Watts Bar Nuclear Plant

Sequoyah Nuclear Plant

Draft Supplemental Environmental Impact Statement

for the Production of Tritium in a Commercial Light Water Reactor

Summary

U.S. Department of Energy
National Nuclear Security Administration

DOE/EIS-0288-S1

August 2014

ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
CLWR	commercial light water reactor
DOE	U.S. Department of Energy
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FR	*Federal Register*
NEPA	*National Environmental Policy Act of 1969*
NNSA	National Nuclear Security Administration
NRC	U.S. Nuclear Regulatory Commission
SEIS	supplemental environmental impact statement
TPBAR	tritium-producing burnable absorber rod
TVA	Tennessee Valley Authority

UNDERSTANDING SCIENTIFIC NOTATION

NNSA has used scientific notation in this SEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers of 10. The number written in scientific notation is expressed as the product of a number and a positive or negative power of 10. Examples include the following:

Positive powers of 10	Negative powers of 10
$10^1 = 10 \times 1 = 10$	$10^{-1} = 1 \div 10 = 0.1$
$10^2 = 10 \times 10 = 100$	$10^{-2} = 1 \div 100 = 0.01$
and so on, therefore,	and so on, therefore,
10^6 = 1,000,000 (or 1 million)	10^{-6} = 0.000001 (or 1 in 1 million)

Probability is expressed as a number between 0 and 1 (0 to 100 percent likelihood of the occurrence of an event). The notation 3×10^{-6} can be read 0.000003, which means that there are 3 chances in 1 million that the associated result (for example, a fatal cancer) will occur in the period covered by the analysis.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor		Scientific notation
tera-	T	1,000,000,000,000	=	1×10^{12}
giga-	G	1,000,000,000	=	1×10^{9}
mega-	M	1,000,000	=	1×10^{6}
kilo-	k	1,000	=	1×10^{3}
deca-	D	10	=	1×10^{1}
deci-	d	0.1	=	1×10^{-1}
centi-	c	0.01	=	1×10^{-2}
milli-	m	0.001	=	1×10^{-3}
micro-	μ	0.000001	=	1×10^{-6}
nano-	n	0.000000001	=	1×10^{-9}
pico-	p	0.000000000001	=	1×10^{-12}

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CONVERSION FACTORS

Metric to English			English to Metric		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
square kilometers	247.1	acres	acres	0.0040469	square kilometers
square kilometers	0.3861	square miles	square miles	2.59	square kilometers
square meters	10.764	square feet	square feet	0.092903	square meters
Concentration					
kilograms/square meter	0.16667	tons/acre	tons/acre	0.5999	kilograms/square meter
milligrams/liter	1[a]	parts/million	parts/million	1[a]	milligrams/liter
micrograms/liter	1[a]	parts/billion	parts/billion	1[a]	micrograms/liter
micrograms/cubic meter	1[a]	parts/trillion	parts/trillion	1[a]	micrograms/cubic meter
Density					
grams/cubic centimeter	62.428	pounds/cubic feet	pounds/cubic feet	0.016018	grams/cubic centimeter
grams/cubic meter	0.0000624	pounds/cubic feet	pounds/cubic feet	16,025.6	grams/cubic meter
Length					
centimeters	0.3937	inches	inches	2.54	centimeters
meters	3.2808	feet	feet	0.3048	meters
micrometers	0.00003937	inches	inches	25,400	micrometers
millimeters	0.03937	inches	inches	25.40	millimeters
kilometers	0.62137	miles	miles	1.6093	kilometers
Temperature					
Absolute					
degrees Celsius × 1.8	+32	degrees Fahrenheit	degrees Fahrenheit−32	×0.55556	degrees Celsius
Relative					
degrees Celsius	1.8	degrees Fahrenheit	degrees Fahrenheit	0.55556	degrees Celsius
Velocity or Rate					
cubic meters/second	2,118.9	cubic feet/minute	cubic feet/minute	0.00047195	cubic meters/second
meters/second	2.237	miles/hour	miles/hour	0.44704	meters/second
Volume					
cubic meters	264.17	gallons	gallons	0.0037854	cubic meters
cubic meters	35.314	cubic feet	cubic feet	0.028317	cubic meters
cubic meters	1.3079	cubic yards	cubic yards	0.76456	cubic meters
cubic meters	0.0008107	acre-feet	acre-feet	1,233.49	cubic meters
liters	0.26418	gallons	gallons	3.78533	liters
liters	0.035316	cubic feet	cubic feet	28.316	liters
liters	0.001308	cubic yards	cubic yards	764.54	liters
Weight/Mass					
grams	0.035274	ounces	ounces	28.35	grams
kilograms	2.2046	pounds	pounds	0.45359	kilograms
kilograms	0.0011023	tons (short)	tons (short)	907.18	kilograms
metric tons	1.1023	tons (short)	tons (short)	0.90718	metric tons
English to English					
acre-feet	325,850.7	gallons	gallons	0.000003046	acre-feet
acres	43,560	square feet	square feet	0.000022957	acres
square miles	640	acres	acres	0.0015625	square miles

a. This conversion factor is only valid for concentrations of contaminants (or other materials) in water.

COVER SHEET

RESPONSIBLE AGENCY: U.S. Department of Energy (DOE), National Nuclear Security Administration (NNSA)

COOPERATING AGENCY: Tennessee Valley Authority (TVA)

TITLE: *Draft Supplemental Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (DOE/EIS-0288-S1) (SEIS)

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ABSTRACT: In March 1999, DOE published the *Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (DOE/EIS-0288; the 1999 EIS). The 1999 EIS addressed the production of tritium in TVA reactors using tritium-producing burnable absorber rods (TPBARs) and analyzed the potential environmental impacts of irradiating up to 3,400 TPBARs per reactor operating on an 18-month fuel cycle. The 1999 EIS included TPBAR irradiation scenarios using multiple reactors to irradiate a maximum of 6,000 TPBARs every 18 months. On May 14, 1999, DOE published the Record of Decision for the 1999 EIS, in which it announced its decision to enter into an agreement with TVA to produce tritium in the Watts Bar Unit 1 reactor (Watts Bar 1) in Rhea County, Tennessee, near Spring City, and Sequoyah Units 1 and 2 reactors (Sequoyah 1 and 2) in Hamilton County, Tennessee, near Soddy-Daisy. In 2002, TVA received license amendments from the U.S. Nuclear Regulatory Commission (NRC) to produce tritium in those reactors. Since 2003, TVA has been producing tritium for the NNSA by irradiating TPBARs only in Watts Bar 1. However, irradiation of TPBARs in the Sequoyah reactors has remained a viable option. TVA has never irradiated TPBARs in the Sequoyah reactors. After irradiation, NNSA transports the TPBARs to the Tritium Extraction Facility at the DOE Savannah River Site in South Carolina. NNSA has prepared this SEIS because there is new information about the amount of tritium required to support the nation's requirements (see Section S.3) and because TVA's experience in irradiating TPBARs has produced new information relevant to the potential environmental impacts at irradiation reactor sites that was not available when the 1999 EIS was prepared (see Section S.1). This SEIS does not revisit DOE's tritium extraction activities because the actions described in this SEIS would result in the extraction of tritium from fewer TPBARs at the Tritium Extraction Facility with subsequently fewer environmental impacts at the Savannah River Site than the 1999 EIS analyzed.

During irradiation of TPBARs in a reactor, while the great majority of tritium is captured inside the TPBARs, a small amount diffuses through the TPBAR cladding into the reactor coolant; this is called permeation. Based on several years of production experience at Watts Bar 1, NNSA has determined that tritium permeation through the cladding occurs at a higher rate than the 1999 EIS projected and analyzed; nevertheless, tritium releases to the environment have been below regulatory limits. NNSA has prepared

this SEIS to analyze the potential environmental impacts from TPBAR irradiation at TVA sites based on a high and thus conservative estimate of the tritium permeation rate and NNSA's revised estimate of the maximum number of TPBARs necessary to support the current tritium supply requirements.

The proposed action this SEIS evaluates is to irradiate up to a total of 2,500 TPBARs every 18 months in one or more TVA reactors. There are two reactors at both the Watts Bar site and the Sequoyah site. However, in the event of a reactor outage, there is a potential that more than 2,500 TPBARs would need to be irradiated every 18 months for some period of time after the outage to compensate for the temporary shortfall in tritium supply. Therefore, this SEIS also evaluates a maximum production scenario of irradiating 5,000 TPBARs every 18 months. The SEIS evaluates the potential environmental impacts from TPBAR irradiation for seven alternatives:

- The No-Action Alternative assumes irradiation of up to a total of 2,040 TPBARs every 18 months using the reactors identified in the 1999 ROD (Watts Bar 1, Sequoyah 1, and Sequoyah 2) to keep permeation levels under currently approved NRC license and regulatory limits.

- Alternative 1 assumes use of the Watts Bar site only to irradiate up to a total of 2,500 TPBARs every 18 months with no TPBAR irradiation at the Sequoyah site.

- Alternative 2 assumes use of the Sequoyah site only to irradiate up to a total of 2,500 TPBARs every 18 months with no TPBAR irradiation at the Watts Bar site.

- Alternative 3 assumes use of both the Watts Bar and Sequoyah sites to irradiate up to a total of 2,500 TPBARs every 18 months.

- Alternative 4 assumes use of the Watts Bar site only to irradiate up to a total of 5,000 TPBARs every 18 months with no TPBAR irradiation at the Sequoyah site.

- Alternative 5 assumes use of the Sequoyah site only to irradiate up to a total of 5,000 TPBARs every 18 months with no TPBAR irradiation at the Watts Bar site[1].

- Alternative 6 assumes use of both the Watts Bar and Sequoyah sites to irradiate up to a total of 5,000 TPBARs every 18 months.

The maximum number of TPBARs analyzed in this SEIS for irradiation in a single reactor (as opposed to a single site) is 2,500 TPBARs per fuel cycle versus the 3,400 TPBARs analyzed in the 1999 EIS. NNSA has identified Alternative 1 as its Preferred Alternative for this SEIS.

The results of the analyses presented in this SEIS indicate there would be no significant increase in radiation exposure associated with TPBAR irradiation for facility workers or the public. For all analyzed alternatives, estimated radiation exposures would remain well below regulatory limits (see Table C-1 in Appendix C for a list of regulatory limits). The calculated estimated exposures for normal reactor operation[2] with the maximum number of TPBARs would remain comparable to those for normal reactor operation without TPBARs.

1. Alternative 4, 5, and 6 are considered mutually exclusive to any other alternative, meaning that NNSA would not select any one of those alternatives in addition to another alternative in the Record of Decision, as that would exceed the maximum production scenario of irradiating 5,000 TPBARs every 18 months.
2. The term "normal operations" refers to a reactor operating as designed and in accordance with the parameters associated with its operating license. Normal operations can include operations with or without TPBARs inserted into the reactor core.

PUBLIC INVOLVEMENT: NNSA published a Notice of Intent to prepare the SEIS in the *Federal Register* (76 FR 60017) on September 28, 2011, to invite comments and suggestions on the proposed scope of the SEIS. NNSA requested public comments by mail, facsimile, or e-mail by the close of the scoping period on November 14, 2011. A public scoping meeting took place on October 20, 2011, at the Southeast Tennessee Trade and Conference Center in Athens, Tennessee. NNSA considered all scoping comments it received in the preparation of this Draft SEIS.

NNSA will accept comments by mail, facsimile, or e-mail on this Draft SEIS for a period of 45 days after publication of the U.S. Environmental Protection Agency's Notice of Availability in the *Federal Register*. Comments should be addressed to Mr. Curtis Chambellan using the contact information above. NNSA will consider all comments received or postmarked by the close of the comment period in the preparation of the Final SEIS. To the extent practicable, NNSA will consider comments it receives after the end of the comment period. NNSA will announce the time and location of a public hearing at a later date. This document is available on DOE's NEPA website at http://energy.gov/nepa/nepa-documents and NNSA's NEPA website at http://nnsa.energy.gov/nepa/tritiumseis.

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SUMMARY

The National Nuclear Security Administration (NNSA), which was established in March 2000 as a semi-autonomous agency within the U.S. Department of Energy (DOE), is the lead Federal agency responsible for maintaining and enhancing the safety, security, reliability, and performance of the U.S. nuclear weapons stockpile. Tritium, a radioactive isotope of hydrogen, is an essential component of every weapon in the U.S. nuclear weapons stockpile and must be replenished periodically due to its short half-life. NNSA has prepared this Supplemental Environmental Impact Statement (SEIS) to update the environmental analyses in DOE's *Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (DOE/EIS-0288; referred to in this document as the 1999 EIS). The 1999 EIS evaluated the potential environmental impacts from producing tritium using tritium-producing burnable absorber rods (TPBARs) in Tennessee Valley Authority (TVA) nuclear reactors. (Section 2.1 of this SEIS describes TPBARs). TVA is a cooperating agency for this SEIS.

The SEIS updates the potential radiological impacts of irradiation of TPBARs in TVA reactors to produce tritium because the tritium permeation rate is now known to be higher than originally estimated and because requirements have decreased so fewer TPBARs are required to be irradiated annually (see Sections S.2 and S.3 for a discussion of tritium requirements). The new analyses do not indicate that there would be any significant increase in radiation exposure associated with TPBAR irradiation for facility workers or the public. For all analyzed alternatives, estimated radiation exposures would remain well below regulatory limits (see Table C-1 of the SEIS for a list of regulatory limits). The calculated estimated exposures for normal reactor operations[3] with the maximum number of TPBARs would remain comparable to those for normal reactor operation without TPBARs.

S.1 Background

In the Record of Decision for the 1999 EIS, NNSA selected the TVA Watts Bar Unit 1 (Watts Bar 1) and Sequoyah Units 1 and 2 (Sequoyah 1 and 2), in Spring City and Soddy-Daisy, Tennessee, respectively, for tritium production (64 FR 26369; May 14, 1999). In 2002, TVA received license amendments from the U.S. Nuclear Regulatory Commission (NRC) to produce tritium in those reactors (NRC 2005). Since 2003, TVA has been producing tritium for NNSA, but has done this only in Watts Bar 1. TVA has not produced tritium in Sequoyah 1 or 2, but that has remained a viable option. NNSA's Interagency Agreement with TVA to irradiate TPBARs is in effect until November 30, 2035 (TVA 2012).

Tritium

Tritium is a radioactive isotope of hydrogen. It has two neutrons and one proton in the nucleus (ordinary hydrogen contains one proton and no neutrons in the nucleus). Tritium is chemically identical to hydrogen and deuterium. Both "H-3" and "T" are used as symbols to designate tritium. Tritium has a half-life of 12.3 years, meaning that every 12.3 years half of the tritium atoms decay to another nuclear form. As a result of this relatively short half-life, an amount of tritium will reduce by about 11 percent in 2 years, 25 percent in 5 years, 50 percent in 12.3 years, and 90 percent in 42 years.

During irradiation of TPBARs in a reactor, a small amount of tritium diffuses through the TPBAR cladding into the reactor coolant; this is called permeation. The 1999 EIS estimated that the permeation rate of tritium through the TPBAR cladding into the reactor coolant system would be less than or equal to 1 curie per TPBAR per year (DOE 1999). Based on tritium production experience at Watts Bar 1, NNSA

3. The term "normal operations" refers to a reactor operating as designed and in accordance with the parameters of its operating license. Normal operations can include operations with or without TPBARs inserted into the reactor core.

Tritium Releases and Regulatory Limits

Although there are no specific regulatory limits on tritium releases, there are regulatory limits to which tritium releases are *applicable.* For example, regulations implemented under the *Safe Drinking Water Act* require the tritium concentration at any drinking water intake to be below 20,000 picocuries per liter (40 CFR Part 141). Consequently, tritium releases that would result in tritium concentrations above 20,000 picocuries per liter at any drinking water intake would violate this regulatory limit.

Another example concerns public doses from radiation. The most stringent regulatory limits for public doses from normal operations are 10 millirem per year from all pathways, 3 millirem per year from the liquid pathway, and 5 millirem per year from the air pathway (see Table C-1 in Appendix C). Because tritium releases contribute to public doses, these releases are applicable to the overall dose limits. Sections 4.1.15 and 4.2.15 of this SEIS present a detailed analysis of applicable regulatory limits and tritium releases.

has determined that tritium permeation through the cladding is about three to four times higher than this estimate; nevertheless, tritium releases to the environment have been below regulatory limits (TVA 2013). To put this permeation rate into perspective, this represents less than 0.1 percent of the total tritium each TPBAR produces during irradiation. NNSA has prepared this SEIS to update the information provided in the 1999 EIS to include: (1) the analysis of the potential environmental impacts from TPBAR irradiation based on a conservative estimate of the tritium permeation rate, (2) NNSA's revised estimate of the maximum number of TPBARs necessary to support the current tritium supply requirements, and (3) a maximum production scenario of irradiating 5,000 TPBARs every 18 months, which NNSA might require as a contingency capability to compensate for potential future shortfalls in the event of a reactor outage.

Figure S-1 shows the tritium production process. As shown on that figure, after irradiation, NNSA transports the TPBARs to the Tritium Extraction Facility at the DOE Savannah River Site in South Carolina. The actions described in this SEIS would result in the extraction of tritium from fewer TPBARs and, as a result, fewer environmental impacts at the Savannah River Site than the 1999 EIS analyzed. In addition, there have been no significant changes at the Savannah River Site that would change the potential environmental impacts at the site from tritium extraction. As a result, TPBAR extraction activities and impacts at the Savannah River Site are not revisited in this SEIS.

S.2 Purpose and Need for Action

U.S. strategic nuclear systems are based on designs that use tritium gas. Because tritium decays at a rate of about 5.5 percent per year (i.e., every 12.3 years one-half of the tritium has decayed), periodic replacement is required as long as the United States relies on a nuclear deterrent. The nation, therefore, requires a reliable source of tritium to maintain its nuclear weapons stockpile. In the 1999 EIS, DOE assumed that up to 3 kilograms of tritium per year might need to be produced in commercial light water reactors (CLWRs) (DOE 1999). Since completion of the 1999 EIS, the projected need for tritium has decreased. Considering the design of the TPBARs and the efficiency of the tritium extraction process, NNSA has determined that irradiation of a maximum of 2,500 TPBARs every 18 months would produce enough tritium to meet current requirements (NNSA 2013). However, in the event of a reactor outage, there is a potential that more than 2,500 TPBARs would need to be irradiated every 18 months for some period of time after the outage to compensate for the temporary shortfall in tritium supply. Therefore, this SEIS also evaluates the potential environmental impacts associated with a maximum production scenario of irradiating 5,000 TPBARs every 18 months.

