spent nuclear fuel would be generated if approximately 2,000 TPBARs or less were irradiated in each operating cycle.

As discussed in Appendix A, the production of tritium in any of the alternative reactor units considered in this EIS would generate additional spent fuel. For the purposes of this EIS, it is assumed that the additional spent fuel generated from tritium production over the duration of the program would be accommodated at the site in a dry cask ISFSI. This section presents the environmental impact of the construction and operation of, and postulated accidents associated with, a generic dry cask ISFSI should it become necessary. This generic ISFSI would be designed to store the number of additional spent nuclear fuel assemblies required for 40-year tritium production at the reactor site.

Number of ISFSI Casks for 40-Year Tritium Production

The number of ISFSI dry casks required to store the additional nuclear fuel needed for tritium production was calculated using fuel usage information for each nuclear power plant and current NRC-licensed ISFSI dry cask designs applicable to pressurized water reactor spent nuclear fuel (VECTRA 1995, NRC 1996d). **Table 5–48** presents the data used for each nuclear plant and the resulting calculated number of ISFSI dry casks required to accommodate the spent nuclear fuel increment from 40 years of tritium production.

The number of dry storage casks calculated to accommodate tritium production as delineated in Table 5–48 is based on the 24 pressurized water reactor spent nuclear fuel assembly capacity of four of the ISFSI cask designs in the United States (VECTRA 1995, NRC 1996d, NRC 1987, NRC 1989). The number of dry storage casks are used in this report to quantify the specific environmental impact for each of the three nuclear power plants.

Table 5–48 Data for Number of ISFSI Cask Determination for Each Nuclear Power Plant

Data Parameter	*Watts Bar*	*Sequoyah* [a]	*Bellefonte* [a]
Operating cycle length	18 months	18 months	18 months
Fresh fuel assemblies per cycle—no tritium	80	80	72
Fresh fuel assemblies per cycle—maximum tritium production (3,400 TPBARs)	136	140	141
Increase in fresh fuel assemblies per cycle due to tritium production	56	60	69
Number of operating cycles in 40 years[b]	27	27	27
Number of additional fuel assemblies for 40-year tritium production	1512	1620	1863
Integer number of ISFSI dry casks needed to store additional tritium production fuel assemblies	63	68	78

[a] Per reactor.
[b] Forty years of operation covers 26 refueling outages and 27 operating cycles. Spent fuel is discharged 27 times.

A number of ISFSI dry storage designs have been licensed by the NRC and are in operation in the United States (NRC 1996d). These designs include the Modular Vault Dry Store, metal casks, and concrete casks. The majority of operating ISFSIs have chosen to use concrete casks (NRC 1996d). Concrete casks consist of either a vertical or horizontal concrete structure housing a metal basket that confines the spent nuclear fuel. The Modular Vault Dry Store is a large reinforced concrete building that has been judged by the utility industry to be economically noncompetitive with metal and concrete casks, especially for the number and type of spent nuclear fuel assemblies being evaluated in this report. Therefore, for the determination of the maximum environmental impact of any economically viable and currently licensed ISFSI, only concrete dry storage casks would be considered for this environmental impact analysis.

Currently, the two concrete pressurized water reactor spent nuclear fuel dry cask designs licensed in the United States are the VSC–24 (NRC 1996d) and the NUHOMS–24P (VECTRA 1995). The VSC–24 shape is that of a vertical concrete cylinder, whereas the NUHOMS–24P shape is a rectangular concrete block. Both designs store the same 24 pressurized water reactor spent nuclear fuel assemblies. However, the NUHOMS–24P requires a greater quantity of concrete and steel and occupies a larger footprint for the same number of stored fuel assemblies compared to the VSC–24. Therefore, the environmental impact of using the NUHOMS–24P concrete dry storage ISFSI design is determined, since it should bound all other currently licensed dry storage cask designs.

The environmental impact of dry cask storage of the excess pressurized water reactor spent nuclear fuel required for tritium production is presented in the following three sections. Supporting information for this environmental impact evaluation was obtained from the Calvert Cliffs NUHOMS–24P ISFSI (BGE 1989a, BGE 1989b) and the Oconee NUHOMS–24P ISFSI (Duke 1988), as well as the standardized NUHOMS ISFSI report (VECTRA 1995).

Construction Impacts

The construction of a concrete dry cask ISFSI uses conventional equipment for land leveling and grading, rebar and concrete forms installation, and pouring of concrete for base slabs and the NUHOMS–24P horizontal storage module. The horizontal storage module consists of a rectangular, reinforced concrete block 5.79 meters (19 feet) long, 2.76 meters (9.7 feet) wide, and 4.6 meters (15 feet) high. The module has a hollow internal cavity to accommodate a stainless steel cylindrical cask that contains the spent nuclear fuel (VECTRA 1995). The stainless steel cask that is placed inside the horizontal storage module is fabricated off site.

Construction of the spent nuclear fuel ISFSI would use a small amount of local water resources. Concrete would be delivered premixed in trucks, while water for drinking, cleaning, and fugitive dust control would be brought onto the construction site by trucks. The portable toilets that would be used on the construction site would also require no local water.

No construction would be located within the limits of the 100-year flood plain, which would be consistent with the requirements of Executive Order 11988, Floodplain Management. Because these facilities would be considered "critical actions," they would be located above the 500-year flood elevation.

Land use during construction of an ISFSI is dependent on the specific site characteristics. More land is disturbed than the actual footprint of the ISFSI due to associated security and personnel exclusion fence boundaries. At Calvert Cliffs, a wooded site that is located approximately 700 meters (2,300 feet) from the nuclear power plant was selected for the ISFSI. Preparation of this site affected approximately 24,281 square meters (6 acres) of land for the ISFSI footprint of 13,982 square meters (3.5 acres) (BGE 1989a). The Calvert Cliffs installation was designed to contain 120 spent nuclear fuel casks (also called horizontal storage modules in the NUHOMS–24P design). For this EIS, it is conservatively assumed that the same ratio (e.g., 1.71) of affected land to actual ISFSI footprint land is applicable. **Table 5–49** delineates the land use for each specific nuclear power plant's tritium excess spent nuclear fuel ISFSI.

Table 5–49 Environmental Impact of ISFSI Construction

No.	***Environmental Parameter***	***Bellefonte***	***Sequoyah***	***Watts Bar***
1	External appearance	78 Horizontal storage modules Rectangular cubes (5.79 × 2.96 meters) (19 × 9.7 feet) constructed on 3 concrete cask foundation pads approximately: (31.4 × 11.58 meters) (106.7 × 38 feet)	68 Horizontal storage modules Rectangular cubes (5.79 × 2.96 meters) (19 × 9.7 feet) constructed on 3 concrete cask foundation pads approximately: (38.43 × 11.58 meters) (126.1 × 38 feet)	63 Horizontal storage modules Rectangular cubes (5.79 × 2.96 meters) (19 × 9.7 feet) constructed on 3 concrete cask foundation pads approximately: (35.47 × 11.58 meters) (116.4 × 38 feet)
Site Preparation and Facility Construction				
2	Health and safety (Only construction work performed subsequent to the loading of any horizontal storage modules with spent fuel may result in worker exposures from direct and skyshine radiation in the vicinity of the loaded horizontal storage modules.)	Total dose during construction: <u>87.8</u> person-rem	Total dose during construction: 51.00 person-rem	Total dose during construction: 47.25 person-rem
3	Electrical distribution	Existing electrical services would be used.	Existing electrical services would be used.	Existing electrical services would be used.
4	Construction water use	Small	Small	Small

No.	***Environmental Parameter***	***Bellefonte***	***Sequoyah***	***Watts Bar***
5	Effects on land use	Footprint: 13,700 square meters (3.4 acres) Disturbed: 23,600 square meters (5.8 acres)	Footprint: 12,920 square meters (3.2 acres) Disturbed: 22,093 square meters (5.5 acres)	Footprint: 12,503 square meters (3.1 acres) Disturbed: 21,380 square meters (5.3 acres)
6	Effects on water bodies use	Small	Small	Small
7	Impact on workers	50 workers	50 workers	50 workers
8	Impact of construction generation of fugitive dust	Small	Small	Small
9	Impact on ecology	Small	Small	Small
10	Construction noise	Small	Small	Small
Transmission Facilities Construction Resources Committed				
11	Water	Small	Small	Small
12	Air	None	None	None
13	Biota	Limited to the land used	Limited to the land used	Limited to the land used
14	Materials (approximate)	Concrete: 12,128 metric tons (13,369 tons) Steel: 1,378 metric tons (1,519 tons)	Concrete: 10,533 metric tons (11,611 tons) Steel: 1198 metric tons (1,321 tons)	Concrete: 9,653 metric tons (10,618 tons) Steel: 1,096 metric tons (1,208 tons)
Construction Impact Control				
15	Construction traffic control	Use of existing public roadways is recommended.	Use of existing public roadways is recommended.	Use of existing public roadways is recommended.
16	Dust and particulate emission control	During construction, paved road would be used.	During construction, paved road would be used.	During construction, paved road would be used.
17	Noise control	Small/No provision required	Small/No provision required	Small/No provision required
18	Chemical waste management	A chemical control program would be prepared. Liquid waste would be stored in a tank.	A chemical control program would be prepared. Liquid waste would be stored in a tank.	A chemical control program would be prepared. Liquid waste would be stored in a tank.
19	Solid waste management	Construction scrap would be collected in designated area for recycling or removal.	Construction scrap would be collected in designated area for recycling or removal.	Construction scrap would be collected in designated area for recycling or removal.
20	Site clearing	Site would be paved. By providing drainage, erosion would be controlled.	Site would be paved. By providing drainage, erosion would be controlled.	Site would be paved. By providing drainage, erosion would be controlled.
21	Excavation and soil deposition	Construction site would be stabilized.	Construction site would be stabilized.	Construction site would be stabilized.

Note 1: Consistent with 10 CFR 51, Subpart A, Appendix B, the following definition of environmental impacts was used.
Small Environmental effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC's regulations are considered small as the term is used in this table.
Note 2: These environmental parameters were taken directly from an earlier, approved NRC environmental assessment for similar ISFSI design. This CLWR EIS states that, if built, all NEPA requirements for the ISFSI will be addressed.

A peak workforce of 50 people is projected for the construction of this ISFSI (BGE 1989a). The use of local contractors and the rather small number of personnel would not be expected to have any impact on housing, transportation, and educational facilities. Construction fugitive dust should be small. The small construction area should not have any impact on local flora and fauna. The effects of construction noise should be limited for the construction workers by Occupational Safety and Health Administration regulations, for the public by distance to the nearest public residence, and for the local fauna by the small area involved with easy access and egress. No electric power transmission lines would have to be erected because access to existing transmission lines to the nuclear power plant would provide the electric power requirements.

The ISFSI construction would not require the commitment of any water or air resources. The principal materials used in the construction of this ISFSI would be steel and concrete. The steel and concrete quantities were delineated previously in Table 5–49. During construction, workers building casks could be exposed to radiation emitted from adjacent casks that have already been completed and loaded with spent nuclear fuel. The dose rates to the construction workers from these casks should average 0.5 millirem per hour (BGE 1989a), and an estimated 1,500 person-hours would be required to complete the construction of one cask or horizontal storage module. The construction dose to workers, as delineated in Table 5–49, conservatively assumes that each cask would be immediately loaded with spent nuclear fuel after it was completed.

Construction traffic would be accommodated by existing nuclear power plant site roadways. Any dust or particulate fugitive emissions caused by earth-moving and grading would be controlled by wetting, seeding, and the use of gravel to minimize soil erosion and runoff. Standard equipment and vehicle noise control devices, limited construction hours, and minimal use of explosives, along with adherence to all applicable Occupational Safety and Health Administration requirements, would minimize noise impact during construction. Any liquid or solid wastes generated during construction would be collected at the construction site and removed from the site for suitable recycling or disposal off site in accordance with applicable EPA regulations. None of the wastes would be radioactive.

Operation Impacts

Spent nuclear fuel decay heat is removed by natural air convection in the NUHOMS horizontal storage module dry cask system. Each horizontal storage module cask is designed and licensed to safely remove up to 24 kilowatts of decay heat from pressurized water reactor spent nuclear fuel (VECTRA 1995). Conservative calculations have shown that, for 24 kilowatts of decay heat, air entering the cask at a temperature of 21°C (70°F) would be heated to a temperature of 72°C (161°F) (VECTRA 1995). The actual spent nuclear fuel decay heat expected for the ISFSI casks would be in the range of 7 to 12 kilowatts with a concomitantly smaller air temperature rise (PN 1993). The environmental impact of the discharge of this amount of heat can be compared to the heat (336 kilowatts) emitted to the atmosphere by an automobile with a 150–brake horsepower engine (Bosch 1976). The heat released by an average automobile is the equivalent of 14 to 48 ISFSI casks at their design maximum heat load. The decay heat released to the atmosphere from the tritium spent nuclear fuel ISFSI is equivalent to the heat released to the atmosphere from two to nine average cars.

The operating ISFSI would not release any radioactive material because the spent nuclear fuel would be in a sealed confinement boundary metal cask. The external surface of the cask would be decontaminated inside the spent fuel pool building to remove any radioactive contamination from the spent fuel pool water. The horizontal storage module concrete cask never would be exposed to any radioactive material and, therefore, could not release any radioactive contamination to the environment.

The ISFSI would be a source of direct and skyshine-scattered radiation that would penetrate the thick concrete shielding of the cask. The ISFSI direct and scattered radiation would be composed of greater than 90 percent gamma radiation and less than 10 percent neutron radiation (BGE 1989b, VECTRA 1995, Duke 1988). The combined direct and scattered dose rate would be a function of distance from the ISFSI, the number and configuration of casks in the horizontal storage module, and the presence of any radiation-absorbing natural structures or intervening topographical features such as earth berms. NRC regulations (10 CFR 72.106) require that a minimum distance of 100 meters (328 feet) be maintained as a controlled area around the ISFSI. The direct-scattered total dose rate to an individual at 100 meters was calculated to be in the range of 0.01 to 0.1 millirem per hour (BGE 1989b, Duke 1988). The determination of the dose to an offsite individual would depend on site-specific factors (e.g., distance and direction of the nearest offsite residence, fuel conditions, contribution of offsite dose from reactor plant effluents). Based on site-specific environmental assessments of operating ISFSIs (e.g., Surry, H.B. Robinson, Calvert Cliffs), the annual dose to the nearest "real"individual would be a small fraction of the 25-millirem per year criterion in 10 CFR 72.67 and 40 CFR 190.[1] This dose was calculated to be 0.00006 millirem per year at Surry (VEPCO 1985), 0.4 millirem per year at H.B. Robinson (CPL 1986), and less than 2 millirem per year at Calvert Cliffs (BGE 1989b). When combined with the dose commitment from other reactor operations, the total dose commitment would be well within the regulatory limits. **Table–50** presents an estimated range of dose rates and annual doses, assuming that onsite workers are 100 meters (328 feet) from the ISFSI and that the nearest public residence is 1,000 meters (3,280 feet) from the installation. The radiation dose effect of the number of casks at each specific ISFSI should be minor because of the small magnitude of the doses.

Table 5–50 Environmental Impact of ISFSI Operation

No.	*Environmental Parameter*	*Bellefonte*	*Sequoyah*	*Watts Bar*
1	Effects of operation of the heat dissipation system	Equivalent to heat emitted into the atmosphere by 2–6 average size cars.	Equivalent to heat emitted into the atmosphere by 2–6 average size cars.	Equivalent to heat emitted into the atmosphere by 2–6 average size cars.
2	Facility water use	Transfer cask decontamination water consumption of less than 35 cubic meters (1,236 cubic feet).	Transfer cask decontamination water consumption of less than 28.9 cubic meters (1,020 cubic feet).	Transfer cask decontamination water consumption of less than 26.8 cubic meters (946 cubic feet).
3	Radiological impact from routine operation	Worker Exposure: As the result of daily inspection of casks, during a 40-year life cycle, workers would be exposed to 74.4 person-rem. Public Exposure: The regulatory limit for public exposure is 25 millirem per year. Doses received by a member of the public living in the vicinity of the ISFSI would be well below the regulatory requirements.	Worker Exposure: As the result of daily inspection of casks, during a 40-year life cycle, workers would be exposed to 64.3 person-rem. Public Exposure: The regulatory limit for public exposure is 25 millirem per year. Doses received by a member of the public living in the vicinity of the ISFSI would be well below the regulatory requirements.	Worker Exposure: As the result of daily inspection of casks, during a 40-year life cycle, workers would be exposed to 58.8 person-rem. Public Exposure: The regulatory limit for public exposure is 25 millirem per year. Doses received by a member of the public living in the vicinity of the ISFSI would be well below the regulatory requirements.
3	Radwaste and source terms	Cask loading and decontamination operation generates less than 4.42 cubic meters (156 cubic feet) of low-level radioactive waste.	Cask loading and decontamination operation generates less than 3.85 cubic meters (136 cubic feet) of low-level radioactive waste.	Cask loading and decontamination operation generates less than 3.57 cubic meters (126 cubic feet) of low-level radioactive waste.

[1] *The term "real" is used for an individual living near the ISFSI under realistic conditions, as opposed to a hypothetical individual living under conditions that would tend to overestimate the resulting exposure.*

No.	Environmental Parameter	Bellefonte	Sequoyah	Watts Bar
4	Effects of chemical and biocide discharges	Small	Small	Small
5	Effect of sanitary waste discharges	Small	Small	Small
6	Effects of maintenance of the electrical distribution system	Small	Small	Small
7	Noise impact	Small	Small	Small
8	Climatological impact	Small (less than 0.1 percent of the nuclear power plant's heat emission to the atmosphere)	Small (less than 0.1 percent of the nuclear power plant's heat emission to the atmosphere)	Small (less than 0.1 percent of the nuclear power plant's heat emission to the atmosphere)
9	Impact on wildlife	Small	Small	Small
10	Impact of runoff from operation	The horizontal storage module surface is not contaminated. No contaminated runoff is expected.	The horizontal storage module surface is not contaminated. No contaminated runoff is expected.	The horizontal storage module surface is not contaminated. No contaminated runoff is expected.
11	Vehicle emissions during construction and operation	Small	Small	Small
12	Socioeconomics	Small	Small	Small

Note 1: Consistent with 10 CFR 51, Subpart A, Appendix B, the following definition of environmental impacts was used.
Small Environmental effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC's regulations are considered small as the term is used in this table.
Note 2: These environmental parameters were taken directly from an earlier, approved NRC environmental assessment for similar ISFSI design. This CLWR EIS states that, if built, all NEPA requirements for the ISFSI will be addressed.

The storage cask-loading operation would include moving the spent fuel into the confinement cask; removing the transport cask out of the pool; draining water from the cask; vacuuming and backfilling the cask; welding the cover plate; decontaminating the cask surface; moving the cask to the ISFSI site; and installing the cask into the concrete horizontal storage module. These operations would result in a total dose to all the involved workers that is conservatively estimated to be in the range of 1.05 to 1.45 person-rem for each ISFSI cask loaded and installed at the ISFSI site (Duke 1988, BGE 1989b). Table 5–50 presents onsite worker doses associated with cask-loading operations for the three nuclear power plants being considered for tritium production. These doses assume that casks would be loaded with the same frequency and quantity of spent nuclear fuel as the fuel cycle predictions given in Table 5–48.

Operation of the ISFSI would generate no chemical, biocide, or sanitary wastes. The loading process for each cask would generate less than 0.43 cubic meters (15 cubic feet) of low-level radioactive liquid waste and less than 0.057 cubic meters (2 cubic feet) of low-level solid waste per cask. This amount of low-level radioactive solid and liquid waste is presented in Table 5–50 for each nuclear power plant.

The ISFSI operation would generate minimal noise. The only measurable noise levels would be generated by the truck transporting each cask from the spent fuel pool building to the site (two times for every 18-month fuel cycle). Additional light traffic noise would be generated by personnel transportation for daily ISFSI inspection and periodic health physics or security personnel visits. The noise level should be within the range of noise typically generated by nuclear power plant activities.

The heat emitted by the fully loaded, largest projected tritium ISFSI, even at the maximum design-licensed decay heat level for each cask of 24 kilowatts, would be less than 2 megawatts (i.e., 78 casks × 24 kilowatts = 1,872 kilowatts or 1.87 megawatts). This amount of heat of less than 2 megawatts added to the atmosphere is less than 0.1 percent of the heat released to the environment from any of the proposed nuclear power plants—on the order of 2,400 megawatts for each operating nuclear reactor. The actual decay heat from spent nuclear fuel in the ISFSI should be lower than 1.87 megawatts and would decay with time due to the natural decay of fission products in the spent nuclear fuel. In addition, the incremental loading of the ISFSI over a 40-year period would not generate the full ISFSI heat until 40 years after the initial operation. The heat emitted from the ISFSI would have no effect on the environment or climate because of its small magnitude.

The small amount of land expected to be disturbed would have no impact on local flora and fauna. Runoff from rain would carry no radioactive contamination and would not require monitoring or holdup capability. ISFSI operational vehicle emissions would be a small fraction of the vehicle emissions generated by the operation of the adjacent nuclear power plant. The operation would not involve an irreversible or irretrievable commitment of resources.

Decommissioning and dismantling of the ISFSI should occur sometime after the availability of a Federal permanent ISFSI. The materials used in the ISFSI (e.g., concrete, steel, and lead) would be identical to materials at the adjoining nuclear power plant. Decontamination and decommissioning methods for the nuclear power plant would be applied to the site and would represent a small fraction of the quantity and radioactive contamination level of components within the nuclear plant. Some decontamination of an inner layer of the concrete shielding and the metal confinement cask would be required. A minimal incremental environmental impact is expected from the decontamination and decommissioning of the ISFSI, assuming that it occurs simultaneously with the decontamination and decommissioning of the nuclear power plant.

The potential increase in spent fuel storage requirements due to tritium production would create additional costs, but would not appreciably increase socioeconomic impacts. The spent fuel dry storage casks would be procured from outside the region. The costs incurred at the site for additional fuel transfers, spent fuel storage cask maintenance, spent fuel cask pad expansion, transfer of spent fuel to shipping casks, etc., as well as related storage activities, should be no more than $1 million per year. These costs are not material in a regional socioeconomic context.

Environmental Effects of Postulated Accidents

The most severe environmental impact of all postulated accidents analyzed for the ISFSI is the nonmechanistic release of the gaseous gap content from all 24 pressurized water reactor spent nuclear fuel assemblies in a storage cask (VECTRA 1995). This accident conservatively assumes that 30 percent of all fission product gases present in all the spent nuclear fuel within one cask would be released to the environment. This scenario is extremely conservative because the ISFSI is designed to maintain its confinement capability under all postulated accidents. In addition, ISFSI casks encapsulate intact fuel. Failed fuel must be enclosed in a second sealed container within the cask to ensure the required two levels of confinement for ISFSI design. The radiological consequences of this accident were calculated using the bounding spent nuclear fuel radioisotope fission product inventory and conservative site-specific atmospheric dispersion factors. The regulatory limit for this accident is a 5,000-millirem whole-body or individual organ dose (10 CFR 72.106). The numerical value of the calculated dose for this accident is a function of the specific stored spent nuclear fuel bounding fission product inventory, site-specific atmospheric dispersion factors, and the site-specific distance from the ISFSI to the nearest public boundary. A generic and conservative calculation for the NUHOMS–24P design resulted in a 300-meter (984-foot) whole-body dose of 53 millirem (VECTRA 1995). Similarly, generic conservative calculations for this accident with the VSC–24 ISFSI design (NRC 1996d) resulted in a whole-body dose of 88 millirem at 200 meters (656 feet), 18 millirem at 500 meters (1,640 feet), and 5.7 millirem at 1,000 meters (3,280 feet). All of these results are well within the regulatory limit. The impact of these calculated doses can be compared with the natural radiation dose of about 300 millirem annually received by each human being in the United States (DOE 1996a). Thus, even at an unrealistically close distance of 200 meters, the public dose to this extremely conservative, nonmechanistic accident represents about 29 percent of the average annual dose due to natural sources. At a more realistic distance of 1,000 meters (3,281 feet), the dose from this accident represents only 2 percent of the average annual natural dose to the public. The generic conservative radiological consequences of this accident are presented in **Table 5–51**.

All other postulated ISFSI accidents would either have no radiological impacts on the public or would deliver a dose smaller than that calculated for the 100 percent fuel failure associated with a cask leakage.

Table 5–51 Environmental Impact of Accidents at ISFSI

Normal Operation and Operational Occurrences			
	Postulated Accident	***Accident Evaluation Requirements***	***Consequences***
Anticipated Accident			
1	An inadvertent cask movement causing lateral impact of the fuel basket against the inside of the storage cask	This event should be evaluated to ensure that no release of radioactive materials in the ISFSI would result.	This event does not result in release of radioactive materials.
2	Extreme ambient temperatures	This event should be evaluated to ensure that no release of radioactive materials in the ISFSI would result.	This event does not result in release of radioactive materials
3	Partial blockage of air passages	This event should be evaluated to ensure that no release of radioactive materials in the ISFSI would result.	This event does not result in release of radioactive materials
4	The postulated release of surface contamination from baskets	This event could result in the release of radioactive materials from the ISFSI. An analysis should be conducted to demonstrate that the proposed contamination limits would not result in radiological concern at a distance of 100 meters from the ISFSI. The analysis also should determine the allowable surface contamination limits.	This accident would result in a dose of less than 10 millirem to a person at 100 meters away
Maximum Credible Accident			
1	Fires	The ISFSI Safety Analysis Report should evaluate the consequences of this hypothetical accident to demonstrate that the storage cask system provides a substantial safety margin for the protection of public, facility personnel, and the environment.	Designed to withstand the accident with no consequence
2	Structural collapse	The presence of any structure, the collapse of which may result in any accident, should be acknowledged. The ISFSI Safety Analysis Report should evaluate the consequences of this hypothetical accident to demonstrate that the storage cask system provides a substantial safety margin for the protection of the public, facility personnel, and the environment.	Designed to withstand the accident with no consequence
3	The postulated tipping over of a storage cask	The ISFSI Safety Analysis Report should evaluate the consequences of this hypothetical accident to demonstrate that the storage cask system provides a substantial safety margin for the protection of the public, facility personnel, and the environment.	Designed to withstand the accident with no consequence