Chapter 2 of the 1999 EIS discussed the purpose and need for DOE action to produce tritium in one or more CLWRs (DOE 1999). That purpose and need remains the same today even though current tritium requirements are smaller than they were in 1999. Even with this reduced need, however, a higher-than-expected tritium permeation rate has resulted in limitations on the number of TPBARs that the NRC has

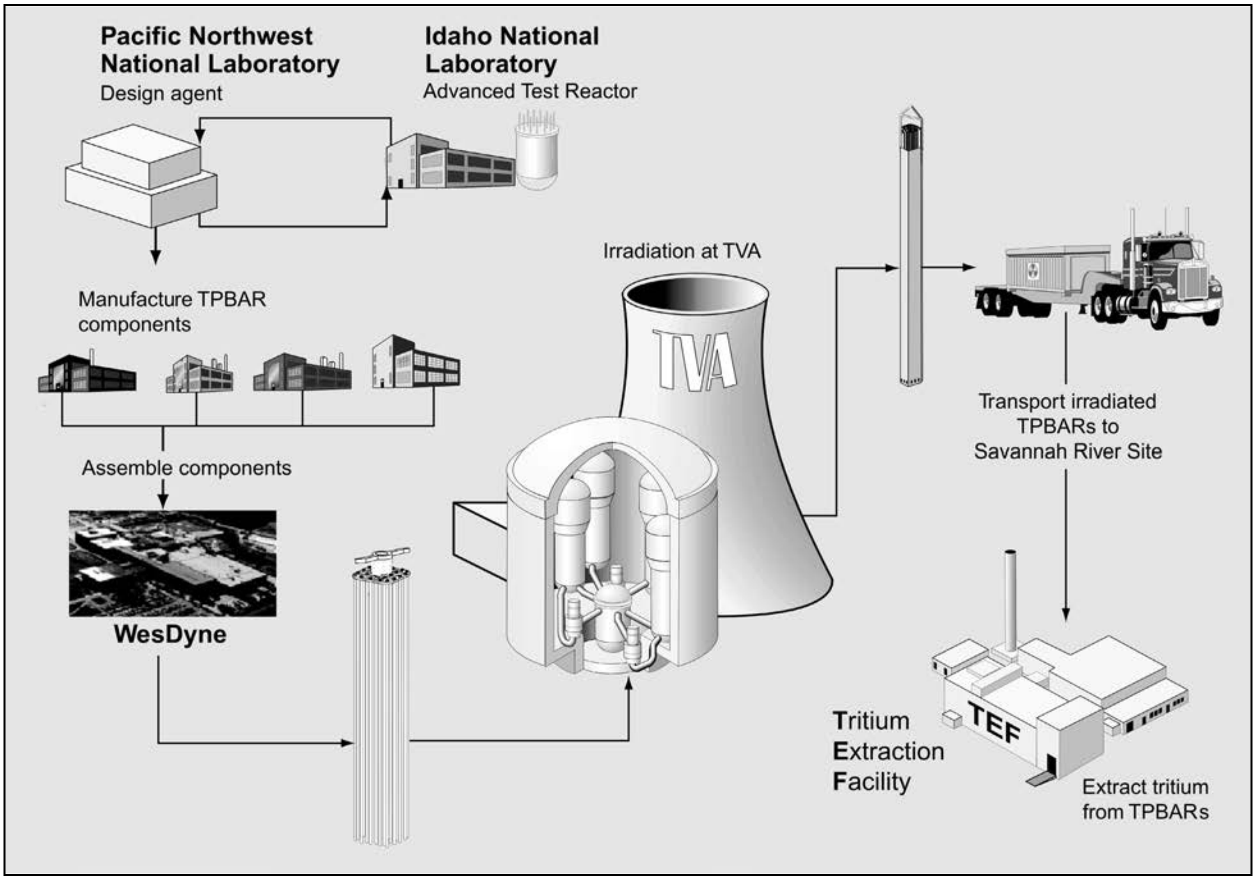

Figure S-1. Tritium production process.

permitted TVA to irradiate in its reactors.[4] As a result, TVA cannot currently irradiate enough TPBARs in its reactors to meet NNSA's projected tritium production requirements (NNSA 2013). NNSA and TVA are supplementing applicable environmental analyses in the 1999 EIS to analyze and evaluate the potential effects of the higher tritium permeation, to support the proposed action of increasing tritium production quantities to meet requirements. This SEIS has been prepared in accordance with Section 102(2)(C) of the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. §§ 4321 *et seq*.), the Council on Environmental Quality regulations (40 CFR Parts 1500 to 1508) and the DOE NEPA implementing regulations (10 CFR Part 1021), and follows DOE NEPA guidance.

National defense support has been one of TVA's historic multipurpose missions. TVA could adopt the SEIS and apply its analysis to update its environmental record for both Watts Bar and Sequoyah (Figure S-2).

S.3 Proposed Action and NNSA Tritium Requirements

The 1999 EIS assessed the potential environmental impacts of irradiating up to 3,400 TPBARs per reactor per fuel cycle (a fuel cycle lasts about 18 months). The 1999 EIS included TPBAR irradiation scenarios using multiple reactors to irradiate a maximum of 6,000 TPBARs every 18 months. Since DOE prepared

4. Because of the higher-than-previously-expected rate of permeation, TVA requested, and the NRC approved, a reduction in the number of TPBARs TVA can irradiate per fuel cycle. Section 1.3 of this SEIS discusses the NRC licensing process for TPBAR irradiation in the TVA reactors.

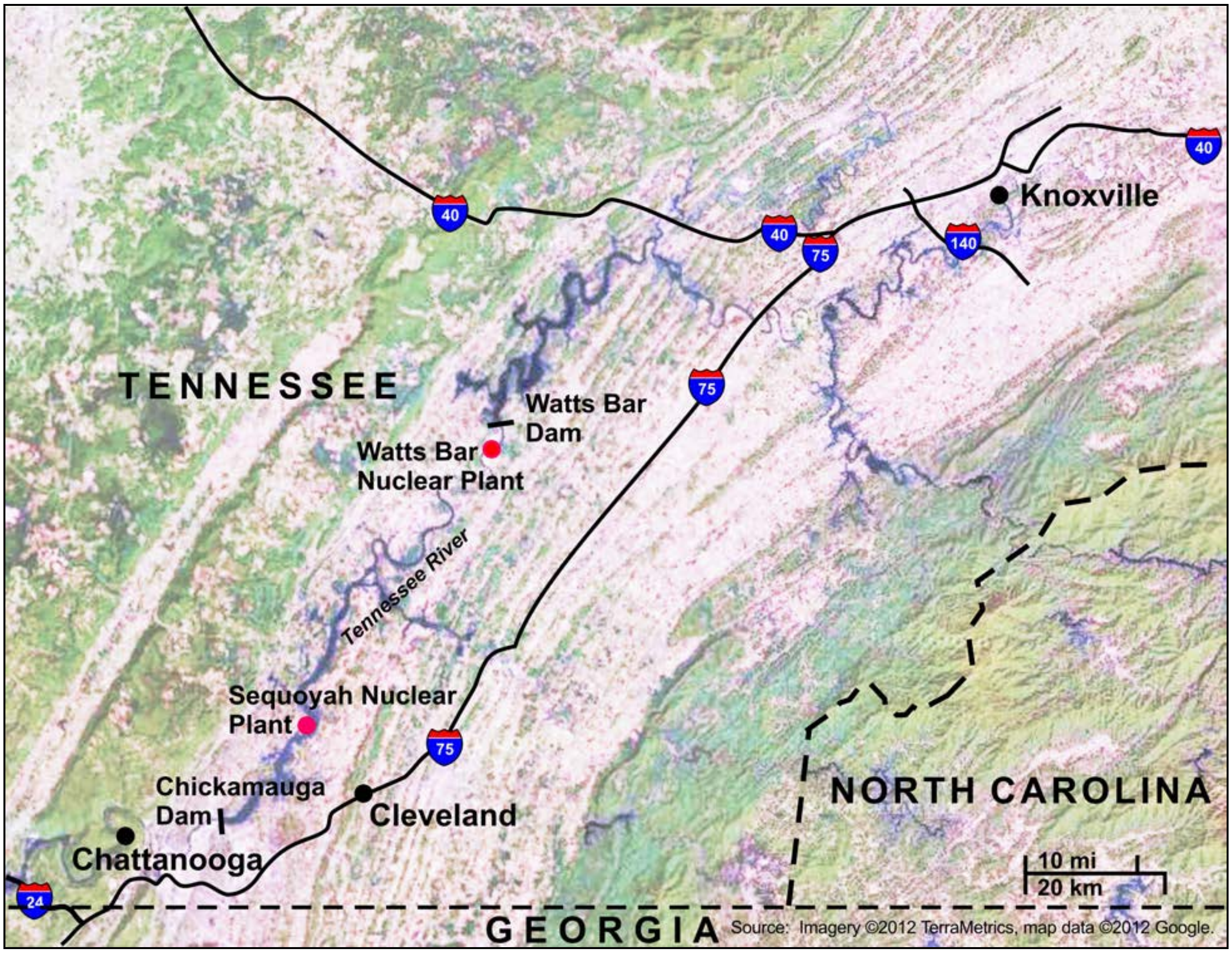

Figure S-2. Locations of TVA reactors.

the 1999 EIS, the projected need for tritium has decreased (NNSA 2013). Based on the *Fiscal Year 2014 Stockpile Stewardship and Management Plan* (NNSA 2013), NNSA needs a capability to irradiate up to 2,500 TPBARs every 18 months to meet current requirements (see Table 5-1 of NNSA 2013). The proposed action in this SEIS is to irradiate up to a total of 2,500 TPBARs every 18 months in one or more TVA reactors. In addition, as discussed above, this SEIS analyzes a maximum production scenario of irradiating 5,000 TPBARs every 18 months.

S.4 Public Scoping

NNSA published its Notice of Intent to prepare this SEIS in the *Federal Register* on September 28, 2011 (76 FR 60017), and invited stakeholders and the public to contribute to scoping the SEIS. A public scoping meeting took place on October 20, 2011, at the Southeast Tennessee Trade and Conference Center in Athens, Tennessee. The comment period closed on November 14, 2011. In addition to oral comments received at the scoping meeting, NNSA received a total of 25 comment documents (via hand-in at the scoping meeting, e-mail, and letter), from which NNSA identified 180 comments. This section summarizes the range of topics raised by commenters and how NNSA considered those comments.

- Water resources. Commenters expressed concern about increased pollution and contamination of the Tennessee River and the Chattanooga drinking water supply and indicated that the SEIS should address these issues.

Sections 4.1.5 and 4.2.5 assess the potential impacts to the Tennessee River and drinking water supplies as a result of TPBAR irradiation.

- Infrastructure. Commenters requested that the SEIS consider modification or enhanced physical protection of reactors as a result of the NRC report on earthquake- and tsunami-related damage at the Fukushima Dai-ichi Nuclear Power Plant in Japan.

  TVA works closely with the NRC to ensure its reactors meet all safety requirements. Sections 4.1.12 and 4.2.12 discuss the current readiness to respond to natural or man-made disasters and efforts by the NRC and TVA to identify possible gaps, vulnerabilities, or enhancements; and to provide short-, intermediate-, and long-term recommendations to improve overall ability to respond to such events. Those sections also present the potential human health consequences of a range of accident scenarios, including those initiated by natural phenomena. TPBAR irradiation does not affect safety requirements or response readiness. As discussed in Sections 4.1.12 and 4.2.12, because Watts Bar and Sequoyah have sufficient existing response readiness, NNSA concluded that additional discussions about augmenting readiness were unnecessary in this SEIS.

- Waste management. Commenters requested that the SEIS address the wastes associated with TPBAR irradiation and consider the increased storage requirements for spent nuclear fuel and disposition of the TPBARs.

  Sections 4.1.10 and 4.2.10 discuss the potential waste management impacts from TPBAR irradiation, including increases in low-level radioactive waste and spent nuclear fuel generation.

- Human health and safety. Commenters expressed concern about increases in radiation releases from increased tritium production and stated the SEIS should analyze the safety of the Savannah River Site tritium facilities and potential accident impacts to workers at the Watts Bar and Sequoyah sites and the public.

  Sections 4.1.12 and 4.2.12 discuss the potential impacts to public and worker health from both normal operations and accidents at Watts Bar and Sequoyah. The new information about changes to potential environmental impacts is specific to the function of the TPBARs in TVA reactors that produce tritium. The actions described in this SEIS would result in extraction of tritium from fewer TPBARs and fewer potential environmental impacts at the Savannah River Site than the 1999 EIS analyzed. In addition, there have been no significant changes at the Savannah River Site that would change the potential environmental impacts at the site from TPBAR tritium extraction. As a result, this SEIS does not revisit the potential environmental impacts for tritium extraction activities at DOE's Savannah River Site.

- Human health and safety. Commenters expressed concern that application of current radiological criteria to a "standard man" results in an under-assessment of impacts to women, children, infants and human embryos. Commenters requested the SEIS consider the impacts to women, children, infants, and human embryos specifically using more applicable criteria.

  Sections 4.1.11 and 4.2.11 discuss the potential impacts to human health and safety from TPBAR irradiation. The analysis methods are based on factors from the Interagency Steering Committee on Radiation Standards (ISCORS 2002). As shown in those sections, the potential annual dose to the maximally exposed individual would be less than 0.86 millirem at any site. Such an annual dose would be less than 0.2 percent of the 620 millirem average annual dose that an individual receives from natural and man-made radiation. Because the dose from TPBAR irradiation would *be insignificant in comparison with natural and man-made radiation, a more detailed analysis is not warranted.*

- Intentional destructive acts and accidents. Commenters identified several accident scenarios they believe that the SEIS should analyze including a catastrophic event beyond the foreseeable such as a major earthquake (on the scale of that which caused the Fukushima accident), loss of cooling systems and backup power, waste gas decay tank rupture, and increased likelihood of terrorist events due to tritium production.

  The SEIS analyses address the potential consequences of the scenarios identified by the commenters. Sections 4.1.12 and 4.2.12 present the potential human health consequences of a range of accident scenarios, including those initiated by natural phenomena such as earthquakes. In addition, Sections 4.1.12.8 and 4.2.12.8 address the potential impacts from intentional destructive acts, such as terrorism events. Unlike accident analysis, the analysis of intentional destructive acts provides an estimate of potential consequences without attempting to estimate the frequency or probability of a successful destructive act.

- Opposition to project. Commenters expressed opposition to continued or increased production of tritium.

  NNSA tritium production activities are carried out to meet requirements established in concert with the U.S. Department of Defense in accordance with national security policy. Therefore, NNSA has determined that policy questions about whether tritium should be produced will not be addressed in this SEIS.

- Nuclear weapons policy and treaties, purpose and need. Commenters expressed concern about continued weapons maintenance or production in light of the reduced stockpile levels the New Strategic Arms Reduction Treaty identified.

  The purpose and need discussed in the 1999 EIS remains valid today even though tritium requirements are smaller today than in 1999. Section 1.3 of this SEIS provides additional information about current tritium requirements. National security requirements are the programmatic driver for NNSA's continued need for TPBAR irradiation to supply tritium.

- Nonproliferation impact assessment, use of civilian reactors for weapons purposes. Commenters expressed opposition to use of TVA commercial reactors for production of weapons materials, stating it was in breach of the no-dual-use principle and contrary to nonproliferation efforts.

  Nonproliferation issues, which include the no dual-use principle, were addressed in detail during the 1999 EIS process, including the specific issue of using commercial reactors for tritium production. Section 1.2 of this SEIS provides additional information in relation to nonproliferation. As discussed in that section, NNSA has reassessed the relationship between the proposed action and U.S. nonproliferation policy and has concluded that the interagency assessment from 1998 is still valid and that there have been no changes in U.S. nonproliferation policy or regulations that would affect the conclusions presented during the 1999 EIS process.

- Environmental policy and permits. Commenters questioned the need for the original license amendment and requested that the SEIS address new or updated licensing requirements for the Sequoyah site.

Section 1.2 of this SEIS addresses the license amendment process and history for the Watts Bar and Sequoyah reactors in relation to TPBAR irradiation. For interested readers, general information on the NRC licensing process can be found at http://www.nrc.gov/reactors/new-reactor-op-lic/licensing-process.html (for new reactor licenses) and http://www.nrc.gov/reactors/operating/licensing/renewal/process.html (for amendments to existing reactor licenses).

- Cost. Commenters requested that the SEIS provide an accurate accounting of costs and explain why TVA has not recovered fees from DOE.

  Costs are usually beyond the scope of NEPA documents such as this SEIS. The cost agreements between DOE and TVA would not affect the potential environmental impacts of the alternatives analyzed in the SEIS. The Record of Decision will discuss costs if NNSA/TVA decisionmakers determine that they are a relevant consideration in making any decision informed by this SEIS.

- Cumulative impacts. Commenters requested that the SEIS address cumulative impacts including the TVA coal ash spill, radiological and mercury releases from the DOE Oak Ridge Reservation, and increased releases from commercial electricity production at the Watts Bar and Sequoyah sites.

  Chapter 5 of this SEIS presents the potential cumulative impacts from the proposed action and other current and reasonably foreseeable actions such as operations associated with the Oak Ridge Reservation and TVA operations at Watts Bar and Sequoyah.

- Technological aspects of tritium leakage. Commenters expressed concern about ongoing unresolved problems due to tritium leakage and questioned if NNSA planned to address the technical aspects of the leakage.

  Section 2.3.2.2 discusses engineering efforts to address TPBAR tritium permeation. As discussed in that section, the Pacific Northwest National Laboratory has redesigned several TPBAR components in an attempt to reduce tritium permeation into the reactor coolant. For example, Laboratory researchers modified the TPBAR to increase tritium capture efficiency. Despite this redesign, there was no discernible improvement in getter performance and tritium still permeates from the TPBARs at higher-than-previously-expected rates. The scientists and engineers continue to seek a technical solution. Even with this higher tritium permeation, the new analyses do not indicate that there would be any significant increase in radiation exposure associated with TPBAR irradiation for facility workers or the public. For all alternatives analyzed, estimated radiation exposures would remain well below regulatory limits. The calculated estimated exposures for normal reactor operations with the maximum number of TPBARs would remain comparable to those for normal reactor operation without TPBARs.

- Transportation. Commenters requested that the SEIS address transportation issues, risks, and dangers along the route between Athens, Tennessee, and the Savannah River Site in South Carolina.

  Sections 4.1.13, 4.2.13, and Appendix E address potential transportation impacts associated from tritium production, including the potential impacts of transportation between Tennessee and SRS.

S.5 Alternatives

The decision to irradiate TPBARs at the Watts Bar and Sequoyah sites was made in the Record of Decision that followed the issuance of the 1999 CLWR EIS. That decision is not being revisited in this SEIS. To supply tritium to meet stockpile requirements, NNSA could potentially use one or more of four TVA CLWR units at the Watts Bar and Sequoyah sites. The SEIS evaluates the impacts of seven alternatives. Table S-1 summarizes these alternatives and provides information about the number of TPBARs analyzed per site as well as the maximum number of TPBARs that could be irradiated every 18 months for each alternative.

Table S-1. SEIS tritium production alternatives.