Normal Operation and Operational Occurrences			
	Postulated Accident	***Accident Evaluation Requirements***	***Consequences***
4	Blockage of the storage cask air inlet vents	The ISFSI Safety Analysis Report should evaluate the consequences of this hypothetical accident to demonstrate that the storage cask system provides a substantial safety margin for the protection of the public, facility personnel, and the environment.	Designed to withstand the accident with no consequence
Beyond Design-Basis Accident			
5	Dry shielded canister leakage	Sites should identify the radiological consequences of this accident and ensure that it is below the regulatory limit at the ISFSI facility fence.	88 millirem at 200 meters (656 feet) 18 millirem at 500 meters (1,640 feet) 5.7 millirem at 1,000 meters (3,280 feet)
Transportation Accidents Involving Radioactivity			
1	Transportation accidents	Sites should: – Confirm that transportation of the storage system would take place within the existing site boundary. – Describe onsite transportation aspects and procedures (i.e., towing and transfer method, distance traveled). – Ensure that no transportation accident (i.e., drop of a loaded cask) could lead to release of radioactive materials.	Designed to withstand the accident with no consequence
Other Accidents			
1	Tornadoes	Such accidents should be evaluated consistent with the plant's Final Safety Analysis Report requirements.	Consistent with the ISFSI's design criteria in the Safety Analysis Report
2	Floods	Such accidents should be evaluated consistent with the plant's Final Safety Analysis Report requirements.	Consistent with the ISFSI's design criteria in the Safety Analysis Report
3	Earthquakes	Such accidents should be evaluated consistent with the plant's Final Safety Analysis Report requirements.	Consistent with the ISFSI's design criteria in the Safety Analysis Report
4	Volcanoes	Such accidents should be evaluated consistent with the plant's Final Safety Analysis Report requirements.	Consistent with the ISFSI's design criteria in the Safety Analysis Report
5	Nearby explosions	Such accidents should be evaluated consistent with the plant's Final Safety Analysis Report requirements.	Consistent with the ISFSI's design criteria in the Safety Analysis Report
6	Lightning strikes	Such accidents should be evaluated consistent with the plant's Final Safety Analysis Report requirements.	Consistent with the ISFSI's design criteria in the Safety Analysis Report
7	The collapse of structures around the ISFSI	Sites should determine any probability of a failure of a surrounding structure which could affect the integrity of the ISFSI.	Consistent with the ISFSI's design criteria in the Safety Analysis Report
8	Fire protection	Sites should ensure that no combustible materials are stored within the ISFSI or its boundaries.	Consistent with the ISFSI's design criteria in the Safety Analysis Report
9	Explosion protection	Sites should ensure that no explosive materials and no credible internal explosions are possible.	Consistent with the ISFSI's design criteria in the Safety Analysis Report

5.2.7 Fabrication of TPBARs and Blend-Down of Highly Enriched Uranium

Commercial facilities would fabricate and assemble the TPBARs. Potential fabrication and/or assembly sites include: General Electric, Wilmington, North Carolina; Framatome - Cogema Fuels, Lynchburg Virginia; BWX Technologies, Inc., Lynchburg, Virginia; Asea Brown-Boveri/Combustion Engineering, Hematite, Missouri; Siemens Power Corporation, Richland, Washington; and Westinghouse Electric, Columbia, South Carolina. Each of the facilities has a 10 CFR 70 license issued by the NRC. The successful fabrication bidder will determine whether its NRC license will require an amendment. In the event a license amendment is required, the NRC will prepare the appropriate environmental documentation. In addition, if this DOE fabrication procurement is subject to 10 CFR 1021, DOE will consider the environmental impacts during the fabrication procurement process. Since the fabricator of the TPBARs is still to be determined, the qualitative assessment presented in this EIS presents the reasonably foreseeable impacts of fabrication. This EIS provides a brief description of the fabrication process and a qualitative discussion of the potential, non-site-specific environmental consequences. It also provides estimates of the material resources required by the tritium production program.

The TPBARs consist of multiple components of materials designed to produce, capture, and store tritium until the TPBARs can be removed from the reactor and processed under controlled conditions to remove the tritium. The TPBARs contain lithium aluminate ($LiAlO_2$) pellets. The pellets are enriched in lithium-6 to produce tritium. The pellets are stacked in an unplated zircaloy-4 tube called the liner. The liner absorbs oxygen and supports the pellets. The pellets are surrounded by a metal tube of nickel-plated zircaloy. This tube functions as a getter (absorber of tritium). The pellet, liner, and nickel-plated zircaloy components are inserted in stainless steel cladding. The inside surface of the cladding is aluminized to provide a barrier to limit tritium leakage through the cladding.

The enriched lithium aluminate is produced through the chemical reaction of lithium carbonate/lithium monohydrate and aluminum oxide. In the TPBAR fabrication facility, these two materials would be blended, spray dried (to limit the amount of water trapped in the product), and calcined to form the lithium aluminate. The lithium aluminate would be combined with a binder, conditioned for pressing, pressed into its final ceramic annular shape, and sintered. These annular pellets then would be assembled with the remaining rod components, including the zirconium getter and the rod cladding. Final rod assembly would include additional drying, backfilling of the rods with helium, and welding end caps onto the rods. The TPBARs would be attached to a base plate to create a TPBAR assembly, which would be inserted into a fuel assembly; at this point they would be ready for transport to the CLWR.

No filtration of the off-gases (principally carbon dioxide) produced by this reaction would be necessary. Wastes generated from TPBAR production would consist of sanitary wastes, process wastes, and chemical wastes. Wastes would be primarily generated from TPBAR fabrication laboratory analysis, pellet grinding, and stainless steel tube working. Usable scrap material generated during the machining operations would be recycled for later use in the TPBAR production process (DOE 1992).

The quantities of material required for TPBAR production are presented in **Table 5–52**. These numbers are based on the production of 4,000 TPBARs per year (6,000 TPBARs or 250 TPBAR assemblies produced for refueling outages for reactors on an 18-month operating cycle). Each TPBAR assembly would weigh less than 27 kilograms (60 pounds), of which less than 400 grams (0.8 pound) would be lithium (WEC 1997). The amounts of source material for the production of lithium aluminate would be derived from the amount of lithium required for each TPBAR. Materials used for the fabrication of the TPBARs (i.e., lithium) have been mined and processed and are part of DOE's inventory of material resources. Therefore, no environmental consequences of any significance are expected from activities other than the fabrication and assembly of the TPBARs.

Table 5–52 Materials Required for TPBAR Production

Material	*Annual Requirement (kilograms)*	*Program Requirement (metric tons)* [a, b]
Lithium	61	2.4
Lithium carbonate	325	13
Aluminum oxide	450	18
Other materials [c]	4000	160

[a] Based on a 40-year program duration.
[b] 1 metric ton = 1,000 kilograms (2,200 pounds).
[c] Includes aluminum, zircaloy, stainless steel, and nickel.

The TPBARs would be inserted into fresh fuel assemblies in place of burnable absorber rods or an empty thimble tube. The replacement of the burnable absorber rods with TPBARs for tritium production would require that additional fuel assemblies be used in the CLWR fuel cycle. The addition of lithium into the core design would increase the amount of uranium-235 that must be in the core to produce the design power level throughout the 18-month fuel cycle. The number of fresh assemblies required for each 18-month refueling cycle would depend on the number of TPBARs inserted for irradiation in the reactor core. For up to approximately 2,000 TPBARs, no additional fresh fuel assemblies would be required. As the number of TPBARs increased above 2,000, the additional fresh fuel assemblies would increase. For the maximum number of 3,400 TPBARs considered in this EIS, approximately 60 fresh fuel assemblies would be required in addition to the approximately 80 fresh fuel assemblies normally used in an 18-month refueling cycle nontritium production mode. Therefore, the additional number of fresh fuel assemblies that would be required at Watts Bar or Sequoyah for a 40-year program duration would be approximately 1,700 fresh fuel assemblies. At Bellefonte, all fresh fuel required would be attributed to tritium production; therefore, approximately 3,807 fresh fuel assemblies would be required.

Tritium production would require fuel assemblies with higher enrichments of uranium-235 than the assemblies used in a commercial power reactor (approximately 4.9 percent compared to current 4.5 percent). The increased enrichment would be required to compensate for the increased "loss" of neutrons from the power production capability of the reactor core. These two factors, increased number of fuel assemblies and increased uranium-235 enrichment, would result in an increased use of uranium-235 in a tritium production reactor compared to the same reactor operated solely for power production. **Table 5–53** provides a summary of the amounts of uranium-235 required for both commercial operation and tritium production operation of three reactors. These figures are based on the initial core load of fresh fuel and 26 refueling outages over the 40-year life of the program. An average uranium-235 enrichment of 4.95 percent was assumed for the fuel assemblies used for tritium production (WEC 1997).

Enriched uranium used for fuel assemblies in tritium production has already been mined and processed. Therefore, no environmental consequences of any significance are expected from activities other than from the conversion of highly enriched uranium to commercial reactor fuel.

Table 5–53 Additional Fuel Requirements

Requirements	*Tritium Production Core Configuration*	*Watts Bar 1 Sequoyah 1 or 2*[a]	*Bellefonte 1*
Fresh fuel assemblies	3,400 TPBARs	1,700	3,807
	less than 2,000 TPBARs	0	2,013
Uranium-235 (metric tons)	3,400 TPBARs	34.0	75.5
	less than 2,000 TPBARs	0	40.3

[a] The values in this column reflect the requirements at Sequoyah which bound those for Watts Bar.
1 metric ton = 1,000 kilograms (2,200 pounds)

The enriched uranium to be used for the nuclear fuel assemblies would likely be provided by DOE from highly enriched uranium set aside for national security missions such as tritium production. The highly enriched uranium would be downblended with other uranium materials to commercially usable low enriched uranium. Environmental impacts resulting from the potential downblending of highly enriched uranium are described below.

Impacts from the conversion and blending of highly enriched uranium to commercial reactor fuel have been previously described in DOE's *Disposition of Surplus Highly Enriched Uranium Environmental Impact Statement*, DOE/EIS-0240, June 28, 1996 (DOE 1996b). The Highly Enriched Uranium EIS addresses highly enriched uranium conversion and blending at four sites: DOE's Y-12 Plant at the Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee; DOE's Savannah River Site in Aiken, South Carolina; the Babcock & Wilcox Naval Nuclear Fuel Division facility in Lynchburg, Virginia; and the Nuclear Fuel Services facilities in Erwin, Tennessee. The document evaluated three conversion and blending technologies: uranyl nitrate hexahydrate or liquid blending, molten metal blending, and uranium hexafluoride or gas blending. Of the three technologies, both the uranyl nitrate hexahydrate and uranium hexafluoride convert highly enriched uranium to commercial reactor fuel as well as low-level radioactive waste. The molten metal blending would only convert highly enriched uranium to low-level radioactive waste. The Highly Enriched Uranium EIS addressed the disposition of a nominal 200 metric tons of highly enriched uranium, 170 metric tons of which would be converted to commercial fuel (61 FR 40619).

The environmental analyses in the Highly Enriched Uranium EIS estimated that the incremental radiological impact to workers, the public, and the environment during normal blending operations would be very small and would be well within regulatory requirements for all alternatives, technologies, and sites. Since no new construction would be required and the blending activities would be the same as past blending operations at these sites, all impacts would be small.

5.2.8 Transportation of TPBARs

Transportation impacts may be divided into two parts: the impacts of incident-free or routine transportation and the impacts of transportation accidents. Incident-free transportation and transportation accident impacts are divided into two parts: nonradiological impacts and radiological impacts. Incident-free transportation includes radiological impacts on the public and the crew from the radiation field that surrounds the package. Nonradiological impacts of incident-free transportation include vehicular emissions. Nonradiological impacts of potential transportation accidents are traffic accident fatalities. Only in the worst conceivable conditions, which are of low probability, could a transportation cask of the type used to transport radioactive material be so damaged that there could be a release of radioactivity to the environment.

The impacts of accidents are expressed in terms of probabilistic risk, which is the probability of an accident multiplied by the consequences of that accident and summed over all reasonably conceivable accidents. The impacts due to radiological accidents are measured in terms of the latent cancer fatalities that might result while the effect of non-radiological accidents are measured in additional immediate fatalities. Incident-free effects are also expressed in terms of additional latent cancer fatalities.

The first step in the ground transportation analysis was to determine the incident-free and accident risk factors on a per-shipment basis for transportation of the various materials. Calculation of risk factors was accomplished by using the HIGHWAY (ORNL 1993a) and INTERLINE (ORNL 1993b) computer codes to choose representative routes in accordance with U.S. Department of Transportation regulations. These codes provided population estimates so that RADTRAN (SNL 1993), and TICLD codes could be used to determine the radiological risk factors. This analysis is discussed in Appendix E.

Four transportation segments were evaluated in this EIS: (1) shipment of fabricated TPBARs to an assembly facility; (2) shipment of TPBAR assemblies to each of the CLWRs; (3) shipment of irradiated TPBARs to a Tritium Extraction Facility (assumed for purposes of evaluation to be at DOE's Savannah River Site in South Carolina); and (4) shipment of irradiated hardware to a waste disposal site. **Table 5–54** shows the estimated impacts of transportation for the 40-year duration of the program.

Table 5–54 Risks of Transporting the Hazardous Materials

Reactor Site (No. of TPBARs)	*TPBAR Transportation Mode*	*Routine*			*Accidental*	
		Radiological		*Nonradiological*		
		Crew	*Public*	*Emission*	*Traffic*	*Radiological*
Watts Bar (3,400 TPBARs per cycle)	Truck cask via truck	0.0033	0.021	0.0032	0.031	5.1×10^{-6}
	Truck cask via rail	0.0016	0.008	0.0023	0.029	5.7×10^{-6}
	Rail cask via rail	0.0016	0.008	0.0023	0.029	1.6×10^{-6}
Sequoyah (3,400 TPBARs per cycle)	Truck cask via truck	0.0030	0.019	0.0035	0.029	6.1×10^{-6}
	Truck cask via rail	0.0014	0.007	0.0024	0.028	5.2×10^{-6}
	Rail cask via rail	0.0014	0.007	0.0024	0.028	1.5×10^{-6}
Bellefonte (3,400 TPBARs per cycle)	Truck cask via truck	0.0026	0.018	0.0034	0.030	6.4×10^{-6}
	Truck cask via rail	0.0010	0.005	0.0024	0.028	5.8×10^{-6}
	Rail cask via rail	0.0010	0.005	0.0024	0.028	1.6×10^{-6}
Watts Bar (1,000 TPBARs per cycle)	Truck cask via truck	0.0010	0.007	0.0010	0.009	1.7×10^{-6}
	Truck cask via rail	0.0005	0.002	0.0007	0.009	1.9×10^{-6}
	Rail cask via rail	0.0005	0.002	0.0007	0.009	5.3×10^{-7}
Sequoyah (1,000 TPBARs per cycle)	Truck cask via truck	0.0009	0.006	0.0011	0.009	2.0×10^{-6}
	Truck cask via rail	0.0004	0.002	0.0007	0.008	1.7×10^{-6}
	Rail cask via tail	0.0004	0.002	0.0007	0.008	4.9×10^{-7}
Bellefonte (1,000 TPBARs per cycle)	Truck cask via truck	0.0008	0.006	0.0010	0.009	2.1×10^{-6}
	Truck cask via rail	0.0003	0.001	0.0007	0.009	1.9×10^{-6}
	Rail cask via rail	0.0003	0.001	0.0007	0.009	5.4×10^{-7}

Notes:
1. Maximum impacts are assumed for fabrication, assembly, and waste transportation, and are included in these totals.
2. All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accident-Traffic column, which is the number of fatalities.

The impacts from transportation segments (1) and (2) are limited to toxic vehicle exhaust emissions and traffic fatalities since the fabricated TPBARs contain no radioactive elements. Combinations of fabrication and assembly sites were evaluated, including Richland, Washington, (Siemens Power Corporation); Lynchburg, Virginia, (Framatome-Cogema Fuels or B&W Technologies, Inc.); Hematite, Missouri, (Asea Brown-Boveri/Combustion Engineering); and Columbia, South Carolina, (Westinghouse Electric Corporation). The maximum possible impacts are included in Table 5–54. The choice of facilities would be made by DOE using normal commercial procurement practices.

Transportation segment (3) involves shipment of irradiated TPBARs from the CLWRs to the Tritium Extraction Facility at DOE's Savannah River Site. This EIS evaluated the shipment of TPBARs by three distinct methods: (1) truck casks on trucks, (2) truck casks on trains, and (3) rail casks on trains.

Transportation segment (4) involves shipment of irradiated hardware from the CLWRs to either DOE's Savannah River Site or the Barnwell disposal facility in South Carolina for disposal as low-level radioactive waste. Irradiated hardware includes base plates and thimble plugs removed from the TPBARs at the CLWR site. The number of thimble plugs and base plates cannot be determined until the detailed plans for irradiation are completed.

The next step is to use the risk factors and the number of shipments to estimate the risk for transportation segments. The exact number of shipments cannot be determined unless the precise numbers of TPBARs to be handled are known. The transportation analysis provided information to bound the impacts at each site in **Figure 5–7**. The transportation analysis looked at potential implementation approaches for each of the three reactor sites. The approaches quantitatively addressed include production at a single unit with 1,000 TPBARs and maximum production at a single unit with 3,400 TPBARs.

5.2.9 Sensitivity Analysis

As discussed in Section 3.2.1, the maximum number of TPBARs to be fabricated, irradiated, and transported to the Tritium Extraction Facility under the proposed action would be approximately 6,000 TPBARs per 18-month reactor operating cycle, or approximately 4,000 TPBARs per year. This requirement is based on a tritium production design limit of 1.2 grams of tritium per TPBAR. For the purpose of this sensitivity analysis, the "baseline" tritium production CLWR configuration is defined as a CLWR containing 3,400 TPBARs, with a production design limit of 1.2 grams of tritium per TPBAR operating on an 18-month cycle. The environmental consequences of the baseline tritium production CLWR configuration (3,400 TPBARs), as well as a 1,000 TPBAR case, are evaluated in Sections 5.2.1 through 5.2.3 for the Watts Bar plant, the Sequoyah plant, and the Bellefonte plant, respectively. This section provides a sensitivity analysis of the environmental consequences at a single reactor site that would result by considering some variations on assumptions made for the baseline configuration. These variations are: (1) reducing the number of TPBARs to be irradiated in a single reactor to 100 TPBARs, (2) changing the production design limit of tritium to 1.5 grams per TPBAR and, (3) reducing the length of the reactor operating cycle to 15.5 months or 12 months, in conjunction with the tritium production design limit of 1.5 grams per TPBAR. **Table 5–55** provides the values of key parameters used in the sensitivity analyses discussed below. **Table 5–56** presents the public health and safety-related results of the analyses in percent change from the baseline configuration for a single reactor facility. This section also discusses the possibility of producing tritium at some later date than 2005, the production date assumed for the baseline analysis in the EIS.

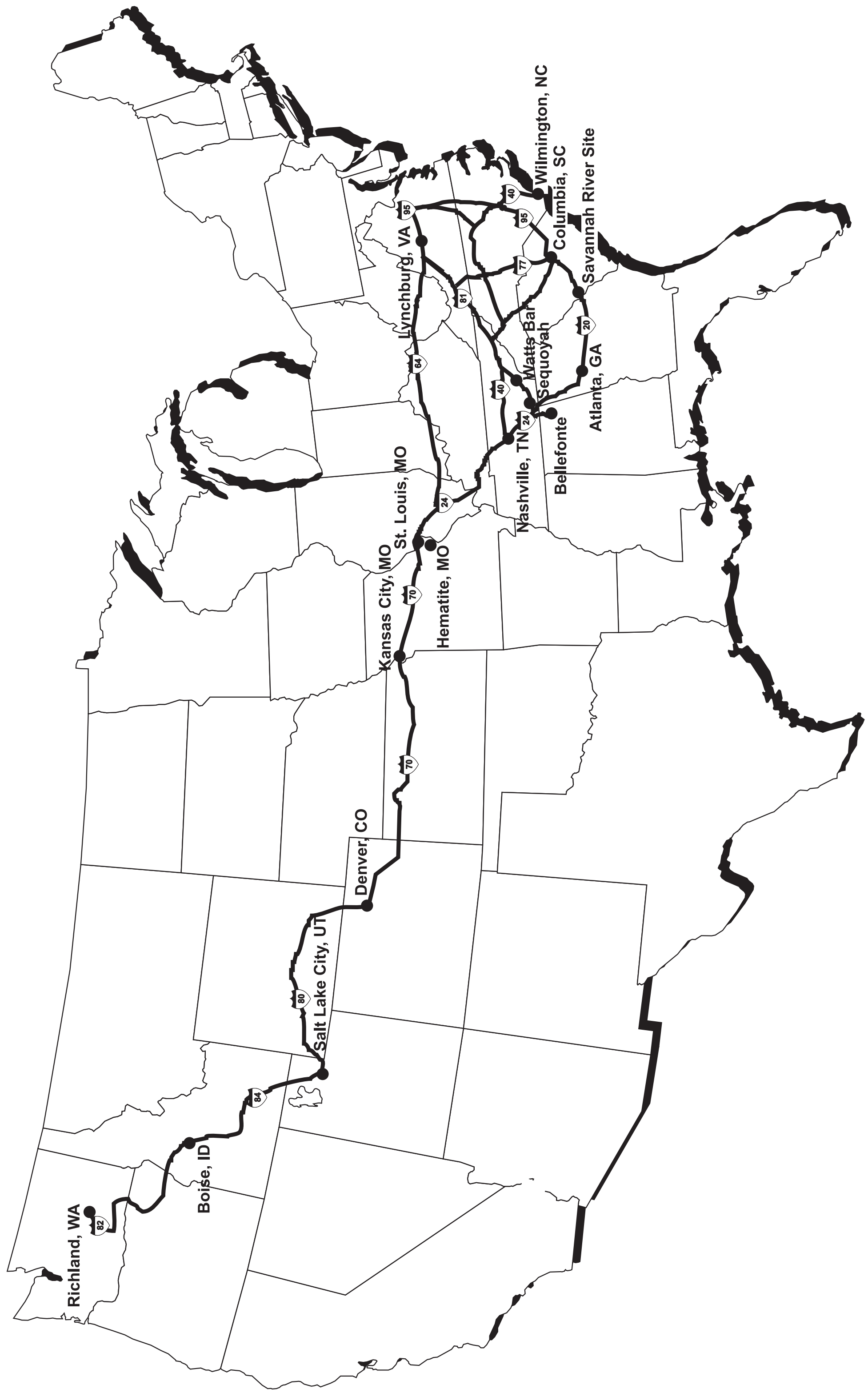

Figure 5–7 Representative Overland Truck Routes

Table 5–55 Sensitivity Analysis Key Parameters

Parameter	*Baseline Configuration*	*Sensitivity Analysis*		
TPBAR production design limit (grams)	1.2	1.2	1.5	1.5
Number of TPBARs in reactor core	3,400	100	3,400	3,400
Operating cycle (months)	18	18	15.5	12
Refueling time (months)	1	1	1	1
Tritium production per TPBAR (grams)	1.0 [a]	1.0	1.2 [b]	1.0 [c]
Total tritium production (grams)	3,400	100	4,080	3,400
Annualized tritium production (grams)	2,267	67	3,160	3,400
TPBAR leakage to Reactor Coolant System (Curies per TPBAR per year)	1 [d]	1 [d]	2 [e]	2 [e]
TPBAR leakage to Reactor Coolant System (Curies per TPBAR per operating cycle) [h]	1.5	1.5	2.6	2
Breached TPBAR leakage to fuel pool (Curies per TPBAR per day)	50 [f]	50 [f]	100 [e]	100 [e]
Breached TPBAR leakage to transportation cask (grams of tritium per TPBAR per hour)	0.00001 [g]	0.00001 [g]	0.00002 [e]	0.00002 [e]
Truck shipments per operating cycle (1 unit per shipment) [I]	12	1	12	12
Rail shipments per operating cycle (2 units per shipment) [I]	6	1	6	6

[a] Westinghouse estimated 0.84 gram average and 1.07 peak for the reference plant (WEC 1997).
[b] Westinghouse estimated 1.07 gram average and 1.31 peak for the reference plant (WEC 1997).
[c] Rounded up to 1.0.
[d] Average value for TPBARs in an operating reactor (PNNL 1999).
[e] Detailed design and analyses of the TPBAR with a tritium production limit of 1.5 grams are not available. For the purpose of this sensitivity analysis, it is assumed that the value associated with the 1.5 gram design-limit TPBAR is two times the equivalent value for the 1.2 gram design-limit TPBAR.
[f] Average value for breached TPBARs in a fuel pool (PNNL 1999).
[g] Average value for breached TPBARs in an air or inert atmosphere. No water or moisture is present in the breached TPBAR and the ambient temperature of the air or inert atmosphere is less than 93°C (200°F) (PNNL 1999).
[h] Nominal value. No credit taken for refueling outage.
[I] 1 unit = 1 17 × 17 consolidation unit array = 289 TPBARs.

Reduction of Number of TPBARs at a Single Reactor

Reducing the number of TPBARs to be irradiated in a single reactor could affect the need for fresh nuclear fuel and spent nuclear fuel production. As discussed in Section 3.2.1 and 5.2.6, the need for additional fresh fuel assemblies for a core reload starts at about 2,000 TPBARs for a single reactor. Therefore, if the implementation of the proposed action would take place in more than one reactor with less than 2,000 TPBARs to be irradiated in each, there would be no need for additional fuel assemblies and associated material resources. In addition, there would be no need for the construction and operation of additional dry storage spent fuel facilities at the reactor sites solely because of tritium production.

Table 5–56 Sensitivity Analysis Summary for a Single Reactor Site

	Number of TPBARs in Core	***100***	***3,400***	***3,400***
	Operating Cycle (months)	***18***	***15.5***	***12***
CLWR Configuration	***Tritium Production Design Limit per TPBAR per gram***	***1.2***	***1.5***	***1.5***
Normal Operation		**Percent Change from Baseline Configuration**		
Radiological liquid effluent (tritium)	Quantity per year	-97	100	100
Radiological gaseous emissions (tritium)	Quantity per year	-97	100	100
Hazardous chemical liquid emissions	Quantity per year	0	0	0
Hazardous chemical gaseous emissions	Quantity per year	0	0	0
Facility Accidents		**Percent Change from Baseline Configuration**		
Reactor design-basis accident[a]	Consequence[d]	-97	20	0
	Risk per year[e]	-97	13	-8
Reactor design-basis accident[b]	Consequence [d]	0	0	0
	Risk per year[e]	0	-6	-8
Nonreactor design-basis accident[a]	Consequence[d]	-97	72	31
	Risk per year[e]	-97	100	97
Nonreactor design-basis accident[b] (Thyroid dose consequences and risks)	Consequence[d]	-69	51	23
	Risk per year[e]	-69	75	85
Nonreactor design-basis accident[b] (Beta+gamma whole body dose consequences and risks)	Consequence[d]	-2	1	0
	Risk per year[e]	-2	17	51
TPBAR handling accident	Consequence[d]	0	20	0
	Risk per year[e]	-97	39	50
Truck cask handling accident	Consequence[d]	0	100	100
	Risk per year[e]	-94	132	200
Rail cask handling accident	Consequence[d]	0	100	100
	Risk per year[e]	-83	132	200
Severe reactor accident	Consequence[d]	-1	0	0
	Risk per year[e]	-1	-6	-8
Hazardous chemical accident	Consequence[d]	0	0	0
	Risk per year[e]	0	0	0
Low-Level Radioactive Waste		**Percent Change from Baseline Configuration**		
Low-level radioactive waste generation	Quantity per year	-96	16	50
Spent Fuel Space		**Percent Change from Baseline Configuration**		
Spent fuel storage space	Storage positions per year	[c]	16	50
Overland Transportation of Irradiated TPBARs from a Single Reactor Facility		**Percent Change from Baseline Configuration**		
Truck shipments	Number per year	-92	16	50
Rail shipments	Number per year	-83	16	50

[a] Design-basis accident consequences only reflect the incremental increase in accident consequences due to the production of tritium in TPBARs.
[b] Design-basis accident consequences estimated using NRC-based deterministic approach.
[c] The baseline configuration requires 56 to 69 additional fresh fuel assemblies and, therefore, requires 75-96 percent of additional spent fuel storage space for each core reload with 3,400 TPBARs. No additional fresh fuel assemblies are required for 2,000 TPBARs.
[d] Maximally exposed offsite individual, average individual in population, and noninvolved worker dose in rem.
[e] Maximally exposed offsite individual, average individual in population, and noninvolved worker increased likelihood of cancer fatalities per year.