	Alternatives									
	No-Action		**1**	**2**	**3**		**4**	**5**	**6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor Units	1	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs analyzed per site	680	1,360	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	2,040		2,500	2,500	2,500		5,000	5,000	5,000	

In the Notice of Intent to prepare this SEIS, NNSA stated that it would assess the impacts associated with tritium production in CLWRs based on a permeation rate of about 5 curies of tritium per TPBAR per year (76 FR 60017; September 28, 2011). Although the observed tritium permeation through the cladding has been less than 5 curies of tritium per TPBAR per year, the current permeation rate does not take into account potential uncertainties about operating cycle length, tritium production per TPBAR, and future operational changes that could occur at the TVA reactors, all of which could affect the permeation rate. Given these potential uncertainties in operational parameters, and after consultation with TVA and the Pacific Northwest National Laboratory (the TPBAR design agency), NNSA decided to evaluate an even higher and thus more conservative tritium permeation rate (10 curies of tritium per TPBAR per year) in this SEIS instead of 5 curies of tritium per TPBAR per year (TVA 2013, PNNL 2013a). NNSA, the Laboratory, and TVA have determined that a tritium permeation rate of 10 curies of tritium per TPBAR per year is the best estimate to ensure that the analyses in this SEIS would reasonably be expected to bound uncertainties in relation to future operations. By analyzing this higher tritium permeation rate, NNSA is confident that the SEIS provides a reasonable, but conservative and bounding, analysis of the potential environmental impacts from tritium production in the Watts Bar and Sequoyah reactors.

No-Action Alternative

The No-Action Alternative for the SEIS is based on the analysis in the 1999 EIS, the Record of Decision for the 1999 EIS, and analyses for NRC license applications and license amendment actions (see Section 1.2). The 1999 EIS analyzed the irradiation of up to 3,400 TPBARs in Watts Bar 1 and Sequoyah 1 and 2 with an assumed permeation rate of 1 curie of tritium per TPBAR per year. As such, the 1999 EIS analyzed the potential impacts associated with the release of 3,400 curies of tritium per year from each of those reactors. In the Record of Decision for the 1999 EIS, DOE selected Watts Bar 1 and Sequoyah 1 and 2 as the specific reactors to produce tritium for national security purposes [64 FR 26369; May 14, 1999]). Following the Record of Decision, TVA prepared applications to amend the Watts Bar 1 and Sequoyah 1 and 2 operating licenses to allow the irradiation of TPBARs in Watts Bar 1 and

Sequoyah 1 and 2, and the NRC issued applicable license amendments (see Section 1.2). Since 2003, TVA has irradiated TPBARs at Watts Bar 1 but has never irradiated TPBARs at Sequoyah 1 and 2.[5]

Consistent with the analysis in the 1999 EIS, the No-Action Alternative in this SEIS assumes that TVA would operate Watts Bar 1 and Sequoyah 1 and 2 to maintain tritium releases that would meet NRC license and regulatory limits. This means that each of these reactors could release no more than 3,400 curies of tritium per year. Based on a conservatively assumed permeation rate of 5 curies of tritium[6] per TPBAR per year, TVA could irradiate 680 TPBARs in each of the Watts Bar 1 and Sequoyah 1 and 2 reactors and stay within the maximum annual release of 3,400 curies of tritium analyzed in the 1999 EIS. Under the No-Action Alternative, the total number of TPBARs TVA could irradiate every 18 months would be 2,040 if TVA used all three currently available reactors for tritium production. This would be 460 TPBARs fewer than the 2,500 TPBARs that NNSA has determined it needs every 18 months to meet current requirements (NNSA 2013).

NNSA has defined the No-Action Alternative to represent the approach that would be taken to supply tritium in the TVA-operated Watts Bar 1 and Sequoyah 1 and 2 reactors within the bounds of the 1999 EIS and reasonably foreseeable NRC license amendments. Although the No-Action Alternative does not represent current operations at Watts Bar and Sequoyah, the impacts of those current operations are presented in Chapter 3.

Alternative 1: Watts Bar Only (Preferred Alternative)

The TVA Watts Bar site occupies about 1,000 acres in Rhea County, Tennessee, on the Tennessee River at River Mile 528 about 50 miles northeast of Chattanooga. Figure S-3 shows the general arrangement of the site. Under Alternative 1, TVA would irradiate up to a total of 2,500 TPBARs every 18 months at the Watts Bar site and would not irradiate TPBARs for tritium production at the Sequoyah site. TVA is currently completing construction of Watts Bar 2, and that reactor is expected to begin operations in about 2015 (TVA 2007). Although TVA has no plans to apply for a license amendment to allow Watts Bar 2 to produce tritium, the SEIS evaluates the potential environmental impacts associated with the use of Watts Bar 2 to provide the flexibility to use it in the future.

Alternative 2: Sequoyah Only

Sequoyah 1 and 2 are on a 525-acre site (not including a training center that occupies about 105 acres) in Hamilton County, Tennessee, along the Tennessee River at River Mile 484.5, about 7.5 miles northeast of Chattanooga. The total area of the Sequoyah site is 630 acres. Figure S-4 shows the general arrangement of the site. Under Alternative 2, TVA would irradiate up to a total of 2,500 TPBARs every 18 months at the Sequoyah site and would not irradiate TPBARs for tritium production at the Watts Bar site. TVA proposes to construct and operate a 500,000-gallon tritiated water tank system at Sequoyah, similar to the tank system TVA constructed at Watts Bar, to facilitate effluent water management to minimize potential impacts from tritium releases. This SEIS evaluates the potential impacts of constructing and operating such a tank system at the Sequoyah site for Alternatives 2, 3, 5, and 6.

Alternative 3: Watts Bar and Sequoyah

Under Alternative 3, TVA would irradiate up to a total of 2,500 TPBARs every 18 months using both the Watts Bar and Sequoyah sites. This would provide NNSA and TVA the ability to supply requirements at either site independently or to use both sites, with each supplying a portion of the necessary tritium. For

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5. TVA has concluded that it will not use the Sequoyah reactors for tritium production until it prepares new license amendment applications and the NRC issues new license amendments for those reactors (Krich 2011).
6. The permeation rate of 5 curies of tritium per TPBAR per year represents a rounding up of the 3 to 4 curies of tritium per TPBAR per year that has been observed at Watts Bar 1 since the beginning of TPBAR irradiation at that reactor.

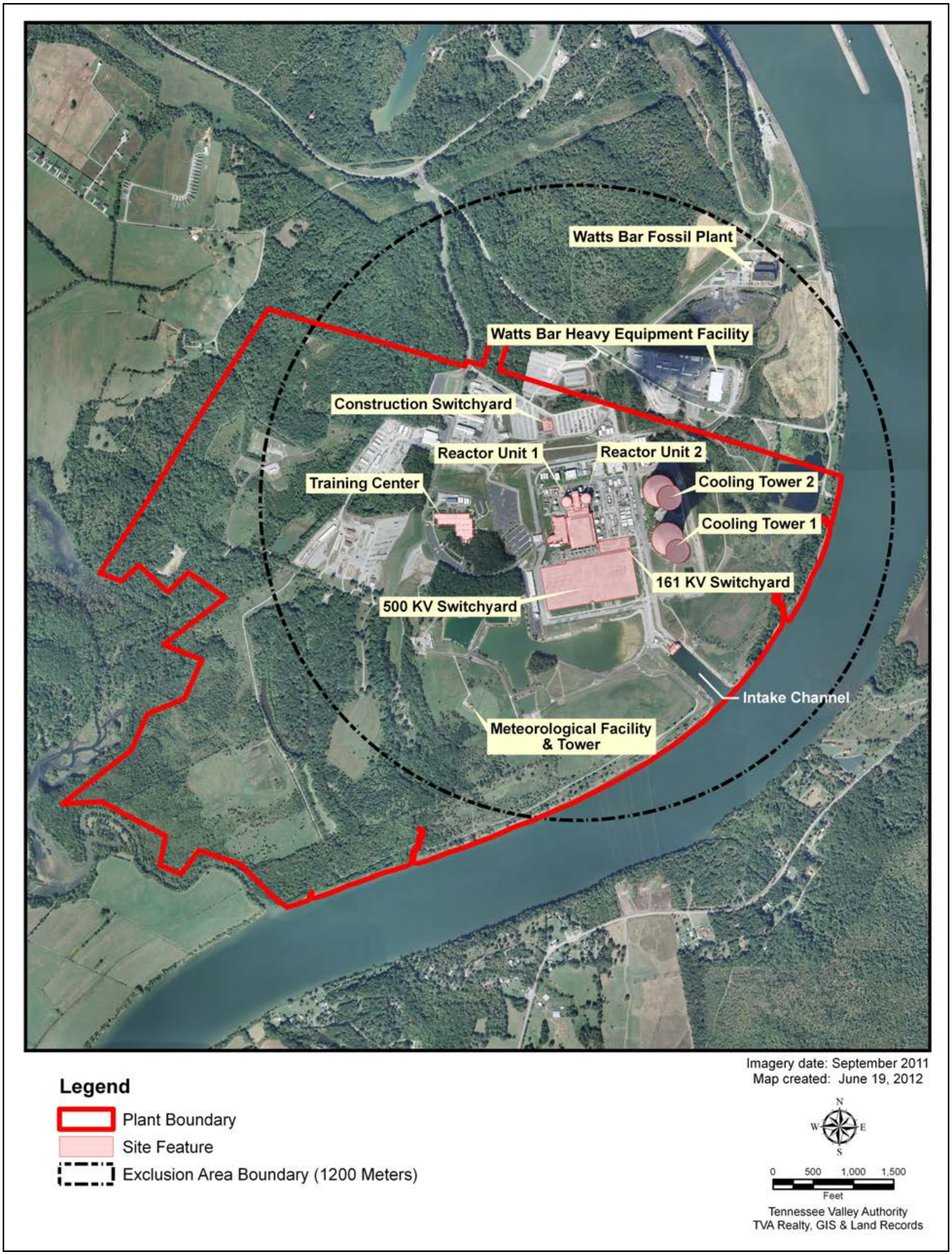

Figure S-3. Watts Bar site.

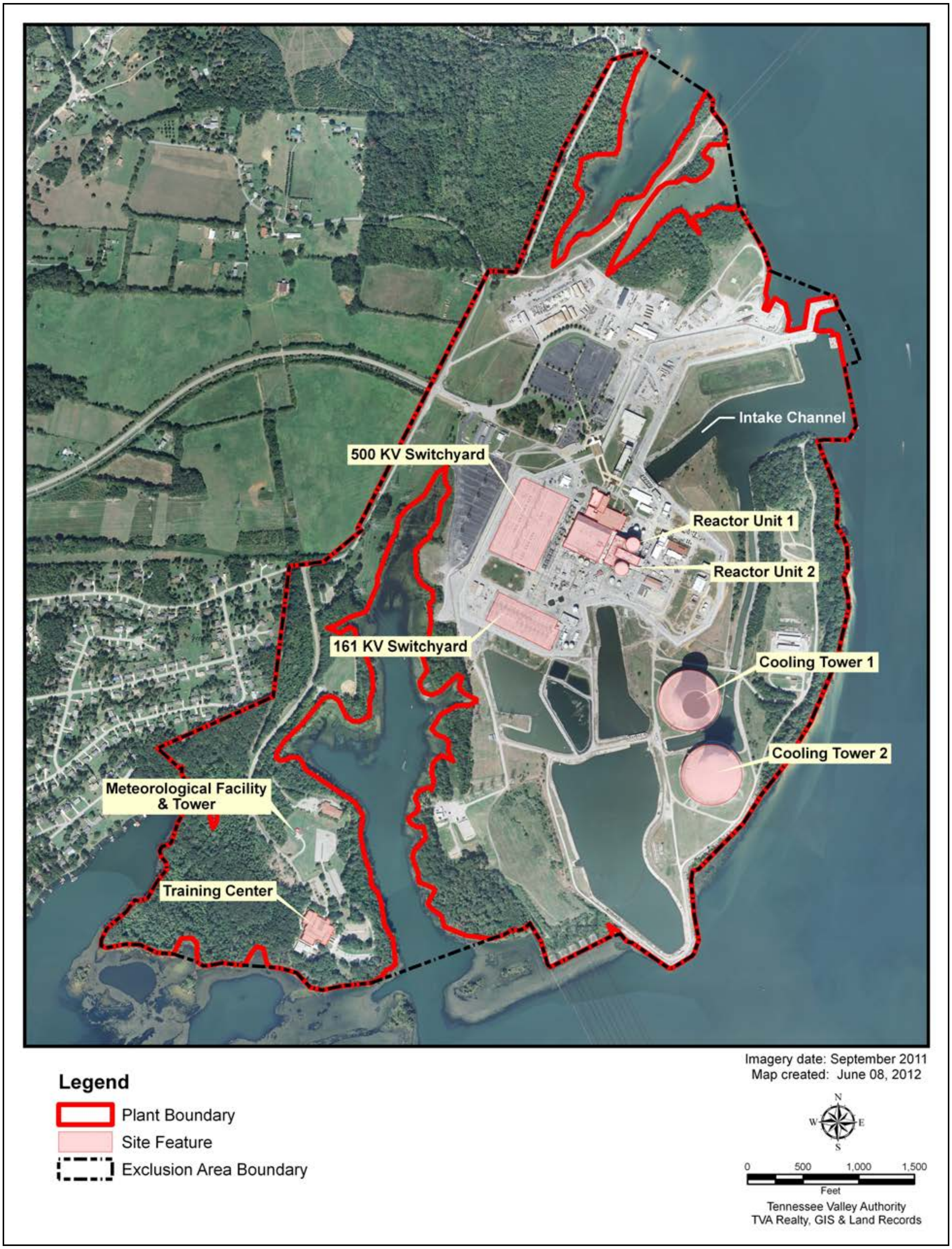

Figure S-4. Sequoyah site.

the analyses in this SEIS, NNSA assumed for Alternative 3 that each site would irradiate 1,250 TPBARs every 18 months

Alternative 4: Watts Bar Only (5,000 TPBARs)

Under Alternative 4, TVA would irradiate up to a total of 5,000 TPBARs every 18 months at the Watts Bar site using Watts Bar 1 and 2. Because TVA would irradiate a maximum of 2,500 TPBARs in any one reactor, this would involve use of both Watts Bar reactors. TVA is currently completing construction of Watts Bar 2. Under this alternative, TVA would not irradiate TPBARs for tritium production at the Sequoyah site. Although TVA has no current plans to apply for a license amendment to allow Watts Bar 2 to produce tritium, the SEIS evaluates the potential environmental impacts associated with the use of Watts Bar 2 to provide the flexibility to use it in the future.

Alternative 5: Sequoyah Only (5,000 TPBARs)

Under Alternative 5, TVA would irradiate up to a total of 5,000 TPBARs every 18 months at the Sequoyah site using Sequoyah 1 and 2. Because TVA would irradiate a maximum of 2,500 TPBARs in any one reactor, this would involve use of both Sequoyah reactors. Under this alternative, TVA would not irradiate TPBARs for tritium production at the Watts Bar site.

Alternative 6: Watts Bar and Sequoyah (5,000 TPBARs)

Under Alternative 6, TVA would irradiate up to a total of 5,000 TPBARs every 18 months using both the Watts Bar and Sequoyah sites. Because TVA would irradiate a maximum of 2,500 TPBARs in any one reactor, this could involve the use of one or both reactors at each of the sites. For the analyses in this SEIS, NNSA assumed for Alternative 6 that each site would irradiate 2,500 TPBARs every 18 months.

Alternative 4, 5, and 6 are considered mutually exclusive to any other alternative, meaning that NNSA would not select any one of those alternatives in addition to another alternative in the Record of Decision, as that would exceed the maximum production scenario of irradiating 5,000 TPBARs every 18 months.

S.6 Alternatives Considered but Eliminated from Detailed Analysis

This section discusses alternatives that NNSA considered but eliminated from detailed study in this SEIS. Section S.6.1 discusses alternatives previously considered by NNSA that have been reconsidered in this SEIS. Section S.6.2 discusses alternatives not previously considered by NNSA that have been considered in this SEIS.

NNSA considered and ultimately dismissed the following alternatives in relation to tritium production in either the *Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE/EIS-0161, October 1995) (DOE 1995) and/or the 1999 EIS:

- Redesign weapons to use less or no tritium,
- Purchase tritium from foreign sources,
- Exclusively recycling tritium, and
- Use non-TVA reactors.

The *Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE/EIS-0161, October 1995) (DOE 1995) and/or the 1999 EIS explain the reasons why these alternatives were eliminated from detailed analysis. NNSA has reviewed the bases for eliminating these alternatives in the previous analyses and has determined that they remain valid. Therefore, NNSA is not revisiting them in this SEIS.

S.6.1 ALTERNATIVES CONSIDERED PREVIOUSLY AND RECONSIDERED IN THIS SEIS

Produce Tritium in an Accelerator

DOE evaluated this as a reasonable alternative in the *Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE 1995) and as part of the No-Action Alternative in the 1999 EIS. In the Record of Decision for the 1999 EIS, DOE selected the CLWR as the primary tritium supply technology and designated accelerator production of tritium as the backup technology (64 FR 26369; May 14, 1999). DOE concluded that CLWR production of tritium would have the best chance of meeting all national security requirements. NNSA does not believe the higher tritium permeation rate from TPBAR irradiation (in comparison with the rate DOE evaluated in the 1999 EIS) changes this conclusion. In addition, since 1999 DOE has not pursued development or implementation of the technology to produce tritium using accelerators. It would take many years and would be much more costly to initiate a program to do so than to increase tritium production using TPBARs. For these reasons, accelerator production of tritium is not a reasonable alternative.

Use the TVA Bellefonte Reactors

TVA previously proposed the Bellefonte reactors for TPBAR irradiation, and DOE assessed those reactors as a reasonable alternative in the 1999 EIS. The 1999 EIS Record of Decision did not select the TVA Bellefonte reactors for TPBAR irradiation (64 FR 26369; May 14, 1999), and those reactors remain uncompleted. On August 18, 2011, the TVA Board of Directors approved the completion of Bellefonte Unit 1, a 1,260-megawatt-electric nuclear reactor near Scottsboro in northern Alabama. The timeline for the completion of construction of Bellefonte Unit 1 is uncertain, and TVA is not proposing the use of the Bellefonte reactors for TPBAR irradiation. As a result, using the Bellefonte reactors for TPBAR irradiation is not a reasonable alternative.

S.6.2 ALTERNATIVES NOT CONSIDERED PREVIOUSLY BUT CONSIDERED IN THIS SEIS

Redesign TPBARs To Decrease the Tritium Permeation Rate

The Pacific Northwest National Laboratory has redesigned several TPBAR components in an attempt to reduce tritium permeation into the reactor coolant. For example, Laboratory researchers modified the nickel-plated getter in the TPBAR to increase tritium capture efficiency. (A getter is a material that absorbs free tritium gas and chemically binds it within its own structure.) Despite this redesign, there was no discernible improvement in getter performance and tritium still permeates from the TPBARs at higher-than-expected rates. However, the scientists and engineers continue to seek a technical solution (GAO 2010). Because redesign activities have not resolved the issue, TPBAR redesign is not a reasonable alternative at this time.