Reducing the number of TPBARs to be irradiated in a single reactor would reduce the tritium releases to the environment under normal operation from that reactor, since the normal operation release of tritium is assumed to be proportional to the number of TPBARs.

Reducing the number of TPBARs to be irradiated in a single reactor would reduce the low-level radioactive waste production and the number of irradiated TPBAR shipments from the reactor site. It would not affect environmental resources at a reactor site such as land, ecology, historical resources, aesthetics, and socioeconomics, and would have reduced already small impacts on resources such as noise and aesthetics. Overall, the baseline analysis of 3,400 TPBARs at a single reactor site bounds the effects of irradiation with fewer TPBARs at the site.

Tritium Production Design Limit of 1.5 grams per TPBAR

The increase of the tritium production design limit to 1.5 grams per TPBAR, assuming the maximum number of 3,400 TPBARs to be irradiated at a reactor site, would increase the tritium emission to the environment under normal operating and accident conditions compared to the baseline case. The necessary shortening of the reactor operating cycle from 18 months to 15.5 months also would result in increases in low-level radioactive waste production and spent fuel generation and storage requirements. It would have no effect on all other environmental resources considered in this EIS, such as land, aesthetics, archeological and historic resources, ecology, and socioeconomics. The increase in noise due to more frequent refuelings would be small.

From a program point of view, the increase of the tritium production design limit from 1.2 grams per TPBAR to 1.5 grams per TPBAR, would provide the potential for using fewer TPBARs for the same tritium production goal. The number of TPBARs that would need to be fabricated, irradiated, and transported would be reduced. Fewer TPBARs would mean lesser environmental consequences from fabrication. The number of shipments of both nonirradiated and irradiated TPBARs would be reduced, thus proportionately reducing the incident-free risk to the health and safety of the public.

Length of Reactor Operating Cycle

Shortening the length of the reactor operating cycle to 12 months is discussed in conjunction with the 1.5 grams per TPBAR design limit, as opposed to the 1.2 grams per TPBAR design limit. As discussed above, a shorter cycle (15.5 months) would be required to irradiate the maximum number of 3,400 TPBARs in a reactor. Shortening the reactor operating cycle even further to 12 months with the 1.5 grams per TPBAR design limit, would allow the increase of tritium production from 2,667 grams per year (baseline in a single reactor) to 3,400 grams per year.

Shortening the reactor operating cycle to 12 months would directly affect the number of TPBARs that could be irradiated annually in a single reactor, from 3,400 in 18 months (2,267 grams per year) to 3,400 per year. This would increase the annual generation of spent fuel; the annual generation of low-level radioactive waste; the annual gaseous emissions and liquid effluent releases of tritium; the activities required to handle the irradiated TPBARs at the site; and the number of refueling outages required at the reactor for the 40-year duration of the proposed action. Consequently, there would be proportional increases to impacts associated with air and water quality, ecological resources, and occupational and public health and safety.

Shortening the reactor operating cycle to 12 months would increase the environmental consequences associated with the construction and operation of a dry cask ISFSI at the reactor site by approximately 50 percent. It would have no effect on all other environmental resources considered in this EIS such as land, archaeological and historic resources, aesthetics, and socioeconomics. The noise increase due to more frequent refuelings would be small.

From a program point of view, shortening the reactor operating cycle to 12 months would be practical if the program requirements for tritium production were reduced so that the total number of TPBARs that would need to be fabricated and transported were reduced to approximately 3,400 TPBARs per year, which would be irradiated at single rather than multiple reactor facilities.

Producing Tritium at a Later Date

This EIS evaluates the environmental impacts associated with producing tritium at one or more of five TVA reactors. The need for this tritium is based on the 1996 Nuclear Weapons Stockpile Plan and the accompanying Presidential Decision Directive. The 1996 Nuclear Weapons Stockpile Plan, which represents the latest official guidance for tritium requirements, is based on a START I-level stockpile size of approximately 6,000 accountable weapons. In accordance with the Nuclear Nonproliferation Treaty, the United States is committed to good faith efforts to reduce the nuclear weapons stockpile. The United States recently ratified the START II Treaty and is hopeful that Russia will do likewise. In the event START II is ratified by Russia, a program to allow for a lower START II stockpile size of approximately 3,500 accountable weapons would be implemented. Under such a scenario, the existing tritium reserve would last a little longer and the need date for tritium would be pushed out until approximately 2011. At the same time, the annual steady-state tritium requirement also would be reduced to approximately 1.5 kilograms of tritium. This section addresses the environmental impacts associated with tritium production in one or more CLWRs to support a smaller stockpile than the current START I requirements.

The alternatives evaluated in this EIS would not change for a smaller START II stockpile. In fact, the procurement process through which the five TVA reactors were identified as reasonable alternatives included a requirement that offerors respond to a range of tritium production quantities. This range was designed to allow for varying tritium requirements, including a production level commensurate with supporting a START II stockpile size. Accordingly, all 18 of the alternatives presented in Table 3-2, Tritium Production Reasonable Alternatives (see Section 3.2.3) are also reasonable alternatives for a smaller START II-sized stockpile.

Use of existing TVA reactors to satisfy this reduced START II quantity of tritium would result in environmental impacts similar to those presented in Sections 5.2.1 and 5.2.2 of this EIS. A slightly smaller number of TPBARs would be manufactured and transported to the reactors, and a slightly smaller number of irradiated TPBARs would be shipped from the reactor sites to the Savannah River Site. The reactor site impacts associated with the reduction of the number of TPBARs to be irradiated at a single reactor are discussed earlier in this section. The impacts from transportation are bounded by the analysis presented in Section 5.2.8.

For the Bellefonte alternative, environmental impacts could be similar to those presented in Section 5.2.3 of this EIS, should DOE and TVA choose to complete these reactors according to a similar schedule. With a smaller sized stockpile, however, DOE and TVA would have the additional flexibility either to delay the construction start date or to stretch out construction over a longer period of time. Delaying the construction start date would entail similar environmental impacts to those presented in Section 5.2.3 of this EIS. These would be incurred at a later date (commensurate with the delay in the construction start date). If DOE chooses to stretch out the construction period over a longer period of time, the socioeconomic impacts described in Section 5.2.3 of this EIS likewise would be spread out over a longer period of time. This would lessen the severity of the impacts on housing, transportation, and schools.

5.2.10 Safeguards and Security

CLWRs are required by the provisions of their NRC license to have security and safeguard procedures to protect against a design-basis threat. On a site-specific basis, a design-basis threat comprises: (1) a determined, violent, external attack by stealth or deception by several persons or a small group; (2) a well-trained and dedicated adversary group with suitable weapons and hand-carried equipment, tools, and/or explosives that may be aided by an insider; (3) an internal threat by an insider who may attempt theft and per or sabotage; and (4) other threat actions such as attacks on computer systems. Requirements for developing the design-basis threat, as well as requirements for measures to guard against this threat for NRC-licensed facilities, are provided in 10 CFR 73 and 74.

Facilities and activities associated with the production of tritium for DOE are also required to comply with the requirements in DOE 5632.1C and 5633.3A. DOE Orders require a graded protection for all safeguard and security interests, classified matter, property, and sensitive information from theft, diversion, industrial sabotage, radiological sabotage, espionage, unauthorized access or modification, loss or compromise, or other hostile acts that could cause unacceptable adverse impacts on national security, our business partners, or on the health and safety of employees and the public. The DOE Orders also require a facility associated with the production of tritium to provide protection against a design-basis threat. A CLWR used for the production of tritium must comply with NRC and DOE regulatory requirements. The transportation of DOE materials also are required to comply with a graded set of DOE safeguard and security requirements, in addition to the NRC, DOE, and the U.S. Department of Transportation safety requirements.

The DOE Safeguards and Security Protection Program defines procedures to ensure physical protection of material and equipment, materials control and accountability, nuclear materials control, nuclear materials accountability, security of personnel, personnel security awareness, information security, automated information security, and personnel training.

TPBARs were placed in the Watts Bar Nuclear Plant as part of the Lead Test Assembly Demonstration Project. The Inspection Branch of DOE's Safeguards and Security Division, Oak Ridge Operations Office, conducted a security survey of the Watts Bar plant in preparation for the Lead Test Assembly Demonstration Project. The existing NRC Program was found to fulfill all DOE requirements satisfactorily. (DOE 1997b)

No environmental impacts are expected as a result of compliance with both NRC and DOE safeguard and security provisions based on the adequacy of the existing TVA security provisions. Before introducing any TPBARs into any CLWR, DOE would conduct an in-depth site-specific safeguards and security inspection. This rigorous review would ensure that the existing safeguards and security programs of any reactor used in the CLWR program satisfy the stringent DOE requirements. Any inadequacies would be resolved before the introduction of any DOE materials to the facility. Although it is not anticipated, if the safeguards and security review determined that additional security provisions were required, DOE would perform the appropriate NEPA review.

This EIS identifies credible accident scenarios caused by internal disturbances; addresses the probability of such accidents; and quantifies the releases and exposures resulting from such accidents. Accidents initiated as a result of sabotage are considered speculative and, accordingly, have not been addressed in the CLWR EIS.

5.2.11 Programmatic No Action

DOE is preparing a separate EIS to analyze the environmental impacts of the construction and operation of an Accelerator Production of Tritium (APT) facility at DOE's Savannah River Site in South Carolina. DOE published an APT Draft EIS in December 1997, (DOE 1997e), and the Final EIS in March 1999 (DOE 1999a). Since the No Action Alternative for the CLWR EIS entails production of tritium in the APT facility, this section summarizes the environmental impacts from accelerator production of tritium as presented in Chapter 4 of the APT Draft EIS. For a more detailed analysis of these potential impacts, the reader is referred directly to the APT Draft EIS (DOE 1997e, DOE 1999a).

The APT EIS considered two design alternatives: klystron radio frequency power tubes (the preferred alternative) and inductive output radio frequency power tubes. It also considered two operating temperature alternatives for the design of the accelerator: (1) operating electric components at essentially room temperature, and (2) operating most components at superconducting temperatures and the rest at room temperature (the preferred alternative). Two feedstock alternatives were considered: helium-3 (the preferred alternative) and lithium-6. Four cooling water system designs were considered for the APT EIS: mechanical-draft cooling towers with groundwater makeup; once-through cooling using river water; and use of the existing K-Area natural-draft cooling tower with river water makeup.

The APT EIS also considered two design variations to the preferred alternative to enhance DOE's flexibility: a modular or staged accelerator configuration and a combination of tritium separation and tritium extraction facilities. It also considered two site alternatives. The preferred site is 4.8 kilometers (3 miles) northeast of the Tritium Loading Facility and approximately 10.5 kilometers (6.5 miles) from the boundary of DOE's Savannah River Site. The alternative site is located 3.2 kilometers (2 miles) northwest of the Tritium Loading Facility and approximately 6.4 kilometers (4 miles) from the boundary of DOE's Savannah River Site. Due to the projected magnitude of the electric power usage (peak load as high as 600 megawatts for the room temperature alternative), the APT EIS considered obtaining electricity from the construction and operation of two new electrical source alternatives: coal-fired or natural gas-fired generating plants.

The potential environmental impacts are presented as construction impacts and operational impacts. This summary provides the potential impacts of the APT Preferred Alternative and indicate where alternative impacts vary from the Preferred Alternative. Since the APT EIS was developed in parallel with the CLWR EIS, the impacts represent the conclusions of the APT Draft EIS. These impacts are not expected to change in the APT Final EIS.

Construction Impacts

For the APT Preferred Alternative, construction of the APT facility would convert approximately 101 hectares (250 acres) of forested land into an industrialized area. Excavation of 20 meters (65 feet) in depth would be required. If DOE were to choose the modular design variation, construction impacts could be spread over a longer period of time and require the clearing of an additional 12 hectares (30 acres). New roads, bridge upgrades, and rail lines also would be required. At the preferred site, the construction excavation would reach the water table; therefore, the site would require dewatering. Impacts on the water table would be minimal due to the rather short period of dewatering and the fact that construction would only affect the shallowest portion. Air emissions (fugitive dust and exhaust emissions) should be well below applicable regulatory standards.

Potential impact to terrestrial ecology would result from clearing this land. DOE does not expect, however, that this would create a long-term reduction in the local or regional diversity of plants and animals. No threatened or endangered species occur at any of the alternative sites for the APT facility.

The generation of construction wastes could require the construction of a state-permitted construction debris landfill at DOE's Savannah River Site. Sanitary solid waste would be disposed of in the Three Rivers Regional Landfill. Construction noise at the APT facility site could be higher than the limits imposed by the Occupational Safety and Health Administration. However, DOE would ensure compliance with the Occupational Safety and Health Administration's 8-hour noise exposure guidelines through the use of administrative controls, engineering, and protective equipment. Noise to offsite receptors would not present a nuisance.

DOE expects an incremental increase in occupational injuries based on historic Savannah River Site information for injuries requiring medical attention and injuries resulting in lost work time during the construction phase. DOE also expects a slight increase in the potential for traffic fatalities.

The potential socioeconomic impacts of the APT facility should not stress existing regional infrastructure or result in a “boom” situation. Peak employment would add about 1,400 additional jobs during the construction period.

Operational Impacts

Operation of the APT facility could affect surrounding groundwater. If the groundwater makeup alternative were selected, the removal of 22,700 liters per minute (6,000 gallons per minute) on a sustained basis could result in changes or reductive groundwater flows to some streams surrounding the well field and compaction of clay layers. Operation of the APT facility would produce neutrons that have the potential to penetrate the accelerator’s protective shielding and be absorbed by the soil and groundwater. The accelerator would be designed so that the dose associated with this activity would be less than one-eighth of the EPA drinking water standard of 4 millirem per year.

The withdrawal of Savannah River water for cooling would result in the impingement of adult fish and the entrainment of fish eggs and larvae at the river water intake. The once-through cooling water alternative would result in considerably higher rates of impingement and entrainment than the various cooling tower alternatives, but losses of adult fish, fish eggs, and fish larvae under all alternatives would be small relative to total fish production in the upper and middle reaches of the Savannah River.

Operation of the APT facility would result in thermal discharges from the cooling water system to either Indian Grave or Pen Branch or the existing series of precooler ponds and ultimately Par Pond. For all cooling alternatives except the once-through cooling water alternative, water temperature in the receiving water bodies would not exceed 32°C (90°F), meeting South Carolina Department of Health and Environmental Control standards for fresh water. In the case of the once-through cooling water alternative, however, discharges would be well in excess of 32°C (90°F) in late summer. Under this scenario, DOE could be required to conduct a Clean Water Act Section 316a(1) Demonstration. Under each cooling water alternative, cesium-137 trapped in the fine sediments of Par Pond would be disturbed and remobilized. The once-through cooling water alternative would remobilize the most cesium-137, but in all cases, exposures of the public would be less than allowed by regulatory limits. Par Pond and the precooler ponds, however, are utilized by American alligators and bald eagles. The alligators do not breed in Ponds 2 and 5 and would abandon the ponds and relocate if water temperature exceeded their tolerance range. In Par Pond and Pen Branch, potential effects on alligators could be positive in that the warmer waters could lengthen the active period for the reptiles. Bald eagles use the Par Pond system for feeding. Potential fish kills associated with the once-through cooling water alternative could provide the eagles with an additional food source.

Air emissions of both radiological and nonradiological pollutants would be well below applicable standards for the operation of the APT facility. Offsite concentrations would be slightly higher from the nonpreferred alternative site because it is closer to the Savannah River Site boundary. Tritium would constitute over 99 percent of the offsite dose, but would be well below the 100 millirem per year dose limit for Savannah River Site atmospheric releases.

Operational waste would be managed and treated according to waste type using both Savannah River Site and offsite facilities. Potential impacts on other facilities should be negligible because of the low volume of waste generation.

From normal operations, DOE expects that the dose to the public from the APT facility would be within regulatory limits. Similarly, all concentrations of noncarcinogenic materials would be well below all established limits; consequently, there should be no health impacts. Of the materials expected to be released from the APT facility, only beryllium is a carcinogen. Using EPA’s Integrated Risk Information System database, DOE calculated an additional lifetime latent cancer risk of 4.6×10^{-9} to the maximally exposed individual. This value is well below the 1×10^{-6} risk value that the EPA typically uses as a threshold of concern. Impacts would be slightly higher at the alternative site because it is closer to the Savannah River Site boundary, but would still be well below the EPA threshold of concern. Potential impacts on workers would be slightly higher.

All accidents with a postulated frequency of more than once during the 40-year operating life of the accelerator would have negligible consequences. Only four low-probability accidents (highest frequency = once per 2,000 years) would raise offsite doses high enough (1 rem at site boundary) to warrant public protective actions under the Savannah River Site Emergency Plan.

There should be no significant socioeconomic impacts from the operation of the APT facility at the DOE's Savannah River Site in South Carolina. The workforce of 500 additional individuals would produce approximately one-third of the socioeconomic impacts during construction of the APT facility.

The preferred APT alternative would require approximately 350 megawatts of electricity to operate. DOE is considering either purchasing electricity from existing sources through market transactions or obtaining electricity from a new electric power-generating plant. The purchasing of electricity would increase expected environmental impacts from 1 to 3 percent. If a new electricity-generating plan were to be constructed, potential impacts would depend upon its operation. If it were constructed at the Savannah River Site, impacts would probably be only slightly higher than those of the purchasing option.

Although impacts would depend upon the specific location and type of the new electric power-generating facility, such a facility could require about 45 hectares (110 acres) for a natural gas plant or 117 hectares (290 acres) for a coal plant. While the specific constituents of air emissions and discharges to surface water would depend upon the actual location of the new electric power generating plant, overall environmental impacts should be no higher than those of the Preferred Alternative. A peak workforce of about 1,100 workers would be required for the rather short construction period and a workforce of about 200 individuals for operation of the facility. Impacts on the socioeconomics of the region would depend upon the actual location of the facility.

In addition to the impacts on land use, waste would be generated from construction, and the operation of such an electric power generating facility would generate greenhouse gas emissions. Of the greenhouse gases expected to be generated, carbon dioxide emissions would be the largest. **Table 5–57** summarizes the expected carbon dioxide emissions from the APT power plant options and compares these emissions to existing U.S. and global carbon dioxide emissions.

Table 5–57 Estimated Accelerator Production of Tritium Carbon Dioxide Emissions

Accelerator Production of Tritium Power Plant Option	***Estimated Carbon Dioxide Emissions (million tons per Year)***	***U.S. Fossil Combustion Carbon Dioxide Emissions (%)[a]***	***Global Combustion Carbon Dioxide Emissions (%)[b]***
Existing capacity/market transactions	3.45	0.063	0.014
New coal-fired power plant	3.60	0.066	0.014

[a] U.S. estimates of fossil fuel carbon dioxide emissions is 5.446 million tons per year (TVA 1997f).
[b] Global estimates of fossil fuel carbon dioxide emissions is 25.038 million tons per year (TVA 1997f).
Source: DOE 1997e.

5.2.12 CLWR Facility Accident Impact to Involved Workers

The range of accident impacts to involved workers at a CLWR tritium production facility would vary depending on the energy and radioactive material released during the accident. The involved workers would evacuate the immediate area of the accident to minimize exposure in accordance with general employee training and emergency procedures. **Table 5–58** summarizes accident impacts on involved workers.

Table 5–58 Accident Impacts on Involved Workers

Accident	*Worker Location*	*Impact on Worker*	*Mitigation*
Reactor design-basis accident (large break loss of coolant accident)	Reactor containment	Workers in containment at the time of the accident will die due to the energy (steam) released to the containment. Evacuation from the containment is not considered feasible.	The containment is not normally occupied during power operation. Entrance to containment during power operation is limited by work permits approved by the operations staff.
Nonreactor design-basis accident (waste gas decay tank rupture)	Auxiliary building waste gas tank area	If the accident is initiated by rupture of the tank or associated piping, the worker could be injured by debris or the stream of gas from the rupture. In addition, the worker could receive a radiation dose while evacuating the area.	The probability of this initiating event is extremely unlikely (in the range of 10^{-6} to 10^{-4} per year). Involved workers will evacuate the immediate area of the accident to minimize radiation exposure in accordance with general employee training and emergency procedures.
		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.	None required
TPBAR handling accident	Auxiliary building spent fuel pool area	The involved worker would observe the drop and immediately evacuate the area. Adequate time will exist to evacuate the area before the release of tritium from the TPBARs. The worker would receive no additional radiological dose.	Involved workers will evacuate the immediate area of the accident to minimize radiation exposure in accordance with general employee training, emergency procedures, and TPBAR handling operating procedures.
Truck or rail cask handling accident	Auxiliary building spent fuel pool area	The involved worker would observe the drop and immediately evacuate the area. Adequate time will exist to evacuate the area before the release of tritium from the TPBARs. The worker would receive no additional radiological dose.	Involved workers will evacuate the immediate area of the accident to minimize radiation exposure in accordance with general employee training, emergency procedures, and TPBAR handling operating procedures.
Beyond design-basis accident	Reactor containment	If the accident sequence is initiated by a large break loss of coolant accident or another high energy release mechanism, workers in containment at the time of the accident will die due to the energy (steam) released to the containment. Evacuation from the containment is not considered feasible.	The containment is not normally occupied during power operation. Entrance to containment during power operation is limited by work permits approved by the operations staff.
		Most of the postulated accident sequences have adequate time for workers to evacuate the containment before there is a radioactive release to the containment.	Involved workers will evacuate the containment to minimize radiation exposure. As the accident sequence progresses, all nonessential personnel will be directed to evacuate the site in accordance with site emergency procedures.

5.2.13 Secondary Impact of CLWR Facility Accidents

For purposes of this EIS, the primary impacts are measured in terms of public and worker exposures to radiation and toxic chemicals. Accidents could also affect elements of the environment other than humans. For example, a radiological release could contaminate farmland, surface water, recreational areas, industrial parks, historic sites, or the habitat of an endangered species. As a result, farm products might have to be destroyed; the supply of drinking water could be lowered; recreational areas could be closed; industrial parks could suffer economic losses during shutdown for decontamination; historical sites could have to be closed to visitors; and endangered species could move closer to extinction. These types of impacts are referred to as secondary impacts in this EIS.

There should be no secondary impacts from design-basis accidents. The most severe class of design-basis accident, a core damage accident with no containment failure or bypass, occurred at the Three Mile Island Nuclear Plant, Unit 2, in Middletown, Pennsylvania, in 1979. There were no secondary impacts of this accident.

This section addresses the secondary impacts of a reactor beyond design-basis accident with radiological release. Secondary impacts are addressed qualitatively; that is, the types of impacts that could result and a range of potential outcomes are identified. These secondary impacts are divided into two types: (1) habitation of land by humans (population dependent); and (2) agricultural uses of land (area dependent). Each of these impact types are discussed below.

Population Dependent—Secondary impacts could produce four possible outcomes: (1) land is immediately habitable; (2) land will be habitable after decontamination; (3) land will be habitable after a combination of decontamination and interdiction; and (4) land will not be habitable (condemnation).

Area Dependent—Secondary impacts could produce three possible outcomes: (1) no restrictions on agricultural use; (2) short-term restrictions on agricultural use; or (3) long-term restrictions on agricultural use (condemnation).

At the Watts Bar and Sequoyah plants, tritium production would not change the potential secondary impacts that could result from a beyond design-basis accident. This is due to the fact that secondary impacts would be dominated by the radionuclides other than tritium that would be released; any such impact would be independent of tritium production.

At the Bellefonte plant, there would be a potential for secondary impacts arising from the proposed action. This is because the Bellefonte reactors are currently not operating. While it is noted that any secondary impacts would be caused by radionuclides other than tritium, these impacts would still represent a change from no action. As described above, these secondary impacts could range from no change to land habitability/use to long-term restrictions on agricultural use (condemnation). Any secondary impacts would have an extremely low probability of occurring—less than one in a million years.

5.3 CUMULATIVE IMPACTS

A cumulative impact is identified as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

5.3.1 TPBAR Fabrication

The fabrication and assembly process of the TPBARs would not result in environmental impacts beyond the impacts associated with the normal activities of the commercial facilities where fabrication and assembly would take place. Therefore, the fabrication and assembly process would not alter the cumulative impacts at these facilities.

5.3.2 TPBAR Irradiation

The only significant distinction between the effects of tritium production and those of the No Action Alternative at Watts Bar and Sequoyah would be the additional release of tritium and an associated small increase in the risk to occupational and public health and safety. No other known actions, Federal and nonfederal, could effect further changes in the radiological environment of the region of influence. Accordingly, the cumulative impacts at Watts Bar and Sequoyah, as reflected in **Tables 5–59** and **5–60**, respectively, are the sum of the impacts of the No Action Alternative and the small, incremental impacts of tritium production.

Table 5–59 Cumulative Impacts at the Watts Bar Nuclear Plant Site

Resource/Material Categories	*Tritium Production Increment*	*Cumulative Total*
Land resources	Potential permanent land requirement - 3.1 acres of developed land at the dry cask ISFSI if constructed	1,770 acres (existing developed land; no additional undisturbed land requirement)
Air quality		
Nonradiological emissions	No additional emissions	No change from current air quality conditions (See Table 4–1)
Greenhouse gases (carbon dioxide)	No additional emissions	0.027 metric tons per year
Radiological emissions	Annual radiological emissions of tritium: 1,000 TPBARs: 100 Curies 3,400 TPBARs: 340 Curies Other Emissions: 0 Curies	Annual radiological emissions of tritium: 1,000 TPBARs: 106 Curies 3,400 TPBARs: 346 Curies Other emissions: 283 Curies
Water quality		
Surface water	No additional surface water requirements, discharge, or water quality conditions	No changes from current surface water requirements, discharge, or water quality conditions (see Table 4–3)
Radioactive effluent	Annual radiological effluent of tritium: 1,000 TPBARs: 900 Curies 3,400 TPBARs: 3,060 Curies Other releases: 0 Curies	Annual radiological effluent of tritium: 1,000 TPBARs: 1,539 Curies 3,400 TPBARs: 3,699 Curies Other releases: 1.32 Curies
Groundwater	No additional groundwater requirements or additional impacts to groundwater quality conditions	No change from current groundwater requirements or additional impacts to groundwater quality conditions
Socioeconomics	Less than 1 percent impact on regional economy	No change from current regional socioeconomic conditions

Resource/Material Categories	Tritium Production Increment	Cumulative Total
Public and occupational health and safety Normal operation	Annual dose for 1,000 TPBARs: *Average worker*: 0.33 millirem *Maximally exposed (offsite) individual*: 0.013 millirem *50-mile population*: 0.34 person-rem Annual dose for 3,400 TPBARs: *Average worker*: 1.1 millirem *Maximally exposed (offsite) individual:* 0.047 millirem *50-mile population*: 1.2 person-rem	Annual dose for 1,000 TPBARs: *Average worker*: 104.33 millirem. *Maximally exposed (offsite) individual:* 0.30 millirem *50-mile population*: 0.89 person-rem. Annual dose for 3,400 TPBARs: *Average worker*: 105.1 millirem. *Maximally exposed (offsite) individual:* 0.34 millirem *50-mile population*: 1.8 person-rem.
Waste management	Low-level radioactive waste: approximately 0.43 cubic meters per year	Low-level radioactive waste: approximately 41 cubic meters per year
Spent nuclear fuel generation	less than 2,000 TPBARs: 0 fuel assemblies 3,400 TPBARs: up to a maximum of 56 fuel assemblies per cycle	less than 2,000 TPBARs: 80 fuel assemblies per cycle 3,400 TPBARs: up to a maximum of 136 fuel assemblies per cycle