Use of a Tritium Removal System for Effluent Management

NNSA considered alternatives that could remove tritium from the reactor coolant rather than releasing the tritium to the environment. Researchers have conceived technologies for tritium removal including separation processes based on water distillation, catalytic exchange of hydrogen isotopes, combined electrolysis and catalytic exchange, palladium metal membrane/reactor separation, gas adsorption/desorption, gaseous diffusion, and thermal diffusion (EPRI 2002; DOE 2009).

While it would be technologically feasible for TVA to use a tritium removal system, the analysis in this SEIS demonstrates that tritium concentrations in TVA reactor coolant are very small and associated releases to air and liquid pathways would remain very small even with tritium permeation of as much as 10 curies per TPBAR per year for either 2,500 TPBARs or 5,000 TPBARs. TVA can maintain tritium releases from its reactors well below applicable regulatory limits without implementing a tritium removal system. While NNSA and TVA continue to monitor the development of tritium removal technologies, they have concluded that TVA can use a large holding tank to manage tritium releases effectively. A large holding tank will enable TVA to better control the timing of releases of coolant containing tritium to continue to stay well within NRC and U.S. Environmental Protection Agency (EPA) limits. Section 1.6 of the SEIS includes a discussion of the Watts Bar tritiated water tank system that has been constructed. TVA proposes to construct and operate a tritiated water tank system at Sequoyah if there was a decision to irradiate TPBARs at that site or to facilitate routine tritium management. It should be emphasized that because of the very low concentrations of tritium present in TVA reactors, any tritium removal system, no matter how effective, would not yield enough tritium to eliminate the need to irradiate TPBARs to meet tritium production requirements.

S.7 Production of Tritium in a Nuclear Reactor

TVA built the Watts Bar and Sequoyah reactors, which are Westinghouse-designed pressurized water reactors, to produce electricity for commercial sale. The reactors use fuel that consists of pellets of uranium dioxide stacked in about 12-foot-long tubes called fuel rods. Fuel rods are grouped together as fuel assemblies, in which metal grids hold the rods side-by-side at fixed distances from each other. A typical fuel assembly for a reactor is an array with 17 rows and 17 columns; it holds 264 fuel rods and has positions for 25 nonfuel tubes (see Figure S-5). The nonfuel positions are for moveable control rods, neutron source rods, or fixed burnable absorber rods (in this context, “burnable” means “capable of being consumed or altered by neutron absorption” rather than “flammable”), and instrumentation.

During the fission process, uranium atoms split and release energy. Some of this energy becomes heat, which the power plant uses to generate electricity. Two types of nonfuel rods, movable and fixed, control the fission process. The movable control rods start or stop the reactor. The fixed burnable absorber rods control the distribution of heat and extend the fuel cycle.

A reactor can produce tritium during normal operations. The process uses TPBARs, which are specially fabricated rods that replace nonmoveable burnable absorber rods in the reactor core. TPBARs are long, thin tubes that contain lithium-6. When neutrons in the reactor core strike a lithium-6 nucleus, the nuclear reaction produces tritium. The exterior dimensions of the TPBARs are similar to those of the boron-containing burnable absorber rods, so they fit in the fuel assemblies in place of the burnable absorber rods. To facilitate insertion and removal from fuel assemblies, TPBARs are attached to a base plate. Figure S-6 shows the typical structure of a TPBAR. In addition to producing tritium, TPBARs fill the same role as burnable absorber rods in the operation of the reactor.

During the reactor’s normal fuel cycle (about 18 months), TPBARs are irradiated and the tritium gas is captured in the getter. At the end of the fuel cycle, some fuel rods are depleted, which means they no longer contain enough uranium-235 to power the reactor as designed and must be replaced. During the refueling period, depleted fuel assemblies, as well as fuel assemblies that contain TPBARs, are removed from the reactor core and transferred to the spent fuel pool.

TPBAR assemblies are then removed from the fuel assemblies, mechanically separated from the base plate, and placed in a consolidation container. The consolidation container with the TPBARs is placed in a shipping cask, sealed, placed on a truck, and transported to the Tritium Extraction Facility at the Savannah River Site. The tritium is extracted in a high-temperature heating and vacuum process, after which it is purified.

Impacts of Tritium Production on Reactor Operations

The replacement of burnable absorber rods with TPBARs has little effect on the normal operation of the reactor. The normal power distribution in the core, and reactor coolant flow and its distribution in the

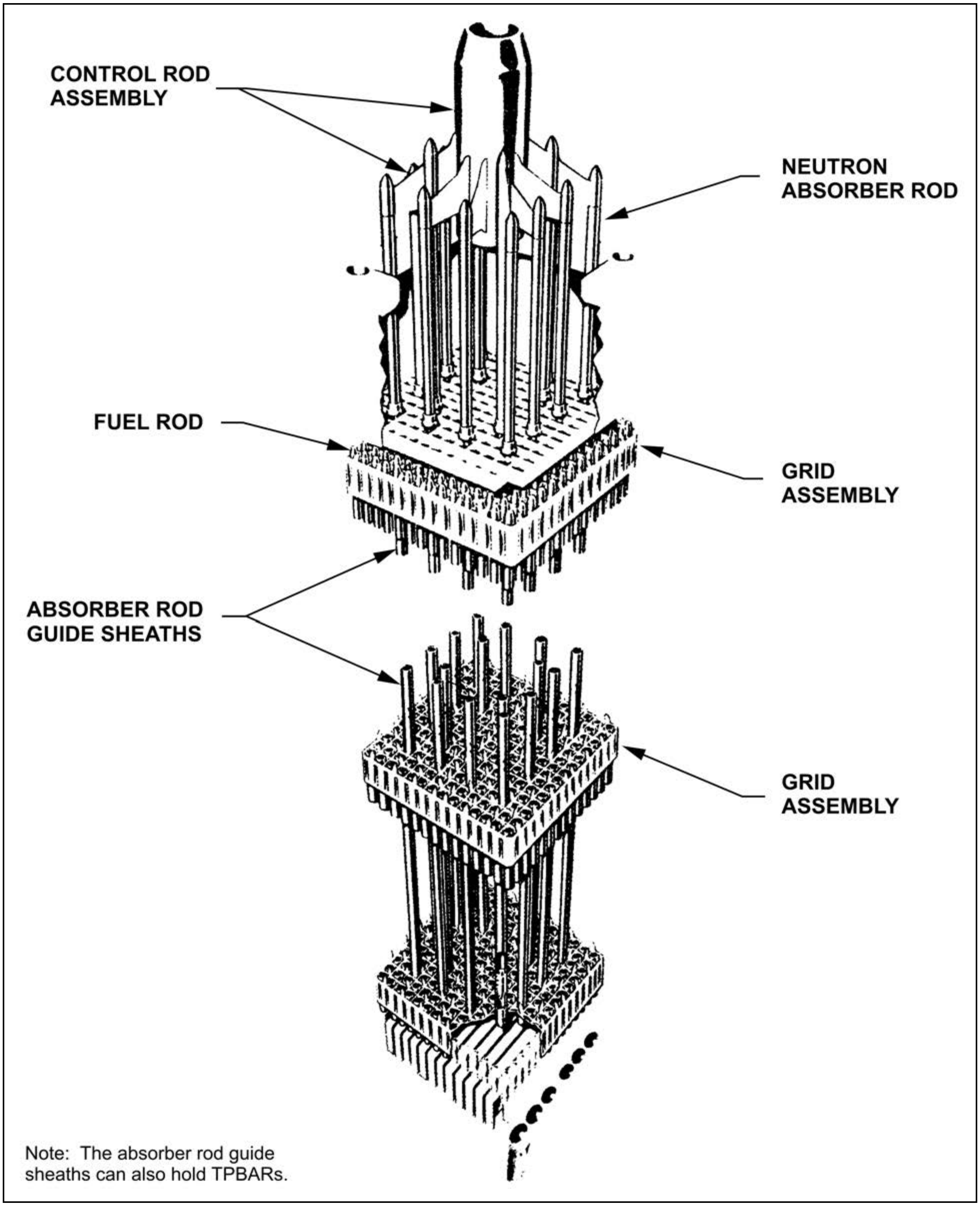

Figure S-5. Typical fuel assembly cross-sections (DOE 1999).

core, remain within the limits of the technical specifications for a reactor without TPBARs. A small amount of tritium permeates through the TPBARs during operation, which increases the quantity of tritium in the reactor's coolant water system in comparison with a reactor that is not being used to

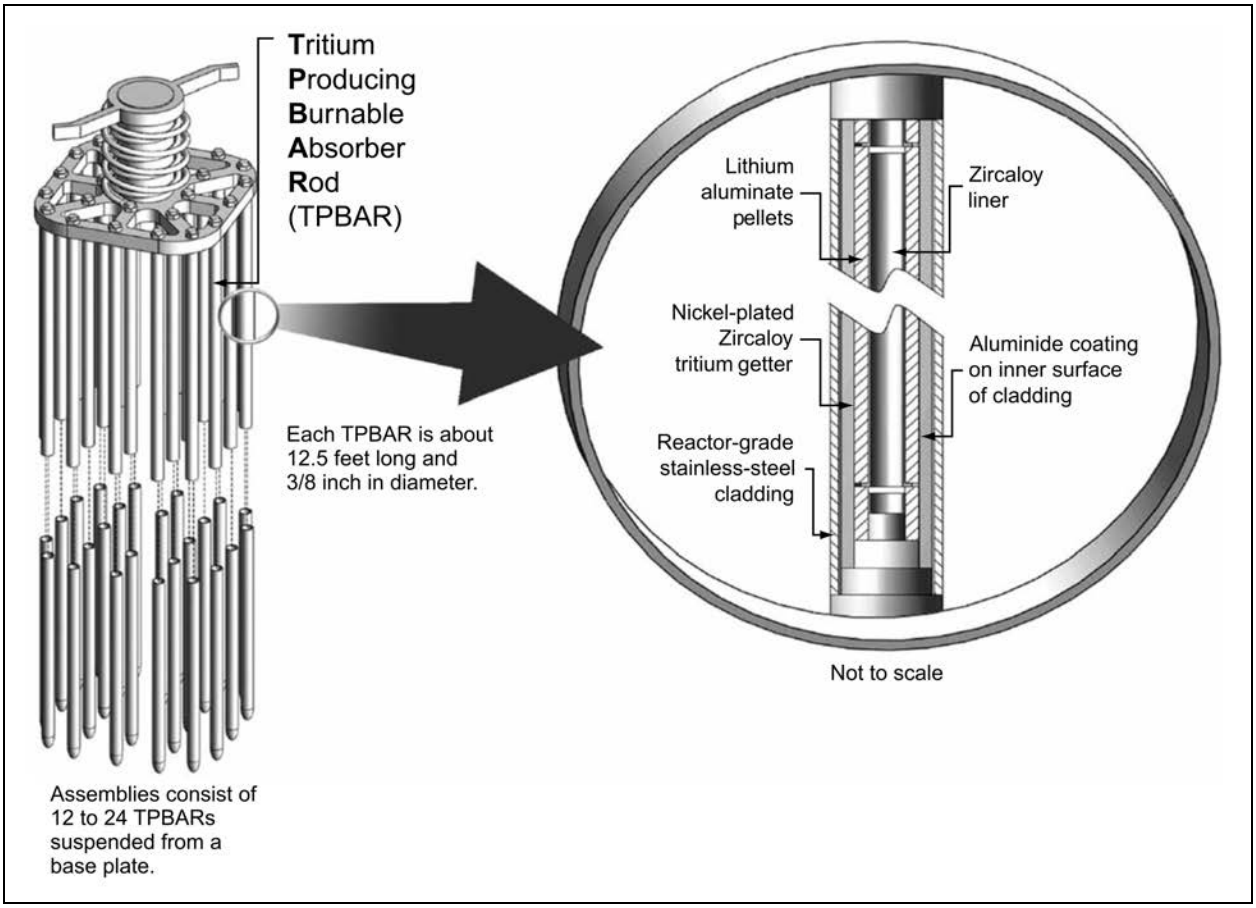

Figure S-6. A typical TPBAR.

produce tritium. Because tritium is an isotope, or type, of the hydrogen atom, it can combine with oxygen in the coolant water to become part of a water molecule (tritiated water). Tritiated water in the reactor coolant can reach the environment via several mechanisms including (1) operations that refresh the reactor coolant to maintain the correct system parameters, (2) refueling operations, and (3) normal leakage and diffusion from the primary system into secondary systems. Tritium is released to the environment through the normal operations of the radioactive waste system or in steam system blowdown or condensing cooling water.

The following points provide a qualitative summary of the operational differences between a tritium production reactor and a nuclear power reactor without tritium production; Chapter 4 of the SEIS describes the impacts for each analyzed tritium production alternative.

- Tritium releases. The amount of tritium in liquid effluents and gaseous emissions increases due to the presence of TPBARs in the reactor.

- Public and worker radiation exposure. The increased levels of tritium released to the environment and the additional handling and processing of TPBARs result in a slight increase in radiation exposure for the public and workers.

- Accident conditions. The physical changes to the reactor core involve replacing some burnable absorber rods with TPBARs. This change slightly increases the estimated amount of radionuclides that certain accidents could release.

- Waste. The additional handling, processing, and shipping of TPBAR assemblies slightly increases low-level radioactive waste generation rates.

- Spent nuclear fuel. Operating a reactor in a tritium-producing mode can produce additional spent nuclear fuel. This occurs because more fresh fuel is necessary to produce the design power level throughout the reactor's 18-month fuel cycle in comparison with reactors that use only standard burnable absorber rods. Maintaining the design power level for the reactor is achieved by adding more fresh fuel assemblies during refueling, which results in additional spent nuclear fuel. Without tritium production, more fuel assemblies can stay in the reactor for more than one cycle during operations. Irradiation of 2,500 TPBARs in a single reactor would increase spent nuclear fuel generation by about 24 percent per fuel cycle (see Sections 4.1.10.2 and 4.2.10.3). Irradiation of 5,000 TPBARs at a single site would increase spent nuclear fuel generation at either Watts Bar or Sequoyah by about 48 percent per fuel cycle (see Sections 4.1.10.5 and 4.2.10.6). However, TVA has an infrastructure in place or has a plan to manage the increased volume of spent nuclear fuel assemblies (see Sections 3.1.10 and 3.2.10).

- Transportation and handling. Irradiated TPBAR assemblies are packaged and transported from the reactor site to the Savannah River Site for tritium extraction and purification. In addition, low-level radioactive waste is packaged and transported for disposal at a low-level waste disposal facility. These activities entail small increases in radiological exposures and accident risks.

- Personnel requirements. TPBAR irradiation creates a small number of additional jobs at the reactor facilities and for transportation.

S.8 Potential Environmental Impacts

To aid the reader in understanding the differences among the alternatives, this section compares the environmental impacts of the alternatives. Section S.8.1 discusses the key analyses and findings in the SEIS. Sections S.8.2 through S.8.8 summarize the environmental impacts of the alternatives. The impacts of the No-Action Alternative in Section S.8.2 are a baseline for comparison with the impacts of the action alternatives. Table S-2 summarizes this comparison. In addition to the data for the alternatives, Table S-2 includes data that reflect current operating conditions for the Watts Bar and Sequoyah sites. Section S.8.9 summarizes differences between this SEIS and the 1999 EIS. Lastly, Section S.8.10 summarizes the cumulative impact analysis and Section S.8.11 discusses proposed mitigation measures.

S.8.1 KEY ANALYSES AND FINDINGS

This SEIS analyzes the potential environmental impacts of irradiating TPBARs and the resulting release of tritium. The key analyses are:

- The potential impacts of tritium releases on the health of workers and the public,

- The potential impacts of tritium releases on the Tennessee River, and

- The potential impacts of TPBAR irradiation on the operation and safety of the TVA reactor facilities.

The key SEIS findings are:

- The tritium releases from normal operations with TPBAR irradiation would have an insignificant impact on the health of workers and the public.

  – For the average worker, irradiation of 2,500 TPBARs could increase the annual dose by a maximum of 8.3 millirem in comparison with not irradiating TPBARs (see Tables 4-8 and 4-23 of the SEIS). A dose increase of 8.3 millirem would result in an additional latent cancer fatality risk of about 5×10^{-6}, or 1 chance in 200,000. Irradiation of 5,000 TPBARs at one site could increase the average worker's annual dose by a maximum of 16.5 millirem in comparison with not irradiating TPBARs (Sections 4.1.11.5 and 4.2.11.6). A dose increase of 16.5 millirem would result in an additional latent cancer fatality risk of about 1×10^{-5}, or 1 chance in 100,000.

  – For the hypothetical member of the public who received the highest dose from irradiation of 2,500 TPBARs, the annual dose could increase by a maximum of 0.33 millirem in comparison with not irradiating TPBARs (Section 4.1.11, Table 4-7). A dose increase of 0.33 millirem would result in an additional latent cancer fatality risk of 2×10^{-7}, or 1 chance in about 5 million. Irradiation of 5,000 TPBARs at one site could increase the annual dose by a maximum of 0.67 millirem in comparison with not irradiating TPBARs (Section 4.1.11, Table 4-7). A dose increase of 0.67 millirem as a result of TPBAR irradiation would result in an additional latent cancer fatality risk of 4×10^{-7}, or 1 chance in about 2.5 million.

- The tritium releases from TPBAR irradiation would increase tritium concentrations in the Tennessee River in comparison with not irradiating TPBARs. However, the tritium concentration at any drinking water intake would remain well below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter identified in 40 CFR Part 141. Even at the conservative permeation levels NNSA analyzed for this SEIS, the analyses determined that the average tritium concentration at any drinking water intake would be no more than about one-tenth the 20,000-picocurie-per-liter limit (Sections 4.1.5 and 4.2.5).

- TPBAR irradiation would not have a significant adverse impact on the operation and safety of TVA reactor facilities. Potential risks from accidents would remain essentially the same whether TPBARs were irradiated in a TVA reactor or not. Irradiation of 2,500 TPBARs in a single reactor would increase spent nuclear fuel generation by about 24 percent per fuel cycle (see Sections 4.1.10.2 and 4.2.10.3). Irradiation of 5,000 TPBARs at a single site could increase spent nuclear fuel generation at either Watts Bar or Sequoyah by about 48 percent per fuel cycle (see Sections 4.1.10.5 and 4.2.10.6). However, TVA has an infrastructure in place or has a plan to manage the increased volume of spent nuclear fuel assemblies.

- As discussed in Sections 4.1.14 and 4.2.14, for all alternatives, TPBAR irradiation would not cause any disproportionately high and adverse consequences to minority or low-income populations.

S.8.2 POTENTIAL IMPACTS OF THE NO-ACTION ALTERNATIVE

Under the No-Action Alternative, TVA would irradiate as many as 680 TPBARs every 18 months in each of the following reactors: Watts Bar 1, Sequoyah 1, and Sequoyah 2. The total number of TPBARs TVA would irradiate every 18 months could be up to 2,040 if TVA used all three reactors for tritium production.

Watts Bar

Tritium releases would result from normal reactor operations, without TPBARs, of Watts Bar 1 and 2 (even though Watts Bar 2 would not irradiate TPBARs under this alternative, it would nonetheless produce and release some tritium during normal reactor operations without TPBARs[7]) as well as from tritium production in Watts Bar 1. TVA is currently completing construction of Watts Bar 2 (TVA 2007). TVA recently constructed a 500,000-gallon tritiated water tank system to facilitate effluent water management to mitigate impacts on the river. With this system in place, normal operations at the levels analyzed for this alternative could potentially release an estimated 10,440 curies of tritium a year to the Tennessee River. Of this tritium released, 6,120 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium. Tritium concentrations in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter within about 30 feet of the diffuser that returns water to the river (the nearest drinking water intake is 23 miles away). Annual radioactive releases to the air from Watts Bar could potentially total 1,196 curies, with tritium making up 1,160 curies. As discussed in Sections 3.1.3 and 4.1.3.1, greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation without TPBAR irradiation. The continued TPBAR irradiation in Watts Bar 1 would generate about 15 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste that would occur from Watts Bar normal operations if TPBARs were not irradiated (see the text box on the next page. TPBAR irradiation would have no impact on nonradioactive hazardous and nonhazardous waste generation. Operation of the tritiated water tank system would have no impact on the quantities or management of wastes. Once Watts Bar 2 becomes operational, the two reactors at the site would generate about 115 assemblies of spent nuclear fuel per year, which would include about 3 additional spent nuclear fuel assemblies associated with TPBAR irradiation at Watts Bar 1.

Radiation, Dose Units, and Latent Cancer Fatalities

Radiation dose is the amount of energy in the form of ionizing radiation absorbed per unit mass of any material. For people, radiation dose is the amount of energy absorbed in human tissue. In the United States, radiation dose is commonly measured in units called rem; a smaller fraction of the rem is the millirem (1/1,000 of 1 rem). Person-rem is a unit of collective radiation dose applied to populations or groups of individuals; it is the sum of the doses received by all the individuals of a specified population.

Numerical fatal cancer estimates presented herein were obtained using a linear no-threshold extrapolation from the nominal risk estimated for lifetime total cancer mortality that results from a large dose of radiation. Use of this approach is the basis for current radiation protection regulations to protect the public and workers. According to the extrapolation, if a certain radiation dose has an associated risk of a cancer, one-tenth of that dose would have one-tenth of the risk. Thus, the cancer risk is not 0, however small the dose. In accordance with DOE guidance, a risk factor of 0.0006 latent cancer fatality per rem was used in this SEIS as the conversion factor for all radiological exposures up to 20 rem per individual. A risk factor of 0.0012 was used for individual doses of 20 rem or greater.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 116 millirem per year. Of this dose, about 114 millirem per year would be from normal operations unrelated to TPBAR irradiation. Statistically, if a worker received a dose of 116 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 14,400. The total annual workforce dose would be about 102 person-rem. Of this dose, about 100 person-rem would be from normal operations unrelated to TPBAR irradiation. The collective dose to

[7] Tritium is produced in all U.S. commercial nuclear reactors from fission of uranium in the reactor fuel and neutron activation of boron in burnable absorber rods.

Additional Low-Level Radioactive Waste

Any reactor that irradiated TPBARs would generate more low-level radioactive waste than one that did not. Much of the low-level waste would consist of TPBAR base plates and other irradiated hardware that would remain after the TPBARs were separated from their assemblies in preparation for shipping to the Savannah River Site. In the 1999 EIS, DOE and TVA estimated that low-level waste would increase by about 15 cubic feet per year for irradiation of 3,400 TPBARs (DOE 1999a), which would represent less than 0.1 percent of the low-level waste the Watts Bar site generates annually. Because this is such a small percentage, DOE and TVA do not think a more precise estimate is needed for irradiation of fewer TPBARs (a maximum of 2,500 under the proposed action in this SEIS). Therefore, this SEIS, like the 1999 EIS, estimates an additional 15 cubic feet of low-level waste annually for all reactors that irradiate TPBARs, regardless of the number of irradiated TPBARs, recognizing that this number is conservatively high for the alternatives discussed in this SEIS. For Alternatives 4, 5, and 6, an additional 30 cubic feet of low-level waste would be generated annually.

facility workers would result in 0 (0.06)[8] latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations with TPBARs would also be well within the NRC regulatory limit of 25 millirem per year. At Watts Bar, the total annual dose to the population within 50 miles (about 1.45 million people in 2025) during normal operations would be about 7.6 person-rem per year, which equates to 0 (0.005) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.28 millirem. For comparison, the average annual dose from natural and man-made radiation is about 620 millirem.

Based on the analyzed design-basis accidents, the highest dose to the maximally exposed individual would be well below the NRC regulatory limit (25 rem) and the average individual dose to the 50-mile population would be much less than 1 rem. Based on the analyzed beyond-design-basis accidents, the early containment failure accident would represent the highest dose to the maximally exposed individual, with an estimated frequency of about 1 chance in 3 million of the accident occurring per year of operation. The effects of radionuclide releases inherent to reactor operations without TPBARs would dominate the risk of a reactor accident. The analysis of intentional destructive acts indicates that potential consequences would be no worse than those of the most conservative beyond-design-basis accident NNSA analyzed. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Watts Bar operations would be 0 (0.003) for crew, 0 (3×10^{-4}) for members of the public, and 0 (5×10^{-6}) for radiological accidents, along with 0 (0.004) traffic fatality.

Sequoyah

Tritium releases would occur as a result of tritium production as well as normal reactor operations without TPBARs. Normal operations would release 16,560 curies of tritium to the Tennessee River each year. Of this tritium released, 12,240 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium. Tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter after leaving the diffusers. Annual radioactive releases to the air would total 1,867 curies, including about 1,840 curies of tritium. As discussed in Sections 3.2.3 and 4.2.3.1, greenhouse gas emissions (7,100 tons of carbon dioxide annually)

8. Because the numbers of latent cancer fatalities are whole numbers, the statistically calculated values are provided in parentheses when the reported result is a small fraction of 1.

would be essentially the same as from normal operation without TPBAR irradiation. TPBAR irradiation would generate about 15 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste from current Sequoyah operations. TPBAR irradiation would have no impact on nonradioactive hazardous or nonhazardous waste generation. Sequoyah would generate spent nuclear fuel at a rate of about 113 spent nuclear fuel assemblies annually, which would include about 6 spent nuclear fuel assemblies associated with TPBAR irradiation at Sequoyah 1 and 2.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 109 millirem per year. Of this dose, about 105 millirem per year would be from normal operations unrelated to TPBAR irradiation. Statistically, if a worker received a dose of 109 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 15,300. The total annual workforce dose would be about 132 person-rem. Of this dose, about 128 person-rem would be from normal operations unrelated to TPBAR irradiation. The collective dose to facility workers would result in 0 (0.08) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles (about 1.29 million people in 2025) during normal operations would be about 10.8 person-rem per year, which equates to 0 (0.006) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.24 millirem. For comparison, the average annual dose from natural and man-made radiation is about 620 millirem.

Tritium Concentrations in Discharge Plumes

The analysis for this SEIS modeled the tritium concentration in the Tennessee River after discharge from the reactors to determine at what point the concentration would be below the EPA-established drinking water limit of 20,000 picocuries per liter.

For Watts Bar, under Alternatives 1, 3, 4, and 6, tritium concentrations would be below the limit after dilution occurred, no more than 140 feet downstream after exiting the diffuser. Under Alternatives 2 and 5, Watts Bar would not irradiate TPBARs and the tritium concentration would be below the limit soon after exiting the diffuser.

For Sequoyah, under Alternatives 2, 3, 5, and 6, tritium concentrations would be below the limit after dilution occurred, no more than 18 feet downstream after exiting the diffuser. Under Alternatives 1 and 4, Sequoyah would not irradiate TPBARs and the tritium concentration would be below the limit before exiting the diffuser.

The reason for the difference between Watts Bar and Sequoyah release concentrations is that the cooling systems for the two plants are different. Watts Bar is basically a closed system that recycles most of its cooling water and has a relatively low discharge rate (about 80 cubic feet per second). Sequoyah operates primarily in an open mode in which cooling water is pumped through the heat exchanging system and discharged to the river without recycling. The typical average discharge rate is 2,333 cubic feet per second. As a result of recirculation and a lower discharge rate, tritium is concentrated in the effluent and disperses more slowly at Watts Bar compared to Sequoyah. This is why the tritium concentration in Sequoyah effluent would be less than the tritium concentration in Watts Bar effluent.

Based on the analyzed design-basis accidents, the highest dose to the maximally exposed individual would be well below the NRC regulatory limit (25 rem) and the average individual dose to the 50-mile population would be much less than 1 rem. Based on the analyzed beyond-design-basis accidents, the early containment failure accident would represent the highest dose to the maximally exposed individual, with an estimated frequency of approximately 1 chance in 1.5 million of the accident occurring per year of operation. The effects of radionuclide releases inherent to reactor operations without TPBARs would dominate the risk of a reactor accident. The analysis of intentional destructive acts indicated that potential consequences would be no worse than

Additional Spent Nuclear Fuel

The amount of additional spent nuclear fuel from TPBAR irradiation depends on the number of irradiated TPBARs. As TPBARs are irradiated, they absorb neutrons, which reduces the plant's power levels. In order to maintain design power levels during TPBAR irradiation, TVA would need to increase the number of fresh fuel assemblies. The increase in fresh fuel assemblies generates additional spent nuclear fuel. Irradiation of 680 TPBARs per cycle would generate about 4 additional spent nuclear fuel assemblies every 18 months (which would equate to about 3 additional spent nuclear fuel assemblies annually) in comparison with operations without TPBARs. As the number of TPBARs were increased, they would absorb an increasingly higher percentage of neutrons, which would reduce the plant's power levels. TVA would then need to increase the number of fresh fuel assemblies to maintain design power levels. The increase in fresh fuel assemblies would generate additional spent nuclear fuel.

The relationship between the number of irradiated TPBARs and the amount of additional spent nuclear fuel is not linear. For example, irradiation of 1,250 TPBARs in a reactor would generate 8 to 12 additional spent nuclear fuel assemblies every 18 months. At twice the number of TPBARs (2,500), the number of spent nuclear fuel assemblies would increase to 41 (about 3 to 5 times more than for 1,250). This nonlinearity occurs because, as more TPBARs are added to the reactor, fewer neutrons are available to initiate fission in uranium atoms, and increasingly greater quantities of fresh fuel are needed to maintain the design power level for the reactor.

those of the most conservative beyond-design-basis accident NNSA analyzed. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Sequoyah operations would be 0 (0.005) for crew, 0 (6×10^{-4}) for members of the public, and 0 (1×10^{-5}) for radiological accidents, along with 0 (0.005) traffic fatality.

S.8.3 POTENTIAL IMPACTS OF ALTERNATIVE 1 (PREFERRED ALTERNATIVE)

Under Alternative 1, TVA would irradiate up to a total of 2,500 TPBARs every 18 months in Watts Bar 1, Watts Bar 2, or both, which would represent an increase of 1,820 TPBARs at Watts Bar in comparison with the No-Action Alternative. At Sequoyah, no TPBARs would be irradiated under this alternative, which would represent a decrease of 680 TPBARs for each of the Sequoyah reactors in comparison with the No-Action Alternative.

Watts Bar

During normal operations, the two reactors could potentially release about 26,820 curies of tritium (of which 22,500 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium) to the Tennessee River each year, which would be an increase in comparison with the 10,440 curies of tritium assumed to be released under the No-Action Alternative. Tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter within about 70 feet of the diffuser. Annual radioactive releases to the air from Watts Bar could potentially total 3,016 curies, including 2,980 curies of tritium, which would be an increase in comparison with the total release of 1,196 curies, including 1,160 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation without TPBAR irradiation. TPBAR irradiation would generate about 15 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste that would occur from normal operations if TPBARs were not irradiated. TPBAR irradiation would have no impact on nonradioactive hazardous and nonhazardous waste generation. Irradiation of 2,500 TPBARs would generate no more than 41 additional spent nuclear fuel assemblies every 18 months over the No-Action Alternative if TVA irradiated all 2,500 TPBARs in a single reactor. On an annual basis, this would increase spent nuclear fuel generation at Watts Bar by about 24 percent in comparison with the No-Action Alternative. TVA has an infrastructure in place or has a plan at Watts Bar to manage the increased volume of spent nuclear fuel assemblies.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 122 millirem per year, which would be an increase in comparison with the 116 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 122 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 13,700. The total annual workforce dose would be about 107 person-rem, which would be an increase in comparison with the 102 person-rem the worker population would receive each year under the No-Action Alternative. Of this dose, about 100 person-rem would be from normal operations unrelated to TPBAR irradiation. The collective dose to facility workers would result in 0 (0.06) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations with TPBARs would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 16.7 person-rem per year, which would be an increase in comparison with the 7.6 person-rem annual dose under the No-Action Alternative. A collective dose of about 16.7 person-rem per year equates to 0 (0.001) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.52 millirem, which would be an increase in comparison with the 0.28 millirem that individual would receive each year under the No-Action Alternative. An annual dose of 0.52 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Based on the analyzed design-basis accidents, the highest dose to the maximally exposed individual would be well below the NRC regulatory limit (25 rem) and the average individual dose to the 50-mile population would be much less than 1 rem. Based on the analyzed beyond-design-basis accidents, the early containment failure accident would represent the highest dose to the maximally exposed individual, with an estimated frequency of about 1 chance in 3 million of the accident occurring per year of operation. The effects of radionuclide releases inherent to reactor operations without TPBARs would dominate the risk of a reactor accident. The analysis of intentional destructive acts indicates that potential consequences would be no worse than those of the most conservative beyond-design-basis accident NNSA analyzed. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Watts Bar operations would be 0 (0.01) for crew, 0 (0.001) for members of the public, and 0 (2×10^{-5}) for radiological accidents, along with 0 (0.004) traffic fatality.

Sequoyah

Under this alternative, no irradiation of TPBARs would take place using the Sequoyah nuclear reactors. Therefore, there would be no impacts attributable to TPBAR irradiation. The following discussion describes the impacts of normal operations at Sequoyah without TPBARs. During normal operations without TPBARs, the reactors would release 4,320 curies of tritium to the Tennessee River each year, which is the same as current conditions and would be a reduction in comparison with the 16,560 curies of tritium assumed to be released under the No-Action Alternative. Tritium concentrations in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter after leaving the diffusers. Annual radioactive releases to the air would total 507 curies, including about 480 curies of tritium, which would be a reduction in comparison with the total release of 1,867 curies, including 1,840 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation with TPBAR irradiation. Without TPBAR irradiation, low-level radioactive waste generation would decrease by about 15 cubic feet per year in comparison with the No-Action Alternative. There would be no changes to nonradioactive hazardous and nonhazardous waste generation. The reactors would generate about 107 spent nuclear fuel assemblies per year, which is the same quantity the site currently generates.

Worker exposure to radiation during normal operations without TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 105 millirem per year, which would be a reduction in comparison with the 109 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 105 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 15,900. The total annual workforce dose would be about 128 person-rem, which would be a reduction in comparison with the 132 person-rem the worker population would receive under the No-Action Alternative. The collective dose to facility workers would result in 0 (0.08) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 4.4 person-rem per year, which would be a reduction in comparison with the 10.8 person-rem that the population would receive each year under the No-Action Alternative. A collective dose of about 4.4 person-rem per year equates to 0 (0.003) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.13 millirem, which would be a reduction in comparison with the 0.24 millirem that this individual would receive each year under the No-Action Alternative. An annual dose of 0.13 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Potential impacts from onsite accidents and intentional destructive acts would be essentially identical to those analyzed for the No-Action Alternative. Under Alternative 1, there would be no irradiation of TPBARs at Sequoyah and no transportation in relation to tritium production taking place at the Sequoyah site.

S.8.4 POTENTIAL IMPACTS OF ALTERNATIVE 2

Under Alternative 2, TVA would irradiate up to a total of 2,500 TPBARs every 18 months in Sequoyah 1, Sequoyah 2, or both, which would represent an increase of 1,140 TPBARs at Sequoyah in comparison with the No-Action Alternative. At Watts Bar, no TPBARs would be irradiated, which would represent a decrease of 680 TPBARs in Watts Bar 1 in comparison with the No-Action Alternative.

Watts Bar

Under this alternative, no irradiation of TPBARs would take place using the Watts Bar nuclear reactors. Therefore, there would be no impacts attributable to TPBAR irradiation. The following discussion describes the impacts of normal operations at Watts Bar without TPBARs. During normal operations without TPBARs, the reactors would release 4,320 curies of tritium to the Tennessee River each year, which would be a reduction in comparison with the 10,440 curies of tritium assumed to be released under the No-Action Alternative. The tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter soon after leaving the diffuser. Annual radioactive releases to the air would total 514 curies, including 480 curies of tritium, which would be a decrease in comparison with the total 1,196 curies, including 1,160 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation with TPBAR irradiation. Without TPBAR irradiation, low-level radioactive waste generation would decrease by about 15 cubic feet per year in comparison with the No-Action Alternative. Nonradioactive hazardous and nonhazardous waste generation would not change. Because Watts Bar would no longer irradiate TPBARs, about 3 less spent nuclear fuel assemblies would be generated annually in comparison with the No-Action Alternative. The reactors would generate about 112 spent nuclear fuel assemblies per year when Watts Bar 2 becomes operational.

Worker exposure to radiation during normal operations without TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 114 millirem per year, which would be a decrease in comparison with the 116 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 114 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 14,600. The total annual workforce dose would be about 100 person-rem, which would be a decrease in comparison with the 102 person-rem the worker population would receive each year under the No-Action Alternative. All of this dose would be from normal operations unrelated to TPBAR irradiation. The collective dose to facility workers would result in 0 (0.06) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 4.2 person-rem per year, which would be a decrease in comparison with the 7.6 person-rem dose received each year under the No-Action Alternative. A collective dose of about 4.2 person-rem per year equates to 0 (0.003) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.19 millirem, which would be a decrease in comparison with the 0.28 millirem that this individual would receive each year under the No-Action Alternative. An annual dose of 0.19 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Potential impacts from onsite accidents and intentional destructive acts would be essentially identical to those analyzed for the No-Action Alternative. Under Alternative 2, there would be no irradiation of TPBARs at Watts Bar and no transportation in relation to tritium production taking place at the Watts Bar site.