Table 5–60 Cumulative Impacts at the Sequoyah Nuclear Plant Site

Resource/Material Categories	Tritium Production Increment[a]	Cumulative Total[b]
Land resources	Potential permanent land requirement - 3.2 acres of developed land at the ISFSI if constructed.	525 acres (existing developed land, no additional undisturbed land requirement)
Air quality Nonradiological emissions	No additional emissions	No change from current air quality conditions (See Table 4–14)
Greenhouse gases (carbon dioxide)	No additional emissions	0.039 metric tons per year
Radiological emissions	Annual radiological emissions of tritium: 1,000 TPBARs: 100 Curies 3,400 TPBARs: 340 Curies Other emissions: 0 Curies	Annual radiological emissions of tritium: 1,000 TPBARs: 249 Curies 3,400 TPBARs: 729 Curies Other emissions: 240 Curies
Water quality Surface water	No additional surface water requirements, discharge, or water quality conditions	No changes from current surface water requirements, discharge, or water quality conditions (see Table 4–16)
Radioactive effluent	Annual radiological effluent of tritium: 1,000 TPBARs: 900 Curies 3,400 TPBARs: 3,060 Curies Other releases: 0 Curies	Annual radiological effluent of tritium: 1,000 TPBARs: 3,277 Curies 3,400 TPBARs: 7,597 Curies Other releases: 2.3 Curies
Groundwater	No additional groundwater requirements or additional impacts to groundwater quality conditions	No change from current groundwater requirements or additional impacts to groundwater quality conditions

Resource/Material Categories	*Tritium Production Increment*[a]	*Cumulative Total* [b]
Socioeconomics	Less than 1 percent impact on regional economy	No change from current regional socioeconomic conditions
Public and occupational health and safety Normal operation	Annual dose for 1,000 TPBARs: *Average worker*: 0.24 millirem *Maximally exposed (offsite) individual*: 0.017 millirem *50-mile population*: 0.57 person-rem Annual dose for 3,400 TPBARs: *Average worker*: 0.82 millirem *Maximally exposed (offsite) individual*: 0.057 millirem *50-mile population*: 1.9 person-rem	Annual dose for 1,000 TPBARs: *Average worker*: 90.24 millirem *Maximally exposed (offsite) individual*: 0.14 millirem *50-mile population*: 4.4 person-rem Annual dose for 3,400 TPBARs: *Average worker*: 90.82 millirem *Maximally exposed (offsite) individual*: 0.22 millirem *50-mile population*: 7.0 person-rem
Waste management	Low-level radioactive waste: approximately 0.43 cubic meters per year	Low-level radioactive waste: approximately 384 cubic meters per year
Spent nuclear fuel generation	less than 2,000 TPBARs: 0 fuel assemblies 3,400 TPBARs: up to a maximum of 60 fuel assemblies per cycle	less than 2,000 TPBARs: 160 fuel assemblies per cycle 3,400 TPBARs: up to a maximum of 280 fuel assemblies per cycle

[a] Assumes tritium production in one unit.
[b] Assumes tritium production in both units.

As discussed in Chapter 5, operating the Bellefonte units as a nuclear power plant represents a change from the No Action Alternative with impacts to air, water, and ecological resources; socioeconomic characteristics; and an increased risk to human health and safety from potential radiological emissions. Expansion of existing industry and the planned development of new industries in the vicinity of the Bellefonte site also would affect the environmental and socioeconomic characteristics of the region. **Table 5–61** indicates industrial expansion would occur in Jackson County, and that additional population growth would occur in the absence of any developments at Bellefonte (TVA 1997f). **Table 5–62** shows the cumulative impacts for two-unit operation at the Bellefonte site.

Table 5–61 Announced Major Recent and Future Expansions and New Industrial Facilities for Jackson County (1997 and 1998)[a]

Nature of Business	*Size of Expansion/Facility*	*Location*
Aluminum forming (Southeastern Metals)	1997 New Facility - 25 new jobs, $1.6 million	Scottsboro
Nylon fiber (Beaulieu)	1997 Expansion - 15 jobs, $28 million 1998 Expansion - 50 jobs, $25 million	Bridgeport
Coaxial TV cable for electronics (CommScope, Inc.)	1997 Expansion - 81 jobs 1998 Expansion - 40 jobs	Scottsboro
Air purifiers (Environmental Health)	1997 Expansion - 45 jobs	Scottsboro
Floor rugs (Maple Industries)	1997 Expansion - 120 jobs 1998 Expansion - 50 jobs, $4.0 million	Scottsboro
Rolled Aluminum (Norandal USA)	1997 Expansion - $5 million	Scottsboro
Industrial Plastics (Polymer Industries)	1997 Expansion - 20 jobs, $2.1 million	Henagar
U.S. Textiles	1997 Expansion - 43 jobs	Scottsboro
Wausau Homes	1998 New - 175 jobs	Scottsboro

Nature of Business	Size of Expansion/Facility	Location
ARES Corporation	1998 New - 45 jobs, $5.9 million	Scottsboro
Premier Industries	1998 New - 40 jobs	Scottsboro
Buccaneer Rope	1998 New - 40 jobs	Skyline
Wenzel Metals	1998 Expansion - 15 jobs, $1.66 million	Scottsboro

[a] Only those expansions larger than 40 new jobs or a $1 million investment are listed.
Source: Jackson County 1998.

Table 5–62 Cumulative Impacts at the Bellefonte Nuclear Plant Site

Resource/Material Categories	Tritium Production Increment [a]	Cumulative Total [b]
Land resources	Potential permanent land requirement - 3.4 acres of developed land at the ISFSI if constructed and a small amount of land for support buildings	1,500 acres (existing developed land, no additional undisturbed land requirement)
Air quality		
Nonradiological emissions	Additional emissions; concentrations within standards (see Tables 5–23 and 5–25)	Additional emissions; concentrations within standards (see Tables 5–23 and 5–25)
Greenhouse gases (carbon dioxide)	0.031 metric tons per year	0.031 metric tons per year
Radiological emissions	Annual radiological emissions of tritium: 1,000 TPBARs: 105.6 Curies 3,400 TPBARs: 345.6 Curies Other emissions: 283 Curies	Annual radiological emissions of tritium: 1,000 TPBARs: 211 Curies 3,400 TPBARs: 691 Curies Other emissions: 566 Curies
Water quality		
Surface water	Increased surface water use and discharge. Water usage less than 1 percent of Tennessee River flow. All water quality parameters within limits (see Tables 5–21, 5–22, and 5–23).	Increased surface water use and discharge. Water usage less than 1 percent of Tennessee River flow. All water quality parameters within limits (see Tables 5–21, 5–22, and 5–23).
Radioactive effluent	Annual radiological effluent of tritium: 1,000 TPBARs: 1,539 Curies 3,400 TPBARs: 3,699 Curies Other releases: 1.32 Curies	Annual radiological effluent of tritium: 1,000 TPBARs: 3,078 Curies 3,400 TPBARs: 7,398 Curies Other releases: 2.6 Curies
Groundwater	No groundwater requirements or additional impacts to groundwater quality conditions	No change from current groundwater requirements or additional impacts to groundwater quality conditions
Ecological resources	Additional impacts on ecological resources including fish impingement and entrainment of aquatic biota and thermal impacts of less than 5°F on resident aquatic communities in the vicinity of the diffuser	Additional impacts on ecological resources including fish impingement and entrainment of aquatic biota and thermal impacts of less than 5°F on resident aquatic communities in the vicinity of the diffuser
Socioeconomics	800 to 1,000 workers. 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 7.9 percent to approximately 5.9 percent; and minor impacts to school resources.	1,555 to 1,755 workers including other industries. 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 7.9 percent to approximately 4.4 percent); and minor impacts to school resources.

Resource/Material Categories	Tritium Production Increment [a]	Cumulative Total [b]
Public and occupational health and safety Normal operation	Annual dose for 1,000 TPBARs: *Average worker*: 104.33 millirem *Maximally exposed (offsite) individual*: 0.26 millirem *50-mile population*: 1.6 person-rem Annual dose for 3,400 TPBARs: *Average worker*: 105.1 millirem *MEI*: 0.28 millirem *50-mile population*: 2.3 person-rem	Annual dose for 1,000 TPBARs: *Average worker*: 104.33 millirem *Maximally exposed (offsite) individual*: 0.52 millirem *50-mile population*: 3.2 person-rem Annual dose for 3,400 TPBARs: *Average worker*: 105.1 millirem *MEI*: 0.56 millirem *50-mile population*: 4.6 person-rem
Waste management	Low-level radioactive waste: approximately 41 cubic meters per year	Low-level radioactive waste: approximately 82 cubic meters per year
Spent nuclear fuel generation	less than 2,000 TPBARs: 72 fuel assemblies per cycle 3,400 TPBARs: up to a maximum of 141 fuel assemblies per cycle	less than 2,000 TPBARs: 144 fuel assemblies per cycle from both units 3,400 TPBARs: up to a maximum of 213 fuel assemblies per cycle from both units

[a] Assumes tritium production in one unit.
[b] Assumes tritium production in both units.

5.3.3 TPBAR Transportation

In determining the impacts of the transportation of DOE-owned spent fuel, the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995a) analyzed the cumulative impacts of all transportation of radioactive materials, taking into account impacts from reasonably foreseeable actions that include transportation of radioactive material and general radioactive materials transportation that is not related to a particular action. The total worker and general population collective doses are summarized in **Table 5–63**. Total collective worker doses from all types of shipments (historical, the alternatives, reasonably foreseeable actions, and general transportation) were estimated to be 320,000 person-rem (130 latent cancer fatalities) for the period 1943 through 2035 (93 years). Total general population collective doses were also estimated to be 320,000 person-rem (160 latent cancer fatalities). The majority of the collective dose for workers and the general population resulted from the general transportation of radioactive material. Examples of these activities are shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of commercial low-level radioactive waste to commercial disposal facilities. The total number of latent cancer fatalities estimated to result from radioactive materials transportation over the period between 1943 and 2035 was 290. Over this same period of time (93 years), approximately 28 million people would die from cancer, based on 300,000 cancer fatalities per year (NRC 1977). It should be noted that the estimated number of transportation-related latent cancer fatalities would be indistinguishable from other latent cancer fatalities, and the transportation-related latent cancer fatalities would be 0.0010 percent of the total number of latent cancer fatalities.

Table 5–63 Cumulative Transportation-Related Radiological Collective Doses and Latent Cancer Fatalities (1943 to 2035)

Category	*Worker Dose (person-rem)*	*General Population Dose (person-rem)*
CLWR		
Shipment of TPBAR and LLW	less than 100	less than 100
Latent cancer fatalities from TPBAR and LLW	less than 1	less than 1
Other nuclear material shipments		
Reasonably foreseeable actions[a]		
Truck	11,000	50,000
Rail	820	1,700
General transportation (1943–2035)	310,000	270,000
Total collective dose	320,000	320,000
Total latent cancer fatalities	130	160

LLW = Low-level radioactive waste.
[a] DOE 1995a.

5.3.4 Impacts at the Tritium Extraction Facility

An integral part of the program to produce tritium in a CLWR is the Tritium Extraction Facility proposed for construction and operation at DOE's Savannah River Site in South Carolina (as discussed in Section 1.5.2.2). The Draft EIS for the Tritium Extraction Facility was issued in May 1998; a Final EIS was issued concurrently with the CLWR EIS (DOE 1998c, DOE 1999b). **Table 5–64** provides a summary of the environmental impacts associated with the Preferred Alternative in the Tritium Extraction Facility EIS. Since the Tritium Extraction Facility EIS was developed in parallel with the CLWR EIS, the impacts shown in Table 5–64 are those provided in the Draft Tritium Extraction Facility EIS. These impacts are not expected to change in the Final EIS.

Table 5–64 Summary of Environmental Impacts, Tritium Extraction Facility

Resource	*Savannah River Site Baseline*	*Increment Above Baseline for Preferred Alternative*
Schedule and Operating Parameters		
Construction	Tritium Extraction Facility is not built	5 years
Annual electricity (megawatt-hours)		20,600
Annual sanitary wastewater (gallons)		770,000
Annual radioactive process wastewater (gallons)		11,000

Resource	***Savannah River Site Baseline***	***Increment Above Baseline for Preferred Alternative***
Impacts to the Physical and Manmade Environment		
Geology	Existing sites are cleared and graded, grassed, paved, or graveled, and used for industrial purposes	Minimal construction impacts through application of best management practices and compliance with Federal and state regulations. Minor dewatering during construction activities near or below the water table. Design would prevent process water migration into the groundwater during operations. With an immediate response by Savannah River Site to contain and remediate spills, it is unlikely that a spill would impact groundwater.
Surface water	Construction in an industrial area with established stormwater control systems Permitted process wastewater discharges Permitted sanitary wastewater discharges	Minimal construction impacts; construction would not disturb undeveloped areas. Effluent treatment would remove radioactive cobalt from process water to safe levels before discharge to Upper Three Runs. Tritium concentration in the effluent would be less than the regulatory limit of 20,000 picocuries per liter. Effluent would be treated before release to Fourmile Branch. All discharges would be within permit limits. Minimal impacts expected.
Air resources Nonradiological constituent concentrations at the Savannah River Site and Allied General Nuclear Services Facility site boundaries	Concentrations vary from approximately 0 to 60 percent of applicable standards and average 25 percent.[a]	Concentrations vary from approximately 0 to 0.19 percent of applicable standards and average 0.02 percent.[a] Ozone concentrations (measured as VOCs) would be 0.19 percent of the regulatory standard of 235 $\mu g/m^3$. All other contaminant levels would be less than 0.02 percent of their respective regulatory standards.
Annual radiological dose to the maximally exposed (offsite) individual (millirem). Dose limit = 10 millirem per year.	0.05 millirem	0.02 millirem: The emission is 0.2 percent of the dose limit.