Sequoyah

NNSA analyzed irradiation of 2,500 TPBARs every 18 months using one or both reactors at the Sequoyah site. In addition, TVA proposes to construct and operate a 500,000-gallon tritiated water tank system to facilitate effluent water management. The stainless-steel tank, which would be about 45 feet in diameter and 45 feet tall, would disturb less than 1 acre of land in the existing protected area. Due to the small area of construction and use of previously disturbed land, impacts to soils and cultural resources from construction activities would be unlikely. Some minor emissions could occur during construction of the 500,000-gallon tank from the use of cranes and other construction equipment. Such emissions would be temporary and similar to the levels generally experienced at the site from on-going operations. The construction workforce, about 100 skilled and general laborers, would be on site for about 15 weeks. The operational impacts of that tritiated water tank system are included in the discussion below.

During normal operations, the Sequoyah reactors could potentially release 26,820 curies of tritium (of which 22,500 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium) to the Tennessee River each year, which would be an increase in comparison with the 16,560 curies of tritium assumed to be released under the No-Action Alternative. The tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter after leaving the diffusers. Annual radioactive releases to the air from Sequoyah could potentially total about 3,007 curies, including about 2,980 curies of tritium, which would be an increase in comparison with the total 1,867 curies, including 1,840 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation without TPBAR irradiation. TPBAR irradiation would generate about 15 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste that would occur from normal operations if TPBARs were not irradiated. TPBAR irradiation would have no impact on nonradioactive hazardous and nonhazardous waste generation. Operation of the tritiated water tank system would have no impact on the quantities or management of wastes. Irradiation of 2,500 TPBARs would generate no more than 41 additional spent nuclear fuel assemblies every 18 months if all 2,500 TPBARs were irradiated in a single reactor. On an annualized basis, this would increase spent nuclear fuel generation at Sequoyah by about 24 percent in comparison with the No-Action Alternative. TVA has an infrastructure in place at Sequoyah to manage the increased volume of spent nuclear fuel assemblies.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 111 millirem per year, which would be an increase in comparison with the 109 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 111 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 15,000. The total annual workforce dose would be about 135 person-rem, which would be an increase in comparison with the 132 person-rem the worker population would receive under the No-Action Alternative. The collective dose to facility workers would result in 0 (0.08) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 16.2 person-rem per year, which would be an increase in comparison with the 10.8 person-rem that the population would receive each year under the No-Action Alternative. A collective dose of about 16.2 person-rem per year equates to 0 (0.01) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.33 millirem, which would be an increase in comparison with the 0.24 millirem that this individual would receive each year under the No-Action Alternative. An annual dose of 0.33 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Based on the analyzed design-basis accidents, the highest dose to the maximally exposed individual would be well below the NRC regulatory limit (25 rem) and the average individual dose to the 50-mile population would be much less than 1 rem. Based on the analyzed beyond-design-basis accidents, the early containment failure accident would represent the highest dose to the maximally exposed individual, with an estimated frequency of about 1 chance in 1.5 million of the accident occurring per year of operation. The effects of radionuclide releases inherent to reactor operations without TPBARs would dominate the risk of a reactor accident. The analysis of intentional destructive acts indicates that potential consequences would be no worse than those of the most conservative beyond-design-basis accident NNSA analyzed. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Sequoyah operations would be 0 (0.01) for crew, 0 (0.002) for members of the public, and 0 (2×10^{-5}) for accidents, along with 0 (0.005) traffic fatality.

S.8.5 POTENTIAL IMPACTS OF ALTERNATIVE 3

Under Alternative 3, TVA would irradiate up to a total of 2,500 TPBARs every 18 months using both the Watts Bar and Sequoyah sites. This would provide NNSA and TVA the ability to supply requirements at either site independently or to use both sites, with each supplying a portion of the tritium required. For the analyses in this SEIS, NNSA assumed for Alternative 3 that each site would irradiate 1,250 TPBARs.

Watts Bar

During normal operations, the reactors could potentially release 15,570 curies of tritium (of which 11,250 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium) to the Tennessee River per year, which would be an increase in comparison with the 10,440 curies of tritium assumed to be released under the No-Action Alternative. Tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter within about 30 feet of the diffuser. Annual radioactive releases to the air could potentially total about 1,766 curies, including 1,730 curies of tritium, which would be an increase in comparison with the total 1,196 curies, including 1,160 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation without TPBAR irradiation. TPBAR irradiation would generate about 15 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste that would occur from normal operations if TPBARs were not irradiated. TPBAR irradiation would have no impact on nonradioactive hazardous and nonhazardous waste generation. Irradiation of 1,250 TPBARs in a single reactor would generate from 8 to 12 additional spent nuclear fuel assemblies every 18 months. On an annualized basis, this would increase spent nuclear fuel generation at Watts Bar by 5 to 7 percent in comparison with the No-Action Alternative.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 118 millirem per year, which would be an increase in comparison with the 116 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 118 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 14,100. The total annual workforce dose would be about 104 person-rem, which would be an increase in comparison with the 102 person-rem the worker population would receive each year under the No-Action Alternative. Of this dose, about 100 person-rem would be from normal operations unrelated to TPBAR irradiation. The collective dose to facility workers would result in 0 (0.06) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 10.5 person-rem per year, which would be an increase in comparison with the 7.6 person-rem dose received each year under the No-Action Alternative. A collective dose of about 10.5 person-rem per year equates to 0 (0.04) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.36 millirem, which would be an increase in comparison with the 0.28 millirem that this individual would receive each year under the No-Action Alternative. An annual dose of 0.36 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Based on the analyzed design-basis accidents, the highest dose to the maximally exposed individual would be well below the NRC regulatory limit (25 rem) and the average individual dose to the 50-mile population would be much less than 1 rem. Based on the analyzed beyond-design-basis accidents, the early containment failure accident would represent the highest dose to the maximally exposed individual, with an estimated frequency of about 1 chance in 3 million of the accident occurring per year of operation. The effects of radionuclide releases inherent to reactor operations without TPBARs would dominate the risk of a reactor accident. The analysis of intentional destructive acts indicates that potential consequences would be no worse than those of the most conservative beyond-design-basis accident NNSA analyzed. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Watts Bar operations would be 0 (0.005) for crew, 0 (4×10^{-4}) for members of the public, and 0 (1×10^{-5}) for radiological accidents, along with 0 (0.004) traffic fatality.

Sequoyah

TVA proposes to construct and operate a 500,000-gallon tritiated water tank system to facilitate effluent water management. The impacts from constructing that system would be the same as those for Alternative 2. During normal operations, the reactors could potentially release 15,570 curies of tritium (of which 11,250 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium) to the Tennessee River each year, which would be a decrease in comparison with the 16,560 curies of tritium assumed to be released under the No-Action Alternative. The tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter after leaving the diffusers. Annual radioactive releases to the air could potentially total about 1,757 curies, including about 1,730 curies of tritium, which would be a decrease in comparison with the total 1,867 curies, including 1,840 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation without TPBAR irradiation. TPBAR irradiation would generate about 15 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste that would occur from normal operations if TPBARs were not irradiated. TPBAR irradiation would have no impact on nonradioactive hazardous and nonhazardous waste generation. Irradiation of 1,250 TPBARs in a single reactor would generate from 8 to 12 additional spent nuclear fuel assemblies every 18 months. On an annualized basis, this would increase spent nuclear fuel generation at Sequoyah by 5 to 7 percent in comparison with the No-Action Alternative.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 108 millirem per year, which would be a slight decrease in comparison with the 109 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 108 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 15,400. The total annual workforce dose would be about 132 person-rem, which would be essentially the same as the 132 person-rem the worker population would receive under the No-Action Alternative. The collective dose to facility workers would result in 0 (0.08) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 10.3 person-rem per year, which would be a slight decrease in comparison with the 10.8 person-rem that the population would receive each year under the No-Action Alternative. A collective dose of about 10.3 person-rem per year equates to 0 (0.006) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.23 millirem, which would be a slight decrease in comparison with the 0.24 millirem that this individual would receive each year under the No-Action Alternative. An annual dose of 0.23 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Based on the analyzed design-basis accidents, the highest dose to the maximally exposed individual would be well below the NRC regulatory limit (25 rem) and the average individual dose to the 50-mile population would be much less than 1 rem. Based on the analyzed beyond-design-basis accidents, the early containment failure accident would represent the highest dose to the maximally exposed individual, with an estimated frequency of about 1 chance in 1.5 million of the accident occurring per year of operation. The effects of radionuclide releases inherent to reactor operations without TPBARs would dominate the risk of a reactor accident. The analysis of intentional destructive acts indicates that potential consequences would be no worse than those of the most conservative beyond-design-basis accident NNSA analyzed. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Sequoyah operations would be 0 (0.005) for crew, 0 (5×10^{-4}) for members of the public, and 0 (1×10^{-5}) for accidents, along with 0 (0.005) traffic fatality.

S.8.6 POTENTIAL IMPACTS OF ALTERNATIVE 4

Under Alternative 4, TVA would irradiate up to a total of 5,000 TPBARs every 18 months at Watts Bar (2,500 in each of Watts Bar 1 and 2), which would represent an increase of 4,320 TPBARs at Watts Bar in comparison with the No-Action Alternative. At Sequoyah, no TPBARs would be irradiated under this alternative, which would represent a decrease of 680 TPBARs for each of the Sequoyah reactors in comparison with the No-Action Alternative.

Watts Bar

During normal operations, the two reactors could potentially release about 49,320 curies of tritium (of which 45,000 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium) to the Tennessee River each year, which would be an increase in comparison with the 10,440 curies of tritium assumed to be released under the No-Action Alternative. Tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter within about 140 feet of the diffusers. Annual radioactive releases to the air from Watts Bar could potentially total 5,516 curies, including 5,480 curies of tritium, which would be an increase in comparison with the total release of 1,196 curies, including 1,160 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation without TPBAR irradiation. TPBAR irradiation would generate about 30 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste that would occur from normal operations if TPBARs were not irradiated. TPBAR irradiation would have no impact on nonradioactive hazardous and nonhazardous waste generation. Irradiation of 5,000 TPBARs would generate no more than 82 additional spent nuclear fuel assemblies every 18 months over the No-Action Alternative if TVA irradiated 2,500 TPBARs in each of the Watts Bar reactors. On an annual basis, this would increase spent nuclear fuel generation at Watts Bar by about 48 percent in comparison with the No-Action Alternative. TVA has an infrastructure in place or has a plan at Watts Bar to manage the increased volume of spent nuclear fuel assemblies.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 130.5 millirem per year, which would be an increase in comparison with the 116 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 130.5 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 12,800. The total annual workforce dose would be about 114.7 person-rem, which would be an increase in comparison with the 102 person-rem the worker population would receive each year under the No-Action Alternative. Of this dose, about 100 person-rem would be from normal operations unrelated to TPBAR irradiation. The collective dose to facility workers would result in 0 (0.07) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations with TPBARs would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 29.4 person-rem per year, which would be an increase in comparison with the 7.6 person-rem annual dose under the No-Action Alternative. A collective dose of about 29.4 person-rem per year equates to 0 (0.02) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.86 millirem, which would be an increase in comparison with the 0.28 millirem that individual would receive each year under the No-Action Alternative. An annual dose of 0.86 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Potential impacts from accidents at a reactor would be the same as for Alternative 1 because TVA would not irradiate more than 2,500 TPBARs in any one reactor. The analysis of intentional destructive acts would be the same as for Alternative 1. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Watts Bar operations would be 0 (0.02) for crew, 0 (0.002) for members of the public, and 0 (4×10^{-5}) for radiological accidents, along with 0 (0.008) traffic fatality.

Sequoyah

Under this alternative, no irradiation of TPBARs would take place using the Sequoyah nuclear reactors and the impacts would be the same as discussed for Sequoyah under Alternative 1.

S.8.7 POTENTIAL IMPACTS OF ALTERNATIVE 5

Under Alternative 5, TVA would irradiate up to a total of 5,000 TPBARs every 18 months at Sequoyah (2,500 in each of Sequoyah 1 and 2), which would represent an increase of 3,640 TPBARs at Sequoyah in comparison with the No-Action Alternative. At Watts Bar, no TPBARs would be irradiated under this alternative, which would represent a decrease of 680 TPBARs in comparison with the No-Action Alternative.

Watts Bar

Under this alternative, no irradiation of TPBARs would take place using the Watts Bar nuclear reactors and the impacts would be the same as discussed for Watts Bar under Alternative 2.

Sequoyah

NNSA analyzed irradiation of 5,000 TPBARs every 18 months using both reactors at the Sequoyah site. In addition, TVA proposes to construct and operate a 500,000-gallon tritiated water tank system to facilitate effluent water management. The impacts from constructing that system would be the same as those for Alternative 2.

During normal operations, the Sequoyah reactors could potentially release 49,320 curies of tritium (of which 45,000 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium) to the Tennessee River each year, which would be an increase in comparison with the 16,560 curies of tritium assumed to be released under the No-Action Alternative. The tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter within about 18 feet of the diffusers (the nearest drinking water intake is 10 miles away). Annual radioactive releases to the air from Sequoyah could potentially total about 5,507 curies, including about 5,480 curies of tritium, which would be an increase in comparison with the total 1,867 curies, including 1,840 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation without TPBAR irradiation. TPBAR irradiation would generate about 30 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste that would occur from normal operations if TPBARs were not irradiated. TPBAR irradiation would have no impact on nonradioactive hazardous and nonhazardous waste generation. Operation of the tritiated water tank system would have no impact on the quantities or management of wastes. Irradiation of 5,000 TPBARs would generate no more than 82 additional spent nuclear fuel assemblies every 18 months if TVA irradiated 2,500 TPBARs in each of the Sequoyah reactors. On an annualized basis, this would increase spent nuclear fuel generation at Sequoyah by about 48 percent in comparison with the No-Action Alternative. TVA has an infrastructure in place at Sequoyah to manage the increased volume of spent nuclear fuel assemblies.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 117.4 millirem per year, which would be an increase in comparison with the 109 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 117.4 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 14,200. The total annual workforce dose would be about 142.4 person-rem, which would be an increase in comparison with the 132 person-rem the worker population would receive under the No-Action Alternative. The collective dose to facility workers would result in 0 (0.09) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 28.1 person-rem per year, which would be an increase in comparison with the 10.8 person-rem that the population would receive each year under the No-Action Alternative. A collective dose of about 28.1 person-rem per year equates to 0 (0.02) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.55 millirem, which would be an increase in comparison with the 0.24 millirem that this individual would receive each year under the No-Action Alternative. An annual dose of 0.55 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Potential impacts from accidents at a reactor would be the same as for Alternative 2 because TVA would not irradiate more than 2,500 TPBARs in any one reactor. The analysis of intentional destructive acts would be the same as for Alternative 2. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Sequoyah operations would be 0 (0.02) for crew, 0 (0.004) for members of the public, and 0 (4×10^{-5}) for radiological accidents, along with 0 (0.01) traffic fatalities.

S.8.8 POTENTIAL IMPACTS OF ALTERNATIVE 6

Under Alternative 6, TVA would irradiate up to a total of 5,000 TPBARs every 18 months using both the Watts Bar and Sequoyah sites. Because TVA would irradiate a maximum of 2,500 TPBARs in any one reactor, this could involve the use of one or both reactors at each of the sites. For the analyses in this SEIS, NNSA assumed for Alternative 6 that each site would irradiate 2,500 TPBARs every 18 months. At Watts Bar, this would represent an increase of 1,820 TPBARs in comparison with the No-Action Alternative. At Sequoyah, this would represent an increase of 1,140 TPBARs in comparison with the No-Action Alternative.

Watts Bar

During normal operations, the two reactors could potentially release about 26,820 curies of tritium (of which 22,500 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium) to the Tennessee River each year, which would be an increase in comparison with the 10,440 curies of tritium assumed to be released under the No-Action Alternative. Tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter within about 70 feet of the diffuser. Annual radioactive releases to the air from Watts Bar could potentially total 3,016 curies, including 2,980 curies of tritium, which would be an increase in comparison with the total release of 1,196 curies, including 1,160 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation without TPBAR irradiation. TPBAR irradiation would generate about 15 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste that would occur from normal operations if TPBARs were not irradiated. TPBAR irradiation would have no impact on nonradioactive hazardous and nonhazardous waste generation. Irradiation of 2,500 TPBARs would generate no more than 41 additional spent nuclear fuel assemblies every 18 months over the No-Action Alternative if TVA irradiated all 2,500 TPBARs in a single reactor. On an annual basis, this would increase spent nuclear fuel generation at Watts Bar by about 24 percent in comparison with the No-Action Alternative.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 122 millirem per year, which would be an increase in comparison with the 116 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 122 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 13,700. The total annual workforce dose would be about 107 person-rem, which would be an increase in comparison with the 102 person-rem the worker population would receive each year under the No-Action Alternative. Of this dose, about 100 person-rem would be from normal operations unrelated to TPBAR irradiation. The collective dose to facility workers would result in 0 (0.06) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations with TPBARs would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 16.7 person-rem per year, which would be an increase in comparison with the 7.6 person-rem annual dose under the No-Action Alternative. A collective dose of about 16.7 person-rem per year equates to 0 (0.001) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.52 millirem, which would be an increase in comparison with the 0.28 millirem that individual would receive each year under the

No-Action Alternative. An annual dose of 0.52 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Based on the analyzed design-basis accidents, the highest dose to the maximally exposed individual would be well below the NRC regulatory limit (25 rem) and the average individual dose to the 50-mile population would be much less than 1 rem. Based on the analyzed beyond-design-basis accidents, the early containment failure accident would represent the highest dose to the maximally exposed individual, with an estimated frequency of about 1 chance in 3 million of the accident occurring per year of operation. The effects of radionuclide releases inherent to reactor operations without TPBARs would dominate the risk of a reactor accident. The analysis of intentional destructive acts indicates that potential consequences would be no worse than those of the most conservative beyond-design-basis accident NNSA analyzed. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Watts Bar operations would be 0 (0.01) for crew, 0 (0.001) for members of the public, and 0 (2×10^{-5}) for radiological accidents, along with 0 (0.004) traffic fatality.

Sequoyah

NNSA analyzed irradiation of 2,500 TPBARs every 18 months using one or both reactors at the Sequoyah site. In addition, TVA proposes to construct and operate a 500,000-gallon tritiated water tank system to facilitate effluent water management. The impacts from constructing that system would be the same as those for Alternative 2.

During normal operations, the Sequoyah reactors could potentially release 26,820 curies of tritium (of which 22,500 curies would be from TPBAR irradiation and 4,320 curies would be from non-TPBAR tritium) to the Tennessee River each year, which would be an increase in comparison with the 16,560 curies of tritium assumed to be released under the No-Action Alternative. The tritium concentration in the discharge plume would be below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter after leaving the diffusers. Annual radioactive releases to the air from Sequoyah could potentially total about 3,007 curies, including about 2,980 curies of tritium, which would be an increase in comparison with the total 1,867 curies, including 1,840 curies of tritium, assumed to be released under the No-Action Alternative. Greenhouse gas emissions (7,100 tons of carbon dioxide annually) would be essentially the same as from normal operation without TPBAR irradiation. TPBAR irradiation would generate about 15 cubic feet per year of low-level radioactive waste, which is less than 0.1 percent of the low-level waste that would occur from normal operations if TPBARs were not irradiated. TPBAR irradiation would have no impact on nonradioactive hazardous and nonhazardous waste generation. Operation of the tritiated water tank system would have no impact on the quantities or management of wastes. Irradiation of 2,500 TPBARs would generate no more than 41 additional spent nuclear fuel assemblies every 18 months if all 2,500 TPBARs were irradiated in a single reactor. On an annualized basis, this would increase spent nuclear fuel generation at Sequoyah by about 24 percent in comparison with the No-Action Alternative.

Worker exposure to radiation during normal operations with TPBARs would remain well below the NRC regulatory limit of 5,000 millirem per year, with an average worker dose of about 111 millirem per year, which would be an increase in comparison with the 109 millirem an average worker would receive each year under the No-Action Alternative. Statistically, if a worker received a dose of 111 millirem, the estimated probability of that worker developing a fatal cancer sometime in the future from 1 year of normal operations would be about 1 in 15,000. The total annual workforce dose would be about 135 person-rem, which would be an increase in comparison with the 132 person-rem the worker population would receive under the No-Action Alternative. The collective dose to facility workers would result in 0 (0.08) latent cancer fatality per year of normal operation.

Radiation exposure of the public from normal operations would also remain well within the NRC regulatory limit of 25 millirem per year. The total annual dose to the population within 50 miles during normal operations would be about 16.2 person-rem per year, which would be an increase in comparison with the 10.8 person-rem that the population would receive each year under the No-Action Alternative. A collective dose of about 16.2 person-rem per year equates to 0 (0.01) latent cancer fatality per year of normal operation. The annual dose to the maximally exposed offsite individual would be about 0.33 millirem, which would be an increase in comparison with the 0.24 millirem that this individual would receive each year under the No-Action Alternative. An annual dose of 0.33 millirem would be less than 1 percent of the average annual dose of 620 millirem that an individual receives from natural and man-made radiation.

Based on the analyzed design-basis accidents, the highest dose to the maximally exposed individual would be well below the NRC regulatory limit (25 rem) and the average individual dose to the 50-mile population would be much less than 1 rem. Based on the analyzed beyond-design-basis accidents, the early containment failure accident would represent the highest dose to the maximally exposed individual, with an estimated frequency of about 1 chance in 1.5 million of the accident occurring per year of operation. The effects of radionuclide releases inherent to reactor operations without TPBARs would dominate the risk of a reactor accident. The analysis of intentional destructive acts indicates that potential consequences would be no worse than those of the most conservative beyond-design-basis accident NNSA analyzed. Under normal or accident conditions, within the same 50-mile radius, there would be no disproportionately high and adverse consequences to minority or low-income populations. In addition, no unique exposure pathways that could increase doses were identified.

For transportation impacts, over the life of the project (until 2035), the estimated numbers of latent cancer fatalities from Sequoyah operations would be 0 (0.01) for crew, 0 (0.002) for members of the public, and 0 (2×10^{-5}) for accidents, along with 0 (0.005) traffic fatality.

S.8.9 DIFFERENCES IN IMPACTS FROM 1999 EIS

The 1999 EIS analyzed the potential environmental impacts from irradiation of a maximum of 3,400 TPBARs in any one of the Watts Bar and Sequoyah reactors, assuming a tritium permeation rate of 1 curie per TPBAR per year. This was assumed to result in an annual release of a total of 3,400 curies of tritium per reactor to the air and water surrounding the Watts Bar and Sequoyah reactors. This SEIS analyzes the potential environmental impacts from irradiation of 2,500 to 5,000 TPBARs in the Watts Bar and Sequoyah reactors, assuming a high and thus conservative tritium permeation rate of 10 curies per TPBAR per year, which is more than double the tritium permeation rate that has been observed at Watts Bar 1. This is assumed to result in a maximum annual release of a total of 25,000 to 50,000 curies of tritium to the air and water surrounding the Watts Bar and Sequoyah reactors. Both the 1999 EIS and this SEIS demonstrate that the potential environmental impacts from irradiation of TPBARs (whether 3,400, 2,500, or 5,000) in the Watts Bar and Sequoyah reactors would be small, regardless of whether the permeation rate is 1 curie or 10 curies of tritium per TPBAR per year. While the resultant potential impacts are small in either case, the differences between the two analyses are described below.

Water Resources

The 1999 EIS estimated TVA would release a maximum of 3,060 curies of tritium from TPBAR irradiation each year to the Tennessee River from any reactor as a result of TPBAR irradiation. This SEIS estimates a maximum potential release to the river of 26,820 curies of tritium each year for irradiation of 2,500 TPBARs and 49,320 curies of tritium each year for irradiation of 5,000 TPBARs.

These totals include both non-TPBAR tritium releases and those attributed solely to TPBAR irradiation. The results indicate that tritium concentrations at any drinking water intake would remain well below the maximum permissible EPA drinking water limit of 20,000 picocuries per liter. As discussed in Sections 4.1.5 and 4.2.5 of this SEIS, the average tritium concentration at any drinking water intake would be no more than about one-tenth of the limit of 20,000 picocurie per liter.

Air Resources

The 1999 EIS estimated a reactor would release a maximum of 340 curies of tritium from TPBAR irradiation each year to the air. This SEIS estimates maximum potential releases to the air of 2,500 curies of tritium each year for irradiation of 2,500 TPBARs and 5,000 curies of tritium each year for irradiation of 5,000 TPBARs. There are no explicit regulatory limits for tritium releases to the air[9]; however, tritium releases to the air are considered in human health radiation doses, which are regulated, as discussed below.

Human Health

The 1999 EIS estimated the dose to the maximally exposed individual would be 0.34 millirem per year at Watts Bar and 0.11 millirem per year at Sequoyah. For the analyzed tritium production alternatives, this SEIS conservatively estimates that the highest doses to the maximally exposed individual would be 0.52 millirem per year at Watts Bar and 0.33 millirem per year at Sequoyah for irradiation of 2,500 TPBARs and 0.86 millirem per year at Watts Bar and 0.55 millirem per year at Sequoyah for irradiation of 5,000 TPBARs. The results indicate that potential exposure of the public to radiation from normal operations would remain well within the NRC regulatory limit of 25 millirem per year. The 1999 EIS estimated the average annual dose to workers would increase by a maximum of about 1.1 millirem per year as a result of TPBAR irradiation (see Table 5-5 of the 1999 EIS). This SEIS estimates the average annual dose to workers would increase by no more than about 8.3 millirem per year for irradiation of 2,500 TPBARs (see Tables 4-8 and 4-23 of the SEIS) and by no more than about 16.5 millirem per year for irradiation of 5,000 TPBARs (Sections 4.1.11.5 and 4.2.11.6). In all cases, worker exposure to radiation would remain well below the NRC regulatory limit of 5,000 millirem per year.

Spent Nuclear Fuel Generation

The 1999 EIS estimated TPBAR irradiation would generate a maximum of 60 additional spent nuclear fuel assemblies every 18 months for irradiation of 3,400 TPBARs in a single reactor. This SEIS estimates a maximum of 41 additional spent nuclear fuel assemblies every 18 months for irradiation of 2,500 TPBARs in a single reactor and 82 additional spent nuclear fuel assemblies every 18 months for irradiation of 5,000 TPBARs at one site. Both Watts Bar and Sequoyah have infrastructure in place or a plan to manage the increased spent nuclear fuel assemblies.

Accidents and Intentional Destructive Acts

This SEIS confirms that TPBAR irradiation would not substantially affect the types of accidents that could potentially occur or the potential impacts from those accidents. The 1999 EIS did not analyze intentional destructive acts. NNSA estimates through the analysis in this SEIS that the potential consequences of such acts would be no worse than those of the most conservative beyond-design-basis accident NNSA analyzed. Tritium releases from TPBAR irradiation in a beyond-design-basis accident or intentional destructive act would be an extremely small contributor to the consequences of such events.

9. See also Section 8.2.2. The National Emission Standards for Hazardous Air Pollutants for radionuclides (40 CFR Part 61, Subparts H and I) are not applicable to NRC-licensed facilities such as TVA reactors. As cited in an EPA Final Rule (60 FR 46206), compliance with NRC regulations constitutes compliance with 40 CFR Part 61, Subparts H and I.

S.8.10 CUMULATIVE IMPACTS

Based on the analysis in Chapter 4 of this SEIS, the cumulative impact analysis focused on the resources with the greatest potential to experience meaningful effects from the irradiation of TPBARs. These resource areas include human health, biological resources, and air and water quality, which have the potential to be impacted by releases of radiological materials into the environment. As discussed in Chapter 5, this SEIS concludes that the potential proposed action, when considered along with other nearby current and reasonably foreseeable activities, would not have any cumulatively significant environmental impact.

S.8.11 MITIGATION MEASURES

To mitigate potential impacts from tritium releases, TVA proposes to construct and operate a 500,000-gallon tritiated water tank system at Sequoyah in the event of a decision to irradiate TPBARs at that site or to facilitate routine tritium management (see Section 2.4.2). Such a system would be the same as the system that TVA is currently building at the Watts Bar site (see Section 1.6). TVA would use the Watts Bar and Sequoyah tank systems to store tritiated water after it passed through the liquid radioactive waste processing system. TVA would release the stored tritiated water to the Tennessee River by the existing pathways. The tank systems that TVA would potentially have in place at both the Watts Bar and Sequoyah sites would have sufficient capacity to store and release the water at appropriate times (that is, TVA will release the water from the tank during times of higher river flows for better dilution), and it will enable TVA to minimize the potential impacts of tritiated water releases. The systems would enable TVA to plan fewer releases each year and to ensure that site effluents would continue to remain well below regulatory concentration limits.

S.9 Preferred Alternative

Council on Environmental Quality regulations require that an agency identify its Preferred Alternative(s), if one or more exists, in a draft EIS or SEIS [40 CFR 1502.14(e)]. The Preferred Alternative is the alternative the agency believes would fulfill its statutory mission, giving consideration to environmental, economic, technical, and other factors. NNSA has identified the irradiation of up to 2,500 TPBARs every 18 months at the Watts Bar site (Alternative 1) as the Preferred Alternative for this SEIS. Alternative 1 is preferred because TPBAR irradiation operations could be conducted entirely at the site at which tritium irradiation operations currently occurs, and potentially in the one reactor that has successfully supported NNSA's tritium production program.

Table S-2. Comparison of impacts of alternatives.

Alternative	**Current conditions**		**No-Action Alternative**		**Alternative 1**	**Alternative 2**	**Alternative 3**		**Alternative 4**	**Alternative 5**	**Alternative 6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor units	1[a]	1 and 2	1[a]	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs irradiated per site every 18 months	240 to 544	0	680	680 per reactor (total 1,360)	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	544	0	2,040		2,500	2,500	2,500		5,000	5,000	5,000	
Resource	**Environmental impacts**											
Land use	Occupies about 1,000 acres.	Occupies 525 acres.	Occupies about 1,000 acres.	Occupies 525 acres.	No change compared with No-Action Alternative.	Less than 1 acre disturbed at one time for tritiated water tank system.	No change compared with No-Action Alternative.	Less than 1 acre disturbed at one time for tritiated water tank system.	No change compared with No-Action Alternative.	Less than 1 acre disturbed at one time for tritiated water tank system.	No change compared with No-Action Alternative.	Less than 1 acre disturbed at one time for tritiated water tank system.
Aesthetics and noise	Rural setting.	Rural setting.	Rural setting.	Rural setting.	No change.	No change.	No change.	No change.	No change.	No change.	No change.	No change.
Air resources[b]	*Radioactive releases in 2010 in curies:* Tritium: 25 Other: 18 Total: 43 Greenhouse gas emissions: 3,200 tons of carbon dioxide per year.	*Radioactive releases in 2010 in curies:* Tritium: 89[c] Other: 27 Total: 116 Greenhouse gas emissions: 7,100 tons of carbon dioxide per year.	*Annual radioactive releases in curies:* Tritium: 1,160 Other: 36 Total: 1,196 Greenhouse gas emissions would increase to 7,100 tons of carbon dioxide per year once Watts Bar 2 becomes operational.	*Annual radioactive releases in curies:* Tritium: 1,840 Other: 27 Total: 1,867 Greenhouse gas emissions would be essentially the same as from reactor operations without TPBARs.	*Annual radioactive releases in curies:* Tritium: 2,980 Other: 36 Total: 3,016 Greenhouse gas emissions would be essentially the same as No Action Alternative.	*Annual radioactive releases in curies:* Tritium: 2,980 Other: 27 Total: 3,007 Greenhouse gas emissions would be essentially the same as No Action Alternative.	*Annual radioactive releases in curies:* Tritium: 1,730 Other: 36 Total: 1,766 Greenhouse gas emissions would be essentially the same as No Action Alternative.	*Annual radioactive releases in curies:* Tritium: 1,730 Other: 27 Total: 1,757 Greenhouse gas emissions would be essentially the same as No Action Alternative.	*Annual radioactive releases in curies:* Tritium: 5,480 Other: 36 Total: 5,516 Greenhouse gas emissions would be essentially the same as No Action Alternative.	*Annual radioactive releases in curies:* Tritium: 5,480 Other: 27 Total: 5,507 Greenhouse gas emissions would be essentially the same as No Action Alternative.	*Annual radioactive releases in curies:* Tritium: 2,980 Other: 36 Total: 3,016 Greenhouse gas emissions would be essentially the same as No Action Alternative.	*Annual radioactive releases in curies:* Tritium: 2,980 Other: 27 Total: 3,007 Greenhouse gas emissions would be essentially the same as No Action Alternative.
Geology and soils	Typical of Eastern Tennessee.	Typical of Eastern Tennessee.	Typical of Eastern Tennessee.	Typical of Eastern Tennessee.	No change.	No change.	No change.	No change.	No change.	No change.	No change.	No change.

Table 2-5. Comparison of impacts of alternatives (continued).

Alternative	**Current conditions**		**No-Action Alternative**		**Alternative 1**	**Alternative 2**	**Alternative 3**		**Alternative 4**	**Alternative 5**	**Alternative 6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor units	1[a]	1 and 2	1[a]	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs irradiated per site every 18 months	240 to 544	0	680	680 per reactor (total 1,360)	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	544	0	2,040		2,500	2,500	2,500		5,000	5,000	5,000	
Resource	**Environmental impacts**											
Water resources	605-2,070 curies of tritium released to Tennessee River per year (see Table 3-9). Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) soon after leaving the diffuser.	1,270–2,190 curies of tritium[c] released to Tennessee River per year (see Table 3-33). Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) after the diffusers.	10,440 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) within about 30 feet of the diffusers.	16,560 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) after the diffusers.	26,820 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) within about 70 feet of the diffusers.	26,820 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) after leaving the diffusers.	15,570 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) within about 30 feet of the diffusers.	15,570 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) after leaving the diffusers.	49,320 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) within about 140 feet of the diffusers.	49,320 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) within about 18 feet of the diffusers.	26,820 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) within about 70 feet of the diffusers.	26,820 curies of tritium released to Tennessee River per year. Tritium concentration in the discharge plume would be below the EPA drinking water limit (20,000 picocuries per liter) after leaving the diffusers.
Biological resources	Typical of Eastern Tennessee.	Typical of Eastern Tennessee.	Typical of Eastern Tennessee.	Typical of Eastern Tennessee.	No change.	No change.	No change.	No change.	No change.	No change.	No change.	No change.
Cultural resources	No major resources.	No major resources.	No major resources.	No major resources.	No change.	No change.	No change.	No change.	No change.	No change.	No change.	No change.
Infrastructure	In place, supports demands.	In place, supports demands.	No change.	No change.	No change.	No change.	No change.	No change.	No change.	No change.	No change.	No change.

Table 2-5. Comparison of impacts of alternatives (continued).

Alternative	**Current conditions**		**No-Action Alternative**		**Alternative 1**	**Alternative 2**	**Alternative 3**		**Alternative 4**	**Alternative 5**	**Alternative 6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor units	1[a]	1 and 2	1[a]	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs irradiated per site every 18 months	240 to 544	0	680	680 per reactor (total 1,360)	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	544	0	2,040		2,500	2,500	2,500		5,000	5,000	5,000	
Resource	**Environmental impacts**											
Socio-economics	Workforce of about 572 people.	Workforce of about 1,150 people.	Workforce would increase to about 1,150 once Watts Bar 2 becomes operational.	Operational workforce for tritium production requires up to 20 additional workers compared with operations without tritium production.	No change in operational workforce compared with No-Action Alternative.	Construction workforce of about 100 people for tritiated water tank system. No change in operational workforce.	No change in operational workforce compared with No-Action Alternative.	Construction workforce of about 100 people for tritiated water tank system. No change in operational workforce.	Operational workforce for tritium production in 2 reactors requires up to 20 additional workers compared with operations without tritium production.	Operational workforce for tritium production in 2 reactors requires up to 20 additional workers compared with operations without tritium production.	No change in operational workforce compared with No-Action Alternative.	Construction workforce of about 100 people for tritiated water tank system. No change in operational workforce.

Table 2-5. Comparison of impacts of alternatives (continued).

Alternative	**Current conditions**		**No-Action Alternative**		**Alternative 1**	**Alternative 2**	**Alternative 3**		**Alternative 4**	**Alternative 5**	**Alternative 6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor units	1[a]	1 and 2	1[a]	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs irradiated per site every 18 months	240 to 544	0	680	680 per reactor (total 1,360)	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	544	0	2,040		2,500	2,500	2,500		5,000	5,000	5,000	
Resource	**Environmental impacts**											
Waste management	Annual wastes: Hazardous: 9,059 pounds Nonhazardous solid: 1,882 tons LLW: 11,060 cubic feet	Annual wastes: Hazardous: 1,063 pounds Nonhazardous solid: 778 tons LLW: 4,697 cubic feet	Wastes would double once Watts Bar 2 becomes operational. TPBAR irradiation at Watts Bar 1 generates about 15 cubic feet per year of LLW, which is less than 0.1 percent of the total LLW generated from Watts Bar operations. TPBAR irradiation has no impact on hazardous waste and nonhazardous waste generation.	TPBAR irradiation would generate about 15 cubic feet per year of LLW, which is less than 0.1 percent of the total LLW generated from Sequoyah operations. TPBAR irradiation would have no impact on hazardous waste and nonhazardous waste generation.	No change compared with No-Action Alternative.	No change compared with No-Action Alternative. Operation of the tritiated water tank system would have no impact on the quantity of wastes generated or the management of wastes.	No change compared with No-Action Alternative.	No change compared with No-Action Alternative. Operation of the tritiated water tank system would have no impact on the quantity of wastes generated or the management of wastes.	TPBAR irradiation at Watts Bar 1 and 2 would generate about 30 cubic feet per year of LLW, which is less than 0.1 percent of the total LLW generated from Watts Bar operations. TPBAR irradiation has no impact on hazardous waste and nonhazardous waste generation.	TPBAR irradiation at Sequoyah 1 and 2 would generate about 30 cubic feet per year of LLW, which is less than 0.1 percent of the total LLW generated from Sequoyah operations. TPBAR irradiation has no impact on hazardous waste and nonhazardous waste generation.	No change compared with No-Action Alternative.	No change compared with No-Action Alternative. Operation of the tritiated water tank system would have no impact on the quantity of wastes generated or the management of wastes.