Resource	***Savannah River Site Baseline***	***Increment Above Baseline for Preferred Alternative***
Impacts to the Physical and Manmade Environment Continued		
Waste		
Total estimated construction debris (metric tons)	Not applicable	385
Total operations waste by type (cubic meters)		
High-level	150,750 (30 years)	0 (40 years)
Low-level	343,710 (30 years)	9,320 (40 years)
Hazardous or mixed	90,450 (30 years)	132 (40 years)
Transuranic	18,090 (30 years)	0 (40 years)
Impacts to Human Environment		
Aesthetics[b]	Area is not visible to and noise is not heard by offsite public. Historical and archaeological resources are not present.	Temporary increase in noise during construction phase, but it would not be heard by the offsite public. No adverse aesthetic impacts during Tritium Extraction Facility operation. Historical and archaeological resources are not present.
Socioeconomics	Savannah River Site employment is assumed to decline to 10,000 employees by 2001, and regional growth trends are expected to continue.	Regional temporary increase of 740 jobs during peak year of construction, which is 0.29 percent of the projected baseline regional employment of 258,000 jobs. The number of jobs at the Savannah River Site would decline to 108 for Tritium Extraction Facility operation. The overall effects would be positive in terms of assisting to stabilize the regional employment base.
Environmental justice	Minorities or low-income communities would not receive disproportionately high and adverse impacts.	Health effects would be minimal. Minority or low-income communities would not be disproportionately affected.
Public health		
Annual probability of fatal cancer to the maximally exposed (offsite) individual (annual fatal cancer risk from all natural causes is 3.4×10^{-3}).	9.5×10^{-8}	1.0×10^{-8}
Occupational health		
Total estimated number of additional latent cancer facilities to all involved workers from an annual dose.	0.066	0.0016
Number of construction worker injuries resulting in lost work time.	Not applicable	11

Resource	***Savannah River Site Baseline***	***Increment Above Baseline for Preferred Alternative***
	Impacts to Human Environment Continued	
Accidents[c] Additional latent cancer facilities in offsite population	Not applicable	
Annual frequency — Bounding accident		
$>10^{-2}$ — Hood or room fire		0.4
$\geq 10^{-4}$ to $\leq 10^{-2}$ — Area fire		0.4
$\geq 10^{-6}$ to $<10^{-4}$ — Design-basis seismic event with a fire		0.7
	Impacts to Ecological Resources	
Terrestrial ecology	The affected environment is within developed areas consisting of paved lots, graveled surfaces, buildings and trailers, providing minimal terrestrial wildlife habitat.	No physical alterations to the landscape outside of H Area, but limited potential to disturb any nearby resident wildlife as a result of construction and operations noise.
Aquatic ecology	No aquatic habitat within H Area boundaries.	All construction activities would occur under best management practices to limit sedimentation in detention basins. Operations wastewater would be discharged through NPDES-permitted outfalls. DOE would continue to comply with the regulatory standards for water quality established for these outfalls.
Wetland ecology	No wetland habitat within H Area boundaries.	Wetlands in the Upper Three Runs watershed, including Crouch Branch, or the Fourmile Branch watershed would not be adversely affected by the construction and operation of the Tritium Extraction Facility
Threatened and endangered species	No threatened and endangered species within H Area boundaries	No threatened or endangered species live or forage in H Area. There would be no adverse impact.

$\mu g/m^3$ = micrograms per cubic meter.

[a] Concentration increments that would be less than 0.1 percent of standard for both locations are not listed.

[b] Includes land use, visual resources and noise, and historical and archeological resources.

[c] Events with the most additional latent fatalities in offsite public are a full-facility fire and a design-basis earthquake with a secondary fire.

AGNS = Allied General Nuclear Services Facility.
VOCs = Volatile Organic Compound.
Source: DOE 1998c.

5.4 RESOURCE COMMITMENTS

This section describes the unavoidable adverse environmental impacts that could result from the proposed action, short-term uses of the environment, maintenance and enhancement of long-term productivity, and irreversible and irretrievable commitments of resources.

5.4.1 Unavoidable Adverse Environmental Impacts

Construction and operation activities associated with the irradiation of TPBARs at the CLWR sites and the transportation of the irradiated TPBARs to the Tritium Extraction Facility at DOE's Savannah River Site would result in unavoidable adverse impacts to the human environment. In general, the unavoidable adverse impacts from the operation of Watts Bar and Sequoyah are the incremental impacts attributed to tritium production. For the Bellefonte units, the unavoidable adverse impacts are associated with the full operation of the units as a nuclear reactor plant.

Unavoidable adverse impacts at the Watts Bar and Sequoyah sites would be related to the construction activity if the plants are required to provide additional spent fuel dry storage. Workers would receive exposure from the direct and skyshine radiation of the spent fuel already stored there. These exposures would be of the order of 40 to 50 person-rem. In addition, approximately 2 to 2.5 hectares (5 to 6 acres) of land within the site boundary at each site would be disturbed. Any liquid and solid waste generated during the construction activities, none of which would be radioactive, would be collected at the site, stored, and eventually removed for suitable recycling or disposal off site in accordance with applicable EPA regulations.

The construction activities that could be required for the completion of the Bellefonte units and the associated spent fuel dry storage facility would result in unavoidable adverse impacts on land, air, and water resources. The limited amount of land disturbance would result in small impacts to the ecological resources and public and occupational health and safety. More significant adverse effects associated with the completion of the Bellefonte units would be socioeconomic, arising from the rapid increase of the work force in the region of influence. These effects would be offset by the long-term benefits.

Operation of Watts Bar or Sequoyah in a tritium-producing mode would result in unavoidable increases of radiation exposures to workers and the general public. Annual doses from routine radiological air emissions from the proposed action to the maximally exposed individual, general population, and workers are discussed in Sections 5.2.1.9 and 5.2.2.9.

Operation of the Bellefonte units would result in unavoidable impacts to air and water quality, visual resources, and the surrounding communities. Air quality would be affected by routine radioactive gaseous emissions typical of CLWR operations. Impacts to water resources could affect surface use and quality because of routine radioactive liquid effluent releases and the need for cooling water. The routine emission of chemicals would affect the aquatic biota near the plant intake and discharge pipes. Socioeconomic resources of the community could be affected. These impacts would be associated with the operation of Bellefonte as a nuclear power plant regardless of tritium production. They have also been addressed in the EIS for the construction and operation of Bellefonte 1 and 2, issued by the Tennessee Valley Authority in 1974 (AEC 1974).

Spent nuclear fuel would be generated as an unavoidable result of reactor operations to produce tritium. If more than approximately 2,000 TPBARs were to be irradiated at a single unit, construction of a new dry cask ISFSI could be required. However, as stated in Section 3.2.7, under the Preferred Alternative DOE and TVA would minimize, to the extent practicable, the generation of additional spent nuclear fuel. Also unavoidable would be the generation of additional low-level radioactive waste, which would be transported and managed off site at the low-level radioactive waste disposal facility at the Barnwell facility or at the Savannah River Site.

5.4.2 Relationship Between Local Short-Term Uses of the Environment and Enhancement of Long-Term Productivity

Each reactor site would require additional land for the construction of a dry cask ISFSI. Such short- term usage would remove this land from other beneficial uses for the facilities as CLWRs. This land, which is within the site boundary at each candidate site, would not be expected to be used for any other activities as long as the plant is operating.

The use of CLWRs to produce tritium is significant in that carbon dioxide emissions associated with the accelerator option for producing tritium would be avoided. Producing tritium in a CLWR would not add to the “greenhouse” effect and global warming (see Sections 5.2.11 and 5.3).

The use of short-term resources to complete and operate the Bellefonte units for tritium production would affect the long-term productivity of the site by providing both a secure and reliable source of tritium to meet the nation’s needs and production of electricity. The purpose and need for the Bellefonte units as a nuclear power plant is the subject of the *Final Environmental Impact Statement Related to the Construction of Bellefonte Nuclear Plant Unit 1 and Bellefonte Unit 2* (AEC 1974).

5.4.3 Irreversible and Irretrievable Commitments of Resources

This section discusses the major irreversible and irretrievable commitments of resources resulting from the proposed action. A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource. An irreversible commitment refers to the use or consumption of resources that are neither renewable nor recoverable for later use by future generations. The discussion is divided into the functional segments of the proposed action, such as TPBAR fabrication and irradiation.

TPBAR Fabrication

Under the proposed action up to 4,000 TPBARs would need to be fabricated annually for the 40-year duration of the program. The materials involved in the fabrication of the TPBARs, such as lithium, aluminum, stainless steel, and zirconium, would be rendered radioactive during the tritium production process. These materials then would be consumed or reduced to unrecoverable forms of waste. In large part, however, the TPBARs would replace the burnable absorber rods normally used in the operation of the CLWRs and would produce no net change in the irretrievable material resources. None of the associated material resources associated with the fabrication of the TPBARs is in short supply. Material resources associated with the fabrication of the TPBARs are presented in Section 5.2.7.

TPBAR Irradiation

At the reactor facilities where construction is necessary (such as the completion of Bellefonte 1 and 2), the materials required include wood, concrete, sand, gravel, plastics, aluminum, steel, and other materials. No unusual construction materials requirements have been identified for any of the alternative sites. None of these identified construction resources is in short supply. No additional transmission lines, roads, rail line, water pipeline, wastewater pipeline, or wastewater treatment facilities would be required for Watts Bar or Sequoyah as a result of tritium production. Additional material (e.g., concrete and steel) would be required if an ISFSI were to be constructed.

Resources that would be consumed during completion of construction at Bellefonte 1 and 2 are summarized in **Table 5–65.**

Table 5–65 Resources Consumed During Construction–Bellefonte 1 and 2

Resources	Total Consumed	
	Bellefonte 1	Bellefonte 2
Utilities		
Electricity	575,000 megawatts-electric (80 megawatts peak demand [a])	500,000 megawatts-electric (80 megawatts peak demand [a])
Water	280,000 cubic meters (330 cubic meters per day peak demand [a])	160,000 cubic meters (280 cubic meters per day peak demand [a])
Solids		
Concrete	2,190 cubic meters	1,791 cubic meters
Steel	353 metric tons	98 metric tons
Liquids		
Fuel	9,652,872 liters	3,785,440 liters
Gases		
Industrial gases [b]	500 cubic meters	1,300 cubic meters

[a] Peak demand is the maximum rate expected during any hour.
[b] Standard cubic meter measured at 1 atmosphere and 15.55°C.
Source: TVA 1995b.

Additional materials for nuclear fuel assemblies would be required to operate the reactors in a tritium-producing mode. Materials associated with nuclear fuel assemblies include uranium, steel, and zircaloy. After irradiation, these materials and other material byproducts of the fission and irradiation process constitute the high-level radioactive waste constituents of the spent nuclear fuel. At this time, all constituents of the spent fuel are considered nonrecoverable since no reprocessing of the spent fuel is allowed. Material resources associated with use of additional nuclear fuel assemblies were discussed in Section 5.2.7.

5.5 MITIGATION MEASURES

Following the completion of an EIS and its associated Record of Decision, DOE is required to prepare a Mitigation Action Plan that addresses any mitigation commitments expressed in the Record of Decision (10 CFR, 1021.331). This Mitigation Action Plan is required to explain how the corresponding mitigation measures designed to mitigate adverse environmental impacts associated with the course of action directed by the Record of Decision will be planned and implemented. This Mitigation Action Plan is to be prepared before DOE takes any action directed by the Record of Decision that is the subject of a mitigation commitment.

Based on the analyses of the environmental consequences resulting from the proposed action, no mitigation measures would be necessary since all potential environmental impacts would be substantially below acceptable levels or promulgated standards. However, each potential reactor site would follow construction and/or operational practices that would minimize the impacts in such areas as air and surface water quality, noise, operational and public health and safety, and accident prevention and mitigation. These practices are dictated by Federal and state licensing and permitting requirements, as described in Chapter 6.

The completion of the Bellefonte facility could cause impacts which might require mitigative actions. In this situation, the final completion of construction activities would require a large number of workers. Since many of these workers are not available in the immediate area, there would be an immigration to the area for the construction period. Such an immigration could impact the available housing inventory and could place substantial demands upon the school system by requiring additional facilities, teachers, administrators, and buses. Section 5.2.3.8 also estimates a noticeable increase in local traffic over current levels during the potential completion and operation of one or both Bellefonte units. As discussed in that section, possible measures that could be used to mitigate traffic volume impacts are physical improvements to the local roads or road network to increase capacity, including construction of additional vehicle lanes throughout road segments, construction of passing lanes in certain locations, or realignment to eliminate some of the no-passing zones. Employee programs that provide flexible hours could also reduce road travel during peak hours, and restrictions for trucks traveling during the peak hours could be made. Also, establishing employee programs and incentives for ride-sharing could be encouraged, and bus and/or vanpool programs could be initiated.

Although mitigative actions are discussed in the CLWR EIS for these areas, no commitment on the part of DOE can be made until the Record of Decision is issued. It should be noted that the completion of the Bellefonte facility is not the Preferred Alternative.

Although not anticipated, it is possible that DOE may commit to mitigative actions in the CLWR Record of Decision. If this occurs, the Department would prepare a Mitigation Action Plan explaining how all mitigative actions would be planned for and implemented. Such a Mitigation Action Plan would be prepared prior to taking any actions directed by the Record of Decision. Copies of such a Mitigation Action Plan would be placed in the appropriate DOE reading rooms and would be provided to interested parties upon written request.