Table 2-5. Comparison of impacts of alternatives (continued).

Alternative	**Current conditions**		**No-Action Alternative**		**Alternative 1**	**Alternative 2**	**Alternative 3**		**Alternative 4**	**Alternative 5**	**Alternative 6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor units	1[a]	1 and 2	1[a]	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs irradiated per site every 18 months	240 to 544	0	680	680 per reactor (total 1,360)	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	544	0	2,040		2,500	2,500	2,500		5,000	5,000	5,000	
Resource	**Environmental impacts**											
Spent nuclear fuel generation	Watts Bar 1 generates spent nuclear fuel at a rate of about 59 fuel assemblies each year, including about 3 spent nuclear fuel assemblies associated with TPBAR irradiation at Watts Bar 1.	Sequoyah generates spent nuclear fuel at a rate of about 107 fuel assemblies each year.	Watts Bar would generate spent nuclear fuel at a rate of about 115 fuel assemblies each year once Watts Bar 2 becomes operational. This would include about 3 spent nuclear fuel assemblies associated with TPBAR irradiation at Watts Bar 1.	Sequoyah would generate spent nuclear fuel at a rate of about 113 fuel assemblies each year. This would include about 6 spent nuclear fuel assemblies associated with TPBAR irradiation at Sequoyah 1 and 2	Irradiation of 2,500 TPBARs would generate no more than 41 additional spent nuclear fuel assemblies every 18 months, assuming all 2,500 TPBARs were irradiated in a single reactor. This could increase annual spent nuclear fuel generation at Watts Bar by about 24 percent.	Irradiation of 2,500 TPBARs would generate no more than 41 additional spent nuclear fuel assemblies every 18 months, assuming all 2,500 TPBARs were irradiated in a single reactor. This could increase annual spent nuclear fuel generation at Sequoyah by about 24 percent.	Irradiation of 1,250 TPBARs would generate 8 to 12 additional spent nuclear fuel assemblies every 18 months. This could increase annual spent nuclear fuel generation at Watts Bar by about 5 to 7 percent.	Irradiation of 1,250 TPBARs in a single reactor would generate 8 to 12 additional spent nuclear fuel assemblies every 18 months. This could increase annual spent nuclear fuel generation at Sequoyah by about 5 to 7 percent.	Irradiation of 5,000 TPBARs would generate no more than 82 additional spent nuclear fuel assemblies every 18 months. This could increase annual spent nuclear fuel generation at Watts Bar by about 48 percent.	Irradiation of 5,000 TPBARs would generate no more than 82 additional spent nuclear fuel assemblies every 18 months. This could increase annual spent nuclear fuel generation at Sequoyah by about 48 percent.	Irradiation of 2,500 TPBARs would generate no more than 41 additional spent nuclear fuel assemblies every 18 months, assuming all 2,500 TPBARs were irradiated in a single reactor. This could increase annual spent nuclear fuel generation at Watts Bar by about 24 percent.	Irradiation of 2,500 TPBARs would generate no more than 41 additional spent nuclear fuel assemblies every 18 months, assuming all 2,500 TPBARs were irradiated in a single reactor. This could increase annual spent nuclear fuel generation at Sequoyah by about 24 percent.

Table 2-5. Comparison of impacts of alternatives (continued).

Alternative	**Current conditions**		**No-Action Alternative**		**Alternative 1**	**Alternative 2**	**Alternative 3**		**Alternative 4**	**Alternative 5**	**Alternative 6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor units	1[a]	1 and 2	1[a]	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs irradiated per site every 18 months	240 to 544	0	680	680 per reactor (total 1,360)	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	544	0	2,040		2,500	2,500	2,500		5,000	5,000	5,000	
Resource	**Environmental impacts**											
Human health and safety (normal operations)	*Maximally exposed individual:* Dose: 0.28 millirem Risk of LCF: 2×10^{-7} *Population:* Dose: 1.29 person-rem LCFs: 0 (0.0008) *Total worker:* Dose: 101 person-rem LCFs: 0 (0.06)	*Maximally exposed individual:* Dose: 0.18 millirem Risk of LCF: 1×10^{-7} *Population:* Dose: 2.54 person-rem LCFs: 0 (0.002) *Total worker:* Dose: 128 person-rem LCFs: 0 (0.08)	*Maximally exposed individual:* Dose: 0.28 millirem Risk of LCF: 2×10^{-7} *Population:* Dose: 7.6 person-rem LCFs: 0 (0.005) *Total worker:* Dose: 102.2 person-rem LCFs: 0 (0.06)	*Maximally exposed individual:* Dose: 0.24 millirem Risk of LCF: 1×10^{-7} *Population:* Dose: 10.8 person-rem LCFs: 0 (0.006) *Total worker:* Dose: 131.9 person-rem LCFs: 0 (0.08)	*Maximally exposed individual:* Dose: 0.52 millirem Risk of LCF: 3×10^{-7} *Population:* Dose: 16.7 person-rem LCFs: 0 (0.01 *Total worker:* Dose: 107.4 person-rem LCFs: 0 (0.06)	*Maximally exposed individual:* Dose: 0.33 millirem Risk of LCF: 2×10^{-7} *Population:* Dose: 16.2 person-rem LCFs: 0 (0.01) *Total worker:* Dose: 135.2 person-rem LCFs: 0 (0.08)	*Maximally exposed individual:* Dose: 0.36 millirem Risk of LCF: 2×10^{-7} *Population:* Dose: 10.5 person-rem LCFs: 0 (0.006) *Total worker:* Dose: 103.8 person-rem LCFs: 0 (0.06)	*Maximally exposed individual:* Dose: 0.23 millirem Risk of LCF: 1×10^{-7} *Population:* Dose: 10.3 person-rem LCFs: 0 (0.006) *Total worker:* Dose: 131.6 person-rem LCFs: 0 (0.08)	*Maximally exposed individual:* Dose: 0.86 millirem Risk of LCF: 5×10^{-7} *Population:* Dose: 29.4 person-rem LCFs: 0 (0.02) *Total worker:* Dose: 114.7 person-rem LCFs: 0 (0.07)	*Maximally exposed individual:* Dose: 0.55 millirem Risk of LCF: 3×10^{-7} *Population:* Dose: 28.1 person-rem LCFs: 0 (0.02) *Total worker:* Dose: 142.4 person-rem LCFs: 0 (0.09)	*Maximally exposed individual:* Dose: 0.52 millirem Risk of LCF: 3×10^{-7} *Population:* Dose: 16.7 person-rem LCFs: 0 (0.01) *Total worker:* Dose: 107.4 person-rem LCFs: 0 (0.06)	*Maximally exposed individual:* Dose: 0.33 millirem Risk of LCF: 2×10^{-7} *Population:* Dose: 16.2 person-rem LCFs: 0 (0.01) *Total worker:* Dose: 135.2 person-rem LCFs: 0 (0.08)
Design-basis accident (reactor)	*Maximally exposed individual:* Dose: 9.5×10^{-3} rem *Population:* Dose: 8.7 person-rem *Average Individual* Dose: 7.2×10^{-6} rem	*Maximally exposed individual:* Dose: 9.5×10^{-3} rem *Population:* Dose: 15.4 person-rem *Average Individual* Dose: 1.5×10^{-5} rem	*Maximally exposed individual:* Dose: 9.5×10^{-3} rem *Population:* Dose: 10.5 person-rem *Average Individual* Dose: 7.2×10^{-6} rem	*Maximally exposed individual:* Dose: 1.3×10^{-3} rem *Population:* Dose: 20 person-rem *Average Individual* Dose: 1.5×10^{-5} rem	*Maximally exposed individual:* Dose: 3.4×10^{-3} rem *Population:* Dose: 40 person-rem *Average Individual* Dose: 2.8×10^{-5} rem	*Maximally exposed individual:* Dose: 4.8×10^{-3} rem *Population:* Dose: 70 person-rem *Average Individual* Dose: 5.4×10^{-5}rem	*Maximally exposed individual:* Dose: 1.8×10^{-3} rem *Population:* Dose: 20 person-rem *Average Individual* Dose: 1.4×10^{-5} rem	*Maximally exposed individual:* Dose: 2.4×10^{-3} rem *Population:* Dose: 36 person-rem *Average Individual* Dose: 2.7×10^{-5} rem	*Maximally exposed individual:* Dose: 3.4×10^{-3} rem *Population:* Dose: 40 person-rem *Average Individual* Dose: 2.8×10^{-5} rem	*Maximally exposed individual:* Dose: 4.8×10^{-3} rem *Population:* Dose: 70 person-rem *Average Individual* Dose: 5.4×10^{-5}rem	*Maximally exposed individual:* Dose: 3.4×10^{-3} rem *Population:* Dose: 40 person-rem *Average Individual* Dose: 2.8×10^{-5} rem	*Maximally exposed individual:* Dose: 4.8×10^{-3} rem *Population:* Dose: 70 person-rem *Average Individual* Dose: 5.4×10^{-5}rem

Table 2-5. Comparison of impacts of alternatives (continued).

Alternative	**Current conditions**		**No-Action Alternative**		**Alternative 1**	**Alternative 2**	**Alternative 3**		**Alternative 4**	**Alternative 5**	**Alternative 6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor units	1[a]	1 and 2	1[a]	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs irradiated per site every 18 months	240 to 544	0	680	680 per reactor (total 1,360)	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	544	0	2,040		2,500	2,500	2,500		5,000	5,000	5,000	
Resource	**Environmental impacts**											
Design-basis accident (nonreactor)	*Maximally exposed individual:* Dose: 4.4×10^{-2} rem *Population:* Dose: 650 person-rem *Average individual:* Dose: 5.4×10^{-4} rem	*Maximally exposed individual:* Dose: 1.1×10^{-2} rem *Population:* Dose: 850 person-rem *Average individual:* Dose: 8.5×10^{-4} rem	*Maximally exposed individual:* Dose: 4.4×10^{-2} rem *Population:* Dose: 780 person-rem *Average individual:* Dose: 5.4×10^{-4} rem	*Maximally exposed individual:* Dose: 1.1×10^{-2} rem *Population:* Dose: 1,100 person-rem *Average individual:* Dose: 8.5×10^{-4} rem	*Maximally exposed individual:* Dose: 0.16 rem *Population:* Dose: 2,900 person-rem *Average individual:* Dose: 2.0×10^{-3} rem	*Maximally exposed individual:* Dose: 4.0×10^{-2} rem *Population:* Dose: 4,000 person-rem *Average individual:* Dose: 3.1×10^{-3} rem	*Maximally exposed individual:* Dose: 8.4×10^{-2} rem *Population:* Dose: 1,400 person-rem *Average individual:* Dose: 9.6×10^{-4} rem	*Maximally exposed individual:* Dose: 2.0×10^{-2} rem *Population:* Dose: 1,900 person-rem *Average individual:* Dose: 1.5×10^{-3} rem	*Maximally exposed individual:* Dose: 1.6×10^{-1} rem *Population:* Dose: 2,900 person-rem *Average individual:* Dose: 2.0×10^{-3} rem	*Maximally exposed individual:* Dose: 4.0×10^{-2} rem *Population:* Dose: 4,000 person-rem *Average individual:* Dose: 3.1×10^{-3} rem	*Maximally exposed individual:* Dose: 0.16 rem *Population:* Dose: 2,900 person-rem *Average individual:* Dose: 2.0×10^{-3} rem	*Maximally exposed individual:* Dose: 4.0×10^{-2} rem *Population:* Dose: 4,000 person-rem *Average individual:* Dose: 3.1×10^{-3} rem
Beyond-design-basis accident	*Maximally exposed individual:* Dose: 19.7 rem *Population:* Dose: 4.2×10^{5} person-rem *Average Individual:* Dose risk: 4×10^{-7} rem/yr	*Maximally exposed individual:* Dose: 25 rem *Population:* Dose: 7.1×10^{5} person-rem *Average Individual:* Dose risk: 1×10^{-6} rem/yr	*Maximally exposed individual:* Dose: 19.7 rem *Population:* Dose: 5.1×10^{5} person-rem *Average Individual:* Dose risk: 5×10^{-7} rem/yr	*Maximally exposed individual:* Dose: 25 rem *Population:* Dose: 9.2×10^{5} person-rem *Average Individual:* Dose risk: 1×10^{-6} rem/yr	*Maximally exposed individual:* Dose: 19.7 rem *Population:* Dose: 5.1×10^{5} person-rem *Average Individual:* Dose risk: 5×10^{-7} rem/yr	*Maximally exposed individual:* Dose: 25 rem *Population:* Dose: 9.2×10^{5} person-rem *Average Individual:* Dose risk: 1×10^{-6} rem/yr	*Maximally exposed individual:* Dose: 19.7 rem *Population:* Dose: 5.1×10^{5} person-rem *Average Individual:* Dose risk: 5×10^{-7} rem/yr	*Maximally exposed individual:* Dose: 25 rem *Population:* Dose: 9.2×10^{5} person-rem *Average Individual:* Dose risk: 1×10^{-6} rem/yr	*Maximally exposed individual:* Dose: 19.7 rem *Population:* Dose: 5.1×10^{5} person-rem *Average Individual:* Dose risk: 5×10^{-7} rem/yr	*Maximally exposed individual:* Dose: 25 rem *Population:* Dose: 9.2×10^{5} person-rem *Average Individual:* Dose risk: 1×10^{-6} rem/yr	*Maximally exposed individual:* Dose: 19.7 rem *Population:* Dose: 5.1×10^{5} person-rem *Average Individual:* Dose risk: 5×10^{-7} rem/yr	*Maximally exposed individual:* Dose: 25 rem *Population:* Dose: 9.2×10^{5} person-rem *Average Individual:* Dose risk: 1×10^{-6} rem/yr

Table 2-5. Comparison of impacts of alternatives (continued).

Alternative	**Current conditions**		**No-Action Alternative**		**Alternative 1**	**Alternative 2**	**Alternative 3**		**Alternative 4**	**Alternative 5**	**Alternative 6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor units	1[a]	1 and 2	1[a]	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs irradiated per site every 18 months	240 to 544	0	680	680 per reactor (total 1,360)	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	544	0	2,040		2,500	2,500	2,500		5,000	5,000	5,000	
Resource	**Environmental impacts**											
Trans-portation[d]	Crew LCFs: 0 (0.003) Public LCFs: 0 (3×10^{-4}) Radiological accident LCFs: 0 (5×10^{-6}) Traffic fatalities: 0 (0.004)	Crew LCFs: 0 (0.005) Public LCFs: 0 (6×10^{-4}) Radiological accident LCFs: 0 (1×10^{-5}) Traffic fatalities: 0 (0.005)	Crew LCFs: 0 (0.003) Public LCFs: 0 (3×10^{-4}) Radiological accident LCFs: 0 (5×10^{-6}) Traffic fatalities: 0 (0.004)	Crew LCFs: 0 (0.005) Public LCFs: 0 (6×10^{-4}) Radiological accident LCFs: 0 (1×10^{-5}) Traffic fatalities: 0 (0.005)	Crew LCFs: 0 (0.01) Public LCFs: 0 (0.001) Radiological accident LCFs: 0 (2×10^{-5}) Traffic fatalities: 0 (0.004)	Crew LCFs: 0 (0.01) Public LCFs: 0 (0.002) Radiological accident LCFs: 0 (2×10^{-5}) Traffic fatalities: 0 (0.005)	Crew LCFs: 0 (0.005) Public LCFs: 0 (4×10^{-4}) Radiological accident LCFs: 0 (1×10^{-5}) Traffic fatalities: 0 (0.004)	Crew LCFs: 0 (0.005) Public LCFs: 0 (5×10^{-4}) Radiological accident LCFs: 0 (1×10^{-5}) Traffic fatalities: 0 (0.005)	Crew LCFs: 0 (0.02) Public LCFs: 0 (0.002) Radiological accident LCFs: 0 (4×10^{-5}) Traffic fatalities: 0 (0.008)	Crew LCFs: 0 (0.02) Public LCFs: 0 (0.004) Radiological accident LCFs: 0 (4×10^{-5}) Traffic fatalities: 0 (0.01)	Crew LCFs: 0 (0.01) Public LCFs: 0 (0.001) Radiological accident LCFs: 0 (2×10^{-5}) Traffic fatalities: 0 (0.004)	Crew LCFs: 0 (0.01) Public LCFs: 0 (0.002) Radiological accident LCFs: 0 (2×10^{-5}) Traffic fatalities: 0 (0.005)
Intentional destructive acts	NRC safety and security studies show that radiological release affecting public health and safety is unlikely from a terrorist attack.	NRC safety and security studies show that radiological release affecting public health and safety is unlikely from a terrorist attack.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.	Consequences no worse than those of most conservative beyond-design-basis accident analyzed.

Table 2-5. Comparison of impacts of alternatives (continued).

Alternative	**Current conditions**		**No-Action Alternative**		**Alternative 1**	**Alternative 2**	**Alternative 3**		**Alternative 4**	**Alternative 5**	**Alternative 6**	
Site	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah	Watts Bar	Sequoyah
Reactor units	1[a]	1 and 2	1[a]	1 and 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and/or 2	1 and 2	1 and 2	1 and/or 2	1 and/or 2
Number of TPBARs irradiated per site every 18 months	240 to 544	0	680	680 per reactor (total 1,360)	2,500	2,500	1,250	1,250	5,000	5,000	2,500	2,500
Maximum TPBARs irradiated every 18 months for alternative	544	0	2,040		2,500	2,500	2,500		5,000	5,000	5,000	
Resource	**Environmental impacts**											
Environ-mental justice	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.	No disproportion-ately high and adverse consequences to minority or low-income populations.

LLW = low-level radioactive waste; LCF = latent cancer fatality; N/A = not applicable; yr = year.

a. Watts Bar 1 is the only reactor at the Watts Bar site that would irradiate TPBARs under current conditions and the No-Action Alternative. However, the No-Action Alternative also includes the operation of Watts Bar 2 (without TPBARs) while the current conditions do not reflect Watts Bar 2 operation.

b. The annual radioactive releases from current conditions are based on actual measured values using 2010 data. The tritium releases for the alternatives are based on an assumed high and thus conservative permeation rate of 10 curies of tritium per TPBAR per year, with 10 percent released to the air. For Watts Bar, the “other” radiological releases are assumed to increase from 18 curies per year (current conditions) to 36 curies per year (for the alternatives) because Watts Bar 2 is assumed to become operational, which would double the “other” radiological releases.

c. Tritium is produced in all U.S. commercial nuclear reactors from fission of uranium in the reactor fuel and neutron activation of boron in burnable absorber rods.

d. The values presented for transportation are not annualized; instead they reflect the total impacts expected over the entire period evaluated in this SEIS (that is, until 2035).

S.10 References

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